A Statistical Characterization and Comparison of Selected˝Craps Money Management and Bet Selection Systems[1]

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Several money management and bet selection systems used˝in the game of casino craps are statistically analyzed using a computer craps simulator˝run on an IBM PC-compatible computer. The characteristics of the craps simulator are briefly˝discussed, focusing on the random number generator used. Each system is "played" many times to create two types of distributions: the˝bankroll value at the end of each trial for roll-limited simulations, and˝the number of rolls needed to produce a given bankroll (or until the bankroll is 0) for˝bankroll-limited simulations. A number of different starting parameters are used to create distributions for each˝system (e.g., the roll limits range from 100 to 800 rolls per trial, while the goal bankroll values range˝from 50% to 100% of the initial bankroll (which in turn ranges from 5 to 10 times an average bet)). ˝Several measures of the distributions are introduced, such as *volatility* of a system and the *mean win/loss ratio*. The effect of the various starting parameters on each system is examined, and the systems˝are compared to one another using the measures defined.

Motivation

Systems which have attempted to overcome the negative˝expectancy of casino games have existed as long as the games themselves. This paper examines˝systems in the context of casino (bank) craps, although some of the systems are applicable to˝other even-money casino games (e.g., roulette). Since every bet in craps, with the "exception" of free-odds bets, has a negative expectancy, and since the sum of a series of˝negative-expectancy wagers can never be positive, this paper does not attempt to find or define a system˝for craps with positive expectancy.

People who play craps may have different goals which˝would lead them to choose to use one system over another, given that they are going to play˝craps regardless of its negative expectancy. An example may be the player who wishes to use a system˝which has high bankroll variance in order to maximize his potential win, while another˝player may wish to play a system with low bankroll variance in order to conserve her bankroll and˝thus possibly prolong her time at the table.

This paper provides characteristics of several systems˝which are useful in making such determinations; few value judgements as to the relative˝worth of the systems are made (i.e., there will be no pronouncement of a "best system"), as the information is provided primarily so that readers may form their own impressions of the worth of a˝particular system based upon their personal goals.

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[1]Simulations presented in this paper were performed on a˝pre-beta version of CrapSim, produced by ConJelCo, 132 Radcliff Dr., Pittsburgh, PA,˝15237-3382.

The systems examined (and fully described later in this˝paper) are:

- Pass bet with full double odds,
- Simultaneous Pass and Don't Pass bets, with full doubles˝odds on the Pass bet,
- Hoyle's Press,
- Ponzer (Pass, two Come bets, full double odds on all bets),
- D'Alembert,
- Contra-D'Alembert,
- Martingale,
- Anti-Martingale,
- Oscar,
- Five Count,
- Patrick Basic Right system (Pass, place the 6 and 8),
- 31 System,
- Don't/Place system,
- Rec.Gambling Place-Lay system.

The next section introduces the terminology used˝throughout this paper, and then discusses the mechanics of how the systems were “played” and how the characterisics that are reported were generated. The statistical foundations of the˝characteristics are discussed, and then the systems listed above are described in more detail. Following˝this discussion, the characteristics of each system are reported, and some observations on the˝results are given.

Approach

The following terminology is defined so that certain˝system behaviors can be easily described. A *series* is the set of rolls from when the dice come out until˝the time when the dice either pass or don't pass. The *series net* is the amount of money won or lost by a system during a˝single series. A *trial* is defined as a single run of the simulator which˝produced a single result. Multiple trials are needed to produce the distributions presented in˝this paper. A *progression* is defined for systems that vary the size of their bets, and is the set˝of bet sizes that are possible for that system. A progression begins with an initial bet and size, and˝ends when the next bet and size will again be the initial bet and size. The *progression net* is the amount of money won or lost between the progression start and progression end. The following˝two examples should clarify the progression definitions.

The Martingale system stipulates that if a bet loses,˝the next amount bet must be double that of the previous bet. So, if one starts out betting $5,˝then on successive losses the bets would be $10, $20, $40, etc., up to the table limit. The progression˝is the set of values [5, 10, 20, 40, ...], and the initial bet size if $5. The progression starts over˝when a bet wins (or the table limit is reached).

The D'Alembert system stipulates that you start out˝betting some amount β. If you lose the bet, you increase your next bet by β; if you win the bet, and the progression net is less˝than zero, then your next bet is the amount of your last bet decreased by β. If the progression net becomes positive, that progression is over and a new progression˝is started. The progression for this bet (assuming β is $5) is [5,10,15,20,25,...], although movement˝through this array of values is not necessarily monotonically increasing or decreasing.

There are two general cases of interest examined in this˝paper. The first assumes that one has limited time but a relatively large bankroll—what is the typical net dollar loss for a given system? The second is just the opposite: it assumes that one has˝a limited bankroll and a particular stop-win limit, but ample time—what is the typical time it will take the player to˝either exhaust their bankroll (bust out) or reach their stop-win limit? ˝Although in practice most players will desire a strategy somewhere between these two extremes, it is˝still useful to examine them independantly.

To address these two questions, a modified version of the˝commercial CrapSim software package (ConJelCo, Pittsburgh, PA) was used to perform Monte˝Carlo simulations of each of the systems. These simulations, whose parameters are discussed below,˝produced distributions of the two random variables of interest: final bankroll and number˝of rolls. These distributions were subjected to the statistical analysis described in the˝next section to produce the characteristics contained in the *Results* section of this paper. Two other distributions were˝also tracked, and are used in generating some of the characteristics: the˝instantaneous amount bet (amount on the table), and the cumulative amount bet (bet handle).

The instantaneous amount bet is the sum of the amounts˝of all wagers that are not yet resolved at each roll of the dice; for instance, if there is a $5˝pass bet, $10 odds, and $6 place bet on the six, the value of the random variable is 21. If on the next˝roll no decisions were made on any of the bets the value is again 21. If the following roll was˝a six, the place bet is resolved and—if the bet is not made again—the value of the random variable is now 15. The˝motivation for choosing such a measure is an attempt to capture the average amount at˝risk in the face of systems which vary the bet size and only occassionally make certain bets. ˝This measure, while adequate for most systems, is misleading for certain types of hedge˝betting systems (e.g., a system where simultaneous pass and don't pass bets of identical˝amounts are made) because the offsetting wagers artificially inflate the amount at risk. No˝attempt is made to take this into account when producing the characteristics later in this paper, other˝than to point out where it might have an effect.

The cumulative amount bet, commonly refered to as the˝bet handle, is the total amount wagered per trial. While the distribution for the instantaneous˝amount bet has a number of samples roughly equal to the number of rolls across all trials, the˝cumulative amount bet has a number of samples equal to the number of trials.

The simulations were run on a 33 MHz 486 IBM˝PC-compatible computer and took approximately 750 hours to complete. The software used˝is a general purpose craps simulator, which provides the user the ability to place any bet˝allowed in bank craps, and for that bet to be paid correctly. The simulator is parameterized so that˝it is able to play a wide variety of systems without having to specifically code that system's˝algorithm; rather, a system is reduced to a set of parameters (e.g., which bets to make, amounts of bets,˝dependancies of bets on other bets) which, when entered into the simulator, allow the simulator to “play” the system.

