

## ED THORP

Ed Thorp cracked blackjack, used the first wearable computer to beat roulette, started the world's first quantitative hedge fund, anticipated the Black-Scholes formulae by five years, and has maintained consistently excellent returns through nearly forty years in hedged portfolios and derivatives.

**Dan Tudball** reviews the life of one of quantitative finance's great heroes, and speaks to the man himself

The year is 1938. The place, about 45 miles out of Chicago. On the steps of a market a boy of not quite six faces off against a perplexed looking local man who holds a heavy tome belonging to the kid, and studies it with some skepticism. "Egbert 802 to 839," the boy begins, quietly, and in a considered tone somewhat beyond his years he continues, "Ethelwulf 839 to 857, Ethelbald 857 to 860, Ethelbert 860 to 866, Ethelred I 866 to 871, Alfred the Great 871 to 901, Edward I 901 to 924, Ethelstan 924 to 940, Edmund I 940 to 946, Edred 946 to 955, Edwig 955 to 959, Edgar I 959 to 972, Edward II 975 to 978, Ethelred II 978 to 1016, Sven 1013

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to 1014, Canute the Great 1016 to 1035, Harold 1036 to 1039, Harthacnute 1039 to 1042, Edward III 1042 to 1066, Harold...” The man’s face sets in disbelief as the boy continues his litany; the book he refers to is *A Child’s History Of England* by Charles Dickens - every entry in the chronology of monarchs recited from this boy’s memory to perfection. The boy’s father is equally taken aback. Thorp Sr had long known his son was a prodigy, but this display is shocking. Only moments before the

shopping expedition the young Thorp’s parents and friends were sat down trying to induce the child to speak - still a popular pastime in the Thorp household. Some people stepped out of the elevator and someone asked, “Where’s the man gone?” Thorp recounts the moment down the line from Newport Beach “Oh, he’s gone to buy a shirt,” so everybody’s eyes popped out and the next question was “Where has the woman gone?” and I answered ‘Oh, She’s gone to the bathroom to do pee-

physics, electronics, astronomy and mathematics. Being most interested in chemistry he sat for the All-Southern-California high school chemistry test, despite being a few years younger than other students sitting for the exam. He came fourth in that part of the state, and was very proud of that result but he recalls that the reason why he had only achieved that position rather than coming first was down to a new section requiring slide rules. Ed only had a 10-cent slide rule, which was “a piece of

remember seeing pictures of homeless people in the newspapers, tattered clothes and that sort of thing. It’s something that people of that era remember very vividly. Saving everything, And that had an impact on me, I was very frugal for the first twenty-five years of my life and this allowed me to make it through university on very limited means.” With money in short supply, and with a burgeoning interest in expensive experimentation, Ed would deliver newspapers at three in the morning in order to fund his science.

When speaking to Thorp about these formative years a vivid picture is painted of a child whose critical and analytical faculties were highly developed. A child with a preternatural gift for reflection, and independence of thought – only prepared to commit to something, whether an idea or a course of action, after the very deepest consideration. Ed was fascinated with Morse code, and was a radio ham - this in itself deriving from a passion for structure and organization. Certain gifts, like a near photographic memory, died away as life required the skill less, but even to this day Ed has a facility for two and three dimensional geometry – which allows him to mentally map any journey he makes and very quickly draw an accurate map from memory. Other lessons learnt in childhood still resonate with Ed today, his commitment to Reason and its values. “I think as far as the way I approach things professionally and otherwise I’m unusually rational as people go and I don’t feel like I have any of the usual areas of irrationality that people have. I don’t want to offend but I’ll mention things like astrology and tales from olden times about things that allegedly happened. The place I may go wrong from time to time is that I may not have enough experience of some aspects of the world, for instance as I grew up I was very naive about peo-

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man had questioned how such a young child could read such a weighty volume. He’d followed that with a challenge to name all the kings and queens of England in order and with the dates of their reigns. And here was the child, nearing the end of his recitation, suddenly looking puzzled himself “Queen Victoria, I know when her reign began, but I don’t know when it ended.” But then again, neither did Dickens.

Edward Oakley Thorp was born on August 14th 1932 in Chicago, Illinois. His parents had met in Manila, when Thorp Sr was stationed with the Philippine constabulary. That the child Thorp was different was already evident to his parents when, even at the age of two and a half he had not yet uttered a single word. This difference was soon recognized as prodigy when the mute child, by then nearly three, was taken on a shopping trip to Montgomery Ward, a department store in Chicago. During a break from the

pee’ and their faces turned reddish and they started to ply me with questions.”

This revelation motivated Thorp’s father to see how much he could teach his young son. Reading primers led swiftly to more complex books and Ed was reading confidently by the age of three and a half, successively more complex books led to the showdown at the market. Between the ages of five and ten Ed devoured every scrap of reading material he could get his hands on. Worried that he was becoming too cerebral at the expense of other activities, Ed’s parents were concerned he wasn’t getting out enough – they started him on building model airplanes, and then bought him a mineral set when he was ten. This was followed by a chemistry set, which really set Ed off. He cordoned off a section of the garage for his ‘experiments’ which allowed an outlet for his fascination with controlled explosions. These explosions, lead to an explosion of another kind; from chemistry it was

junk” in his hands. He decided to avenge himself the following year by taking the analogous physics test and came out first, by a very large margin. It was this result that got him a scholarship to UC Berkeley - without it Thorp may not have been able to advance further in education, money was so tight.

