

# Interview with Edward O. Thorp

## Putting the Cards on the Table: A Talk with Edward O. Thorp, PhD

University professor, Vegas gambler, financial innovator, and “godfather of the quants”: Edward O. Thorp has managed to combine several careers into one. By applying his background in mathematics to the real-world challenges of gambling, Dr. Thorp devised a proven method for winning at blackjack in the casinos of Las Vegas using an innovative method of counting cards. The next step was to take his game to, in Dr. Thorp’s words, “the biggest casino in the world”: Wall Street. Acknowledged as perhaps the first of the “quants”—those who use quantitative analysis techniques—Dr. Thorp combined mathematical theory with the power of computers to effectively forecast stock market moves. Pioneering the use of quantitative methods for asset management, he established the first market-neutral hedge fund and devised various ways to exploit market inefficiencies.

A native of Chicago, Dr. Thorp was raised in southern California and earned BA and MA degrees in physics and a PhD in mathematics, all from the University of California, Los Angeles. After completing his PhD, he pursued a teaching career as professor of mathematics at the Massachusetts Institute of Technology (1959 to 1961) and New Mexico State University (1961 to 1965). Dr. Thorp then joined the faculty at the University of California, Irvine, where he was professor of mathematics (1965 to 1977) and professor of mathematics and finance (1977 to 1982).

At MIT he met Claude Shannon, then an MIT professor and researcher, and became acquainted with the Kelly criterion, designed to maximize the long-term growth of a bet or an investment. Dr. Thorp and Dr. Shannon shared a mutual interest in gambling and game theory that led the two of them to build the first wearable computer for improving the odds at roulette. Dr. Thorp also was completing much of his now-famous research into card-counting as a strategy for winning at blackjack. In addition to studying roulette and blackjack, Dr. Thorp developed a winning approach for baccarat as well as the “Thorp count,” a method for calculating the likelihood of winning in certain endgame positions in backgammon. Thorp’s work revolutionized the game of blackjack. But he went further: In 1967, Thorp devised a system that uses math and computers to predict the future of the stock market.

After successfully applying some of the theories he formulated in gambling to managing investments for his colleagues



Edward O. Thorp, PhD

at UC Irvine, Dr. Thorp established Convertible Hedge Associates (later renamed Princeton/Newport Partners) in 1969. Dr. Thorp headed the asset management company until it closed in 1988. From 1992 to 2002 he ran a statistical arbitrage fund. During more than 40 years in the investment arena, Dr. Thorp has made seminal contributions to derivative pricing and hedging, warrant hedging, and other areas of mathematical finance. He now serves as president of Edward O. Thorp & Associates, a family office in Newport Beach, California.

Dr. Thorp is author of *Beat the Market: A Scientific Stock Market System* (with Sheen Kassouf, 1967), which helped launch the derivatives revolution that transformed world securities markets. His 1962 best-seller, *Beat the Dealer: A Winning Strategy for the Game of Twenty-One*, details how he analyzed the game of blackjack and created the first scientific system for beating the casinos. Dr. Thorp most recently published *The Kelly Capital Growth Investment Criterion: Theory and Practice* (with Leonard C. MacLean and William T. Ziemba, 2010), which provides the definitive discussion of the Kelly criterion, covering the various aspects of this theory and the practice of dynamic investing. He also has authored many mathematical papers on probability, game theory, and functional analysis.

In late January 2011, Dr. Thorp spoke with members of the *Journal of Investment Consulting's* Editorial Advisory Board about the relationship between gambling and investing, his interest in finding practical applications for theoretical models, and his thoughts on market efficiency. This interview is the tenth in the *Journal's* Masters Series, which presents topical discussions with leading experts and visionaries in finance, economics, and investments. Taking part in the discussion were Margaret M. Towle, PhD, the *Journal's* editor-in-chief, of Greycourt & Co.; Edward Baker of The Cambridge Strategy; Geoffrey Gerber, PhD, of TWIN Capital Management; and Meir Statman, PhD, of Santa Clara University.

**Margaret Towle:** Dr. Thorp, I just want to start out by thanking you for taking the time to talk with us. You are probably familiar with our publication and our emphasis on taking theoretical ideas and discussing their practical applications. I think that is especially appropriate in light of what you’ve done throughout your career in terms of using mathematical

models, while always keeping in mind the inherent challenges and problems of applying them practically. That approach is most obvious in your casino experiences. So let's begin by asking you about the major factors that helped to shape your career, your major achievements, and your biggest mistakes or disappointments. You have such a great background in terms of your academic experience but also in terms of truly applying that experience in the real world. Could you give us some insights based on your experiences?

**Edward Thorp:** The way I think about the world was probably shaped by my early experiences. When I was a child of three, my father took me in hand and decided to see how much he could teach me. That went very well for him for a couple of years, until he got too busy to keep it up. However, that was enough to get me started teaching myself. I learned to read well during the ages of three to five and to do elementary math, and I just took off from there. I got into doing science on my own as a junior high and high school student. Basically, I didn't have anyone to teach me, because the schools I went to weren't particularly good. I thrived on just having time to myself and thinking things through for myself.

