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CHAPTER THREE

An Introduction to the
Theory of Casino Twenty-One

Of all the many games of chance offered in a modern casino, twenty-one is unique in having no fixed percentage working against the player. The other games banked by the casino, such as craps and roulette, for example, are what mathematicians term "independent trials processes." Each toss of the dice or spin of the wheel is a separate, independent event, in no way influenced by previous tosses or spins. For this reason, the odds never change; and since the casinos have been careful to structure these games so the percentage always favors the house, there is no system, betting scheme, or playing strategy capable of overcoming the casino edge. The longer one plays at such games, the more opportunity the unfavorable odds have to express themselves, and the greater the likelihood of a serious loss.

The odds during play at twenty-one, on the other hand, are constantly changing and are subject to what are termed "conditional probabilities." Don't let that term scare you; the idea is really very simple. As cards are dealt out of the deck(s) to complete a round of play, the odds (conditional probabilities) of drawing specific cards change, both during the current round and for future rounds, until the cards are reshuffled. As an example, suppose that on the first round after the shuffle, all four aces appear in a single-deck game; this means that on subsequent rounds dealt before the next shuffle, no aces can appear. Therefore, the chance of the player getting a blackjack is exactly zero. This differs markedly from the 4.8% chance the player has of getting a blackjack on the first round of play after a shuffle. And since blackjacks greatly favor the player, it is obvious their absence shifts the odds in favor of the house. If, on the other hand, no aces had appeared on the first round, the chance of the player getting a blackjack on subsequent rounds dealt before the reshuffle would be greatly increased, and the odds would shift in the player's favor.

It is this unique feature of twenty-one, the constantly changing basic odds, combined with the opportunities afforded the player to exercise skillful play, that makes it possible to beat the game and, in effect, turn the tables on the house.

Why, you may wonder, would the casinos be so foolish as to bank a game that can be beaten with skillful play? That's a fair question. The primary reason is that when the game was first introduced in the casinos, during the early 1930s, no one imagined it was vulnerable to defeat. The casinos knew the basis for the house advantage lay in the fact that if the player busted he lost his wager, even if the dealer, in playing out his hand, were also to bust. In fact, this "double bust" rule was so strong for the house, it was necessary to offer the player a number of bonuses and playing options just to reduce the house advantage to a level the players would tolerate. The most important of the bonuses, the 3 to 2 payoff on untied player blackjacks, reduced the house advantage by 2.3%. The double down and pair splitting options, *with typical play*, took about another 1.2% off the casino edge. And various other minor bonuses (rarely encountered nowadays), such as a $5 bonus for a player natural consisting of the ace of spades and either the jack of spades or jack of clubs (hence the name "Blackjack"), reduced the house edge by another .1% or so, depending on the amount of the player's average wager. In total, these features, *with typical play*, reduced the house edge by about 3.6%. And still, in spite of all this, the casino win consistently amounted to about 20% of the players' total buy-ins, suggesting the players, as a whole, were losing at a rate of between two and three percent of their action!

As tables were full, and profits were excellent, with no players winning consistently, it is little wonder the casinos assumed the game was completely secure and would go on "getting the money" indefinitely.

But this is where the plot begins to thicken. For, about this time, a small team of mathematicians, headed by Roger Baldwin and William Cantey, working at the Army's research laboratory at Aberdeen Proving Grounds in Maryland, began to grow weary of developing ever more efficient ways of blasting large rocks into very small rocks and started looking around for new worlds to conquer. Since both Baldwin and Cantey had been bitten by the blackjack bug and had been consistently picked clean on their infrequent sojourns into casinoland, it seemed natural that a deeper look into this intriguing little game was in order.

When they began their analysis, the Baldwin team reasoned that proper use of the playing options afforded the player, such as when to hit and when to stand, when to double down, and when to split a pair, should decrease the overall house advantage significantly. They had no idea by how much, but it was obvious the

average player, who lost at a rate of between two and three percent, was not using these options anywhere near optimally. Unfortunately, computers were not yet in general use, even in government think tanks, so Baldwin & Co. had to use desk calculators. This unpleasant fact turned a tough job into mission improbable, and our heroes labored for months and months, hovering over their calculators for endless hours, far into the night, in dimly lit little rooms, until finally one night Baldwin looked up from his labors and croaked, "I've got it!" Of course, by this time, Baldwin and his friends were so hunched over from the long hours spent at their desks they looked like they had been studying posture with Quasimodo; but it was worth it because, for the first time, the proper playing strategy for casino twenty-one had been discovered! This strategy has come to be called the basic strategy, and it provides the player with the correct play for any possible hand, when the only information he considers is the dealer's up card, and the cards that comprise his own hand.

When they published their results in the September, 1956, issue of the *Journal of the American Statistical Association*, the Baldwin team claimed their strategy reduced the house advantage to a meager .62%. Further research, using high speed digital computers, has shown that with the rules assumed in the Baldwin study the actual advantage was .1% for the players! In other words, when you are playing basic strategy on the Las Vegas Strip, in a single-deck game, the house has no advantage whatsoever. For all practical purposes the game is dead even. This result has been verified countless times in major research laboratories around the world. IBM, General Dynamics, Sperry Rand, the Jet Propulsion Laboratory, the Massachusetts Institute of Technology, and the Atomic Energy Commission are among the highly respected laboratories that have verified the power and accuracy of basic strategy.

If you are to become a world-class player, or even just a good player, it is absolutely essential that you master basic strategy—and I do mean master. You must be able to play it quickly, accurately, automatically, and without conscious thought. The reason basic strategy is so important is because even when you progress to a more powerful winning system, you will still play basic strategy over 75% of the time. And also because when you pick up your hand, you will immediately know what you are probably going to do and therefore avoid making any foolish mistakes.