### Austerity and Reason

Ed had grown up in the Depression era, and that defining time had affected him just as deeply as his contemporaries. Even at six years old, Ed had begun formulating ways to assist with the household income “It was a time when everybody was very poor, and I remember getting 5 - cent packs of Kool Aid, making six glasses out of each pack and selling them at a penny a glass to WPA workers out on the streets who got hot and sweaty in the summer. I remember I saved every cent. Fortunately my father was in a moderately secure job and we always had food on the table, but I



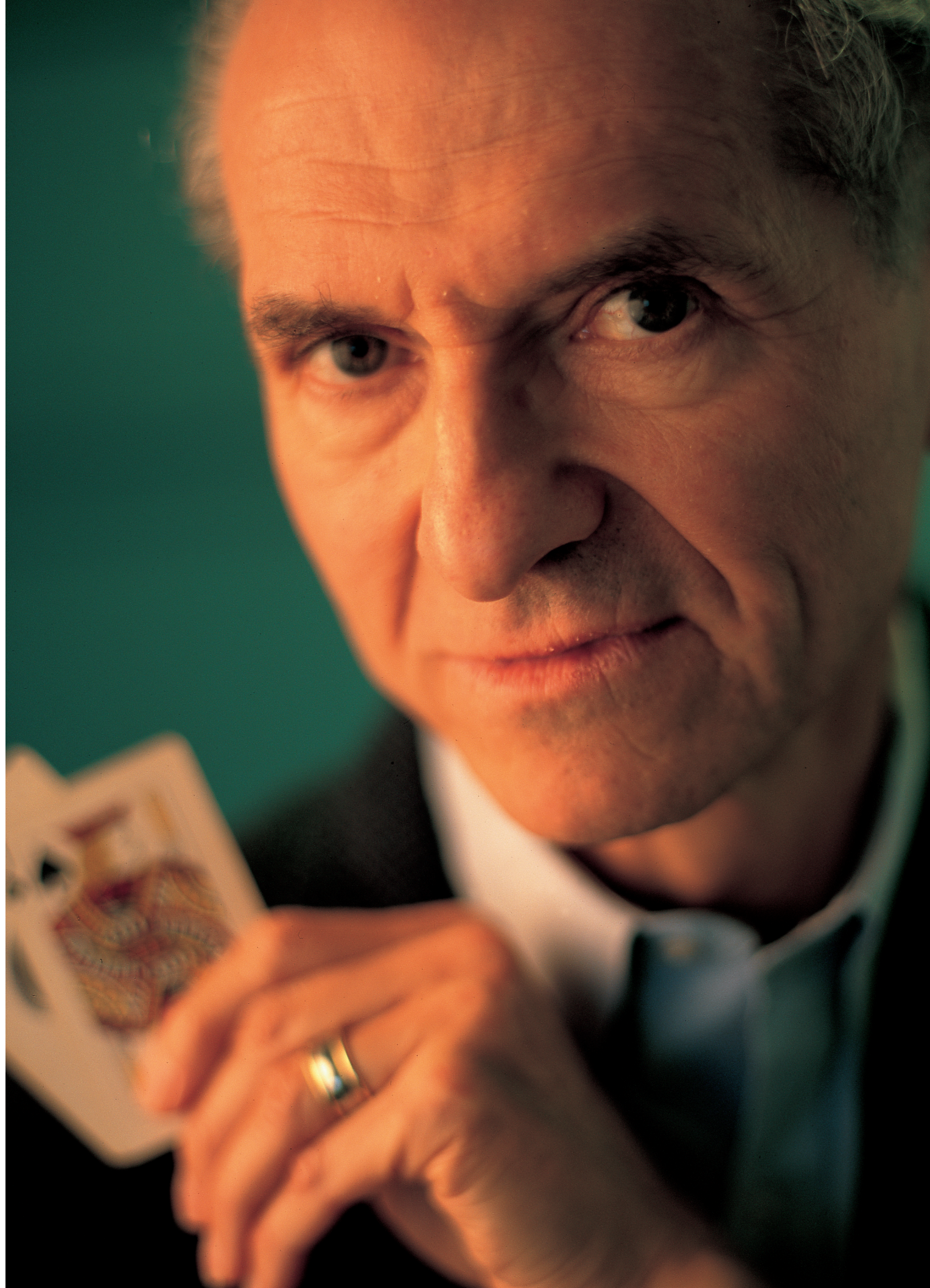
ple. Until I was nine I believed that everything I saw in print was true I found it impossible to believe otherwise. Until, that is, I saw two newspapers with conflicting information and that particular naivety disappeared rather rapidly after that.”

### The deck re-stacked

Back in 1914 Ambrose Bierce wrote, “The gambling known as business looks with austere disfavor upon the business known as gambling.” However during Ed’s formative years through to the late 1960s the notion that the world of finance could derive valuable lessons from the world of casinos had not become the cliché that it is today. As far as gambling was concerned, Thorp’s first brush with that world was under the tutelage of an older cousin who would take his young relative to gas stations that housed illegal slot machines in their washrooms. There, Ed was shown how to jiggle the handles on the machines to pay off when they shouldn’t. Naturally, money being scarce at the time, this was a delight – however it was not until he was at university that Thorp got to seriously thinking about gambling in relation to his innate talents for mathematics and physics. And the challenge that interested him then was less getting the payoff when there shouldn’t be one, but rather when there should.

Between 1955 and 1964 Ed was to work on two things that were to have a profound effect, not only on people in Nevada and Atlantic City who sported names like ‘The Fish’ or ‘Ax Handle’ between their fore and surnames, but also on every person with the slightest interest in reducing risk. The first was the development of the wearable computer for predicting the outcome on a roulette table (See Sidebar) success there primed him for his approach to blackjack.

Photo: Mark Robert Halper





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By 1958, when Ed first started thinking about blackjack, he had married Vivian and had achieved his Ph.D at UCLA, work on roulette had resulted from some idle banter with friends on how to make easy money, back in 1955. This time round it was a trip to Las Vegas for a cheap, non-gambling, vacation that got Ed thinking. At the time the prevailing assumption was that none of the major gambling games allowed for systems. The accepted thought was that because most games depended upon independent trials processes – i.e every spin or dice roll was unaffected by those that preceded it – then there was no way a mathematical system would allow you to numerically track outcomes and reasonably predict future outcomes. Unless you used rigged dice or had some information on the croupier, you may as well bring along a rabbit's foot as a calculator. Ed had previously concluded (in 1955) that roulette was an exception to this rule, because he wasn't using a numerical system and instead relied on the physical properties of the mechanism.