The most significant aspect of the simulator for purposes of this discussion is the random number generator used to generate dice rolls. The random number generator that is supplied with most computer language compilers is barely adequate, and most have known flaws. The one used in this simulator originally appeared in *Toward a Universal Random Number Generator* by G. Marsaglia and A. Zaman (FSU Report: FSU-SCRI-87-50, 1987) and was subsequently modified by F. James. It passess all of the tests for random number generators and has a period of 2^{144}; since the largest number of rolls possible in the simulator before re-seeding is 2^{32}, the random number stream produced will not cycle. The values used to seed this generator are themselves randomly generated from the compiler-supplied random number generator. A one-billion-roll trial of the generator showed that its results agreed with the mathematically predicted results for rolls of two dice to at least 4 decimal places. All of these factors are relevent in that they indicate the results reported in this paper, although statistically generated, are not biased by a non-random number stream.

Time-Limited Distributions

The case where the player has a large bankroll but limited time is modeled by limiting the number of rolls in each trial. The final bankroll is the variable of interest in these trials. Four different distributions of the final bankroll random variable are created for each system by limiting the number of rolls per trial to100 rolls, 200 rolls, 400 rolls, and 800 rolls.[2] The initial bankroll in each trial was large enough so that the trial was terminated when the desired number of rolls had been reached, instead of when the bankroll was exhausted.

Bankroll-Limited Distributions

The case where the player has a limited bankroll and a stop-win limit (defined to be a bankroll value > initial bankroll value that, when reached, the player ceases playing) has as the random variable of interest the number of rolls it takes to either reach the stop-win limit or deplete the bankroll such that another wager cannot be made. A "stop-loss limit," which is defined as a bankroll value > 0 but less than the initial bankroll value, is (barring psychological considerations) no different than playing with an initial bankroll that is equal to the size of the stop-loss limit, so the stop-loss limit is not modeled other than by adjusting the initial bankroll.

The insights that one might wish to glean for this case are the effects that the initial bankroll and the stop-win limit have on how long one can play. This is easy to do for a single system, but if one wants to compare two systems, how can one choose the respective initial bankrolls so that a

[2]If one wants to relate the number of rolls to elapsed time (e.g., hours), 100 rolls is close to the average number of rolls per hour. In a casino, however, the actual number of rolls per hour is dependant on the number of players, the number of bets on the table (which in turn generally depends on whether the players are winning (a "hot" table) or losing (a "cold" table)), and the competency of the dealers.

comparison is valid?[3]

Ideally, one would want to pick an initial bankroll such that the bankroll would be able to withstand some “reasonable” number of consecutive losses; that is, one would choose a baseline scenario of consecutive losses (e.g., five consecutive players not making a point) and then use this probability to measure the cumulative loss in the system of interest. Since exact probability calculations for expected loss on most systems is extremely difficult, this approach, although ideal, is impractical.

Another approach (and the one taken in this paper) is to multiply the mean instantaneous amount bet by some constant, the constant meant to represent the number of consecutive losses of an “average” amount of money at risk. As pointed out above, this works well for all systems except hedge-betting systems, which have high mean instantaneous amounts bet without the corresponding risk to those amounts. To compensate for this, a case-by-case assessment on each hedge-type system was made to determine (in an *ad hoc* way) the mean amount at risk, and this value was used instead of the mean instantaneous amount bet.

Still another approach is choosing an initial bankroll equal to the sum of a consecutive number of maximum losses, which works well for hedge systems and flat betting systems, but in systems (like the Martingale) which only reach the maximum loss after several previous consecutive losses the value would be artificially large, since the probability of a given number of consecutive number of maximum losses for such a system would be very much lower than that probability for a system like the Ponzer.

A final approach is choosing the cumulative amount lost after a certain number of losses. The chief difficulty with this approach is how to deal with multiple-bet systems, since chosing the number of bets to “lose” is arbtrary, yet will have a great effect on the size of the initial bankroll. Systems which re-size their bets will also have slightly inflated initial bankrolls with this approach, although to a lesser extent than indicated in the previous paragraph. The important point that arises from the discussion of these various approaches is that comparisons among systems of different types (e.g., a flat-betting system vs. a hedge-betting system) must be done with an understanding of the relative meanings of the initial bankroll value.

Since our initial bankroll is based on a mean instantaneous amount bet, we need to choose one of the four[4] values generated for each system. We have chosen the mean instantaneous amount bet value for the 400 roll distribution because it represents approximately 4 hours of table play, which is neither excessively short nor excessively long. The intial bankroll, then, is set at five times and ten times the mean instantaneous amount bet at 400 rolls (except for the hedge-bet systems, which are set to five and ten times an “average” amount of money at risk), and for all systems the stop-win limits are set at 150% and 200% of the initial bankroll (that is, if the initial bankroll is

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[3] Since the stop-win limit is chosen as a percentage of the initial bankroll, choosing the initial bankroll is the critical step.

[4] One for the 100 roll distribution, one for the 200 roll distribution, etc.

$1000, then the stop-win limits are $1500 and $2000, which means if the player wins $500 and $1000, respectively, the trial will terminate). A trial consists of a system being played with a given initial bankroll and stop-win limit until either the stop-win limit is reached or the bankroll is depleted such that another wager cannot be made. The number of rolls this takes is then recorded, and the distributions of the number of rolls across all trials for a particular initial bankroll and stop-win limit are created. Four such distributions are created for each system, corresponding to the four combinations of two initial bankrolls (five and ten times an average bet) and two stop-win limits (150 and 200 percent of the initial bankroll). Additionally, for each of these distributions two sub-distributions are kept: the distribution of the number of rolls when the trial resulted in the bankroll being exhausted (i.e., the player busted out), and the distribution of the number of rolls when the trial resulted in the stop-win limit being reached.

Statistical Basis

As mentioned above, all of the characteristics of the systems examined are derived from properties of the distributions of the various random variables. The distributions produced by the simulator are of four types (the type is dependant on the system), three of which are bell shaped and one that is bimodal (at its extreme; see the discussion in the *Bankroll-Limited Distributions* section for a more detailed discussion); that is, it appears as two normal distributions side by side. The latter distribution occurs only in bankroll-limited distributions. Of the former three distributions, one type approximates a normal distribution; the other two types are negatively skewed (having a long leading tail with the “bell” pushed to the right) and positively skewed (having a long trailing tail with the “bell” pushed to the left). The properties of all of these curves are such that, although they are not perfect bell shaped curves, they are close enough so that the measures applied are meaningful.

Since the mean value of the random variable of interest, $\bar{x}$, is critical to many of the characteristics, it is important to define how confident we are that $\bar{x}$ reflects the true population mean μ. We do this by establishing a confidence level and a confidence interval. For the various $\bar{x}$ described in this paper, a confidence level of 99% is used; this means that α is .01 and $Z_{(\frac{\alpha}{2})}$ is 2.58.

The relationship between μ and $\bar{x}$ can then be described as follows:

$$\bar{x} - Z_{(\frac{\alpha}{2})}\left(\frac{s}{\sqrt{n}}\right) \leq \mu \leq \bar{x} + Z_{(\frac{\alpha}{2})}\left(\frac{s}{\sqrt{n}}\right)$$

where *s* is the standard deviation of the distribution and n is the number of samples (trials) in the distribution. We will also define

$$\gamma = Z_{(\frac{\alpha}{2})}\left(\frac{s}{\sqrt{n}}\right)$$

As stated above, when $Z_{(\frac{\alpha}{2})}$ is 2.58 we have 99% confidence that μ falls within the upper and lower confidence limits.