**Margaret Towle:** What area of the country was that, as far as where you grew up?

**Edward Thorp:** We moved to Lomita, California, near Los Angeles when I was about ten-and-a-half, so I grew up in southern California. I went to a little high school called Narbonne, which I think was ranked thirty-one out of thirty-two in the Los Angeles school system. I had the luxury of being neglected, so I could just do what I wanted when I wanted and learn what I wanted whenever I felt like it. That got me into an independent, self-teaching mode and also into a way of thinking about things in which I didn't accept what I was told. I didn't reject what others told me, but I simply wanted to think it through for myself. I came to somewhat of a compromise in life where I didn't try to reinvent the wheel just because I thought I could. If there was something to be learned from other people, I would learn that as well as I could, but I didn't hesitate to go out on my own and investigate an idea or a problem that came to me. That's the sort of orientation that shaped my career.

One thing I felt early on was that when I do something theoretical, which I enjoy, then that theoretical thing ought to be tested in the real world to show that it really is something worthwhile, rather than just a pretty construct that won't be of any further value. I tend to work on problems that are goal-oriented, such as finding a winning strategy for a gambling game or finding a market inefficiency or devising a way of analyzing something in the market that will give me an edge. Then the fun is building models and series and seeing if they actually work. That's what I've been doing.

**Margaret Towle:** To expand upon that a little bit, given your background in a blend of academia, blackjack gambling, and hedge fund management, can you talk about the differences and similarities in those? From what I've read, you had quite a fantastic record in hedge fund management. What

do you see as the similarities between gambling and hedge funds? What are the skills that might apply to both of those, in terms of similarities and differences?

**Edward Thorp:** Academically, I evolved from chemistry to physics to mathematics. I received my PhD in mathematics and then went out into the university world to teach. As it happened, I'd always had an interest in applications from all of my science play in my high school years. One idea I'd had during those days was the physical predicting of roulette. That idea had stuck with me, so as I was getting my PhD, I was working on that problem, just on the side for fun. That gave me an outlook toward gambling games that later paid off in the market. Although conventional wisdom held that you couldn't beat these games, the outlook was that that wisdom was not necessarily true and, in fact, was probably wrong. Gambling games, which were perceived to be efficient—in the financial-world sense of the word, might not be. In fact, I was convinced that wasn't the case in roulette. So I came to this orientation that the conventional wisdom wasn't right. That led me not only to build a wearable computer<sup>1</sup> for roulette in conjunction with Claude Shannon<sup>2</sup> of the Massachusetts Institute of Technology, but also to investigate card-counting in blackjack. I happened to see an article on blackjack strategy published in a statistical journal that was fairly close to even. After I used it just for fun, I came back and figured out a way to construct a winning strategy for the game. That told me you could, in fact, beat gambling games, and I got into exploring that idea in much more depth. When I actually played blackjack, I learned how to manage money. The so-called Kelly criterion<sup>3</sup> was the type of thing I used for bankroll management, and I learned about that from Claude Shannon, who had worked with J. L. Kelly at Bell Labs some time earlier. He had actually refereed Kelly's fundamental paper (Kelly 1956).

That gets me to the point about the relationship between gambling and investing, that is, what you learn from one helps with the other. Gambling games are, for the most part, an area where you can calculate the odds, the probabilities, in detail and get them rather exact. There are some exceptions, like sports betting and so forth, that are more like social or financial markets. But you can actually come into a gambling game with known probabilities and get answers. You have the advantage, like you have in the physical sciences, of so-called repeatable experiments. You can simulate a gambling game a million times if you want because you know the probabilities. It's much more difficult in the securities markets because we just have one history from which we have to infer what's going on, and the probabilities that we have are not exact—they're just estimates. We're in a world that's controlled by people, which evolves in complex ways that we don't fully understand. So you don't have the same simple rules you have in the physical sciences and in the calculations that are behind gambling games. Nonetheless, the things you learn about gambling games carry over, in large part, to the investment world.

**Margaret Towle:** Could you elaborate a little more about the hedge fund side? I read where one interviewer said he

thought that, despite your quantitative orientation, you had quite good “street smarts,” or a common sense feel for this area. It seems that could relate specifically to the role of fundamental research. Do you see a role for that in hedge funds?

**Edward Thorp:** Let me address several things here. First, going back to street smarts, that’s an interesting thing, because I had no street smarts when I entered the gambling world—street dumbs maybe. I simply was naïve about it, I didn’t know what to expect, and so I was cautious because of that. I had to feel my way and go through this very strange, tricky world. If you’ve seen the movie *Casino*, which was about Las Vegas in the 1970s—well, when I played in the casinos in the 1960s, things were worse. They were worse yet in the ’40s and ’50s. That’s when people like Bugsy Siegel<sup>4</sup> were being shot up. Things began to improve when the legitimate corporate people started coming in, starting with Howard Hughes<sup>5</sup> early on and then other people behind him. I picked up some street smarts by being in the gambling world, and that proved to be very helpful when I moved over to the investing world.

