A NEW SYSTEM FOR ROULETTE BASED ON THE PHYSICS OF THE ROULETTE WHEEL

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Summary of the Paper

- In this presentation, we will introduce a system for roulette based on the physics of a tilted roulette wheel.

- It results from a detailed non-mathematical examination of the non-random layout of the roulette wheel pockets.

- It relies on team camouflage and, because it utilizes all three elements of the ABS camouflage model, A(cting), B(etting), S(trategy), it is undetectable.

- For the sake of brevity, we will refer only to the American roulette wheel layout. The same analysis applies to the European roulette wheel layout, and that analysis will appear in the paper to appear in the conference proceedings to be published by the International Gambling Institute.

- CAUTION: The viability of the system depends on the ability of the team to locate and manipulate a croupier who is able to influence the rest sector of, or "steer," the roulette ball.

OUTLINE

1. Can a Croupier Guide the Ball?

2. The Physics of a Tilted Roulette Wheel

3. Skullduggery and Shillology

4. Roulette Bets and the Magic Circle

5. Examples of Team Play

6. Camouflage and Tips

To Guide or Not to Guide?

The basic idea of influencing the pockets into which the ball will fall, referred to by many names such as "section shooting," "steering," "guiding," "directing," "controlling," and the "dealer signature," is that a croupier dealing roulette four to six hours daily, fifty weeks a year, over only a few years, will develop routines and muscle memory that would create predictable and therefore exploitable preferences for where the ball will come to rest.

- Roulette students differ on whether croupiers can steer the ball. Edward Thorp of blackjack fame in a series of articles in Gambling Times magazine and in his book *The Mathematics of Gambling* presents arguments, both mathematical and non-mathematical, that any steering capability is "not exploitable." Other students agree invoking arguments including "the capricious nature of the wheel" and the changing phases of the moon. I tend to agree with the latter as concerns casinos in Transylvania, where many of the croupiers are known to be werewolves.

- Arnold Snyder, a fellow member of the Blackjack Hall of Fame with Thorp, in his authoritative columns in Blackjack Forum Online disagrees. One of my favorite responses of his concerns the claim that if croupiers could steer they would be "taking out" millions and would no longer need to work. His response is "What makes you think they haven't?" and the common sense "a dealer who can steer would probably choose to practice his skill as long as possible."

- Choosing who to believe between these two authorities is like choosing who to believe between Aristotle and Plato.

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Who to Believe?

- The many and lengthy back and forth discussions on the subject of steering remind me of the interchange between the Church figure and the Galileo figure in *Dialogue Concerning the Two Chief World Systems (Dialogo sopra i due massimi sistemi del mondo)*.

- The problem is that only the croupiers know for sure, and, for various reasons, "they ain't talking."

- We, as scientists, however, rely not on authority (not to mention faith and revelation) as a mode to arrive at truth but on experiment. We therefore follow Galileo's lead as relying on rational inquiry and observation.

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Physics of the Roulette Wheel
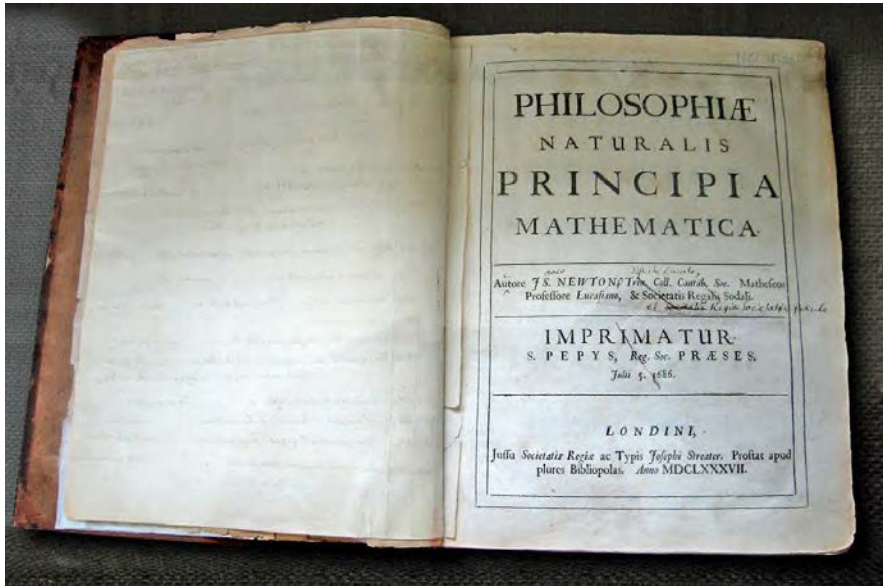
The frontispiece of the most important non-fiction work every published in the English language (outside of *Beat the Dealer*). *Principia Mathematica* by Isaac Newton provided the foundation for the study of the physics of the roulette wheel. (The author's copy was purchased at auction with a small portion of his winnings using the roulette system described in this paper.)

The study of the motion of a ball along its track on the roulette wheel requires only classical mechanics, studied by every student of physics. Based on the same physics that explains that a ball rolling uphill will lose speed and a ball rolling downhill will gain speed, physicists have shown that, given factors including the release point and initial speed of the roulette ball, a tilt of the wheel leads to a preference for the sectors from which the ball will lose contact with the outer rim and begin its descent to the inner rim, the location of the roulette wheel pockets. Given the release point, the ball can leave only a relatively small region of the outer rim of the roulette wheel, but, even more importantly, certain sectors on the wheel are found to exist from which the ball will never leave the rim, the "forbidden zones." Despite the deflectors and pocket frets, the strong bias in the departure point of the ball leads to a bias in where the ball will come to rest on the inner rim.

