



A Brief Introduction to Probability Theory and the Random Distribution of Results

Understanding the Concept of Sequencing in a Trading Operation

April 2014

**A trader's next trade is nothing more or nothing less than a datum point
in a series of data points subject to random probability theory**

**Please complete the questions on this page before reading
the remainder of this paper**

Introduction

Consider the following assumptions:

- You are a novice speculator with a trading account capitalized at \$100,000.
- Until you learn the ropes and figure out exactly how you want to trade, you will be happy to break even for the first few years.
- You adopt a trading program that you are confident will give you breakeven results over an extended period of time. You are confident that the metrics of this trading program are:
 - It will make about 100 trades per year, or two per week.
 - It will have a "hit" or "win" rate over time of 50% -- meaning that over time half the trades should be profitable and half should be losses. [Note – this figure is slightly higher than the win rate of many professional traders.]
 - You believe your average loss per losing trade will be (\$600).

Questions:

1. What must be the size of the average profit of your winning trades to produce breakeven trading for the first few years? Use worksheet to produce your answer below.
2. If you traded this program over a five-year period, what would you estimate the probability to be that your initial \$100,000 account would end up either less than \$70,000 or more than \$130,000?
3. What would you estimate the probability to be that you will experience a 30% peak-to-valley drawdown?

Do math here

Your answers:

1. The average size of each profit must be \$_____ to produce breakeven trading
2. The probability that my \$100,000 will end up at or below \$70,000 is ____%
3. The probability that my \$100,000 will end up at or above \$130,000 is ____%
4. The probability that I will experience a 30% drawdown is ____%

Discussion

Most novice traders believe that trading profitability is a function of the following metrics:

1. Number of trades
2. % win rate
3. Average loss of losing trades
4. Average profit of winning trades
5. Bet size

The assignment was to calculate the arithmetic average profit per trade (N) needed to produce breakeven trading results given the following facts:

- Number of trades = 100 trades per year for five years
- % win rate = 50%
- Average loss of losing trades = \$600
- Average profit of winning trades = N

In this example, the calculation of N is a no-brainer. **At a 50% win rate, the average gain must equal the average loss (\$600) in order to attain arithmetic breakeven.**

But here is where the assignment gets dicey

If the win rate is 50%, most traders assume that over the course of 10 trades, five will be winners. They also assume that over the course of a 100 trades (one year in this example), about 50 will be winners. They assume that the winners and losers will be fairly evenly distributed over any sample size.

Are these correct assumptions?

NO!

In fact, these are assumptions that sinks the ships of many aspiring traders, even if the approach to trading they adopt has the potential to be a long-term winning trading plan.

The goal of this paper is to completely destroy the concept of using simple arithmetic to gauge expected performance

Introducing random probability theory as the overlooked factor to determine trading profitability

Accurately anticipating trading outcome is far more complicated than knowing the following metrics:

- Account size
- Win rate
- Bet size
- Average loss size
- Average win size

Yet, many novice traders use these metrics to develop assumptions on trading outcome. Why can't performance outcomes be adequately projected based simply on the above metrics?

An arithmetic calculation of trading expectations does not take into account the random sequencing of trading outcomes governed by statistical probability theory

A 50% win rate does not mean that every other trade will be a winner, or that five out of 10 trades will be winners or even that 50 out of 100 trades will be profitable. Within a large series of 50% wins and 50% losses, the outcomes of smaller series of trades can vary considerably and in very unpredictable ways. The random distribution of results caused by probability theory can do some strange things – some very strange things.

Consider the table to the right. Based on a sequence run of 600 trades with a 50% win rate, there was one instance of eight consecutive losers and 15 instances of five to six consecutive losers. In the sequence run for this example, there were two separate instances of six consecutive losers separated by two winners – that is 12 losers in a string of 14 trades. Random distribution can do some very strange things.

Probability of Consecutive Profits vs. Losses (Trading Approach with 50% Accuracy)			
Based on simulated run			
Consecutive Occurrences		Percentage of Occurrences	# Occurrences per 600 events
Profit			
	16+	0.0%	0
	11-15	0.0%	0
	9-10	0.0%	0
	7-8	0.6%	2
	5-6	1.9%	6
	3-4	8.7%	27
	2	11.6%	36
	1	27.0%	84
Loss			
	1	26.4%	82
	2	9.3%	29
	3-4	9.3%	29
	5-6	4.8%	15
	7-8	0.3%	1
	9-10	0.0%	0
	11-15	0.0%	0
	16+	0.0%	0

Several years ago, Factor LLC -- in cooperation with several other traders -- developed an Excel-based program that calculates an endless number of equities curves possible with the EXACT SAME benchmark metrics. I call this program the Factor Trade Sequencer. [Note: the Sequence Modeling program I currently used is a version greatly improved from my original program by a member of the Factor community.]