What I typically did was use the skills and knowledge I had—in this case, my background from the gambling world and my belief in the likelihood that the markets were not efficient. I want to say more about efficient markets a little later. I had a lot of mathematical tools, especially some probability and statistics tools that I had used in the gambling world. Those seemed to carry over very nicely to the investment world. So I tended to look at problems from that point of view, unlike somebody like Warren Buffett,<sup>6</sup> who might have gone out and kicked tires on a company when he was a young man and judged whether that company was a bargain to buy into. I looked for situations where the risk was relatively low compared with the return, and I came across the idea of hedging. That’s what got me started. Back in 1965, I read a warrant<sup>7</sup> pamphlet, the RHM warrant survey,<sup>8</sup> and that got me thinking about warrants and options. I saw that you could “mathematicize” it, and I met Sheen Kassouf,<sup>9</sup> with whom I later wrote the book *Beat the Market*, when we were both new professors at the University of California, Irvine, back in 1965. That led me to think more about warrant formulas. Then in 1967, I said to myself, “What if the world were risk-neutral? What warrant formula would you have?” I wrote down what later became known as the Black-Scholes model<sup>10</sup> and started using that to invest. I saw that I had a powerful tool that would give me an edge that no one else seemed to have. I began investing for people around the university, and then in 1968 I ran into Warren Buffett, who was a friend of the dean of the graduate school, Ralph Gerard,<sup>11</sup> who was a Buffett investor. Buffett was shutting down [his investment partnership], and Gerard wanted Buffett to have a look at me and see whether I’d be a good place to invest money. Buffett and I hit it off, and Gerard ended up investing with me. This little pool of investors became part of the hedge fund that I started in 1969 with a fellow named Jay Regan<sup>12</sup> back East. The hedge fund was originally called Convertible Hedge Associates and later renamed Princeton/Newport Partners in

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1974. We thought that was a better name. I don’t remember why now. That ran from 1969 until 1988 when we ran into a misfortune with which you’re probably familiar.<sup>13</sup>

**Ed Baker:** I was very interested in your comment that you tried to apply what you learned in gambling to investing, and one thing in gambling is that you have relatively fixed distributions. That isn’t so clear in the financial markets. Do you think it is true that the distributions are fixed? Is it just a problem of finding the right distribution, or do we need more dynamic techniques that allow for changing distributions?

**Edward Thorp:** No, I don’t think they’re fixed. I think that we only get estimates of the distributions and that we can only be somewhat sure of the estimates. That makes the problem in the financial world much more difficult, I think, because you have these uncertainties in the distributions.

**Meir Statman:** Just to continue that point, there is an analogy between gambling in Las Vegas and investing. Both are negative-sum games. If some make money, others are losing money. Moreover, the casino always takes money. The same applies to investing. If some earn returns higher than average, others must earn less than average. Why don’t losers quit?

**Edward Thorp:** Do you mean the losing side in gambling or investing?

**Meir Statman:** Both.

**Edward Thorp:** I think I’m being lured into an area where you are much more expert than I am, that is, the area of behavioral finance. However, it seems to me that people are not just wealth maximizers but seeking to maximize something else, whether they do it accurately or inaccurately, whatever their total satisfaction is from whatever they’re doing. I imagine that’s the explanation for why people will gamble and lose money. They supposedly get an entertainment payout. Part of it, though, is that gambling is a tax on ignorance. People often gamble because they think they can win, they’re lucky, they have hunches, that sort of thing, whereas in fact, they’re going to be remorselessly ground down over time.

**Geoff Gerber:** You mentioned starting your firm in the late 1960s. Sitting here today, you have more than 40 years of perspective on quantitative systems applied to the stock market. My question really has two parts: First, how have you safeguarded your quantitative system from failing miserably or hitting a long stretch of bad luck? Second, what's your biggest concern at present with the U.S. equity market? Is it inflation or changes in regulation or more financial debacles or something else?

**Edward Thorp:** Regarding the first question, with blackjack, it was a matter of finding something that people believed wasn't true. I thought it was mathematically very interesting, so as an academic, I felt an obligation to publicize my findings so that people would begin to think differently about some of these games. Then there was a lot of skepticism and mockery from the gambling community, so I felt an obligation to prove that what I'd done actually worked. That's why I went out to Las Vegas and played blackjack and wrote a book about it.

Moving on to the investment world, when I began Princeton/Newport Partners in 1969, I had this options formula, this tool that nobody else had, and I felt an obligation to the investors to basically be quiet about it. The tool was just an internal formula that was known to me and a few other people that I employed. Time passed, and Black and Scholes (1973) published this formula. I remember getting a pre-publication copy in the mail with a letter from Fischer Black saying that he and Scholes were admirers of my work and that they had taken the delta hedging idea of my book *Beat the Market* one step further by assuming there was no arbitrage and that this paper presented what they came up with. I thought that this formula had to be the same as what I was running on my computers then, so I plugged it in and drew a graph. However, the graph didn't agree with the graph that I had drawn from my formula, and I realized that I had three formulas, not one. One of the formulas was the Black-Scholes model; another assumed that short-sale proceeds on the stock side—if you were short stock and long warrants—could not be used by the investor or at least wouldn't accumulate interest; and the third assumed if warrants or options were short and stock was long, then the short-sale proceeds on the warrants or options couldn't be used. With the CBOE [Chicago Board Options Exchange]<sup>14</sup> opening in 1973, you could now use short sales, so the central Black-Scholes formula—the middle of the three formulas I had—was the one that applied at that time. However, prior to that, I wasn't able to use short-sale proceeds, so I needed my other two formulas also. I published all three formulas about two or three months later. I was scheduled to give a talk at the International Statistical Institute conference in Vienna, and I needed something to talk about, so—almost the same day that I received the Black-Scholes paper—I just wrote up my three formulas and sent them in at that point, knowing that this was no secret any more (Thorp 1973).