British National Weights and Measures Laboratory Experiment

- In 2005, experimenters at the British National Weights and Measures Laboratory quantified these theoretical findings.

- The NWML experimenters tilted a wheel from 0.1^o to 1.35^o, very small angles, and spun the wheel 176 times.

- In the analysis, the roulette wheel was divided into 8 equal sectors and the ball was always released from the same sector. The NWML recorded into which sectors the ball landed. The bias was overwhelming, as shown in the next slide.

- Even with the 0.1° tilt, which is a deviation from the horizontal by only 1 part in 3600, a 98% chance was found that the final resting place would be biased.

- Because it is virtually impossible to build a casino and place roulette tables with less than a 0.1° tilt, biases originating from tilt must exist in nearly all wheels. We need not bring surveyor's instruments into the casino, which might arouse suspicion.
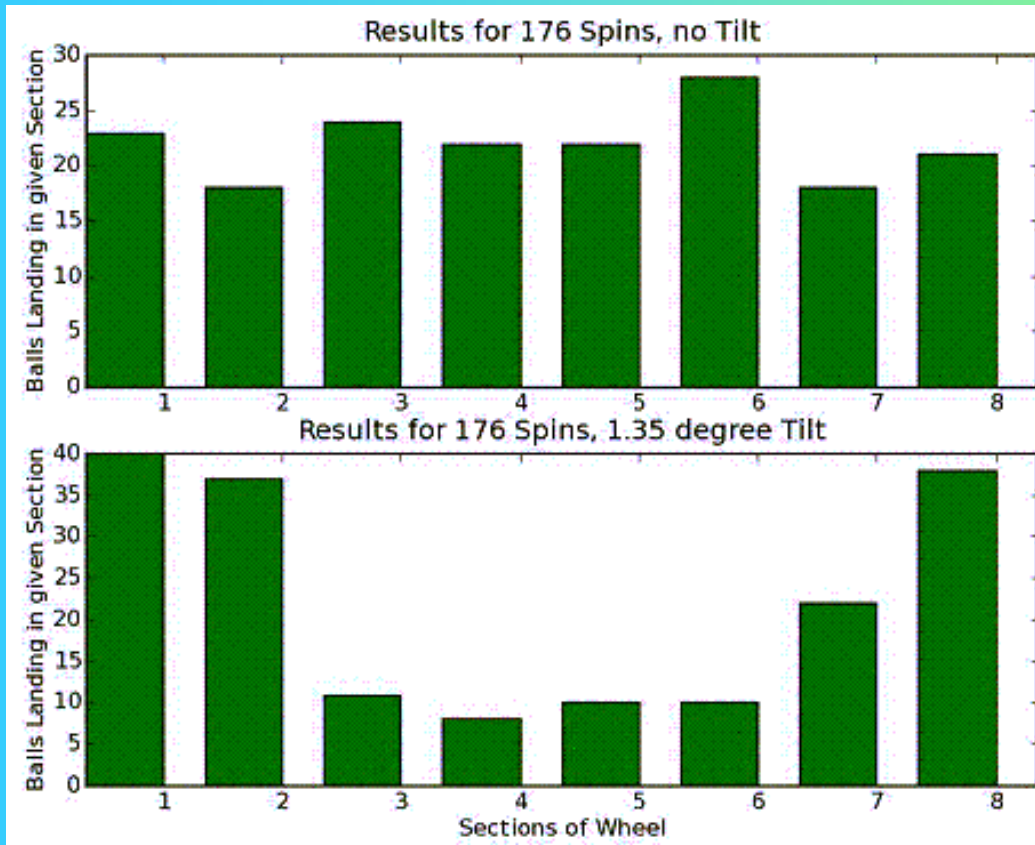
SUMMARY: The NWML experiments show that the forbidden zone, the sectors of the wheel from which the ball cannot lose contact with the outer rim and begin to fall to the inner rim, limits the sectors of pockets into which the ball lands. Even for small tilts, the deflectors as well as the frets of the pockets cannot overcome the bias introduced by the forbidden release zone. Although with only 176 trials one expects statistical variation, the results you will see graphed are clear. A bias exists with the ball landing preferentially in the sectors furthest from that from which it was dropped.