I used the sequencer for the problem presented in this exercise, namely:

- Win rate = 50%
- Trading frequency = 100 trades per year for five years
- Bet size = 2%
- Average profit on winning trades = \$600
- Average loss on losing trades = \$600
- # of sequences sample runs = 30

The graph to the right shows just four sample equity curves taken from the 30 sequences run in the Excel program.

As clearly seen, the sequencing of winners and losers based on random probability distribution can greatly impact outcome.

Remember, the four equity curves were all produced

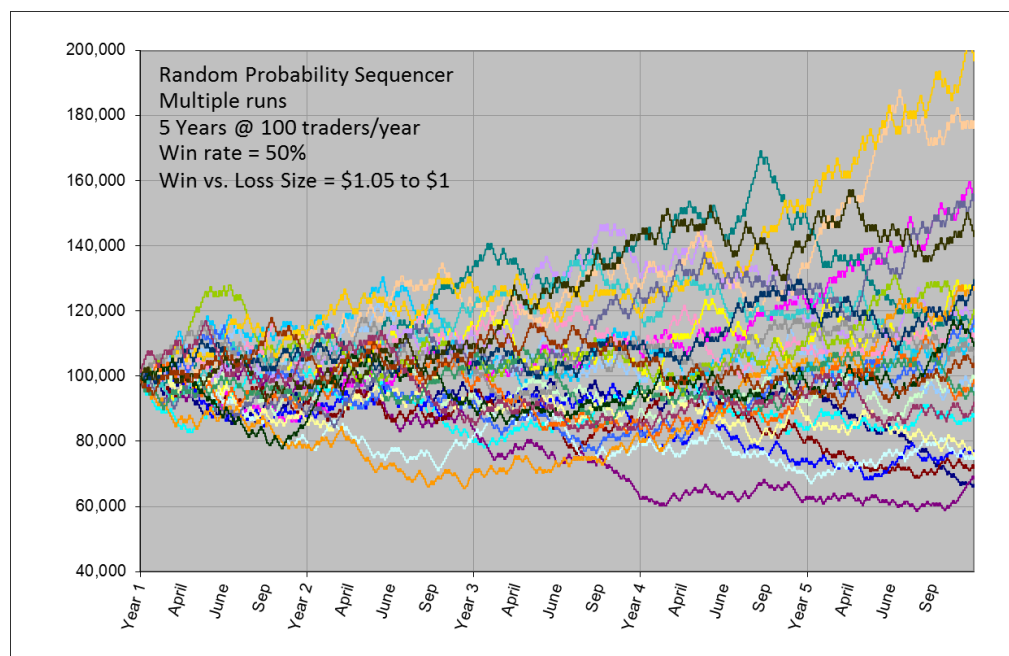
consistent with the same exact benchmark metrics. Of the 30 sequence runs (full graph not shown), five produced a five-year cumulative gain exceeding a 30% (with the highest being a 67% return) and six produced a five-year cumulative loss exceeding 30% (with the largest being a 44% loss). Sixteen (more than half) of the 30 sequence runs had a drawdowns exceeding 30%, the largest being a 51% drawdown.



I hope the practical implication of this exercise is not lost on any of you.

- Two different traders can trade the exact same trading system in the exact same markets at different time periods with vastly different results.
- One trader could have a \$100,000 account grow into a \$167,000 account. This trader might think he or she has a winning program. He or she could be wrong.
- The second trader could have a \$100,000 account shrink into a \$58,000 account. This trader might think he or she has a losing program. He or she could be wrong.
- Both trading experiences would be governed by the same benchmark trading metrics.

I ran the sequencer again, this time giving a slight advantage of \$1.05 win size vs, \$1.00 loss size. The equity curves of all 30 sequences are shown in the graph below. As a reference for further discussion herein, the AVERAGE of the 30 runs required 370 months for the initial equity to double.



