Blackjack Player Analysis and PROTEC 21

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Casino Blackjack is a game unlike most other casino games in that the natural flow of the advantage (for every player) is to swing to and from the house's favour, and the advantage ratio (dependent upon house edge) is approximately 70% of the time in favour of the casino. If the house edge was 0% then the advantage ratio would flow 50/50.

The skilled player attempts to mentally trace the cards by using a count system and accurately read these advantage points at each round and bet and play accordingly which suggests the question: ***What are the values that can be obtained from bet/play?***

By defining or altering the game rules the starting point advantage can be manipulated from zero to extreme casino/player advantages which naturally effects the fluctuating advantage at any point throughout the game.

The rules that alter the house edge are primarily the number of decks and the double and split restrictions. The more freedom a player has to "get more money" out on the table the less disadvantage a skilled player will initially face. By increasing the decks and restricting what can be split or doubled will increase the casino advantage over the player. A higher house edge does not necessarily mean more casino revenue. A relaxed game offering more occasions to put extra money onto the table will generally mean more mistakes by the typical player, hence possible extra revenue.

The starting point advantage (house edge) is calculated from the following parameters: what percentage of the player's bet will be lost, long term, with a flat bet (that is, betting the same unit every hand) and without "counting" (analysing) the cards or knowing any following segment make-up and adopting the optimal playing strategy (computer generated-no errors) for each situation.

Actual result outcomes of the rounds should favour the casino approximately 51% using a normal distribution of cards, following basic strategy (worse if the player deviates wrongly). Revenue is distributed differently: taking into account that Blackjack pays 3:2 for the player, and doubling down and so on, revenue is actually down to about 0.5% of turnover - this is the house edge.

Everyone has an error rate. It is possible to have a 100% error rate whereby every hand is hit until bust including a Blackjack! An optimal (common sense) playing strategy drastically reduces this figure. From casino revenue reports we know that the cumulative effect of all "bad play" totals approximately 1% of turnover (plus house edge totals 1.5%). A typical non threatening playing style (dependent on the individual player skill level) will therefore make approximately 1% loss of turnover from playing mistakes which suggests that playing strategy analysis is more useful in measuring a player loss rating. It is estimated that a proficient card counter/tracker could have a playing error rate as low as approximately 0.1%.

For a player at the table, the basic strategy is memorised from well documented and published playing charts (the "basic strategy") which state that the most important card on the table is the dealer up-card whereby its strength or weakness determines the playing decision: for example, *Player 16 against a dealer 10 is a hit.*

The average worldwide house edge is around the 0.5% mark. This figure in itself is marginally subjective. There are credible Blackjack experts in the world who have built software simulators for this purpose, who use slightly different analysis algorithms, therefore arriving at slightly different figures for any rule set and these calculations can differ randomly from box to box.

The simulation statistics shown in Table 1 are provided from a typical casino rule set, flat betting every round, no counting but playing the optimal strategy for every hand. In physical playing terms if someone played against a dealer it would take 500 years to play this many rounds. This would be considered a small- to medium-sized sample.

Player #	Rounds	Result
Player 1	50,000,000	-0.47%
Player 2	50,000,000	-0.47%
Player 3	50,000,000	-0.45%
Player 4	50,000,000	-0.43%
Player 5	50,000,000	-0.44%
Player 6	50,000,000	-0.48%
Player 7	50,000,000	-0.46%
Average	**50,000,000**	**-0.46%**

Table 1

The PROTEC 21 calculation for this rule set is -0.47. More samples could be generated and other boxes will "lose less" than others. The more hands simulated the closer the figures will get but they will never be all identical. This is why figures can be subjective.

Everyone has heard around "casino world" all the gambling theories including "lucky boxes". Well they are right!, there are such things as lucky boxes. Some simulations have maintained wins against the house using only basic playing strategy for long periods that would relate in physical terms to decades of play, longer than most would play in a lifetime! A lifetime lucky gambler! The problem is it is random and rare and impossible to mathematically predict, hence the customer goes "crazy and broke" searching for these winning streaks.

Therefore it is acknowledged that if a suspect randomly bets throughout the shoe (or flat bet equivalent) achieving a **Counter** and **Tracker rating** of approximately 1.0 and plays exact basic strategy the long term outcome is for the player to lose approximately -0.47% of turnover. Short term actual values are measured and indicated on the graphs as the **Session rating: x%.** A non threatening, typical style casino customer will on average make a further 1% of turnover loss from playing mistakes.