Results of the NWML Study
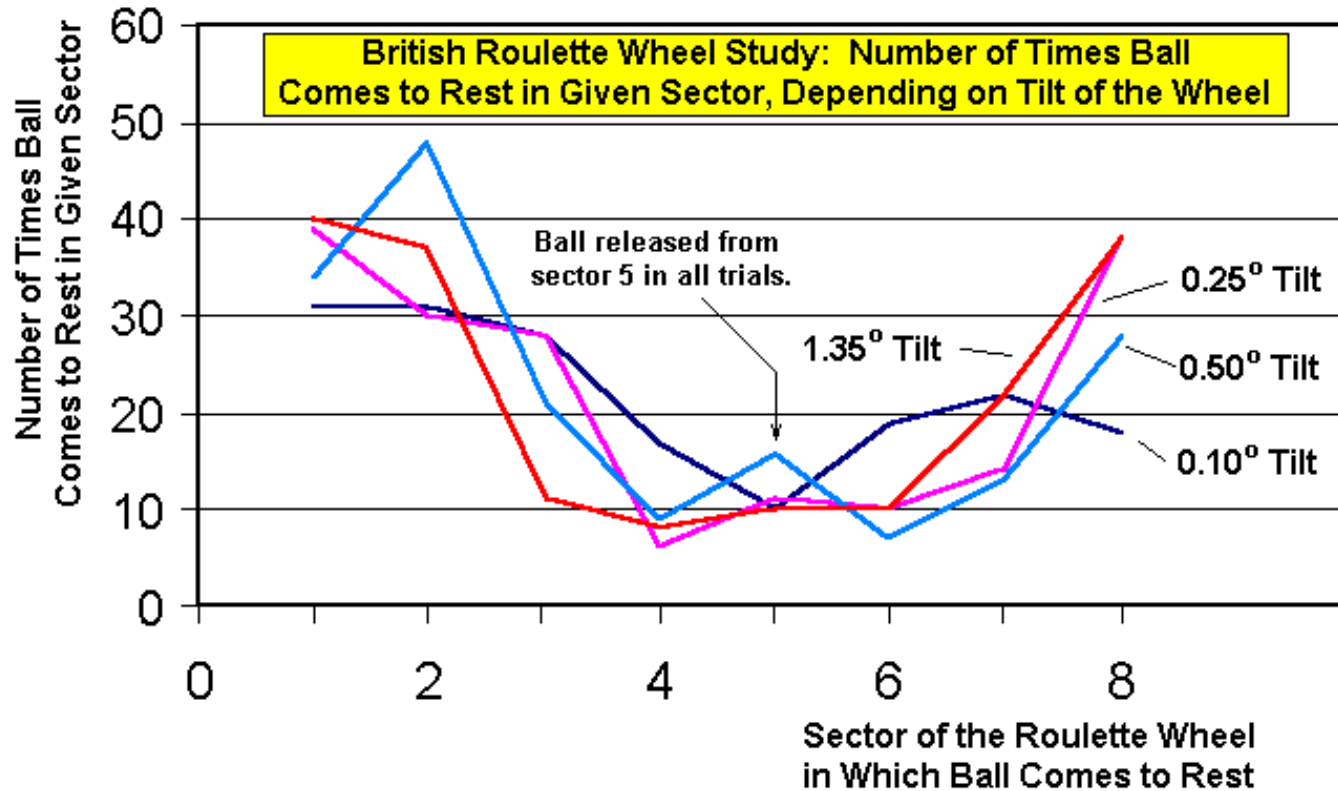
Studies at the British National Weights and Measures Laboratory indicate that the ball does not comes to rest randomly on a tilted roulette wheel. In these studies, the ball was released from sector 5.

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Histogram Results for 1.35º Tilt

Results for 176 Spins, no Tilt
Results for 176 Spins, 1.35 degree Tilt

TITLE: The results for 1.35º tilt displayed in histogram form.

The results are shown strikingly in this representation. The ball comes to rest preferentially in the sectors opposite from the sector of release.

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Thorp vs. Snyder

- It is beyond rational doubt that an experienced croupier would not come to the realization of this bias. The result is simply too striking.

- Conclusion: Experiment, not authority, leads to the finding of truth. Galileo wins. Again. The croupier can influence the resting sector of the ball, even given a roulette wheel possessing a very small tilt.

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Croupier Science

The viability of our system depends upon

a) locating a croupier who can steer the ball and then

b) manipulating or influencing him to steer the ball into favored sectors of the wheel.

The Croupier: Finding a Skillful One

Locating a skilled croupier is perhaps the most difficult aspect of the strategy and may take time. Here are some ways you can try to locate a skillful croupier.

1. Become friendly with the croupier. Tipping helps. Lay down a bet and on the same position on the layout put another bet and tell him, "This one's for you, Bud." After a while, you might broach the subject tactfully. "Some have told me that some croupiers can actually determine where the ball will fall. Is that possible? Here's five bucks for you on number 8, Bud." Converse with the croupier. Perhaps your croupier had mentioned that some other croupiers at his casino can steer the ball.

2. Watch the play at the table to determine if the ball falls in certain sectors more than others. This was practiced by those trying to find faulty roulette wheels before manufacturing improved. If someone lays down a few sizable bets on one sector of the wheel and the ball falls on the opposite sector, the dealer may be able to steer. When a player leaves that wheel, follow him and ask him if he received any hint or suspected that this or any other croupier could steer.

3. If that data-gathering technique fails, you may have to play yourself. Sit down, lay down sizable bets on one sector of the wheel, and observe if the ball falls on the opposite sector. This may take a small investment.

Once we have located a skillful croupier, we have to influence him to locate the ball where we desire.

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The Croupier: Skullduggery

We can attempt to influence the croupier in two ways.