For each type of distribution, we specified a target˝confidence interval as follows. For the time-limited distributions of 100 and 200 rolls, we wanted $\bar{x}$ to be within $1. For time-limited distributions of 400 and 800 rolls, we relaxed the˝confidence interval to $5, primarily because for certain systems a $1 confidence interval would require˝more than 2^{32} dice rolls, which is beyond the capability of the simulator. The confidence interval˝desired on the overall distribution was 1 roll, which causes the interval on the sub-distributions˝to vary.

Since γ depends on the standard deviation of the distribution,˝we cannot solve for n (the desired number of trials) until we find the standard deviation *s*. The method we used was to first run 1000 trials, calculate s, and then solve for n:

$$n = (\gamma_d Z_{(\frac{\alpha}{2})} s)^2$$

where γ_d is the desired confidence interval (e.g., $1) divided˝by 2. Since this is only an estimation, when n trials had been performed the˝simulator checked to see if the calculated γ was less than or equal to our desired γ_d. This process continued until the desired confidence˝interval had been obtained.

Although we are reasonably confident of our results, we˝must reiterate that the values shown in this paper are the result of statistical˝characterizations of distributions, and not precise mathematical probability calculations. This is˝especially important to keep in mind when the "casino hold" values are presented, since they do not exactly match˝those produced by such calculations. However, they are close enough so that˝the values produced for systems which are too complex to easily calculate mathematically can still˝be used as a valid basis of comparison.

Systems Examined

The systems examined in this paper are placed in four˝different categories. One category is for systems which employ hedge betting. The other systems˝are divided into categories according to the shape of the final bankroll distribution they˝produce (the hedge systems examined in this paper all produce an approximately normal distribution) for˝their bankroll-limiting results: a normal distribution that is somewhat symmetric about $\bar{x}$, a positively-skewed distribution where the "bell" is pushed to the left (long trialing tail), and a˝negatively-skewed distribution where the "bell" is pushed to the right (long leading tail).   With˝respect to the way the systems are played, they generally have one bet that is made and then just the˝bet size is varied for subsequent bets, although one system has integral bet switching as part˝of the system and other multi-bet systems have bets that are either switched or taken down˝occassionally. The four categories defined, then, are *normal-producing*, *positive-skew-producing*, *negative-skew-producing*, and *hedge betting*; all are discussed in further detail later in this section. ˝Because of time limitations and the number of simulations that needed to be run, 6 of the 104˝simulations were not complete at the writing of this paper. These values are marked with an asterisk in˝the tables.

The following descriptions of the systems examined are˝minimal; the *References* section of this paper contains pointers to material which has greater˝detail on each of these systems.

Normal-Producing Systems

This type of system is characterized by producing final˝bankroll distributions which are roughly normal; i.e., they are bell-shaped and symmetric about $\bar{x}$. In general, systems in this category have no bet size variation between successive bets, and˝all bets are either “right” or “wrong” (i.e., there is no hedging). The Patrick Basic Right system˝does generally increase the size of the bets on a win, but the size of the increases isn't enough to˝skew the distribution to the left, as is more common with systems which have rapidly escalating wagers˝on successive wins (e.g., the Anti-Martingale System). Note that the hedge betting systems˝examined in this paper also produce normal distributions; they are categorized seperately˝because of their instantaneous amounts bet characteristics.

Pass Bet: $5 is bet on the pass line, and if a point is˝established, $10 odds are taken.

Ponzer: $5 is bet on the pass line, and two $5 come bets are˝made. $10 odds are taken on all bets when possible. The odds on the come bets do not˝work on the come-out.

Patrick Basic Right: This system makes initial bets of $5 on the pass line˝and, assuming a point is established, $6 place bets on the six or eight. If˝six is the point, a place bet is made on the five instead of the six. If eight is the point, a place bet˝is made on the nine instead of the eight. The progression for each of these bets is on successive˝wins; if a bet loses, the progression for that bet starts over. For the pass line bet, the progression is˝[5,5,10,10,15,15,20,20,25,25]. For the place bets, it is [6,6,12,6,12,18,24,30]. If a place bet must˝be moved to the five or nine, the bet amount is adjusted to the closest amount that can be paid˝correctly (e.g., if an $18 place six bet is made, and six becomes the point, the bet is moved to the five˝and $2 is added to make a $20 place five bet, since the place five (and nine) bet pays off at˝seven to five and thus an $18 bet cannot be paid correctly).

31 System: A structure is constructed with 9 “plateaus:”

Plateau	Init Bet	Double-up Bet
1	1	N/A
2	1	2
3	1	2
4	2	4
5	2	4
6	4	8
7	4	8
8	8	16

9	8	16

The progression starts after the initial $1 bet loses. ˝If you lose the bet in the “Init Bet” column, you move to the next plateau. If you win the bet in the “Init Bet” column, you make the bet in the “double-up” column. The progression stops when the double-up bet on˝the 9th plateau loses, or two consecutive bets win. The system is called the 31˝system because if the double-up bet on the 9th plateau loses (the “worst case” for this system), the loss sustained is $31. All bets˝are made on the pass line.

Negative-Skew-Producing Systems

This type of system is characterized by producing final˝bankroll distributions with long leading tails, and the characteristic bell shape pushed to the˝right of the graph. This is because these systems produce many small wins, but are susceptible to˝large losses. In general, systems in this category increase the size of the next bet (up to some˝limit) when the previous bet loses. There is no hedging in these systems. Two noteworthy systems in˝this category are the Oscar and Hoyle's Press systems. Both keep the bet the same after a loss˝instead of returning to the first bet in the progression, so although these systems increase the˝amount bet on a win, the distribution of the final bankroll they produce makes them members of this˝category.

Martingale: The archetypal up-when-you-lose system, this system˝doubles the previous bet on a loss, up to the table limit. If the bet wins, or if the˝next bet would be greater than the table limit, the progression starts over. The initial bet used for˝this paper is $5 on the pass line.

D'Alembert: Start with an initial bet of $5 on the pass line. If˝the bet loses, increase the amount bet by $5. If the bet wins and the progression net is˝negative, decrease the amount bet by $5. If the table limit is reached or the progression net˝becomes positive, the progression starts over.

Oscar: Start with an initial bet of $5 on the pass line. If˝a bet loses, bet the same amount again. If a bet wins and the progression net is negative,˝increase the amount bet by $5. The progression is terminated when the progression net is positive or˝the table limit is reached.

Hoyle's Press: Start by betting $5 on the pass line. Whenever a bet˝wins, switch the bet to the opposite “side” (i.e., if the winning bet is on the pass line, the˝next bet will be on the don't pass, and if the winning bet was on the don't pass, the next˝bet will be on the pass line). Likewise, if a bet loses three consecutive times, switch sides. Like˝the Oscar system, if a bet loses the size of the next bet remains the same. If a bet wins and the˝progression net is negative, the amount to bet is increased by $5 or is made to produce a $5 win,˝whichever amount is smaller. For example, if the last bet made was $50 and it won, making the˝progression net -$25, the next bet would bet $30 instead of $55, because a winning $30 bet will˝produce a $5 progression net.

Positve-Skew-Producing Systems

This type of system is characterized by producing final˝bankroll distributions with long trialing tails, and the characteristic bell shape pushed to the˝left of the graph. This is because these systems produce many small losses, but occassionally˝garner large wins. Systems in this category increase the size of the next bet (up to some limit)˝when the previous bet wins. There is no hedging in these systems.

Contra-D'Alembert: Start with an initial bet of $5 on the pass line. If˝the bet wins, increase the amount bet by $5. If the bet loses, decrease the amount˝bet by $5 (however, if the bet was $5, it remains at $5).