Then there was essentially a race between me internally at Princeton/Newport Partners and my little research group and the academic world. The academic world was exploring

the options formula and applying it in many different ways, but it was taking them a while. One of the big hang-ups was the so-called American put formula. There's a differentiation in the options formula between European options, which are exercisable at expiration, and options that are exercisable prior to expiration, sometimes in complex ways as it turned out in later years. The original distinction was European versus American options, which could be exercised at any time. The American options had boundary conditions that were more complex than they were for the European options, and they generally could not be solved by analytic methods with a complete formula. Sometimes they could, but more often than not they could not. The European option, on the other hand, could be solved by a formula. The CBOE was planning to bring out American puts in 1974. One afternoon I sat down and, in about an hour, I programmed the solution to the American put problem. We ran off options curves and they looked right and we tested them. So we were ready to go. Then I was having dinner with Black in late 1974 or early 1975, prior to a Center for Research in Security Prices (CRSP)<sup>15</sup> meeting. At that time, CRSP had meetings every six months, where people talked about these kinds of issues, and Black had invited me to Chicago to give one of the talks. He began to ask me about the American put problem. I had brought the curves to show him because I had already solved it, and I was ready to explain how it worked. Then he began

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to explain to me how hard it was and why so far no one had figured it out. I realized that if I revealed the solution to the problem, then the competitive edge that my partnership had with American puts would disappear almost immediately. I put my papers back in my briefcase and simply listened.

Our misfortune in this particular instance was that the American put problem got solved around 1977 in academic papers, and the CBOE delayed using them until about that time. So we lost that competitive edge. There was a race of this sort internally between the academic world and Princeton/Newport Partners all through the '70s into the '80s. We stayed

enough ahead that we had a significant edge in a number of areas. Convertible bonds, for example—we had a better model than anybody else until probably the late '80s, maybe even 1990. When Princeton/Newport shut down and I took a break in 1989 and 1990, I called Black at Goldman Sachs and told him that we had this convertible bond model and that we knew he was looking to build one, so he might want to buy ours. He flew out to see it, and he liked it, but he didn't buy it because it was programmed in a language that would have caused him to do extensive reprogramming. Even at that time, he acknowledged that it was well ahead of what he'd seen. It was an interesting time for me because I spent a lot of time and energy trying to stay ahead of the published academic frontier. Of course, the unpublished frontier is further along because there's a time delay between creation and the appearance in print.

**Meir Statman:** I wonder if you would speak about the difference between the reward system of the academic world and the world of money management. I don't know if there's some wistfulness that I hear in your voice about the fact that you made money but never received the recognition that should have accompanied your intellectual accomplishments.

**Edward Thorp:** I realized in retrospect that there was no chance I was going to get any recognition for an options formula because I was not part of the economic academic community, and that was extremely important. For example, when Black and Scholes first tried to publish in 1970, they had great difficulty getting the paper accepted. I would say there was almost no chance that I could have gotten a paper accepted unless I published it in a math journal somewhere, and then people said years later, "Oh, yeah, this guy found it too." It wasn't apparent to me that it was as revolutionary, in the broad sense, as it turned out to be. To me, the thing to do seemed to be to protect my investors and their interests and do the best I could for them and just stay ahead in research as well as I could. So that's what I focused on. If you don't publish, you're not going to get credit.

**Geoff Gerber:** But you were able to make money for your clients?

**Edward Thorp:** Yes. There was sort of a branch point. If I had been brought up in the traditional economic academic community, then I think that I would have gone the "get credit" route and probably succeeded in doing that. But I didn't come up that way, so I went toward practical application.

**Geoff Gerber:** If we could, I'd like to go back for a minute to the second part of my earlier question, that is, what's your biggest concern with the U.S. equity market today?

**Edward Thorp:** Let me start at a lower level than the level I want to get to. I think that one of the big issues today is that the playing field in the financial world is not level. If big institutions behave in a risky way and threaten to bring down the whole financial community and throw the entire country into a depression, they don't seem to have to pay a price commensurate with what they've done. Instead, the public ends up bailing them out. We're in a situation where the "too big to

fail" institutions seem to have an option on the future rather than taking the full upside/downside risk that they should be assuming. They have privatized profits and socialized risk, in one formulation. That's a concern for me, and I don't see that has been changed by what we've gone through in the last few years. The fact that we don't have this level playing field, that people who are powerful and politically connected can manage things for themselves in a way that's much more advantageous than the run-of-the-mill rich or the run-of-the-mill public can, is an issue. It's led to a major transfer of wealth from the rest of the country to a very small group at the top. I happen to be fortunate in being one of the relatively wealthy people at the top, but I haven't used political connections or any extra edge of that type, any nonleveling of the playing field, to get there. I got there just by thinking. This polarization of wealth and increasing inequality in the country bothers me, not just because of itself but because of the way it's happened. It's happened because there's not a level playing field, and there's a lack of concern about the bottom in the country, which troubles me a lot, and a lack of concern about investing in things that are useful, like science, education, infrastructure, and so forth, things that we need to build an economic machine that will be more productive. I think a lot of the GNP [gross national product] is getting wasted. People don't seem to think about this or care about it. They're more focused on more immediate details. That's my overarching concern.

**Ed Baker:** I have a somewhat different question. Going back to some of your other comments, I presume that the no-arbitrage principle is very important to the way you approach opportunities. Do you see that as a principle in the market that's changed a lot over time? Do you see it getting worse now with some of the regulatory issues coming up and frictional costs unfolding the way they are? What are your experiences there?