1) Be nice to him so that he will guide the ball to *a favored sector where you are betting.* This includes tipping him. Place small bets so that he won't fear management reprisals.
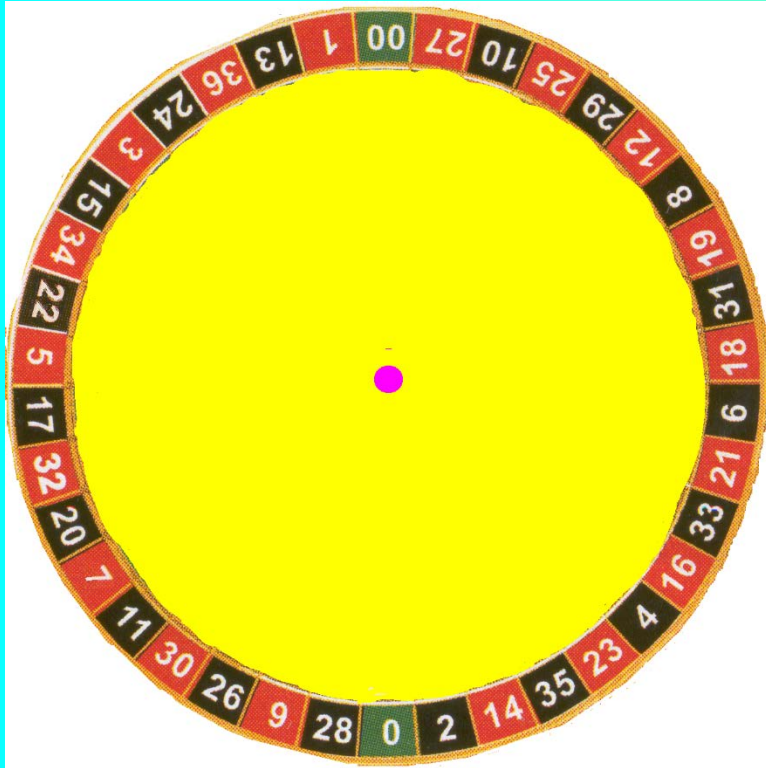
2) Utilize the skill of a shill-actor big bettor to alienate the croupier so that he will guide the ball to *a favored sector on the opposite side* of the wheel from where the shill-actor is placing large bets. The shill-actor can be rude, spill a drink, act drunk, lay a lit cigarette on the layout, make comments about the career or appearance of the croupier, and employ other means of incurring his wrath. Because he is avoiding paying off a big bettor, the croupier will have no fears of management reprisals. This desire to please the house encourages him to avoid paying off the big bettor even if he's not been alienated.

In our actual casino play, we have had only moderate luck utilizing the first method. Our further discussion in this paper will deal with influencing the croupier using the second method.

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Types of Bets in American Roulette and Their Payouts

Inside or layout bets

A - 1 number, "Individual" or "Straight up," pays 35:1
B - 2 numbers, "Split," pays 17:1
C - 3 numbers, "3 Line," pays 11:1
D - 4 numbers, "4 Corner," pays 8:1
E - 5 numbers, "1st Five," pays 6:1
F - 6 numbers, "6 Line," pays 5:1

Outside bets

Columns pays 2:1
Dozens   pays 2:1
Even/Odd - Pays even money 1:1
Red/Black - Pays even money 1:1
1-18/19-36 - Pays even money 1:1

These are the eleven American roulette bet types and their payoffs, the amount paid to a winning player for a 1 unit bet. The letters A-F indicate the location on the layout of the inside bets.

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Expectation Values in American Roulette

To compare our strategy to that of unbiased roulette, we will calculate the expectation value. The expectation value, *E*, of a bet is the expected winnings or losses after many (infinite) number of trials. If *P* is the probability of winning or losing,

$$E = [P(win) \; x \; Payout - P(lose)] \; x \; Bet$$

where, of course,

$$P(win) + P(lose) = 1 \quad .$$

For an individual $1 bet, because 38 pockets exist on the (American) roulette wheel

P(win) = 1/38, Payout = $35,
P(lose)= 37/38,

And the formula gives the well-known, sad result,

E = [1/38 x $35 − 37/38] x $1 = -$0.0526

The house has a 5.26% advantage. For every $100 bet, the player expects to lose $5.26. This is a familiar number to roulett players. It is easy to show the house has this same advantage for all bets except the 5 numbers bet, for which the house has an even greater advantage.

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Examples of Expectation Values: 5.26% in Favor of the House

In American roulette, the house has a 5.26% advantage.

Using the formula, the expectation value for the "dozens" bet, 12 ways to win with a payoff of 2:1, is:

$$E = [12/38 \times \$2 - 26/38] \times \$1 = -2/19 \times \$1 = -\$0.0526 .$$

The expectation value for the "4 corner" bet, 4 ways to win with a payoff off 8:1, is again 5.26%:

$$E = [4/38 \times \$8 - 34/38] \times \$1 = -2/19 \times \$1 = -\$0.0526 .$$

Non-randomness in Roulette

- Any viable gambling system relies on the non-randomness of the possible outcomes. Because the roulette wheel surface is a two-dimensional object and eleven betting options exist, it is clear that not all bet types can be randomized.

- The designers of the American roulette wheel decided that the pockets alternate between red and black (except for 0 and 00) and that diametrically opposite numbers differ by unity (again, except for 0 and 00). That design eliminates the advantage of steering for the red/black bet and reduces it substantially for the inside bets.

- That's it. A two-dimensional roulette wheel allows only two constraints in its design. We, therefore, are led to carefully examine the roulette wheel to determine which bet types exhibit the most exploitable non-randomness.