Anti-Martingale: Also known as the parlay system, $5 is bet initially on˝the pass line. If a bet wins, its size is doubled and the bet is made again, up˝to the table limit. If a bet loses, the progression starts over with a $5 pass line bet.

Hedge Bet Systems

Systems in this category are not characterized by the˝final bankroll distribution they produce (they all produce normal distributions), but rather by the˝fact that they have two or more bets which offset each other; that is, if one bet wins, then˝another bet (or bets) made at the same time loses. These systems use odds or bets which are not exact˝opposites in order to produce opportunities for winning trials.

Do/Don't Odds Do: $5 pass line and $5 don't pass bets are made˝simultaneously. If a point is established, $10 odds on the pass line bet are taken.

Don't/Place: A $25 don't pass bet is made. If a point is˝established, the point is placed for $25, and a don't come bet of $25 is made. If a don't come˝point is made, then the don't come point is placed for $25. The place bets work on the come-out roll.

Five Count: The "count" is as follows: the count begins (called the *one count*) when a point number (4, 5, 6, 8, 9, 10) is rolled. Any roll except˝a seven increases the count by one, up to the *five count*. For a roll to change the count to five, it must again˝be a point number. After the five count is established, the count is no longer a concern. ˝When a seven-out occurs, the count starts over (so a seven rolled on the come-out does not reset˝the count). Betting starts at the *two count*. After the two count is reached, a $5 come bet and $5˝don't come bet (or $5 pass bet and $5 don't pass bet if it's the come-out roll) is made. As long˝as a seven-out does not occur, these bet pairs are made until there are four numbers covered by bets. ˝After the five count, $10 odds are taken on all come bets (and the pass line bet, if one is˝made). If in three rolls none of the bets are resolved, the odds are taken off for two rolls. If˝there is still no resolution on the bets, the odds are put back on and the process is repeated.

Rec.Gambling Place/Lay: A $5 pass line bet is made. If a point is˝established, $5 in odds are taken andthe inside numbers (5, 6, 8, 9) are placed˝for $22, $17, or $16 (depending on the point; if one of these numbers is the point, it is not˝placed). A $50 no-four (or $50 no-ten if four is the point) lay bet is also made. If the series net becomes˝greater than $25, the no-four/no-ten bet is taken down. If the no-four or no-ten bet is lost due to˝a four or ten, respectively, being thrown, the lay bet is not put back up.

Results

In this section, both the time-limited and˝bankroll-limited distributions are discussed, and the characteristics from these distributions are calculated˝and tabulated.

Time-Limited Distributions

There were three general distribution shapes for the˝final bankrolls, as noted above. Figure 1 represents a typical distribution for a normal-producing˝system. Figure 2 is a typical distribution for a positive-skew-producing system, while figure 3 is˝that for a typical negative-skew-producing system.

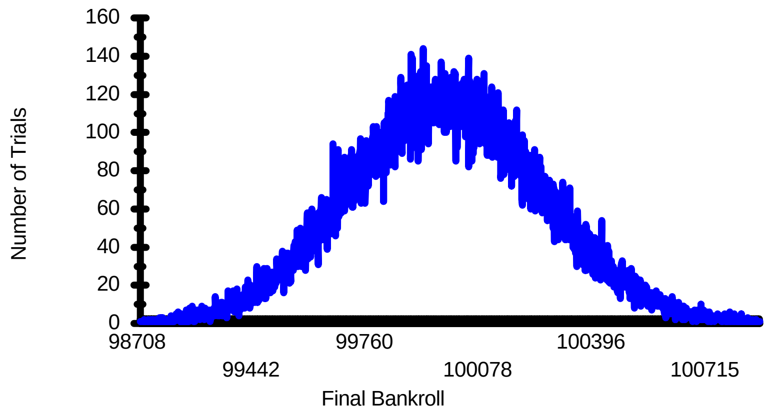

Figure 1 - Normal Distribution (Ponzer 400 Roll)

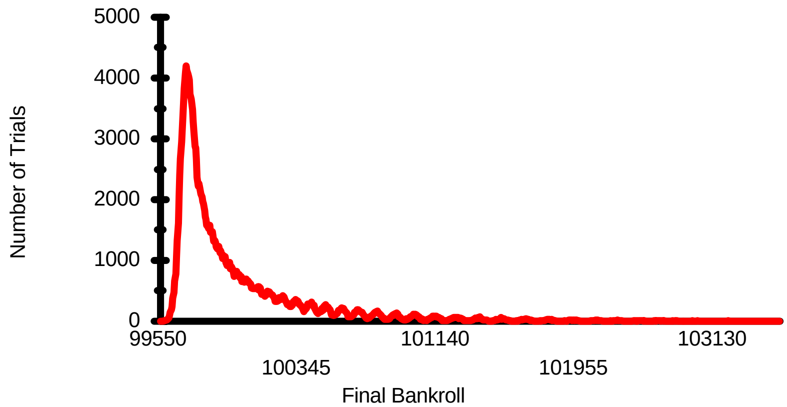

Figure 2 - Positive-Skewed Distribution˝(Contra-D'Alembert 400 Roll)

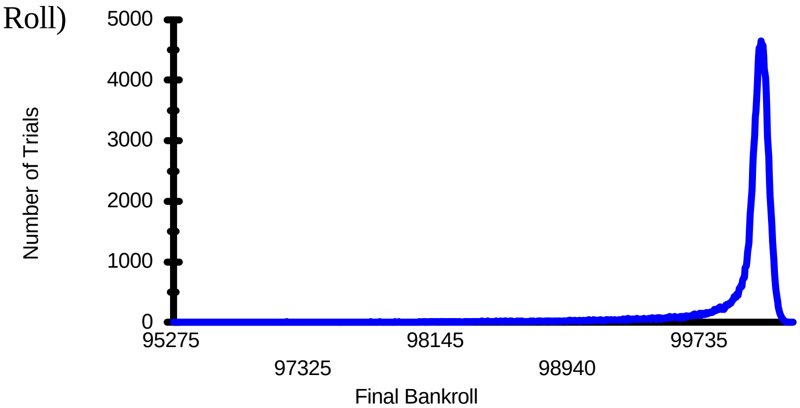

Figure 3 - Negative-Skewed Distribution (Hoyle's Press 400 Roll)

The characteristics that will now be presented are˝calculated from distributions like those above, generated for each of the test cases described earlier. ˝Characteristics presented in this section for the four distributions for each system are: the mean net˝loss, statistical hold, standard deviation of the final bankroll, volitility of the final bankroll,˝mean win index, mean loss index, mean win/loss amount ratio, and the win/loss ratio. Each of these˝characteristics is further explained in the following sections.

There are two other distributions that were generated for˝each of the four runs of each system: the instantaneous amount bet and the cumulative amount bet. ˝The following two tables indicate the values for each combination of system/number of rolls˝that we will be discussing in this section.