**Edward Thorp:** Your point about frictional costs and lack of regulation—in particular, lack of transparency—is a good one. It leads to inequities in pricing. The same product sells at different prices in different places because you don't have enough transparency in the markets. If derivatives—convertibles, CDOs [collateralized debt obligations], and so forth—were traded on an exchange like options are, then everybody would see what the prices are, they'd all be trading at the same prices, and there'd be transparency as well as protection, because the exchange would stand between the counterparties. That would be good. I think that the people who trade these derivatives heavily at larger institutions don't want this situation to change because they can charge much higher fees if there is no transparency. It reminds me a little of the real estate market and the way it was earlier. That market is slowly becoming more transparent, but they've been quite good at nontransparency too, with great disparity in the commission structure depending on who the players are. So, anyway, I'm concerned about a lack of transparency in the markets and a lack of accountability and a lack of protection for the various counterparties.

**Meir Statman:** Let me go back to the lack of a level playing field. We can see that in many fields. Banks privatize profits and socialize risks. Why is there no pushback? Hedge fund managers make billions, but academic studies show that investors in hedge funds receive at best a return equal to what they could get with an equivalent risk elsewhere. Why is this not remedied?

**Edward Thorp:** I don't know how to answer that question. I've mused over your point for a lifetime, and I am continually amazed how nonreactive most people are to all of these things that really need to be fixed.

**Margaret Towle:** In the *Wall Street Journal* interview you did together with Bill Gross of PIMCO,<sup>16</sup> you commented—not so much on how people react—but about the huge amount of money that has flowed into hedge funds, seemingly overwhelming available investment opportunities, and you made reference to the overbetting phenomenon or gamblers' ruin. In your opinion, are there still opportunities, or pockets of inefficiencies, in this market that could be exploited using mathematical models?

**Edward Thorp:** What's generally happened over the last four decades is that there were very few hedge funds around when we started back in 1969—a couple hundred, maybe. Also, there weren't any market-neutral or derivatives-based hedge funds at that time until Princeton/Newport Partners became the first one. Then more and more people began to enter this area, over the next two decades, with the derivatives revolution. Quantitative investing became very profitable and very successful. We got to a point in the 1990s when, if you hung out a shingle saying "Hedge fund opening here," a line would form at your door almost immediately, and all kinds of investors would join up if they heard about good profits being made in earlier years. So the same opportunity set was being chased by much more money. I also think that many of the new hedge fund managers were perhaps of less quality and competence than the ones who had already been around for a while. Not only did they have less experience, but we were tapping into a broader base of candidates, so we were getting ones that weren't as good. Hedge funds began to migrate from a place where, collectively, they had a significant edge to more of an asset-gathering group. I think that now there are significant edges in hedge funds here and there, but it's not nearly as easy to find good ones in which to invest as it used to be, and I don't think the edge is as large. Hedge funds have headed toward being just another large asset class.

**Geoff Gerber:** You mentioned the abundance not just in terms of hedge funds but even in terms of long-only managers. What are your thoughts on the crowding out theory?<sup>17</sup> As all of these quant managers started growing, did you have reason to change your model? Did it cause you to change how you implemented your market-neutral strategy?

**Edward Thorp:** Basically, I had two large periods of hedge fund management. One was Princeton/Newport Partners from 1969 through the end of 1988, during which I generally was using derivatives to hedge and capture excess return. One

of the strategies that we developed during that period was something now known as statistical arbitrage.<sup>18</sup> We actually first found it in our shop in either December 1979 or January 1980. It was right around the end of the year. We were working on a project, and one of the researchers came and asked us to look at what he had done, which was running the portfolio of the most up stocks in the last month versus the most down stocks. He had run it over the past 18 years or so, using a CRSP database that went back to 1962 at that time, I think. In any case, there was a very statistically significant separation between the two portfolios. In fact, if you were long the recently most down stocks and short the recently most up stocks, you would have captured an annualized 20-percent return. It wasn't really regular. It had probably a standard deviation of 20 percent or 25 percent.

**Geoff Gerber:** And huge turnover as well.

**Edward Thorp:** Yes, huge turnover. So costs were a big issue. But even with the costs that we were paying, we could get fairly close to that. However, we were already making that much with convertible hedging, so we said, "Well, convertible hedging has much less risk, so we'll put this strategy aside as an interesting idea." Then Gerry Bamberger<sup>19</sup> at Morgan Stanley discovered this principle in 1982. He later felt that he had been marginalized and that the credit due him had been taken over by a person who had come in from the outside to run the quantitative group there. So Bamberger left Morgan Stanley, and he answered an ad that we had put out looking for people with strategies that might have an edge. So we co-ventured with him, and that worked quite well. We ran that strategy until the end of Princeton/Newport Partners. The original strategy began to weaken in 1987, so I devised a different version that then also did very well. When Princeton/Newport shut down in 1988, I took some time out and did Japanese warrant hedging and not much else. Then in 1992, a large Fortune 100 pension and profit-sharing plan that had been one of Princeton/Newport's investors heard how well statistical arbitrage was doing and we started a statistical arbitrage fund for them. We ran that until 2002, and we found that in later years—2000 to 2002—there seemed to be a lot more participants and the edge seemed to be diminishing. It had fallen from returns in the 20-percent range down into the low teens. I decided it wasn't worth doing and I might as well just take time out and enjoy myself, so we wound that down. I think times got a little tougher for statistical arbitrage after that.

**Geoff Gerber:** Yes, they did. So you stopped in 2002?

**Edward Thorp:** Yes. I basically then turned into a family office and just ran our family money, allocating it to hedge funds and to other places after that. We also do some securities research. We spent a fair amount of time looking at commodity trend following,<sup>20</sup> for example. That looked reasonably good when you examined the past, but then strategies that worked well in the past did not do nearly as well when you did them in real time. So it seemed like it was very hard to get rid of the data mining issue there.