Prior to his trip to Vegas Thorp had been given a paper, published in the *Journal of the American Statistical Association* written by US Army mathematicians (Roger R. Baldwin, Wilbur E. Cantey, Herbert Maisel, and James P. McDermott) on basic strategy in the game of blackjack. The contention of the paper was that the house edge on blackjack could fall as low as 0.0062 (somewhat later corrected by them to .0032), Ed made himself a little reference card to take to the table, purchased ten bucks' worth of chips and prepared to test the methodology. Once at the table he played the game for about twenty minutes – never having played it before, and this being the first time he'd set foot in a Casino – eventually losing the ten dollars, but the important observation he took with him was that he had been losing at a far slower rate than oth-

### THE WORLD'S FIRST WEARABLE COMPUTER

In spring 1955 Ed Thorp was in his second year of graduate physics at UCLA. At tea time one Sunday he got to chatting with colleagues about how to make 'easy money'. The conversation turned to gambling, and roulette in particular. Was it possible to predict, at least with some exploitable degree of accuracy, the outcome of a spin of the wheel? Some of his colleagues, the ones in the know, were certain that the roulette wheels were manufactured so precisely that there were no imperfections that could be discerned, never mind exploited. But Ed's counter to that was simple, if the wheels are so perfect you should be able to predict, using simple Newtonian principles, the path of the ball and its final resting place.

Ed got to work in the late 1950s, playing around with a cheap miniature roulette wheel, filming and timing the revolutions. He met up with Claude Shannon, the father of information theory in 1959, originally to discuss his blackjack results, but the conversation soon turned to other games and roulette in particular. Shannon was fascinated. Shortly afterwards they met up at Shannon's house, the basement of which was packed with mechanical and engineering gadgets, the perfect playground for further roulette experiments.

Ed and Shannon together took the roulette analysis to greater heights, investing \$1,500 in a full-size professional wheel. They calibrated a simple mathematical model to the experiments,

to try to predict the moment when the spinning ball would fall into the waiting pockets. From their model they were able to predict any single number with a standard deviation of 10 pockets. This converts to a 44 per cent edge on a bet on a single number. Betting on a specific octant gave them a 43 per cent advantage.

It is one thing to win on paper, or in the comfort of a basement. It is quite another to win inside a noisy casino.

From November 1960 until June 1961 Ed and Shannon designed and built the world's first wearable computer. The twelve transistors, cigarette-pack sized computer was fed data by switches operated by their big toes. One switch initialized the computer and the other was for timing the rotation of the ball and rotor. The computer predictions were heard by the computer wearer as one of eight tones via an earpiece. (Ed and Shannon decided that the best bet was on octants rather than single numbers since the father of information theory knew that faced with  $n$  options individuals take a time  $a+b \ln(n)$  to make a decision.)

This computer was tested out in Las Vegas in the summer of 1961. But for problems with broken wires and earpieces falling out, the trip was a success. Similar systems were later built for the Wheel of Fortune which had an even greater edge, an outstanding 200 per cent.

On 30th May 1985 Nevada outlawed the use of any device for predicting outcomes or analyzing probabilities or strategies.

## The important observation he took with him was that he had been losing at a far slower rate than others on the table

ers on the table and the realization that he could modify the methodology.

Like roulette, Blackjack was in fact also an exception to the rule that gambling games couldn't be beaten by fair means. At that time, when a card was dealt it was put aside, thus shifting the composition of the now depleted deck in a set manner, a manner that would either favor the player or the casino. Independent trials processes were not a

factor in this game and thus, Ed reasoned, all you needed was a decent frequency of favorable situations and adjustments in the betting spread in order to get the edge. Ed, whether he realized it or not was on the edge of something himself.

In the fall of 1961 Ed was CLE Moore instructor at MIT and went to Washington to present a paper entitled 'Fortune's Formula' at the American

Mathematical Association. After the trip to Nevada Ed had tested some of his own theories on MIT's own IBM 704 mainframe computer (a far cry from 10-cent slide rules!) and duplicated in a few hours what would have taken over 10,000 man years of labor on a hand held calculator. It was these findings that he presented in Washington. At the end of the presentation all of Ed's mimeographed copies of his report were snapped up as the 300 or more mathematicians in the room rushed the podium. When Thorp had arrived in Washington he was already aware that the media had whipped up a small storm in advance. An AP reporter had been leafing through the Association's abstracts prior to the meeting and called Ed, this resulted in a story in the *Boston Globe* the next day. Ed recalls that the phone was ringing off the hook for



the next four days, his wife Vivian filled an entire legal pad with messages before finally refusing to pick up the phone, their daughter - for weeks after - would cry at the sound of a phone ringing. The following weeks at MIT all six faculty secretaries were snowed under by tens of thousands of letters - until the university had to tell Ed to deal with the correspondence himself because the secretaries weren't able to deal with other faculty business.