# of Rolls:	100	200	400	800
Pass Bet	11.96	12.00	12.02	12.03
Ponzer	28.57	28.81	28.94	29.00
Patrick Basic Right	26.37	26.69	26.81	26.79
31 System	11.66	12.30	12.63	12.79
Do/Don't Odds Do	16.96	17.00	17.02	17.03
Don't/Place	77.06	75.87	73.49	70.31
Five Count	30.86	31.61	31.90	32.13
Rec.Gambling Place-Lay	56.34	56.58	56.71	56.76
Martingale	18.75	*	*	20.55
D'Alembert	15.85	20.67	27.36	36.65
Oscar	12.76	18.51	27.79	42.48
Hoyle's Press	9.00	12.28	17.34	25.33
Contra-D'Alembert	16.85	22.30	29.79	*
Anti-Martingale	17.95	18.67	19.00	19.21

Table 1 -- Mean Instantaneous Bet Amount (Dollars)

An interesting note to Table 1 is that as the number of˝rolls increases, the mean instantaneous amount bet does not stay constant, as one might expect.

The values in Table 2, commonly referred to as the “bet handle,” point out an interesting fact about positive-skew- and negative-skew-producing˝systems: longer playing sessions using these systems (with no loss limit) makes the bet handle˝increase more rapidly than it would using a normal-producing system. This is because the longer one˝plays a positive-skew- or negative-skew-producing system, the greater the likelihood that˝they will wind up making much larger bets as they either chase their losses or parlay their wins.

# of Rolls:	100	200	400	800
Pass Bet	340	686	1376	2760
Ponzer	766	1553	3126	6272
Patrick Basic Right	719	1461	2942	5886
31 System	343	726	1492	3026
Do/Don't Odds Do	487	981	1969	3943
Don't/Place	2136	4239	8280	15984
Five Count	843	1735	3509	7077
Rec.Gambling Place-Lay	1331	2684	5390	10802
Martingale	551	*	*	4867
D'Alembert	466	1219	3236	8675
Oscar	375	1093	3287	10093
Hoyle's Press	264	725	2051	5998
Contra-D'Alembert	495	1316	3521	*
Anti-Martingale	527	1102	2248	4544

Table 2 -- Mean Cumulative Amount Bet (Dollars)

Mean Net Loss

The mean net loss, shown in Table 3, is the average amount that one expects to lose when using the indicated system for the indicated period of time. It is important to note that these numbers are given in absolute terms, so systems with high instantaneous amounts bet will have higher mean net losses. These values, though, will give the reader an indication as to the behavior of various systems as the length of play increases. Again, the positive-skew- and negative-skew-producing systems have a higher rate of increase than the (roughly linear) increase of the normal-producing systems.

Statistical Hold

The statistical hold is calculated as the net loss divided by the cumulative amount bet, multiplied by 100 (because the numbers in Table 4 are given as percentages). We again stress that these numbers are calculated from statistical measures that have some degree of uncertainty in their values. While we believe these numbers are valid for comparison purposes, they do not match the mathematically predicted values exactly, although they are close. The values in this table indicate the percentage of the bet handle that will be lost for each system; therefore, the lower the value, the smaller the amount that will be lost per unit bet. These values should be used in conjunction with those in Table 2, because although two systems may have roughly the same statistical hold, the system with the higher cumulative amount bet will “cost” more.

# of Rolls:	100	200	400	800
Pass Bet	1.52	3.46	7.64	16.08
Ponzer	3.31	8.57	19.78	40.28
Patrick Basic Right	7.10	15.21	31.91	63.88
31 System	3.18	8.39	19.02	40.55
Do/Don't Odds Do	4.20	8.44	16.44	30.56
Don't/Place	55.23	103.30	195.79	357.65
Five Count	8.06	16.20	32.63	66.04
Rec.Gambling Place-Lay	25.70	51.63	103.99	0.00
Martingale	5.26	*	*	0.00
D'Alembert	3.57	13.20	41.32	0.00
Oscar	2.60	11.74	41.72	132.93
Hoyle's Press	3.65	10.23	28.44	0.00
Contra-D'Alembert	3.91	14.63	43.99	*
Anti-Martingale	4.86	12.96	30.23	0.00

Table 3 -- Mean Net Loss (Dollars)

# of Rolls:	100	200	400	800
Pass Bet	0.4469	0.5046	0.5552	0.5826
Ponzer	0.4318	0.5518	0.6328	0.6422
Patrick Basic Right	0.9880	1.0411	1.0847	1.0853
31 System	0.9284	1.1561	1.2752	1.3398
Do/Don't Odds Do	0.8617	0.8601	0.8348	0.7750
Don't/Place	2.5859	2.4370	2.3645	2.2375
Five Count	0.9556	0.9338	0.9299	0.9332
Rec.Gambling Place-Lay	1.9316	1.9240	1.9293	0.0000
Martingale	0.9550	*	*	0.0000
D'Alembert	0.7665	1.0825	1.2770	0.0000
Oscar	0.6934	1.0746	1.2694	1.3170
Hoyle's Press	1.3810	1.4117	1.3867	0.0000
Contra-D'Alembert	0.7897	1.1117	1.2494	*
Anti-Martingale	0.9217	1.1766	1.3448	0.0000

Table 4 -- Statistical Hold (Percent)

Standard Deviation of Final Bankroll

This measure gives some indication of the “spread” of the values around the mean final bankroll. Systems with large standard deviations indicate that the˝bankroll has much more potential for fluctuation than for systems with small standard˝deviations. Eariler in the paper we mentioned that a possible goal for a player using a system with a˝large standard deviation would be to increase their chances for a large win. One must be˝careful when using this criteria in examining the values listed in Table 5, because˝negative-skew-producing systems have the largest part of the contribution to the standard deviation from losing˝trials; hence in these cases a large standard deviation is *not* indicative of a potentially large win.

# of Rolls:	100	200	400	800
Pass Bet	76.90	109.60	154.92	220.23
Ponzer	134.23	191.69	271.23	383.95
Patrick Basic Right	146.04	210.06	298.23	423.41
31 System	93.72	140.96	204.37	293.86
Do/Don't Odds Do	54.33	76.79	109.10	154.52
Don't/Place	130.86	186.55	265.65	379.44
Five Count	87.33	125.73	178.38	255.72
Rec Gambling Place-Lay	130.86	186.04	264.67	372.18
Martingale	287.51	*	*	900.40
D'Alembert	108.88	214.12	427.49	852.23
Oscar	89.85	210.74	515.47	1306.14
Hoyle's Press	63.44	145.14	351.09	889.33
Contra-D'Alembert	113.15	213.02	400.25	*
Anti-Martingale	270.82	399.00	573.61	820.98

Table 5 -- Standard Deviation of the Final Bankroll˝(Dollars)

Volitility

The volitility of the final bankroll distribution is˝another attempt to capture bankroll fluctuation, but normalized so that different systems can be˝compared. This is done by taking a range of four standard deviations (two on either side of the mean) ˝and dividing it by the mean instantaneous amount bet for that particular number of rolls in an˝attempt at normalization. We should note, however, that this is probably more meaningful for˝normal-producing systems than for positive-skew- and negative-skew-producing systems.