- Our definition of "exploitable" is suggested by the NWML study, which divided the European roulette wheel of 37 pockets into 8 sectors, each of 37/8 = 4.6 "pockets." We accordingly search for betting options in which at least three of four adjacent pockets pay off. That's the implied steering ability of the croupier in our study.

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Non-randomness in Evens/Odds Bet Locations
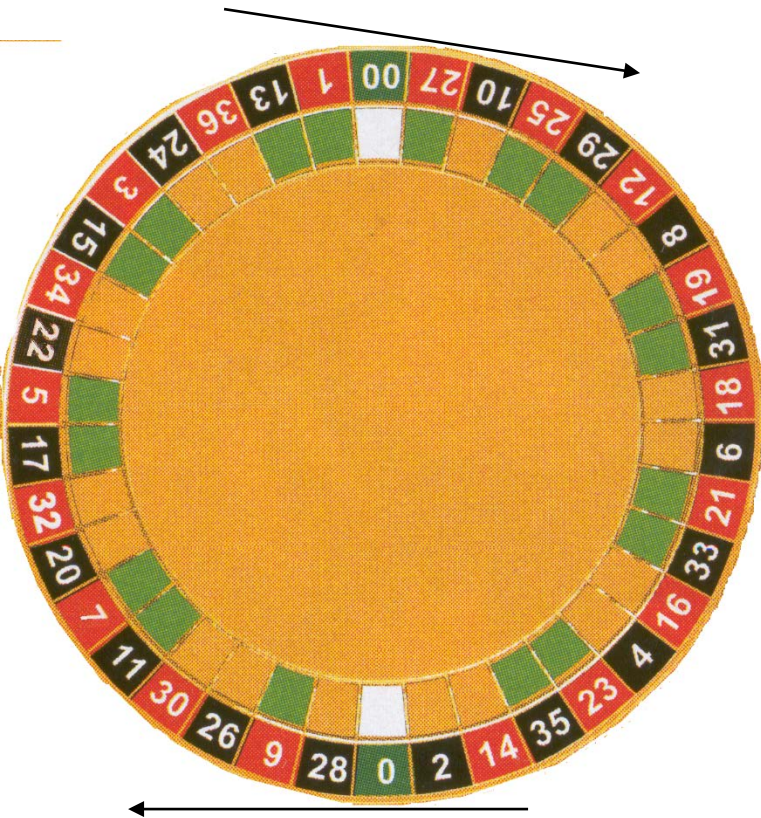
In the American roulette wheel, we have shaded the areas adjacent to the odd pockets the color green and those adjacent to the even pockets the color orange. As can be seen, the odds and evens pockets are distributed in pairs, two odds followed by two evens followed by two odds, and so on. About the 0 and 00 pockets, however, the trend is violated and we have non-randomness on a scale larger than two pockets.

There, we find sequences of seven numbers. About the 00 pocket (top of wheel as shown) five odd-numbered pockets and one even-numbered pocket appear, 13-1-00-27-10-25-29. In the 4-pocket sequence of 27-10-25-29 we have three odd-numbered pockets.

Around the 0 pocket five even-numbered pockets and one odd-numbered pocket appear, 14-2-0-28-9-26-30. In the 4-pocket sequence 28-9-26-30 we have three even-numbered pockets.

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Non-randomness in Dozens and 19-36 Bet Locations
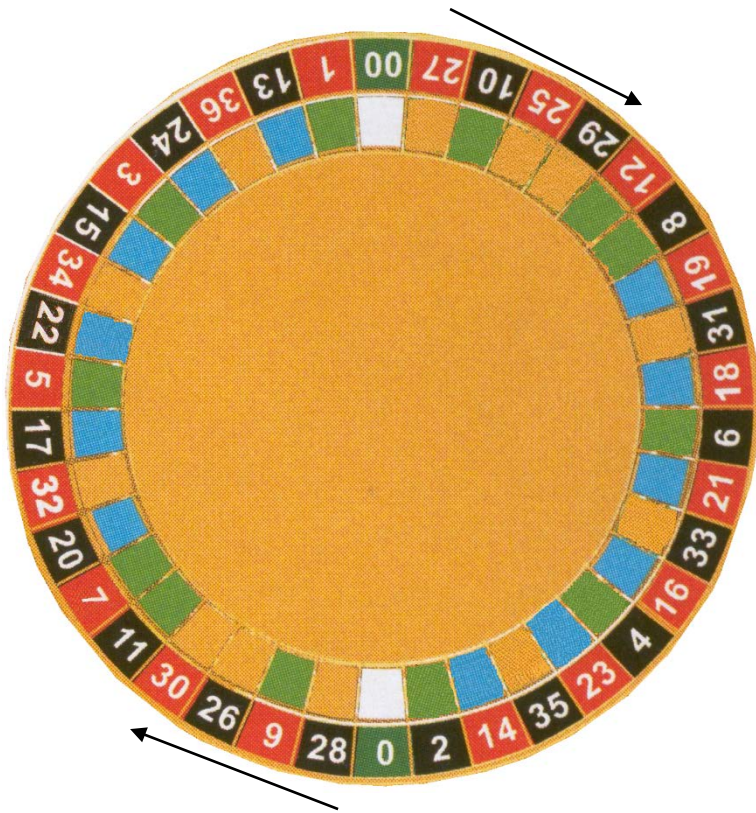
Non-randomness also appears in the placement of the dozens and 19-36 bet locations on the roulette wheel. The areas colored green are adjacent to pockets of the 1-12 dozen, those colored blue are adjacent to pockets of the 13-24 dozen, and those colored yellow are adjacent to pockets of the 25-36 dozen. We see two 4-pocket sectors have 3 out of 4 pockets in the second dozen:

1. Sector next to 00: 27-10-25-29
2. Sector next to 0:   28-9-26-30

The same non-random location of the 19-36 bets appears in these two sectors.