In spite of the fact that the Baldwin strategy showed the player how to confront the casinos on essentially even terms, it had very little impact and went virtually unnoticed outside of academic circles. One person who did notice, however, was an associate professor of mathematics and statistics at the University of California at Los Angeles (UCLA) named Edward O. Thorp. Thorp took a long, hard look at Baldwin's results, then submerged himself in deepest thought. By the time he finally surfaced, he had reached some startling conclusions, conclusions that were to revolutionize the game of twenty-one, and shake the casino gambling industry to its very foundation. Thorp had perceived that blackjack could be beaten! And beaten badly.

He began his analysis with two facts. First, he knew from Baldwin's work that a player using basic strategy was playing about even with the house, over-all. But he also knew that the conditional probabilities were constantly changing, sometimes favoring the player and sometimes favoring the house. To be sure, the favorable swings were just canceled out by the unfavorable swings, and overall the results averaged out just as Baldwin had said. But what if the favorable situations could be identified, and "large" bets made at these opportune times, and "small" bets made when the deck(s) favored the house? The net effect should be that the player would win more on his "large," favorable bets than he would lose on his "small," unfavorable bets—for a substantial net win! Thorp also reasoned that, although basic strategy was the best way to play blackjack on the average, it was obvious that as cards were dealt during play, and the composition of the undealt pack changed, the player could sometimes improve upon basic strategy, and there-by add to his advantage, by varying his play depending on the current composition of the undealt pack.

To test his ideas, Thorp wrote a program, in Fortran, for an IBM 704 computer that, using direct probability theory, allowed him to analyze any arbitrary set of cards. He called this program the "Arbitrary Subsets Program." He found that when "small" cards (2,3,4,5,6,7) were removed from a complete deck, the odds were shifted in favor of the player and, conversely, when "large" cards (10,J,Q,K,ace) were removed, the odds favored the house. The density of the "intermediate" cards (8,9) was found to have little significance.

The reason a deck depleted of "little" cards favors the player is because when drawing to a "stiff" (hard 12,13,14,15,16) a relative excess of "large" cards in-

creases the likelihood of busting the hand; since the dealer hits all stiffs and the player does not, the dealer will bust many more hands than the player. In addition, when the player doubles down, he generally hopes to catch a "large" card; with a deck depleted of "small" cards, his chance of doing so increases. Finally, when the deck is rich in "large" cards, the chance of a blackjack increases, and since untied player blackjacks pay 3 to 2, and dealer blackjacks pay only even money, a blackjack will help the player more (50% more) than it will help the dealer.

Using all this information and more, Thorp developed a powerful winning system that involved keeping track of the relative density of the 10s (10,J,Q,K) versus the other cards. He called this system the Ten Count; it was the first scientifically derived "count" system ever devised.

In 1962 Thorp published the Ten Count, together with basic strategy and other valuable information, in his classic book *Beat the Dealer*. The book was an instant sensation. Within 30 days of publication it had shot to the top of the *New York Times* nonfiction best-seller list. And after the media picked up the story, people who didn't know a blackjack table from a picnic table were suddenly fighting each other for the last copy at the local book store.

For here was a book, written by a respected mathematician from a prominent university, that contained the secret formula for making free money! Or so some thought.

But if the man in the street were overreacting a bit, it was nothing compared to the hysteria that seized the casino industry. Their sweet little game had turned on them! Suddenly, they had nightmares of thousands of trained counters swooping down on them like swarms of merciless locusts, devouring every hundred-dollar bill in sight. The tension in the casinos was electric! Finally, their paranoia totally out of control, the Las Vegas casinos snapped! On April Fool's Day 1964, the casinos on the Las Vegas Strip changed the rules of blackjack. The first (and only) time the rules of a major casino game had ever been significantly altered. And the changes were drastic. Doubling down was restricted to two-card totals of 11 only, and a pair of aces could no longer be split. The effect on the average player was disastrous, and play at the twenty-one tables all but vanished. After a few weeks, when it became obvious the players would never buy the new rules, they were quietly scuttled, and play resumed as before.

In the aftermath of this bizarre incident, two important facts emerged. First,

before the rules changes, play at the blackjack tables had increased dramatically as new players, drawn in by Thorp's book, discovered twenty-one for the first time. And second, at the time of the rules changes there were not 10 counters in the entire State who played well enough and were well enough financed to pose any kind of a threat to the casinos at all. But how, you may ask, could this be so? After all, Thorp's system *did* work. The answer lay in human nature. Tens of thousands of people had bought *Beat the Dealer*, hoping to find a simple rule for riches they could memorize on the taxi ride to the casino. What they found instead was a scholarly textbook crammed with tables, charts, formulas, ratios, and all manner of forbidding esoterica. Though not difficult to understand, the Ten Count did require a lot of work and practice to learn to play well, and this is not what the people were looking for. They preferred instead to continue in their old uninformed ways: hitting all stiffs, standing on all stiffs, always splitting, never splitting, playing hunches, betting bunches, and watching their money disappear.

It has now been a good many years since *Beat the Dealer* burst on the scene, and despite the fact that several other fine books detailing powerful winning systems have also appeared, there has been far from any invasion of killer counters to overwhelm the casinos. Basic play has improved slightly, as players have picked up a pointer or two, but for every expert player turned out by books on counting, there are a multitude who think they can win but who have learned just about enough to lose. So, let me warn you now. Lady Luck has a heart of stone. If you treat her with respect and court her favor with care, she will reward you with riches. If you do not, she will wipe you out. It is just that simple.

I want you to be a winner, and this book contains everything you need to know to become a winning player. It includes all the knowledge and insight I have gained in over 20 years on the pro tour, as well as the results of many hours of theoretical analysis and computer simulations. Everything I know about twenty-one is here. The rest is up to you.