# of Rolls:	100	200	400	800
Pass Bet	25.719	36.533	51.554	73.227
Ponzer	18.793	26.614	37.489	52.959
Patrick Basic Right	22.152	31.481	44.495	63.219
31 System	32.151	45.841	64.725	91.903
Do/Don't Odds Do	12.814	18.068	25.640	36.294
Don't/Place	6.793	9.835	14.459	21.587
Five Count	11.320	15.910	22.367	31.836
Rec.Gambling Place-Lay	9.291	13.152	18.668	26.228
Martingale	61.335	*	*	175.260
D'Alembert	27.478	41.436	62.499	93.013
Oscar	28.166	45.541	74.195	122.989
Hoyle's Press	28.196	47.277	80.990	140.439
Contra-D'Alembert	26.861	38.210	53.743	*
Anti-Martingale	60.350	85.485	120.760	170.948

Table 6 -- Volitility of the Final Bankroll (Unitless)

<u>Mean Win, Loss Index</u>

The mean win index and mean loss index are designed to˝show the average win and average loss in terms that are meaningful for comparison across˝systems. The approach is to take the absolute value of the difference between the mean value of the˝final bankroll and the mean value of the final bankroll for winning trials (i.e., those trials˝which resulted in a final bankroll value of the initial starting bankroll or higher) or losing trials,˝and divide that result by the instantaneous amount bet, again in an attempt to normalize the˝results. A high mean win index is desirable (the higher the index, the larger the number of averages bets˝the expected win is), while a low mean loss index is also desirable. Tables 7 and 8 contain˝the two sets of indicies.

# of Rolls:	100	200	400	800
Pass Bet	5.257	7.503	10.763	15.453
Ponzer	3.861	5.536	7.968	11.495
Patrick Basic Right	4.823	6.978	10.054	14.624
31 System	5.286	10.085	13.256	19.362
Do/Don't Odds Do	2.736	3.945	5.860	8.437
Don't/Place	1.798	2.854	4.708	7.924
Five Count	2.579	3.663	5.280	7.884
Rec Gambling Place-Lay	2.076	3.147	4.864	3.995
Martingale	3.901	*	*	28.175
D'Alembert	3.480	5.095	7.518	8.017
Oscar	3.889	5.478	7.779	11.238
Hoyle's Press	3.463	4.819	6.843	6.737
Contra-D'Alembert	7.141	10.779	16.061	*
Anti-Martingale	36.639	54.939	58.441	50.134

Table 7 -- Mean Win Index (Unitless)

# of Rolls:	100	200	400	800
Pass Bet	5.028	7.083	9.811	13.754
Ponzer	3.653	5.100	7.026	9.675
Patrick Basic Right	3.857	5.514	7.727	10.793
31 System	9.739	8.766	12.994	17.309
Do/Don't Odds Do	2.399	3.294	4.411	6.141
Don't/Place	0.943	1.189	1.425	1.653
Five Count	1.979	2.751	3.771	5.036
Rec Gambling Place-Lay	1.624	2.111	2.673	6.826
Martingale	35.650	*	*	50.496
D'Alembert	7.395	10.969	16.183	26.368
Oscar	7.746	13.090	21.982	37.360
Hoyle's Press	7.441	13.028	23.461	45.446
Contra-D'Alembert	3.388	4.635	6.283	*
Anti-Martingale	3.587	6.948	13.781	30.875

Table 8 -- Mean Loss Index (Unitless)

<u>Mean Win/Loss Amount Ratio</u>

This measure is designed to give an overall assessment of˝a system's desirability in terms of the average size of its wins and the average size of its˝losses. It is formed by dividing the values in Table 7 by the values in Table 8; thus, the larger the˝ratio, the greater the difference between the relative size of a win vs. a loss.

# of Rolls:	100	200	400	800
Pass Bet	1.046	1.059	1.097	1.124
Ponzer	1.057	1.085	1.134	1.188
Patrick Basic Right	1.251	1.265	1.301	1.355
31 System	0.543	1.151	1.020	1.119
Do/Don't Odds Do	1.141	1.198	1.328	1.374
Don't/Place	1.906	2.399	3.304	4.795
Five Count	1.304	1.332	1.400	1.566
Rec.Gambling Place-Lay	1.278	1.490	1.820	0.585
Martingale	0.109	*	*	0.558
D'Alembert	0.471	0.464	0.465	0.304
Oscar	0.502	0.418	0.354	0.301
Hoyle's Press	0.465	0.370	0.292	0.148
Contra-D'Alembert	2.108	2.326	2.556	*
Anti-Martingale	10.214	7.907	4.241	1.624

Table 9 -- Mean Win/Loss Amount Ratio (Unitless)

<u>Win/Loss Ratio</u>

Of course, the measure in Table 9 can also be˝misleading, since even if a system has a large mean win/loss amount ratio it could have significantly fewer˝wins than losses, thus possibly offsetting the attractiveness of that particular system. The˝win/loss ratio is the number of trials that produce a final bankroll that is greater than the initial˝bankroll divided by the number of trials that produce a final bankroll that is less than the initial bankroll.˝ Since in a negative expectation game a final bankroll that is equal to the initial bankroll is “winning,” that case is also counted as a win for purposes of this measure. Another use for this table is˝in pointing out the attraction of systems like the Martingale, which have a very high win/loss˝ratio. However, the mean win/loss amount ratio for these systems (from Table 9) is˝correspondingly low, indicating that the relatively many small wins is not enough to overcome the relatively few˝small losses.

# of Rolls:	100	200	400	800
Pass Bet	0.9563	0.9440	0.9116	0.8901
Ponzer	0.9463	0.9212	0.8817	0.8416
Patrick Basic Right	0.7997	0.7903	0.7686	0.7380
31 System	1.8426	0.8692	0.9802	0.8940
Do/Don't Odds Do	0.8765	0.8347	0.7528	0.7279
Don't/Place	0.5248	0.4167	0.3027	0.2085
Five Count	0.7670	0.7511	0.7141	0.6387
Rec.Gambling Place-Lay	0.9350	0.8602	0.7804	0.6795
Martingale	9.1388	*	*	1.5062
D'Alembert	2.1250	2.1528	2.1525	2.0859
Oscar	1.9913	2.3898	2.8258	3.3243
Hoyle's Press	2.1484	2.7030	3.4283	4.2172
Contra-D'Alembert	0.4744	0.4300	0.3912	*
Anti-Martingale	0.0979	0.1265	0.2358	0.5166

Table 10 -- Win/Loss Ratio (Unitless)

Bankroll-Limited Distributions

As discussed earlier, the random variable of interest in˝creating these data is the number of rolls that it takes to either reach a stop-win limit or to˝reduce the bankroll such that the next wager for that particular system can not be made. Three˝distributions were produced for every system for every combination of initial bankroll and stop-win˝limit: the number rolls needed to reach the stop-win limit; the number of rolls needed to reach the “bust-out” limit, and the overall number of rolls it takes to reach either one of these two limits. ˝Although the individual stop-win and bust-out distributions were largely normal, the overall˝distribution was made by combining these two sub-distributions and as such produced a distribution˝that was anywhere from normal to distinctly bimodal, depending on the distance between the means of˝the stop-win distribution and the bust-out distribution. The three graphs below depict overall˝distributions in which the means of the component distributions are successively farther apart.