The next level of skill that is of concern is: ***What if the player flat bets but varies his play strategy according to the count? How much extra value can be extracted by doing this?*** (Assuming there is no cheating involved). A counting system that a player will use is one that can trace as accurately as possible the concentration flow of the cards as they are played thereby determining the make-up of what is remaining. Vary the play accordingly and with other calculations assess the advantage at any point in the game, concluded from long term probabilities of occurrence.

Again the player will memorise more charts, strategy variation charts ie: *at "x" point in time stand instead of hit; player 16 against a dealer 10 is a stand* (rather than *hit* in the earlier example) if 1 small card is removed over 6 decks. That is how sensitive some decisions are whilst most other variations require a larger bias to deviate. This is advanced play and does increase value but means more mental workload, the more charts the better value so as to derive an optimal decision for more possible bias situations and then recalling them accurately whilst under pressure at the table. Some counts are more accurate than others offering higher playing efficiencies and others higher betting efficiencies. The most common counts used by players would be the Hi/Lo or the Halves counts. Simply, one small card extra (per deck) represents a true +1 and one high card extra (per deck) is a true -1 and each + or - 1 is equivalent to 0.56% advantage swing increments. Therefore, if the house edge is determined as being 0.56% and a section of cards to be played contained one extra Ten (or Ace) card per deck (giving the player a 0.56% boost) then it is considered a break-even game.

This set of statistics (Table 2) comes from the same size sample as Table 1 above, flat betting but changing play strategy using index variations ranging from true Hi/Lo counts from -20 to +20 (many more than could be remembered in a player's head).

Player #	Rounds	Result
Player 1	50,000,000	-0.40%
Player 2	50,000,000	-0.38%
Player 3	50,000,000	-0.39%
Player 4	50,000,000	-0.37%
Player 5	50,000,000	-0.39%
Player 6	50,000,000	-0.38%
Player 7	50,000,000	-0.40%
Average	**50,000,000**	**-0.39%**

Table 2

As a general rule, the cumulative total value obtainable from the effect of all play strategy variations equates to approximately 0.1% showing that absolute computer perfect play variation (with flat betting) will reduce the house edge on these simulations from -0.46% to -0.39%. However, nobody could ever realistically expect to play this precisely. A reasonable error rate would likely negate most of this extra value.

Therefore, maximum extra advantage that can be obtained from play strategy variation cannot mathematically overcome a typical casino starting point advantage. The complementary values of bet variation proportionate to the advantage is essential. The bet size is where the "action" is. This represents the final debit or credit. *If the suspect isn't betting right they can double and split until the cows come home" and they won't win long term!* This is what is meant in the PROTEC 21 Frequently Asked Questions literature whereby it states that ***maximising advantage via playing strategy is 1/20th of the gain obtainable from bet strategy variation.***

PROTEC 21: The **Session rating** gives the actual bet value from the data (playing basic strategy). If it is believed that a suspect is playing better or worse than this value then some options could be used to compromise if desired:
a) Subtract (or add) an applicable value to the **Session rating**.
b) Alter the house edge - for example, to 0.39% instead of 0.46% on a suspect.
c) Alter the **Session rating** thresholds from the breakeven point of zero to what ever is considered applicable.
d) As in all cases, management judgement should always determine the final result toward any player privileges. It doesn't take too many rounds to get an idea of a suspect basic strategy skill level and adjust accordingly.

A bet size variation must be adopted in proportion to the fluctuating advantage with a playing style closely in accordance to the basic strategy charts as generated for a particular rule set in order to beat the game of casino Blackjack. Any negative value deviation from this basic strategy creates an undesirable (for the player) effect from the initial value gained from the bet placement.

NOTE: It must be emphasised that a bankroll management system must be also adopted. For example, for a 1% advantage bet no more than 1% of the bankroll (practically, 0.5%), otherwise over-betting will eventually lead to ruin. The same formula applies to casino management when accepting wagers from "Whale" bettors.

The analysis of a playing style is more to determine a player loss value rather than from a win/threat perspective which suggests it is of more value to the Gaming Floor/Host (rebates, complimentaries, etc?) rather than Surveillance/Security. From a practical **PROTEC 21 Bet Strategy Analysis Report** account, this playing style variation effect with a typical casino house edge may turn a (flashing) "Red" threat player into a "Green" (a loser by making playing errors as PROTEC 21 assumes the suspect plays accurate in a sense) but cannot turn a "Green" bettor into a "Red" threat via playing strategy. Surveillance/Security management should view this concern of low importance.