“ Suppose that you can construct a portfolio that has three things in it—Treasury bills, a stock index, and options on that stock index; can you use the options to get a better payoff structure than if you didn’t use options in that mix? ”

**Geoff Gerber:** And that would have been a reversal from reversal to momentum.

**Edward Thorp:** Yes, exactly.

**Margaret Towle:** In that regard, it does sound like you are working on some interesting projects. What are some of the areas, or the next problem, that you plan on tackling?

**Edward Thorp:** Most recently I’ve been thinking about “black swan”<sup>21</sup> insurance. Just to use the terminology from Nassim Taleb’s famous book, there are two worlds you can think about. One he called the world of “Mediocristan” in which standard statistics—the kind of statistics you see in the physical sciences, things that behave fairly reasonably—apply. The log-normal world of Black-Scholes is Mediocristan. Then there’s the world of “Extremistan,” where you get fat tails<sup>22</sup> and black swans and huge upside or downside moves periodically—the crash of 1987, the 2008–2009 period, and so forth. The question I’ve been thinking about is a simple one: Suppose that you can construct a portfolio that has three things in it—Treasury bills, a stock index, and options on that stock index; can you use the options to get a better payoff structure than if you didn’t use options in that mix? Traditional investing, that is, a long index with any excess money going into Treasury bills just for super simplicity, would be modified by adding options. They could be way out of the money, they could be in the money, or whatever, and you have the constraint that you can’t lose everything. So you can’t put it all in options because if the market went down enough, you would lose all that you had invested. You just buy an option at Black-Scholes prices, let the clock run for one time period, see what happens, and do it again. Then you analyze how the short-term and long-term payoff characteristics behave. I’m in the middle of looking at that now to see if we can get anything better by using options. It’s been very interesting so far, but we’re not done.

**Margaret Towle:** That does sound interesting. We would like to explore a few larger issues related to the role of an investment advisor or investment consultant for institutional clients. Many of our readers are part of this profession so we

would like to get your perspective on how you see that role. We talked earlier about some of the mistakes investors might make. What do you see as the role of the investment advisor or consultant in helping investors avoid these mistakes, and how does that differ between institutional clients and individual clients?

**Edward Thorp:** I sit on the board of a university endowment, a university foundation, and this comes up periodically at our meetings. We get advice from outside advisors, and it seems to me there are two issues. The first is to figure out what risk/return characteristics best suit the client, and that’s going to vary from client to client. The second is to see whether there are any excess risk-adjusted returns that really are available. That’s usually rather questionable from what I’ve seen. Most of the strategies that are proposed don’t have demonstrable excess return in them. There are stories, but the stories usually aren’t good enough. So I think one role of the investment advisor would be to very carefully screen out asset-gatherers who are masquerading as alpha-gatherers.

**Margaret Towle:** That’s good advice.

**Edward Thorp:** It’s a tough one, though, because there are a lot of conflicts of interest that arise, or that may arise, depending on who’s paying whom what.

**Ed Baker:** And once you identify such an investment manager, how would you characterize the objectives in their investment guidelines?

**Edward Thorp:** I know the board that I sit on has investment guidelines that allocate in a certain range to various categories, such as real estate, private equity, bonds, domestic equity, international equity, and so forth. They move these guidelines around. They spend a lot of time adjusting the mixes. That’s a traditional way to do it. You won’t get in trouble doing it that way. I’m not sure that the time and energy spent get us very much, though. They’ll debate whether to have 20 percent or 25 percent in domestic equity, and the finance committee will spend a lot of time offering opinions about this. Maybe they’ll decide to move the guideline from 20 percent to 25 percent, but no matter what happens, it will only have an incremental effect on returns that is so small that it’s hardly noticeable and appears to me to be almost random.

My view is that this should be a simplified process. Basically, people should be putting money into index funds when they can’t demonstrate that an investment with similar characteristics is better. For instance, suppose that they go to a long equity manager. In order to give him money, I think they should have to be able to demonstrate that the index that most closely matches him—small stock, intermediate stock, growth, value—is not as good. It’s tricky to do that with just historical information, because if you have 100 managers out there and none of them is any better than the index—let’s say they’re all the same, just to be charitable—then there will be a random fluctuation around the index return, and you tend to select the managers who did better. However, if in fact they had the same expected returns going

forward, you would have accomplished nothing. Actually, what seems to happen, from what I can see, is that the under-performance roughly matches the fees. I would say that the burden of proof is on the non-index manager. There are inefficiencies in the market, but they're not easy to demonstrate, and I think that needs to be done before one shifts money in that direction.

**Margaret Towle:** I think the industry does seem to be moving away from those traditional asset classes and categories to more factor-based exposures in allocating a portfolio. If we look at the so-called Yale model<sup>23</sup> or other models for endowments, there seems to be at least an argument that skill-based strategies—that is, more alpha rather than beta—would be appropriate for that. So your example of a long-only manager seems perfectly reasonable, given what we've seen about that as far as inefficiency, especially in the large capitalization area. What do you think about skill-based strategies, not even necessarily long/short, but a strategy such as a global macro where the manager is processing information and has a world view using a variety of instruments across many asset classes? Would that fit anywhere into your conceptual framework as far as endowments?