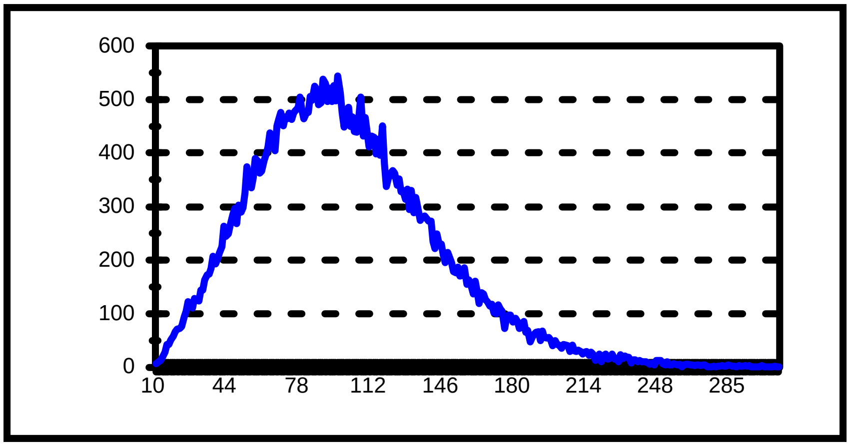

Figure 4 – Normal (D'Alembert 5x 150%)

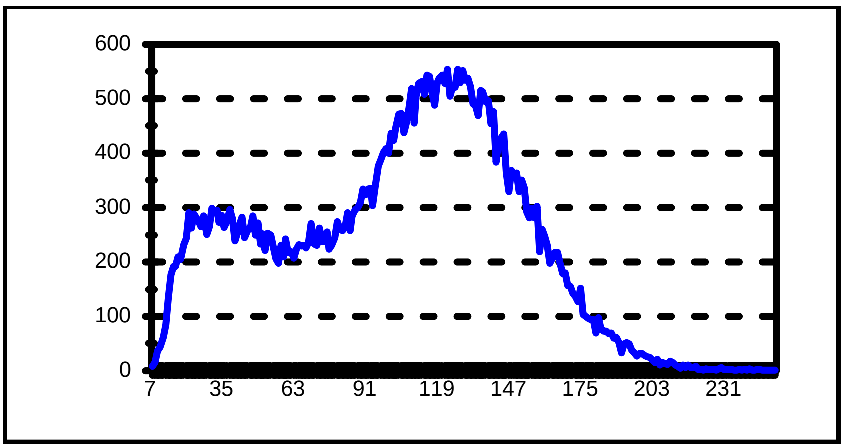

Figure 5 – "Midway" (Oscar 10x 150%)

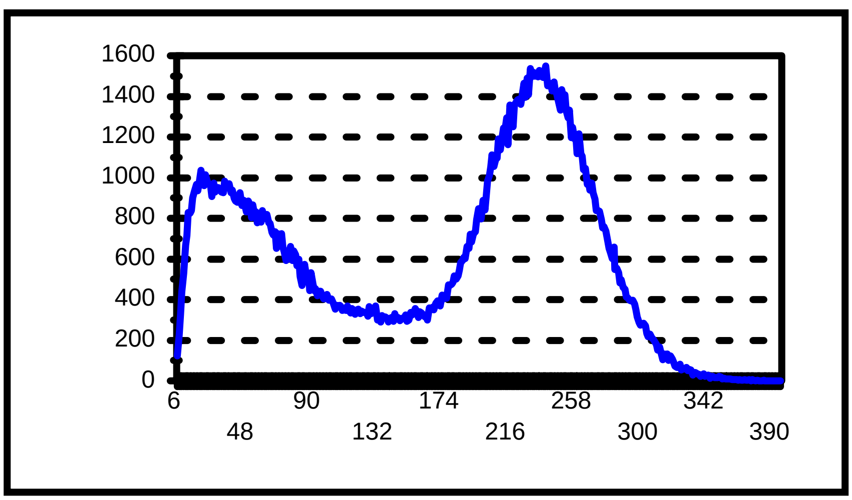

Figure 6 – Bimodal (Anti-Martingale 10x 150%)

In the *Statistical Basis* section we noted that the confidence level and interval˝was specified for the overall distribution; this means that while there is˝a 99% confidence level that the actual average number of rolls it will take to either reach the˝stop-win limit or bust out is going to be within one roll of the number reported (± .50 rolls), the same cannot be said for the two sub-distributions. For the stop-win distribution, the˝largest confidence interval is ± .91 rolls, while for the bust-out distribution it is ±1.01 rolls, which are still relatively tight.

As discussed above, the critical parameter in these˝distributions is the initial bankroll; as the initial bankroll increases, the overall mean length increases. ˝Table 11 summarizes the initial bankrolls for each system (the 5x column is for five times the˝base amount, and the 10x column is for ten times the base amount); the stop-win limits are merely˝150% and 200% of the amounts shown in these columns (for example, the stop-win limits for the˝Pass Bet at the 5x initial bankroll are 90 and 120, while at the 10x initial bankroll they are 180˝and 240). The "Amt @ 400 Rolls" column gives the base amount for the initial bankroll as˝discussed earlier (recall that the numbers for the hedge systems are best guesses, and are not taken from˝the instantaneous amount bet distribution as they are for all other systems).

	Amt. @ 400 Rolls	**5x**	**10x**
Pass Bet:	12.02	60	120
Ponzer:	28.94	145	289
Patrick Basic Right:	26.81	134	268
31 System	12.63	63	126
Do/Don't Odds Do	10.00	50	100
Don't/Place	25.00	125	250
Five Count	15.00	75	150
Rec.Gambling Place-Lay:	35.00	175	350
Martingale:	20.31	102	203
D'Alembert:	27.35	137	274
Oscar:	27.72	139	277
Hoyle's Press:	17.34	87	173
Contra-D'Alembert:	29.76	149	298
Anti-Martingale:	19.00	95	190

Table 11 - Initial Bankroll Amounts (Dollars)

The characteristics that will be presented in this˝section are: overall mean length, mean length for busting out, mean length for reaching stop-win limit,˝standard deviation of the overall mean length distribution, stop-win/bust-out ratio, and win/loss ratio. Each of these characteristics is further explained in the following sections.

Overall Mean Length

The overall mean length is average number of rolls needed before the stop-win limit is reached or the bankroll is reduced such that the next wager for that particular system cannot be made. The results given are most valuable when compared against other systems of the same category—as defined by the distribution for the bankroll-limiting case—but are still substantially useful when comparing systems of different categories. Table 12 gives the results for each system. Since the Martingale (and Anti-Martingale) systems increase their bets more rapidly than other systems, increasing the win limit has less of an effect on length of play than it has on the other systems.

Initial Parameters:	5x 150%	5x 200%	10x 150%	10x 200%
Pass Bet	37	62	130	241
Ponzer	69	115	251	453
Patrick Basic Right	66	101	211	353
31 System	47	70	89	164
Do/Don't Odds Do	41	70	165	*
Don't/Place	26	37	143	219
Five Count	27	33	133	207
Rec.Gambling Place-Lay	76	127	*	*
Martingale	52	79	102	157
D'Alembert	100	167	226	372
Oscar	114	184	232	377
Hoyle's Press	118	197	258	418
Contra-D'Alembert	132	165	276	345
Anti-Martingale	83	98	168	197

Table 12 -- Overall Mean Length (Rolls)

Mean Bust-Out Length

The mean bust-out length is the mean number of rolls of the sub-distribution generated by trials that resulted in the bankroll reaching a point where the wager for the system of interest could not be made. An interesting point to note in Table 13 is that increasing the win limit has a fairly substantial effect on most systems in that the length of time before busting out is increased. The reason for this is that trials which would have terminated at the lower (150%) win limit continue at the higher win limit (200%), thus allowing the inherent negative expectancy to deplete the bankroll.

Initial Parameters:	5x 150%	5x 200%	10x 150%	10x 200%
Pass Bet	32	65	110	247
Ponzer	63	128	217	477
Patrick Basic Right	57	103	171	345
31 System	49	89	94	203
Do/Don't Odds Do	36	79	141	*
Don't/Place	38	80	150	324
Five Count	35	60	122	248
Rec.Gambling Place-Lay	82	177	*	*
Martingale	64	126	131	259
D'Alembert	110	227	255	516
Oscar	119	238	256	510
Hoyle's Press	127	264	294	588
Contra-D'Alembert	93	125	191	259
Anti-Martingale	51	60	98	112

Table 13 -- Mean Bust-Out Length (Rolls)

Mean Stop-Win Length

The mean stop-win length is the mean value of the˝sub-distribution generated by trials that resulted in the stop-win limit being reached.