The advantage flow can only be exploited by an initial bet on the table and this represents that at a certain point in time, with a certain concentration of cards, the outcome of round results will favour the player or casino by a certain amount. If a suspect bets small with a casino advantage then the expected outcome will be to lose more hands with a smaller bet, then bet bigger with a player advantage and the expectation is to win more hands with a bigger bet, hence, a nett positive result to the player: lose more hands but win more chips! This has a direct bearing to the concentration levels of the ten and ace cards within the shoe.

So how much bigger does a suspect need to bet? This is totally dependent upon the distribution of rounds played at each advantage point. If a player has an advantage on every round then every hand has a positive expectation so it doesn't matter what the bet variation is.

As in calculating the house edge over many millions of long term trials and standard deviation theories, the same applies where we know that, using the Hi/Lo count, approximately 65% of all hands played will fall between true -1 and true +1. With each true 1 (T1) representing a 0.56% advantage, the advantage will lie between -0.56% and +0.56% approximately 65% of the time (assuming a 0% house edge). A typical House edge (-0.50%) will reduce this ratio to yield the casino an advantage about 70% of the time. A very different scenario may occur in the short term and the psychology for players is to ignore "long term" mathematical theories and somehow, some way, in the short term achieve more "positive" than "negative" results. Some succeed, most don't.

However, working from the long term advantage occurrence probabilities, we know that a certain number of hands should occur at specific advantage points. It can therefore be determined from a spreadsheet (Table 3) the wager required at each advantage point necessary to overcome the starting point House advantage.

a	**Total hands played**	**1,000**						
b	**House edge**	**0.47%**						
c	**Wager**	**$100**	**$100**	**$100**	**$100**	**$375**	**$375**	**$375**
d	**True count**	**<-3**	**-2**	**-1**	**0**	**1**	**2**	**>3**
e	**Frequency occurrence**	7.5%	10%	20%	25%	20%	10%	7.5%
f	**Frequency hands played**	75.0	100.0	200.0	250.0	200.0	100.0	75.0
g	**Turnover**	$7,500	$10,000	$20,000	$25,000	$75,000	$37,500	$28,125
h	**% advantage less House edge**	-2.15%	-1.59%	-1.03%	-0.47%	0.09%	0.65%	1.21%
i	**Turnover * advantage**	-$161.3	-$159.0	-$206.0	-$117.5	$67.5	$243.8	$340.3
j	**% of turnover**	0.0038%						
k	**EXPECTED PLAYER VALUE**	**$7.81**						

Table 3

A zero count occurs "x" often producing "y" number of hands multiplied by turnover multiplied by the current advantage, giving the value for each advantage increment.
If the turnover times advantage figure is greater than the turnover times disadvantage figure, this will theoretically produce more chips, long term to the player.
In Table 3, this is represented as: i = (g * h) and k = sum of i for each count.

Using the House edge figure of -0.47% it can be calculated that an **absolute bet spread ratio** of (approaching) 4:1 (as indicated on the **PROTEC 21 Counter rating**) is required to attain the breakeven point if every hand is played with a normal distribution. Practically, on the floor, with error rates, a player would look at around 5 or 6:1 to break even, and more to actually make money. However, if the negative expectation hands are minimised (via many means) obtaining a biased distribution then the required bet spread is reduced to the point where all hands being positive then no bet spread at all is needed (flat bet). If playing errors occur then the bet value figure (+ or -) is further eroded (in the casino's favour) by the value of the error. These error values are subjective but the cumulative effect of a typical style is known to be approximately1% of turnover.

The **Counter Rating** takes the average bet size when the projected advantage favoured the player and divides it by the average bet size when the projected advantage favoured the house. This will detect if larger bets were placed when there was a projected player advantage. The normal figure should be approximately 1.0 whereby a similar average bet size was placed at all projected advantage points. From the sample simulations we know a 4:1 bet spread is the breakeven point, therefore a **PROTEC 21 Counter rating** threshold setting could be fixed at a minimum of around 3.0, indicating a “Low alert “ on suspects approaching the breakeven point of just on 4:1.

The **Tracker rating** detects whether the player made larger bets on rounds that contained player advantage (more tens and aces) wherever they actually occurred in the shoe, not just projected. The normal figure should be approximately 1.0 whereby a similar bet size was placed at all actual advantage points. A higher than average (1.0) tracker rating is required to win, generally around the 2.0 mark (this is dependant upon the house edge). A card counter should get a slightly higher tracker rating than normal due to the natural effect of counting cards. A tracker is much more efficient in locating advantageous rounds by whatever means. A card counter may need to bet around10:1 on the **Counter rating** to achieve a 3:1 **Tracker rating**. Skilful trackers may rate 1.0 (or less!) on the **Counter rating** but 4.0 or more on the **Tracker rating** - undetectable by conventional means and yet much more threatening.