### Lady Luck RIP

Of course, it wasn't just letters. Offers to bankroll Thorp came apace, but Ed didn't take the bait. However, this situation was to change in early 1961. One of the people who had read about Ed's presentation was Emmanuel 'Manny' Kimmel, a professional (and very successful) gambler whose own background could not be further from that of Thorp's. The story goes that Kimmel was kidnapped as a child and put to sea - he managed to jump ship somewhere in the Far East where he found work on a cattle boat - the work involved a shovel - and from then on he raised himself. He was a well-known face in the demimonde and one of the best proposition men in the US, he had a good uneducated, intuitive understanding of odds and "proposition bets". Not being a man of letters Kimmel had Thorp checked out, phoned him, and made his way to Thorp's apartment in Cambridge, MA. Kimmel's proposal coincided with Ed's decision to try out his theories in practice, to show skeptics that his theory really worked and in preparation for a book he planned. "A lot of people said it was pie in the sky; a half-baked theory and a few challenged me to actually do it. So having a childhood experience of actually doing things in science as well as thinking about theories I knew I had to do it." Ed goes on to describe the day he met Kimmel, "One wintry afternoon

in February 1961 we looked out our window and saw a midnight blue Cadillac pull up, but I didn't see the man I'd spoken to on the phone - I saw two young blondes in mink coats and they got out - and tucked as snug as could be between them in a long cashmere coat was Kimmel. He introduced the two blondes as his nieces; I took it on face value but my wife disagreed! She was much more aware of the ways of the world than I was, she was a literature major and very widely read. She's very perceptive about people, what makes them tick and what their hidden agendas are."

Whatever Kimmel's background was Ed was blissfully unaware of it at the time. Kimmel was later to be immortalized as Mr X in *Beat the Dealer*,

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wherein Thorp goes into some detail about the trip to Reno that Kimmel and another flush gambler, Eddie Hand (Mr Y), bankrolled in 1961. It wasn't until the early '90s that Ed learned about Kimmel's credentials, during a conversation with the author Connie Brook who was working on *Master of the Game*, 

### THE RULES OF BLACKJACK OR 21

The aim of the game for the player is to hold a card count greater than that of the dealer without exceeding 21 (going 'bust').

Before any cards are dealt, the player must place his bet in front of his table position. The dealer deals two cards to each of the players, and two to himself (one of the dealer's cards is dealt face up and the other face down). Court cards (kings, queens and jacks) count as 10, ace counts as either one or 11 and all other cards are counted at their face value. The value of the ace is chosen by the player.

If the player's first two cards are an Ace and a 10-count card he has what is known as 'blackjack' or a natural. If he gets blackjack with his first two cards the player wins, unless the dealer also has a blackjack, in which case it is a standoff or tie (a 'push') and no money changes hands. A winning blackjack pays the player 3 to 2.

'Hit' means to draw another card. 'Stand' means no more cards are taken. If the player hits and busts, his wager is lost.

The player is also allowed to double the bet on his first two cards and draw one additional card only. This is called 'doubling down'.

If the first two cards a player is dealt are a pair, he may split them into two separate hands, bet the same amount on each and then play them as two distinct hands. This is called 'split-



ting pairs'. aces can receive only one additional card. After splitting, ace+10 counts as 21 and not as blackjack.

If the dealer's up card is an ace, the player may take insurance, a bet not exceeding one half of his original bet. If the dealer's down card is a 10-count card, the player wins 2 to 1. Any other card means a win for the dealer.

It is sometimes permitted to 'surrender' your bet. When permitted, a player may give up his first two cards and lose only one half of his original bet.

The dealer must draw on 16 and stand on 17. In some casinos, the dealer is required to draw on soft 17 (a hand in which an ace counts as 11, not one). Regardless of the total the player has, the dealer must play this way.

In a tie no money is won or lost.

Rules differ subtly from casino to casino, as do the number of decks used.

The advantage to the dealer is that the player can go bust, losing his bet immediately, yet the dealer may later bust. This asymmetry is the key to the house's edge. The key to the player's edge is that he can vary both his bets and his strategy.



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a book about the creation of Time-Warner. Mr X was closely associated to Longie Zwillman – aka Mobster Number Two – and had made his money bootlegging and running numbers in the '30s. Ed recalled that on their first meeting, on a bitter winter day, Kimmel had told him that he owned 64 parking lots in New York, and due to the weather snowing them out for two days he had lost \$1.5 million. Bruck explained to Ed that Kimmel had a controlling stake in Kinney National Services, whose 1960s SEC filings revealed that amongst their assets were indeed 64 parking lots in New York!

Hand and Kimmel had one very simple goal; they wanted to bankrupt

Nevada. They were sure that with the help of their secret weapon, 'The Professor' and a bankroll of \$100,000 this would be a feat both achievable and worth savoring. Ever the empiricist, Thorp declined the colossal stake and opted instead for the less imposing (but still sizeable) float of \$10,000. Four nights into the experiment Ed system was proving unstoppable. The Wagon Wheel in Lake Tahoe saw Thorp play against six dealers in a row, without a break and without losing a cent. Kimmel was also playing at the same table, and Ed was so into the system that he was able to direct his



All Ed needed to know about blackjack in the palm of his hand

backer as well as play his own hands. By the time Ed decided to bring the slaughter to an end and retire to his room, he was \$17,000 ahead. But superstition and luck are constant companions to the dyed in the wool gambler, Kimmel could not equate the streak with anything but the 'fact' that the cards were 'hot'. The system, the professor, and good management were but a distant concept to him now. Ed left, exasperated after trying to convince Kimmel to cash in his chips and return another day. In less than an hour Kimmel squan-

dered \$11,000. After five days the group decided to call it quits, they discovered that despite Kimmel's voodoo possession they had still managed to leave with \$21,000 on a capital outlay of \$10,000, Ed returned to Boston financially secure for the first time in his life.

A question of finance

During the summer of 1964 Ed was at liberty to conduct whatever kind of research he wanted. He decided to spend it educating himself about the stockmarket and see if he could discover a system for giving himself an edge in the stockmarket over the kind of performance people attained by chance. He observed that on average everyone did

BEATING THE DEALER

The first key is in having the optimal strategy. That means knowing whether to hit or stand. You're dealt an eight and a four and the dealer's showing a six, what do you do? The optimal strategy involves knowing when to split pairs, double down (double your bet in return for only taking one extra card), or draw a new card. Thorp used the computer to calculate the best strategies by simulating thousands of Blackjack hands. In his best-selling book *Beat the Dealer* (Random House, 1962, revised 1966) Thorp presented tables like the ones below showing the best strategies.