Standard Deviation of Overall Mean Length

This measure gives some indication of the “spread” of the values around the overall mean number of rolls. Thus, a large standard deviation for a given˝system indicates that it is difficult to target a narrow range of playing time. For example, the Patrick˝Basic Right system (for the 10x initial bankroll and a stop-win limit of 150%) has a standard˝deviation of 172 rolls that, assuming 100 rolls per hour, indicates that a majority of the time (±1 standard deviation) one would have sessions lasting anywhere in a three-and-one-half -hour˝range. Using the data from Table 12, then, the session could be expected to last anywhere˝from half-an-hour to four hours—not a very narrow range. Contrast that with the 31 System (for˝the 10x initial bankroll and a stop-win limit of 150%), with a standard deviation of about 50 rolls,˝which indicates that session range would more likely be about one hour most of the time; a˝significantly smaller interval. Again using the information from table 12, the session could be expected˝to last from half-an-hour to an hour-and-one-half. The values for this measure are tabulated in˝Table 15.

Initial Parameters:	5x 150%	5x 200%	10x 150%	10x 200%
Pass Bet	43	61	161	236
Ponzer	76	107	299	435
Patrick Basic Right	75	100	259	358
31 System	44	58	82	136
Do/Don't Odds Do	46	65	195	*
Don't/Place	22	31	140	200
Five Count	26	30	140	192
Rec.Gambling Place-Lay	72	110	*	*
Martingale	41	55	74	105
D'Alembert	85	126	184	274
Oscar	107	148	200	287
Hoyle's Press	105	151	207	304
Contra-D'Alembert	185	193	390	405
Anti-Martingale	117	120	242	246

Table 14 -- Mean Stop-Win Length (Rolls)

Initial Parameters:	5x 150%	5x 200%	10x 150%	10x 200%
Pass Bet	27.72	48.40	111.05	195.26
Ponzer	52.90	92.28	209.64	368.40
Patrick Basic Right	49.55	80.15	172.09	286.89
31 System	19.88	33.67	48.39	112.34
Do/Don't Odds Do	30.29	55.91	137.09	*
Don't/Place	21.04	40.30	112.94	200.54
Five Count	18.45	29.66	96.16	173.24
Rec.Gambling Place-Lay	58.34	112.35	*	*
Martingale	23.22	47.10	45.01	95.52
D'Alembert	43.20	87.87	94.95	196.39
Oscar	43.12	85.07	82.91	178.35
Hoyle's Press	55.46	105.15	111.53	223.77
Contra-D'Alembert	68.53	62.37	142.50	125.86
Anti-Martingale	44.77	40.45	91.29	80.75

Table 15 -- Standard Deviation of the Overall Mean˝Length (Rolls)

Stop-Win/Bust-Out Ratio

As discussed above, some of the distributions produced are distinctly bimodal, indicating two somewhat distinct durations for the session, the centers of which are the mean stop-win length and the mean bust-out length. This measure is the mean stop-win length divided by the mean bust-out length, given in Table 16, and can be interpreted as follows. If the ratio is greater than one, it indicates that the stop-win trials will generally take longer than the bust-out trials for that particular system and set of starting parameters. Likewise, a ratio less than one indicates the bust-out trials will generally take longer than the stop-win trials, while a ratio close to one indicates that stop-win trials and bust-out trials will take about the same amount of time. Note that this ratio *does not* give information about frequency or size of the wins and losses. The information in this table may at first appear counter-intuitive, because as the stop-win limit increases the ratio grows smaller, thus indicating that the losses are taking longer than the wins relative to the smaller stop-win limit case. However, as we mentioned before, increasing the stop-win limit allows for very long losing trials by virtue of the fact that trials that would have stopped at the lower (150%) stop-win limit now continue, and those that continue and eventually bust out contribute to the long losing trials and lower ratio in the “200%” columns.

Initial Parameters:	5x 150%	5x 200%	10x 150%	10x 200%
Pass Bet	1.37	0.94	1.47	0.96
Ponzer	1.20	0.83	1.38	0.91
Patrick Basic Right	1.32	0.97	1.52	1.04
31 System	0.90	0.65	0.87	0.67
Do/Don't Odds Do	1.27	0.83	1.38	*
Don't/Place	0.59	0.39	0.94	0.62
Five Count	0.73	0.50	1.14	0.77
Rec.Gambling Place-Lay	0.88	0.62	*	*
Martingale	0.64	0.44	0.57	0.40
D'Alembert	0.78	0.55	0.72	0.53
Oscar	0.90	0.62	0.78	0.56
Hoyle's Press	0.83	0.57	0.70	0.52
Contra-D'Alembert	1.99	1.54	2.04	1.56
Anti-Martingale	2.28	2.01	2.46	2.19

Table 16 -- Stop-Win/Bust-Out Ratio (Unitless)

Win/Loss Ratio

The final measure is the number of winning trials divided by the number of losing trials, given in

Table 17 for each system and its varying starting˝parameters. Note that for all of the 150% stop-win limit trials the ratio is less than two, while for˝all of the 200% stop-win limit trials the ratio is less one. If this were not the case, then the system˝would have a positive expectancy, which is not possible for bank craps. A large ratio is desirable, but˝again Table 9 should also be examined in conjunction with this measure because it is most often˝the case that frequent wins are small wins, meaning that the losses sustained with that type of˝system will generally be large.

Initial Parameters:	5x 150%	5x 200%	10x 150%	10x 200%
Pass Bet	1.3284	0.7577	1.5674	0.8144
Ponzer	1.1314	0.6409	1.3705	0.7161
Patrick Basic Right	1.0473	0.6035	1.2239	0.6561
31 System	1.2737	0.6258	1.4212	0.7147
Do/Don't Odds Do	1.0361	0.5528	1.2325	*
Don't/Place	0.2941	0.1442	0.4456	0.1753
Five Count	0.6424	0.5162	0.6667	0.3695
Rec.Gambling Place-Lay	0.7255	0.3512	*	*
Martingale	0.8872	0.5052	0.9641	0.5059
D'Alembert	1.4203	0.6830	1.4008	0.6770
Oscar	1.3716	0.6804	1.3923	0.6779
Hoyle's Press	1.4384	0.6852	1.3906	0.6742
Contra-D'Alembert	1.3559	0.7014	1.3565	0.6875
Anti-Martingale	1.0953	0.5732	1.0768	0.5720

Table 17 -- Win/Loss Ratio (Unitless)

Summary

We have characterized a number of systems in two cases˝of interest: the typical net loss for a given system, and the typical time it will take the˝player to either exhaust their bankroll (bust out) or reach their stop-win limit. Since different craps˝players will have different desires when playing craps, there is no “best” system for everyone; a player who desires a lot of “action” will not be happy with a system such as the Do/Don't Odds Do system,˝while a player who wants to conserve their bankroll and bet at a lower limit may prefer the˝Ponzer over the Don't/Place system. The measures defined in this paper are intended to provide˝information on system characteristics that are useful not only in comparing two systems, but also˝for observing the effects length-of-play and various starting and stopping parameters have on the˝behavior of a system.

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