**Edward Thorp:** Sure, it makes sense to me if you're outside the traditional markets where participants can force efficiency or extract profits if they don't get the markets to move toward efficiency. If you're in a situation like that, and many of the things you mentioned are like that, then it makes perfect sense that there are going to be opportunities out there. Then the real issue is demonstrating in any specific case that you've found something that qualifies. That was one of the original arguments for hedge funds, too. They could go where you couldn't have gone before or where you couldn't go on your own. There were inefficiencies there because not everybody could get at them to trade them away.

**Margaret Towle:** At this point, I'd like to ask my co-committee members if you have any additional questions or any areas that we haven't covered that you'd like to discuss with Dr. Thorp.

**Geoff Gerber:** As a quant myself, I'd like to ask a question based on Scott Patterson's book, *The Quants: How a New Breed of Math Whizzes Conquered Wall Street and Nearly Destroyed It*. I know that book refers to you as "the godfather of the quants." As the godfather, what do you see as the future of quantitative investing, especially in light of the difficulties quants have faced over the past few years?

**Edward Thorp:** I think that the opportunities for quantitative investing are likely to get better, simply because markets are becoming larger and more interconnected and the tools the quants have continue to improve. So that's one side of it. The other side is that there can be a disconnect between the models that the quants build and the real world, and that disconnect can lead to serious trouble, for example, the mortgage pool models or the Long-Term Capital Management<sup>24</sup> approach to doing things with super-high leverage, assuming the world is Mediocristan rather than something else. So we

have those two sides of it, and I think there will be tension there as this evolves into the future.

**Margaret Towle:** Are there any areas that we haven't asked you about that you think are relevant or that you'd like to discuss?

**Edward Thorp:** One brief comment on market efficiency: It seems to me that to talk about markets being efficient or inefficient is not quite the right way to look at it. It's a combination of what's going on in the markets and the participants in the marketplace. Let me elaborate a little bit. Imagine a casino world where nobody knows about card-counting in blackjack. So everybody's playing along, and they're all losing 2 percent because they're using a strategy that on average loses that much. It's not the best strategy, and they don't think about the cards that fall. It doesn't seem to make any particular difference or, if it does, they don't know how to use that information. Then one person figures out how to count the cards that have been used and how to get an edge. Did the blackjack market suddenly become inefficient at that point, or was it inefficient before anybody figured this out? If the person who figures out how to count cards does nothing, is the market still efficient, or not? Or does that person actually have to walk in and play in order to make the market inefficient?

It seems to me that market efficiency or inefficiency is a joint property of the market itself, what's going on in it, and what the participants know and are able to do. If you look at any one person, that person will have some knowledge of markets and may have some knowledge of efficiency or inefficiency in markets, and that knowledge may be correct or incorrect. However, that is going to vary from person to person. For example, Warren Buffett has knowledge about the fundamentals of a lot of companies, among many other things. So in that area, the markets are inefficient from his point of view, but there are a hundred million people out there who don't have that knowledge, and they should behave as if the markets are efficient because, from their point of view, they don't have any edge at all. Again, I think it's a joint property of the participants and the markets and ought to be looked at that way. If a person says that he can beat this market because it's inefficient, that's not a good statement in itself. That person needs to be able to demonstrate that he has knowledge that gives him an edge in such a way that it can't be refuted by somebody acting as a devil's advocate. Basically, if you think there is inefficiency, you've got to use the devil's advocate test on it.

**Meir Statman:** The way I like to phrase it is, "The market may be crazy, but that doesn't make you a psychiatrist."

**Edward Thorp:** I like that.

**Margaret Towle:** On that note, we'll bring the interview to a close. Dr. Thorp, we all want to thank you very much for taking the time to talk with us, and we look forward to hearing about what you'll be doing in the future.