But the optimal strategy is still not enough, without the second key. You've probably heard of the phrase 'card counter' and conjured up images of Doc Holliday in a ten-gallon hat. The truth is more mun-

dane. Card counting is not about memorizing entire decks of cards but keeping track of the type and percentage of cards remaining in the deck during your time at the blackjack table. Unlike roulette, blackjack has 'memory'. What happens during one hand depends on the previous hands and the cards that have already been dealt out.

A deck that is rich in low cards, twos to sixes, is good for the house. Recall that the dealer must take a card when he holds sixteen or less, the high frequency of low-count cards increases his chance of getting close to 21 without busting. For example, take out all the fives from a single deck and the player has an advantage of 3.3 per cent! On the other hand, a deck rich in 10-count cards (10s and court cards) and aces is good for the player, increasing the

chances of either the dealer busting or the player getting a blackjack (21 with two cards) for which he gets paid at odds of three to two. In the simplest case, card counting means keeping a rough mental count of the percentage of aces and 10s, although more complex systems are possible for the really committed. When the deck favors the player he should increase his bet, when the deck is against him he should lower his bet. (And this bet variation must be done sufficiently subtly so as not to alert the dealers or pit bosses.) In *Beat the Dealer*, Ed Thorp published his ideas and the results of his 'experiments'. He combined the card counting idea, money management techniques (such as the Kelly criterion) and the optimal play strategy to devise a system that can be used by anyone to win at this casino game. "The book that made Las Vegas change the rules", as it says on the cover, and probably



the most important gambling book ever, was deservedly in the *New York Times* and *Time* bestseller lists, selling more than 700,000 copies. Passionate about probability and gambling, playing Blackjack to relax, however even Ed himself could not face the requirements of being a professional gambler. "The activities weren't intellectually challenging along that life path. I elected not to do that."

Once on a film set, Paul Newman asked him how much he could make at blackjack. Ed told him \$300,000 a year. "Why aren't you out there doing it?" Ed's response was that he could make a lot more doing something else, with the same effort, and with much nicer working conditions and a much higher class of people. Truer words were never spoken. Ed Thorp took his knowledge of probability, his scientific rigor and his money management skills to the biggest casino of them all, the stock market.

		DEALER'S UP CARD									
		2	3	4	5	6	7	8	9	10	A
YOUR HAND	17+	S	S	S	S	S	S	S	S	S	S
	16	S	S	S	S	S	S	S	S	S	S
	15	S	S	S	S	S	S	S	S	S	S
	14	S	S	S	S	S	S	S	S	S	S
	13	S	S	S	S	S	S	S	S	S	S
	12	H	H	S	S	S	S	S	S	S	S
	11	D	D	D	D	D	D	D	D	D	H
	10	D	D	D	D	D	D	D	D	D	H
	9	H	H	H	H	H	H	H	H	H	H
	8	H	H	H	H	H	H	H	H	H	H
	7	S	S	S	S	S	S	S	S	S	S
	6	S	S	S	S	S	S	S	S	S	S
	5	S	S	S	S	S	S	S	S	S	S
	4	S	S	S	S	S	S	S	S	S	S
	3	S	S	S	S	S	S	S	S	S	S
	2	S	S	S	S	S	S	S	S	S	S
		Insurance is not recommended									
		Hit Stand Double Down Split									







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468 IF(N-1)74,266,267
268 EDD(I,J)=EDD(I,J)+ES(I,SUM)*
GO TO 270
269 EDD(I,J)=EDD(I,J)-Q(N)/(AMT
270 CONTINUE
470 EDD(I,J)=2.*EDD(I,J)
IF(EM(I,J)-EDD(I,J))272,271
271 E(I,J)=EM(I,J)
GO TO 273
272 E(I,J)=EDD(I,J)
DD(I,J)=1.
273 Q(I)=Q(I)+1.
274 E(J,I)=E(I,J)
275 CONTINUE
Q(J)=Q(J)+1.
280 CONTINUE
DO 281 N=1,10
281 ESP(N)=0.
IF(Q(1)-2.)285,282,282
282 Q(1)=Q(1)-2.
DO 284 N=1,10
284 ESP(1)=ESP(1)+Q(N)*ES(N+11)
Q(1)=Q(1)+2.
285 DO 290 N=2,9
IF(Q(N)-2.)290,286,286
286 Q(N)=Q(N)-2.
DO 287 L=1,10
287 ESP(N)=ESP(N)+Q(L)*E(N,L)/(
Q(N)=Q(N)+2.
290 CONTINUE
Q(10)=Q(10)-2.
DO 293 N=2,10
293 ESP(10)=ESP(10)+Q(N)*E(N,10)
ESP(10)=ESP(10)+Q(1)*ES(21)
Q(10)=Q(10)+2.
DO 295 N=1,10
295 ESP(N)=2.*ESP(N)
DO 299 N=1,10
IF(E(N,N)-ESP(N))297,296,29
296 SP(N)=0.
GO TO 299
297 E(N,N)=ESP(N)
SP(N)=1.
299 CONTINUE
10
EVK(ID)=0.
DO 303 J=1,10

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well in the long run barring short-term unpleasanties. The summer ended and it was back to work at the university, but picked up again in the summer of 1965, which the Thorps spent in Los Angeles. Ed had sent away to the periodical Barrons for some information on warrants and on receiving the material he noted that they could be mathematically analyzed because they were so much simpler than stock. He saw that most of the variables were captured by the stock, and most of the differential behavior was between the stock and the warrant, thus he could eliminate most of the variables.