To simplify the values we know that cards that are given a negative face value are also given a negative advantage for the casino. Therefore, the **Tracker rating** takes the player bet size on hands containing more tens and aces and divides it by the bet size with hands containing more smaller cards, at every point in the shoe, whereby a typical style will again rate approximately 1.0 (having no prior knowledge of up-coming segments). A higher rating here will indicate that somehow, bigger bets (whatever figure) are placed at points that contain more tens and aces that long term will produce more player winning hands. Play strategy may vary (positively) to account for the richness of the extra tens and aces (remember, play strategy variation can only improve marginally by up to 0.1% from the bet/advantage figure).

The **Session rating** gives a value of the data entered, whether it favoured the casino or players. It measures the advantage of the cards that occurred in the round multiplied the bet size, and subtracts the house edge giving an expected value figure for the session.

All the above scenarios are a practical evaluation of a player situation whereby up-coming segments of cards containing favourable player expectation (extra tens and aces) may or may not be detected or exploited by bet variance.

Analysing whether a suspect played correctly or not (such as: the player should have hit, not stood) all becomes somewhat uninteresting after a period of time and a large part of the market will not need or want to analyse a **non-threatening** playing style. The areas of concern from a casino perspective on playing style is whether "**cheating**" was involved, whereby the value of the immediate next card(s) is known and exploited to advantage. This could involve dealer collusion, concealed hardware, and so on.

It would be possible to perform some sort of playing strategy analysis by assigning a value to each deviation from basic strategy (for every deviation, the value would have to take into account the dealer's up card, the currently held cards, the cards in the discard tray, and what the deviated decision was) and measuring a player's correctness against these values to determine a value which could be placed upon the player's deviations from basic strategy. However, according to currently accepted Blackjack theories, this is not adequate for accurate play analysis. The variations are too numerous, so that in fact for every decision *a computer would be required to run millions of simulations against the cards remaining in the shoe* to arrive at what the optimal playing decision should have been. Any value currently placed on a playing decision is inherently subjective and in any case does not indicate any cheating activity which may be taking place. Cheating can be detected by analysing whether more than a reasonable percentage of playing deviations appeared to be more favourable to the player than adhering to basic strategy.

Two pertinent quotes from "The Theory of Blackjack" by Peter Griffin:

> *"The player's many different possible variations in strategy can be thought of as many embedded subgames. Precisely which choices of strategy may confront the player will not be known, of course, until the hand is dealt, and this is in contrast to the betting decision which is made before every hand."*
>
> *"One of the great dreams for card counters is to have an optimal strategy computer for actual play".*

Does casino surveillance need to know how "correct" the suspect is, or how many charts have been memorised, from adopting a **non-threatening** playing style - or is it more important *to know if the suspect is a **threat,** from **cheating?***

A sequence of events from a PROTEC 21 user may be to evaluate everyone through the **Live Data Collection Module** bet analysis to "sieve" the suspects. For further analysis on any individual the data may be re-entered via the **Archive-mode Data Collection Module** to capture and analyse all game play activity.

DigitAce Systems delivers technology which runs on a 32-bit platform and the upgrade path includes networked systems. We have looked at other games using our unique game and player analysis approach in an effort to deliver a comparable level of gaming accountability and quality of management information for live gaming as currently exists with electronic gaming.

Shuffling Machines

If they are used correctly and their benefits maximised they are an excellent management and production tool and very complementary to PROTEC 21. Machines go a long way in standardising and controlling a vital procedure within the gaming industry - namely, shuffling - that has notoriously been open to gross deficiencies and exploitation. Payback benefits are greatly reduced down-time (due to reduced time spent shuffling) and enhanced security.

Some operators using machines are noted to have a procedure of cutting 3 decks off an 8 deck Blackjack game all to deter card counters (most with questionable ability) at what is a great cost from unnecessary shuffle down-time and dissatisfaction by other players at the table. Apart from shuffling more quickly there is also a need to shuffle less often. It still takes the dealer a couple of minutes turnaround downtime per shoe and its occurrence can be drastically reduced by moving the cut-card back to 85% penetration. Concerns toward any player (or machine) can be quickly assessed with PROTEC 21.

Card counters generally find the machines productive as with extra casino turnover comes more turnover for the player, hence more hands per hour for the skilled player.

If there are no machines on the property then the **PROTEC 21 Shuffle analysis** module is an alternative for properties to streamline their hand shuffling procedures.