**Edward Thorp:** Thank you. It was a pleasure meeting and talking with all of you. 

## Endnotes

- 1 The first wearable computer was built in 1961 by Edward Thorp and Claude Shannon and used to predict roulette wheels. The system consisted of a pocket-sized analog computer, microswitches (worn in shoes) that indicated the speed of the wheel, and miniature speakers. The system was tested successfully in Las Vegas in June 1961, but hardware issues with the speaker wires prevented the system from being used beyond the first test runs. The device was first disclosed in the revised edition of Dr. Thorp's book *Beat the Dealer* (1966) and later discussed in detail in Thorp (1969).
- 2 Claude Shannon (1916–2001), known as “the father of information theory” (the science behind the Internet and all digital media), was an American mathematician, electronics engineer, and cryptographer. His 1948 paper titled “A Mathematical Theory of Communication” formed the basis for the field of information theory. He also is credited with originating both digital computer and digital circuit design theory. Shannon was a member of the Massachusetts Institute of Technology faculty from 1956 to 1978.
- 3 The Kelly criterion is a formula used in gambling to establish the optimal size of a series of bets and, by extension, to determine equity allocation and diversification in investing. It is named for John L. Kelly, Jr. (1923–1965), the scientist who formulated the criterion while working on long-distance telephone signal noise issues at AT&T's Bell Labs in the 1950s.
- 4 Benjamin “Bugsy” Siegel (1906–1947), an American gangster, was one of the driving forces behind the development of Las Vegas and built the city's first major casino/hotel, the Flamingo, in 1946. As the result of a dispute over construction funds, Siegel was the target of a mob hit in 1947.
- 5 Howard R. Hughes, Jr. (1905–1976) was an American aviator, industrialist, film producer, and philanthropist. Beginning in 1966, he purchased several casino/hotels, local television stations, and other major businesses in Las Vegas, with the expressed purpose of creating a glamorous image for the city.
- 6 Warren Buffett (1930– ) is an American investor, philanthropist, and chairman and chief executive officer of Berkshire Hathaway, a holding company that manages a diverse range of businesses. Often referred to as “the oracle of Omaha,” Buffett is known for his adherence to a value-investing philosophy. In March 2011, he was ranked by *Forbes* as the third-wealthiest person in the world, with a net worth of \$50 billion; he has pledged to donate 99 percent of his wealth to philanthropic causes.
- 7 Warrants are derivative securities that entitle the holder to purchase the underlying securities (usually equities) of the issuing company at a specific price within a certain timeframe. Warrants are guaranteed by the issuing company, and the lifetime of a typical warrant is measured in years.
- 8 The *RHM Survey of Warrants, Options, and Low-Price Stocks* was a hardcopy newsletter published by Sidney Fried of RHM Press in the 1950s through the 1970s.
- 9 Sheen Kassouf (1929–2006) was an economist known for his research in financial mathematics. Kassouf was a founding faculty member and professor of economics at the University of California, Irvine.
- 10 In 1973, Fischer Black (1938–1995) and Myron Scholes (1941– ) published their option pricing theory, designed to calculate the value of an option by considering the stock price, strike price, expiration date, risk-free return, and the standard deviation of the stock's return. Later that year, Robert Merton expanded the theory and coined the term “Black-Scholes model.”
- 11 Ralph W. Gerard (1900–1974) was a neurophysiologist and behavioral scientist known for his work on the nervous system and psychopharmacology. In the latter part of his career, he focused on education and became the first dean of the graduate division at the newly formed University of California, Irvine, where he served from 1965 until his retirement in 1970.
- 12 James (Jay) Regan served as managing general partner of Convertible Hedge Associates and Princeton/Newport Partners from 1969 to 1988. He is currently a general partner in Harcourt Enterprises.
- 13 In 1988, during a government investigation of insider trading, five officials of Princeton/Newport Partners were charged with stock fraud, tax evasion, and racketeering. Dr. Thorp and other principals at Princeton/Newport Partners were cleared of any wrongdoing, but the negative publicity and loss of assets forced the firm to close in 1988.
- 14 Chicago Board Options Exchange (CBOE), the largest U.S. options exchange, was established in 1973 by the Chicago Board of Trade.
- 15 The Center for Research in Security Prices (CRSP) was established in 1960 with the initial mission of constructing an equity data base that would include the prices, dividends, and rates of return of all stocks listed and trading on the New York Stock Exchange since 1926. This data base was completed in 1964, allowing an average rate of return to be measured for the first time. Data from the NASDAQ markets was added in 1984, and a mutual fund data base was created in the mid-1990s. CRSP files provide a foundation for economic forecasting, stock market research, and financial analyses to academic institutions, investment banks, brokerage firms, corporations, banks, and government agencies.
- 16 William H. (Bill) Gross (1944– ) is a financial manager and investment author who founded Pacific Investment Management Company (PIMCO) in 1971. He manages PIMCO's Total Return Fund, the world's largest bond fund. See Patterson (2008).
- 17 Crowding out theory explains an increase in interest rates due to rising government borrowing in the money market.
- 18 Statistical arbitrage is an equity trading strategy that uses mathematical modeling techniques to identify profit situations arising from pricing inefficiencies between securities.
- 19 Gerald (Gerry) Bamberger, with a background in computer science, pioneered pairs trading at Morgan Stanley & Co. in the 1980s, which led to the concept of statistical arbitrage.
- 20 Commodity trend following is an investment strategy designed to take advantage of long-term moves in the market and benefit from both the ups and the downs. Investors following this strategy use current market price calculations, moving averages, and channel breakouts to determine the general direction of the market and profit from trends.
- 21 The black swan theory describes rare, unpredictable, and high-impact events. In his 2007 book *The Black Swan: The Impact of the Highly Improbable*, Nassim Nicholas Taleb applied the term to events such as the rise of the Internet and the September 11, 2001, attacks on the United States. He also argued that banks and brokerage firms were especially exposed to black swan events and major losses. The term comes from the fact that it was commonly assumed that all swans were white until black swans were discovered in Australia in the seventeenth century.

- <sup>22</sup> In a normal bell-shaped distribution of portfolio returns, the majority of returns can be found in the “bell,” which centers around the weighted average return for the entire market. The ends, or tails, of the curve represent returns that are either extremely bad (left) or extremely good (right). Larger-than-normal tails are called “fat tails,” indicating more data on the extremes than expected. Fat tails indicate that extreme market moves were more likely than would be predicted by normal distributions.
- <sup>23</sup> The Yale model was developed by David Swensen and Dean Takahashi, chief investment officer and senior director of investments, respectively, at Yale University. The model is characterized by broad diversification, low liquidity, higher allocations to asset classes such as private equity, hedge funds, real estate, and other alternative investments, and lower allocations to asset classes such as U.S. equities, fixed income, and commodities. This investment model is followed by many larger endowments and foundations.
- <sup>24</sup> Long-Term Capital Management was a hedge fund established in 1994 that reached \$7 billion under management by the end of 1997. The highly leveraged fund was designed to profit from combining academics’ quantitative models with traders’ market judgment and execution capabilities. In August 1998, following the Russian financial crisis and an ensuing flight to quality, the fund lost substantial amounts of capital and was on the brink of default. The threat of a systemic crisis in the global financial system led the U.S. Federal Reserve to orchestrate a \$3.5-billion bailout by major U.S. banks and investment houses in September 1998. The fund closed in 2000.

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