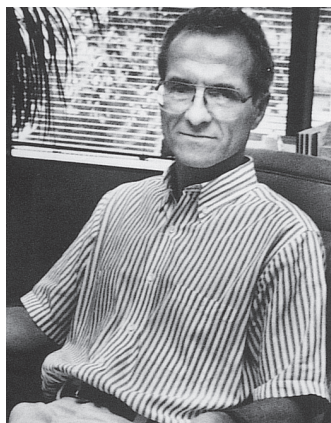
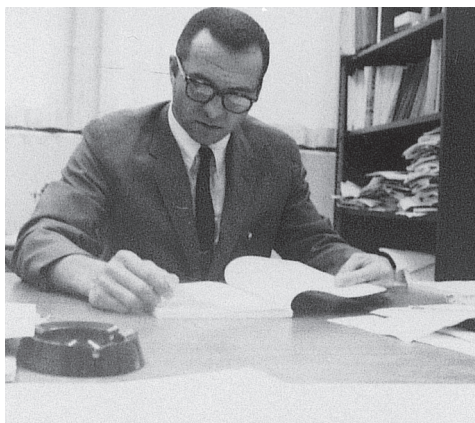
When Ed joined the new University of California campus which opened in Irvine that fall Ed ran into Sheen Kassouf, who was also joining the new faculty as an economist. Kassouf had been working on the same idea, but far in advance of Ed, and had actually started trading on it. The two decided to collaborate and the result was the book *Beat the Market*. Kassouf recalled that time '100 years ago' "I think at the very first meeting when we went to talk about it, we met in this conference room in the dean of social science's office. One of the people there, the associate dean Julian Feldman, later told me that it was a battle for the chalk between Ed and I ... rat-a-tatting there on the blackboard over pricing and relationships and so on. I think he was very interested in finding some mathematical application to finance. Being a mathematician and being able to apply it to finance and make money from it, was a very interesting endeavor. He convinced me that was true." Kassouf was impressed with Thorp's sophisticated approach to life, "I was a naïve, but not young, academic. That was my very first entry into the world of academics and the life of the mind and I hadn't thought of it in a commercial way, I was more interested in the theoretical

underpinnings and of course I was practicing this for a number of years on my own accounts and friends and family, but I never thought of expanding it to a book until I met and talked with Ed. We got a \$50,000 advance, which to me was staggering; my annual salary at the time was something like \$10,000! I was an assistant professor. So it was going to be a sequel to *Beat the Dealer*. He also wanted to develop some expertise, he liked the impersonality of the financial markets rather than the one-on-one of Las Vegas - where you're actually dealing with the person whose money you're winning, leading sometimes to unhappy kinds of results, whereas in financial markets you don't really know who's on the other side, and that appealed to him a good deal I think."

In late 1967 early 1968 Ed started trading OTC options. Prior to this he had sat down to figure out what they were actually worth, using integration. He saw there were a few unknown parameters, so with very little to go on he applied Occam's razor, went for the simplest possible choice, and had a few other reasons for making the choice - actually what Ed had worked out was what would ultimately come to be known as the Black - Scholes formula. Modest to a fault however Ed had this to say about it: "I just happened to guess the right formula and put it to use some years before it was published. I was convinced it was right because all the tests that I applied to it worked. It did all the right things; it gave all the right values, and had all the right properties. The way you prove it is by using the arbitrage argument. Much later, in 1973, Black sent me a preprint of his paper and wrote that he admired my work, and said that his methods differ from mine in that they go one step further than simply hedging - they make an assumption that you have a perfect hedge that you should get the same



## ED THORP



### ON THORP

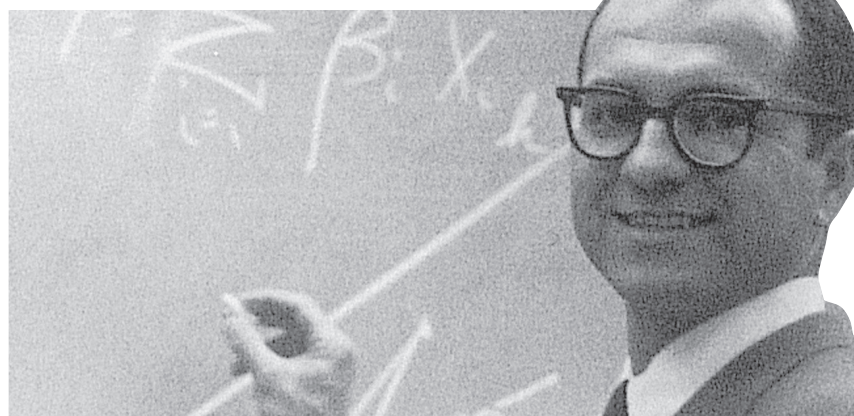
"Over the years, through Princeton Newport and through his recent ventures, Ed has shown that anomalies can be exploited and successfully traded. In my lectures I use the 1968-88 Princeton Newport results: 15.9 per cent mean (net) with 4% standard deviation as the standard for superior hedge fund management. Others such as Soros have had higher means but the smoothness of Ed's record rates it right at the top and a challenge for others to duplicate. We all have a lot to learn from Ed and a few of us have had the pleasure to work with him and learn from the master." **Bill Ziemba**

"One time Ed and I attended a fairly large investment conference at La Quinta in the desert near Palm Springs. As an entertainment activity the conference people were running a 'racetrack' in which they ran films of races and had betting with play money they provided. When it started Ed looked at the process and said something like 'I can figure this out'. He stood and thought about it for less than two minutes and then said 'I've got it'. So we all pooled our money and he placed some bets. An hour or so later we had cleaned up. As I recall we ended with more 'money' than everyone else put together." **Jerome Baesel, Managing Director Morgan Stanley Alternative Investment Partners and lead Portfolio Manager on Morgan Stanley's fund of hedge funds. Jerome and Ed worked together at Princeton-Newport Partners for ten years**