Non-randomness in Columns Bet Locations

With the columns bet, the existence of four 4-pocket sectors create significant non-randomness on the wheel. The are located at 10, 3, 5, and 9 o'clock on the wheel shown.

1. 10 o'clock Sector: 15-3-24-36   (4 of 4 in third column)
2. 3 o'clock Sector: 18-6-21-33   (4 of 4 in third column)
3. 5 o'clock Sector: 23-35-14-2   (4 of 4 in second column)
4. 9 o'clock Sector: 20-32-17-5   (4 of 4 in second column)

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Non-randomness in Inside Bets

Thirteen cases of non-random positions of the pockets occur in the various types of inside bets, but in only two cases do they meet the threshold of three winning numbers in a 4-pocket wide sector.

a) The following numbers are located in 4-pocket wide sectors but have only two winning numbers in the "4 corner" and "6 line" bets: (7,11) (8,12) (9,11) (17,20) (18,21).

b) The following are located in 4-pocket wide sectors but have only two winning numbers in the "4 corner" bet: (25,29) (27,29) (26,28) (26,30).

c) The following have two winning numbers in the "3 line" bet but are located in a sector only three pockets wide: (25,27) and (28,30).

d) The following two sets of pockets, however, satisfy our criteria, having three winning numbers in a 4-pocket wide sector. They appear in the "6 line" bet: (25,27,29) and (26,28,30).

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Summary of 4-Pocket Non-randomness in the American Roulette Wheel

Red/black. The pockets alternate between red and black, except for 0 and 00. No preferential 4-pocket sectors exist.

Even/odd
1. Sector including 00: 13-1-00-27-10-25-29 (5 of 7 are odd, including 3 of the last 4)
2. Sector including 0:   14-2-0-28-9-26-30   (5 of 7 are even, including 3 of the last 4)

Dozens
1. Sector 27-10-25-29 (3 of 4 in 25-36 dozen)
2. Sector 28-9-26-30   (3 of 4 in 25-36 dozen)

1-18 and 19-36
1. Sector 27-10-25-29 (3 of 4 in 19-36)
2. Sector 28-9-26-30   (3 of 4 in 19-36)

Columns
1. 10 o'clock sector: 15-3-24-36   (4 of 4 in third column)
2.   3 o'clock sector: 18-6-21-33   (4 of 4 in third column)
3.   5 o'clock sector: 23-35-14-2   (4 of 4 in second column)
4.   9 o'clock sector: 20-32-17-5   (4 of 4 in second column)

 6 line bets
1.   Sector 27-10-25-29
2.   Sector 28-9-26-30

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So What?

- Question: Do any of these preferred sectors overlap? This would provide a basis for camouflaged team play. Do they?

- Answer: **YES**

- Show me. The overlapping sectors lead us to refer to the following as the *Magic Circle*.