"Despite all his amazing and internationally recognized professional accomplishments, Ed is quite modest and upon a casual meeting with him, a person would not be aware of all his fame. His ethical and moral standards are of the highest quality. He is a very real role model, rare in this day and age. Ed has a great sense of humor and is a wonderful storyteller in person, as you might imagine from his *Beat the Dealer* book. Ed has a large number of personal interests and for each one devours the subject and devises his own quantitative approach. For example, some 20 years ago, Ed and I trained together for some marathons (including Boston and New York). Ed had determined mile markers for a number of routes near his home. I recall Ed then on a training run looking at his watch and saying that we were running (for example) at a 7'10"/mile pace. During his competitive running years, Ed kept large quantities of training data including physiological (pulse rates, etc.) quantities to help him monitor his progress. I'm sure his plots and analyses would be of interest to coaches." **Gordon Shaw professor emeritus of physics at Univ of California Irvine and discoverer of the "Mozart Effect"**

result as if you'd bought a riskless security – that was the key observation. I actually had a note I had made in 1970 saying I ought to pursue that line, but I was so busy trading securities and using the formula that I never took the opportunity. Black and Scholes found the formula in 1969, I was already trading using the formula in 1967/68 trading on OTC Options at the time."

As the sixties came to a close word of Ed's investment methods had spread around UCI, by November of 1969 he had



a dozen or so individual accounts which had anywhere between \$25,000 and \$100,000 in them. These were put into warrant hedges whilst Ed traded in options on his own account using his own anticipation of Black – Scholes – Ed didn't apply this to the other accounts because although he had, as he puts it 'guessed' the method he didn't have what he felt was definite proof. However he was using that methodology amongst others to evaluate warrant hedges. It was at this time that he ran into





the legendary Warren Buffett. The meeting occurred through the auspices of Ralph Gerard – dean of the graduate division at the University of California, and one of Buffett's original investors. Gerard was a relative of Benjamin Graham, the man who single handedly

created modern security analysis and set the highest standards from the 1920s until his retirement in 1955; Graham in turn was Buffett's mentor.

Buffett had decided that stocks were overpriced in 1968 and decided to shut down his partnership, and return the money to all his very happy investors. Gerard was looking for someone to invest with and had just read *Beat the Market*, Buffett had averaged 24 per cent for the last twelve years, and Gerard

wanted him to take a look at Ed as a candidate for investment. The first meeting was at Gerard's where they played bridge and discussed finance; the second

was dinner with their wives. After that Thorp and Buffett never met again, but Gerard invested. In a recent interview by journalist Ken Kurson Buffett fondly remembered his meeting with Ed. 1969 saw Convertible Hedge Associates launched, it was the first market neutral hedge fund utilizing OTC options, convertible bonds, warrants and preferreds. All the hedges were approximately delta neutral, and all of these four years before either options were listed or the Black-Scholes formula was published.

## Consistency to calamity

Between November 1969 and it's dramatic demise in 1988 at the hands of Rudi Giuliani, Princeton Newport Partners (formerly Convertible Hedge Associates) demonstrated astounding consistency and growth. Over the 19 years in operation the total percentage increase was 1,382 per cent, an annual compound rate of return of 15.1 per cent. Compare this to the same period in the S&P 500, which saw an increase of 545 per cent and an annualized rate of return of 10.2 per cent or three-month US Treasury Bills, 345 per cent total increase, 8.1 per cent annualized. Ed worked on the theory from the West coast while his associate Jay Regan did the selling and made the transactions in the East.

The days of the raider loomed large in the 1980s, and the poster boy of the period was Michael Milken of Drexel Burnham. His use of bonds to finance second tier firms and also the raiders who were proving the bane of the 'light shoe' directors of major companies made him an obvious target for reprisals. Unfortunately Milken was also committing a number of excesses and violations of securities laws, trading fast and loose. Thorp's partner, Jay Regan, dealt extensively for the partnership with Milken and his group at Drexel Burnham. Through Regan, Thorp had met several of the leading people in Milken's group, including his brother Lowell, and they always acted cordially

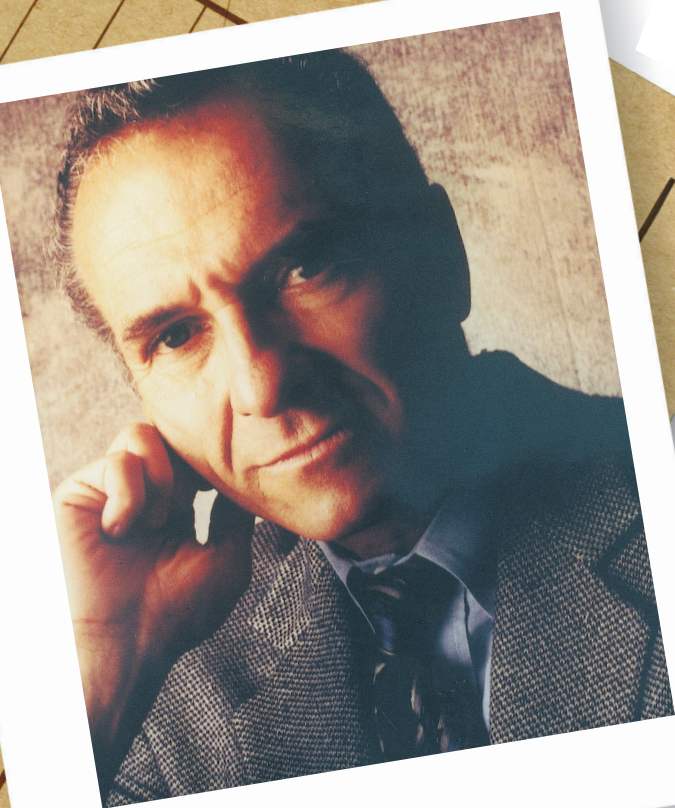
to the professor. There was nothing to suggest any illegal activity whatsoever.

Rudi Giuliani was then US Attorney for the Southern District of New York I, he saw an opportunity to emulate Tom Dewey who busted the bootleggers in the 1930s. Milken proved too difficult to get a grip on The second in line was Robert Freeman at Goldman Sachs. Freeman had been James Regan's roommate at college. Goldman was prime broker for PNP. Giuliani decided if he applied pressure to Regan he'd get Freeman and Milken. PNP became the number one target. In December 1987, the ATF, FBI, Treasury came pouring out the elevators at the Princeton offices of the partnership, and they seized hundreds of cartons of records. To Thorp it was all nonsense, but it turned out there were three tapes that would prove to be destructive.

"They found some incriminating stuff," Ed recalls, "someone at PNP and someone at Drexel were manipulating a new security that Drexel was issuing, they wanted to control the price at issue date, so there was an agreement about what we would buy, and how much and so on. Then there was a stock-parking issue. Someone at Drexel had used up his \$25 million capital limit and wanted to put on more positions. Of course Drexel had a capital limit and didn't want any more positions. What he did was sell part of his positions to Princeton-Newport and agree to buy them back at 20 per cent annualized profit. So this is parking – illegal because it conceals the true ownership of securities.

Giuliani invoked RICO, the first time it was used against a securities firm. Two incidents were needed over ten years to prove a pattern;

"They tried tax fraud, wire fraud, and mail fraud and so on to try to get us. Tax was a joke because it turned out we paid taxes on \$4 million twice – we made an accounting mistake, so we



**1969 saw Convertible Hedge Associates launched, it was the first market neutral hedge fund utilizing OTC options, convertible bonds, warrants and preferreds.**



**YOU HAVE** ↓ **DEALER SHOWS** →

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10	4.2	4.7	████	████	████	4.0	2.7	2.2	2.0	1.8
9	2.1	2.2	2.6	2.9	████	1.9	1.5			1.1
8	1.3	1.4	1.6	1.8	1.9	1.0				
7			1.2	1.2	1.2					
6				1.1	1.0					

were owed money. It took ten years for us to get back some of the money, every individual partner had to file separately. I got my money back – but it cost a lot in legal and accounting fees.”

The case was brought to trial, Thorp offered to take over the running of the partnership if Regan would step down until proven innocent. Everyone could return and reclaim their share once the trial was over. Regan declined. Thorp didn’t want to continue in an atmosphere of suspicion, and the partnership was dissolved.

“Five people, including James Regan were convicted from the Princeton office, given fines and jail terms. One Drexel trader was given fines and jail terms. They appealed, and it was found that the judge had given improper instruction to the jury, so it was brought to retrial. Giuliani had gone on to greater things and he couldn’t care less, US Attorneys had lost interest because by then they’d gotten Milken, Freeman and so on, so didn’t contest. The conclusion was that the defendants were ‘Not found guilty’ as opposed to ‘Found not guilty.’ It was basically a vendetta.

The acrimony, the legal complications, the lack of direct communication decided Ed to quit the business for a time. He felt that he wanted a smaller shop, a simpler life. In the early 1990s he had done some Japanese warrant trading and Nikkei put options. He

shrunk the operation from 40 to 20, then he proceeded to leave warrants, and the staff shrank to six. In 1991 Ed was informed by one of his larger investors that one of his products, Statistical arbitrage, was doing very well. Since 1992 Ed has been running his Stat Arb operation, and a parallel hedge fund since 1994. When LTCM happened statistical arbitrage positions were one of the few good positions left. Thorp profited as hedge funds suffered a run on the bank, liquidating good positions in order to hold on to the bad. Diligence and a supreme commitment to logic and empirical evidence once again proved Ed right. The irony is that mutual friends had offered to have him become a limited partner of LTCM – he had turned it down flat. “Because I knew of Meriwether’s history at Salomon, he was a big roller of the dice. I’d had some interchange with Samuelson and Merton over logarithmic utility; it’s a particular prescription for approaching certain risk problems. They made the trivial point that it’s not all things to all people, but no-one believes that anyhow. And I could see that they didn’t understand how it controlled the danger of extreme risk and the danger of fat tail distributions. So that was a theoretical point on which we fundamentally disagreed. It came back to haunt them in a grand way.”

**“And I could see that they didn’t understand how it controlled the danger of extreme risk and the danger of fat tail distributions. So that was a theoretical point at which we fundamentally disagreed. It came back to haunt them in a grand way.”**

The last year has been an as Ed watches the flight from equities with great interest. His mind now turns to the future. “People who run things like statistical arbitrage operations have gotten a lot of new money, and many of them have imprudently expanded, their returns have gone negative as a result. People have also found it easy to start up funds of that type, due to the demand - and those people may not be particularly qualified. More money is chasing the same opportunities, thus driving the value of the opportunity down. Our policy has been to stay moderate in size and allow size to fluctuate according to what we see as our near term performance in the market. We shrank to a third then expanded to a half of our peak size. That’s where we sit now.”

“The outlook for equities is not quite as good as it has been over the last century. There are a number of excesses that need yet to be corrected, we seem to be reading daily, week after week in the press about this. People are used to a high rate of return, now they’ve seen two-three down years in a row. They tend to over-correct. They’ll flee to other areas, market neutral hedge funds, property – in Southern California where I live the rise in property prices over the last year has been about 20 per cent, and there’s only a two month inventory left of properties at market. Seven months used to be the typical supply. Real estate will run its course, and a thundering herd of investors will run to the next asset class.”

A fitting enough image to leave off on. Ed Thorp has defined not just what it means to take a quantitative approach to finance over the past half century. His values remind us that it is the evidence of your own eyes and the power of the intellect which guard against the temptation to jump on the latest bandwagon until it rolls over a cliff.