"The Magic Circle"!! ♫

KEY
ODD/EVEN SECTORS
DOZEN SECTORS
1-18 AND 19-36 SECTORS
COLUMN SECTORS
6 LINE SECTORS
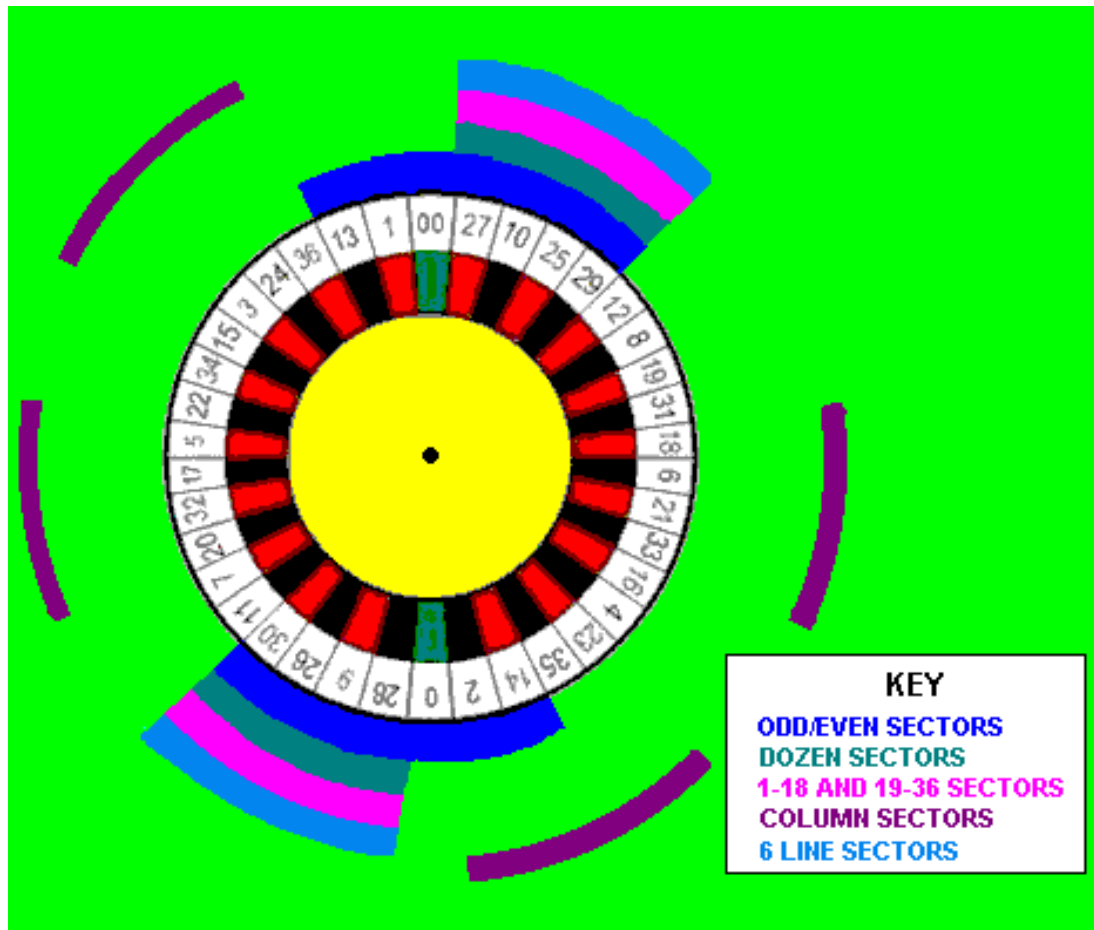
The viability of the camouflage system results from the overlap in two 4-pocket-wide sectors of commonly-played bets, the odd/even, dozens, and 1-18/19-36, as well as the 6 line bet.

Except for the 5 o'clock sector, none of the column sectors (in purple) intersect the others. Yet they can be utilized as an extra element of camouflage.

Our goal is to influence the croupier to steer the ball into these two sectors.

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Quantification of Guiding

- To enable calculation of expected winnings, we need to mathematically incorporate the ability of the croupier to guide the ball into a given sector of the roulette wheel.
- We do this by assigning an increased width to the pockets in the favored sector.
- This in effect increases the number of pockets, with a corresponding change in the probabilities of landing in any given pocket. In particular, the ball is proportionally less likely to fall into the other 34 pockets.
- In the examples given, we provide a Croupier Skill Level of 2.0, implying that the effective width of favored pockets is twice its actual width. The calculations can be performed for any skill level. These examples consider the case in which a shill-actor placing large bets alienates the croupier, influencing him to direct the ball to the *opposite sectors* of the wheel.
- If the croupier is friendly, all the bets are placed in the same sector, increasing further the expected winnings.

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Example for Individual Bets with Croupier Skill = 2.0

EXPECTED WINNINGS WITH UNBIASED GAME

	MOE	CURLY	LARRY	TOTAL
Bet	$10	$1	$2	$13
Payout	35:1	35:1	35:1	
P(win)	1/38	1/38	1/38	
P(lose)	37/38	37/38	37/38	
Expected Winnings	-$0.526	-$0.053	-$0.105	-$0.684

EXPECTED WINNINGS WITH CROUPIER GUIDING BALL

	MOE	CURLY	LARRY	TOTAL
Bet	$10	$1	$2	$13
Payout	35:1	35:1	35:1	
P(win)	1/42	2/42	2/42	
P(lose)	41/42	40/42	40/42	
Expected Winnings	-$1.429	$0.714	$1.429	$0.714

The expected winnings for each player are calculated from the expectation value formula. In the first case, note that for the bets taken together -$0.684/$13 = -$0.0526, the 5.26% house advantage.

In the second case, the alienating shill-actor places a $10 individual bet and the other members of the team place $1 and $2 individual bets on the opposite side of the wheel. The ability of the croupier to guide the ball is mathematically represented by the pockets in the 4-pocket sector having larger widths, here twice as large. In effect, we now have 42 pockets, not 38. In this example, the players' advantage is $0.714/$13 x 100 or 5.5%, a striking result.

Error in box

Individual Single Bets
Provide Poor Camouflage

Although this case provides an encouraging result, the strategy provides poor camouflage.

An observant croupier or pit boss might note that some players consistently bet on pockets opposite that on which a big bettor is placing his bets. The system might be discovered, especially if the players win consistently, and the players face the possibility of being banned from the casino. Even if they are allowed to continue to play, if the croupier has sufficient skill he could manipulate the ball to fall into pockets one-quarter around the wheel from the high roller with the result that everyone on the team loses.

Because the highest payoff results from the individual single bet, the team would like to place as many of these as possible. A team can disguise their placement of such bets by using any of the bet types residing in the preferred sectors of the Magic Circle. For brevity, we present only the scenario in which the 6-line bet is used as a disguise.

Example for Additional Player Using "6 line" Bet with Croupier Skill = 2.0

EXPECTED WINNINGS WITH FOURTH MEMBER PLAYING "6 LINE" BET
LARRY PLACES 1 INDIVIDUAL BET

	MOE	CURLY	LARRY	SHEMP	TOTAL
Bet	$10	$1	$2	$2	$15
Payout	35:1	35:1	35:1	5:1	
P(win)	1/42	2/42	2/42	9/42	
P(lose)	41/42	40/42	40/42	33/42	
Expected Winnings	-$1.43	$0.71	$1.43	$0.57	$1.28

LARRY PLACES 2 INDIVIDUAL BETS

	MOE	CURLY	LARRY #1	LARRY #2	SHEMP	TOTAL
Bet	$10	$1	$2	$2	$2	$17
Payout	35:1	35:1	35:1	35:1	5:1	
P(win)	1/42	2/42	2/42	2/42	9/42	
P(lose)	41/42	40/42	40/42	40/42	33/42	
Expected Winnings	-$1.43	$0.71	$1.43	$1.43	$0.57	$2.71

LARRY PLACES 3 INDIVIDUAL BETS

	MOE	CURLY	LARRY #1	LARRY #2	LARRY #3	SHEMP	TOTAL
Bet	$10	$1	$2	$2	$2	$2	$19
Payout	35:1	35:1	35:1	35:1	35:1	5:1	
P(win)	1/42	2/42	2/42	2/42	2/42	9/42	
P(lose)	41/42	40/42	40/42	40/42	40/42	33/42	
Expected Winnings	-$1.43	$0.71	$1.43	$1.43	$1.43	$0.57	$4.14

With its 5:1 payoff, the 6 line bet appreciably adds to the team's winnings without raising suspicion. The first three players bet a single individual number. Shemp plays the 6 line bet. In each successive table, Larry plays 1, 2, and 3 different individual bets.

Whether Larry places 1, 2, or 3 single bets depends on the balance between desired advantage and quality of camouflage the team thinks is needed.

The summary table below shows that the advantages in all cases are remarkable.

SUMMARY OF ADDING 6 LINE BET

Number of Larry Bets	Winnings	Total Bets	Advantage
1	$1.28	$15	8.5%
2	$2.71	$17	15.9%
3	$4.14	$19	21.8%

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Camouflage Strengths of the Team Strategy

Summary: We assume we have a tilted wheel and that the croupier is skilled in releasing the ball into preferential sectors. One member of the team, the alienating shill-actor, places a large bet on a given number or group of adjacent numbers. The other members of the team place small bets in the sector *opposite* that on which the big-bettor shill-actor has bet. The croupier avoids the shill-actor player, either because he wants to please the house or because he dislikes the shill-actor player, and the probabilities increase that the small bettors win.

Elements of the camouflage:

The Magic Circle strategy is undetectable for several reasons.

1) The team members are not exclusively betting individual bets opposite the shill's sector.

2) They are placing bets commonly employed by beginners, the even/odds, dozens, and 1-18/19-36, in addition to the 6-line bet as used in the example above.

3) They are placing small bets and will not attract scrutiny.

4) The croupier will not be faulted by the house for trying to avoid paying off the shill big bettor. He may be congratulated, leading him to continue doing the same.

5) The team members are easily alternated. No exchange of signals are needed and minimum instruction is needed. As a result, we avoid the situation in which the same group of team members appears at the table, for example, young M.I.T. students. In fact, the team members can be recruited from players at the casinos.

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Tips for Using the Magic Circle

- The single most difficult aspect of the Magic Circle method is to find a skillful croupier. Patience is required. If you cannot befriend the croupier, your shill-actor big bettor must be skillful at alienating the croupier, but not to the extent that he is barred from the casino.

- If the croupier is to be alienated by the shill-actor, we have found that the other team members should appear at the table first and establish their betting patterns of betting small beginner-type bets. They should only rarely bet the individual pocket bets exclusively. As beginners, occasionally ask "advice" from the croupier.

- Once you have found a skillful croupier, you should repeatedly play at his table, but with different team members. To magnify the alienation, the shill-actor should be the same at each playing session.

- Unlike card counting at blackjack, you need not play at a roulette table with no other players. To avoid dilution of the effect of your big bettor shill-actor, however, tables with big bettors should be avoided.

- Because of the ability to identify the multiple players in a team, a general rule of camouflaging gambling systems should be used: Never cash out your chips at foreign casinos. Communication between casinos may lead to their discovery of your techniques and your being barred.

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The Battle Goes On

The use of the Magic Circle strategy was first tested in Reno in 2012. We needed nearly two days to discover a croupier with the sufficient steering skill. We came in with four team members, including myself as the actor-shill. Larry, Curly, and Shemp had limited success persuading the croupier to steer the ball to our sector, although his relations with them were cordial.

I then entered as the alienating actor-shill, Moe. After ten minutes of my less-than-polite behavior, the croupier began to hit the favored sectors. Larry, Curly, and Shemp alternated placing their small bets in various beginner-type bets and the 6 line bet, occasionally betting single bets.

We recruited other team members, with me as a constant, and we continued to play successfully for several days.

Note to the IRS: Darn it, our table profits did not meet the expenses of our business trip. Not even close. We lost a lot.

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We don't own the Earth;
We simply share it.

Remember Tyke
August 20, 1994

Remember Harambe
May 28, 2016

Remember Onion
June 18, 2015

Remember Stoney the bull elephant
http://animalrights.about.com/od/saddestshow/
a/StoneyDeath.htm

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End of Presentation