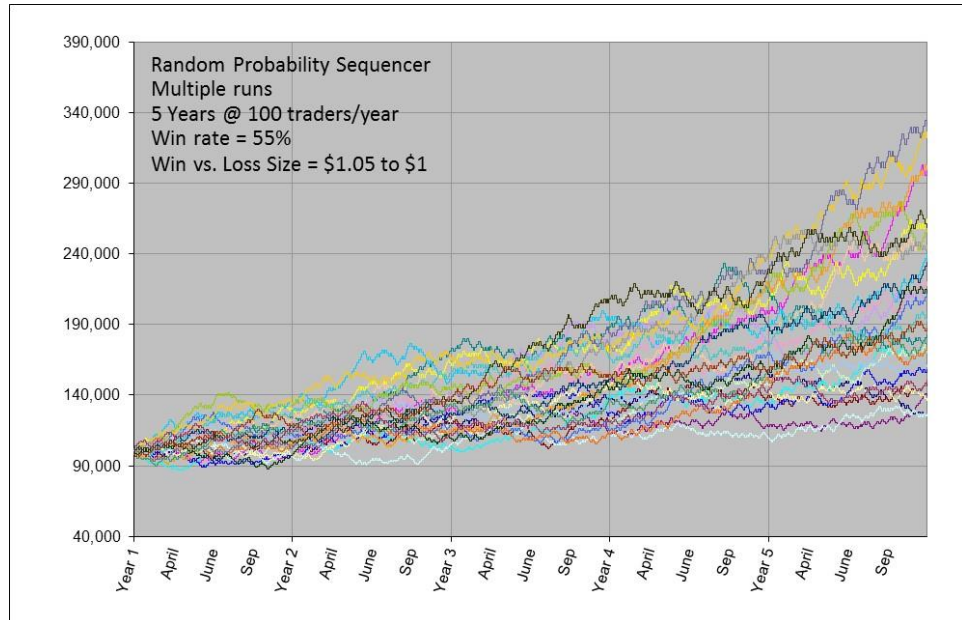
Small changes in baseline metrics can have huge impacts in trading outcomes

Remember, the variation in the equity curves is NOT due to sizes of the gains and losses – these were fixed, as was the bet size. All of the equity curves were also based on the exact same long-term win rate. The variation was completely due to the sequences of wins and losses.

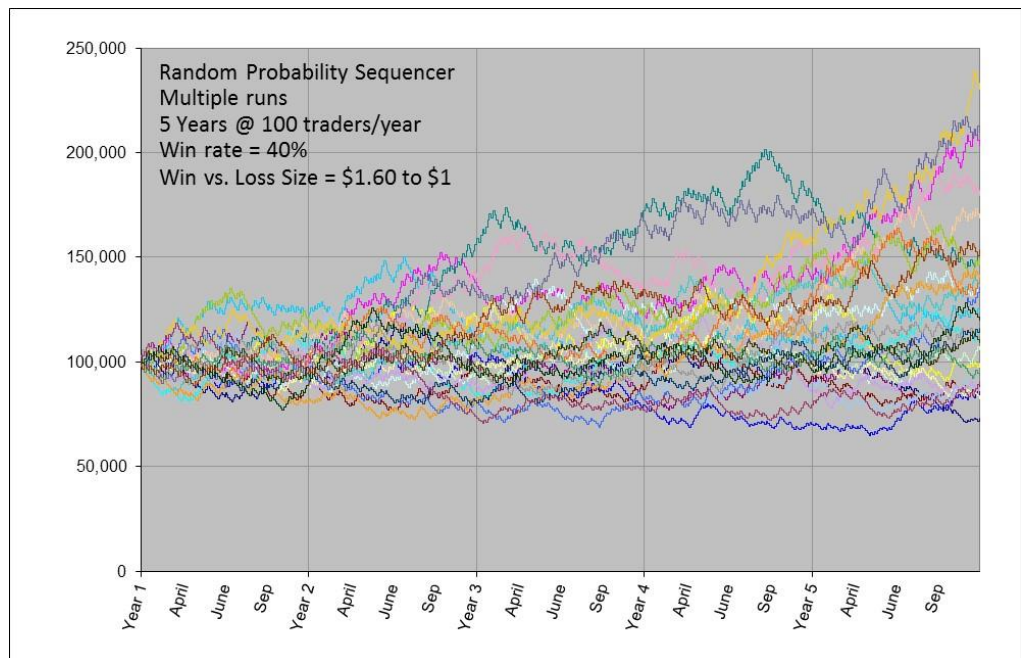
Yet, performance is very sensitive to the average sizes of wins and losses as well as to bet sizing.

The graph to the right (also reflecting 30 random

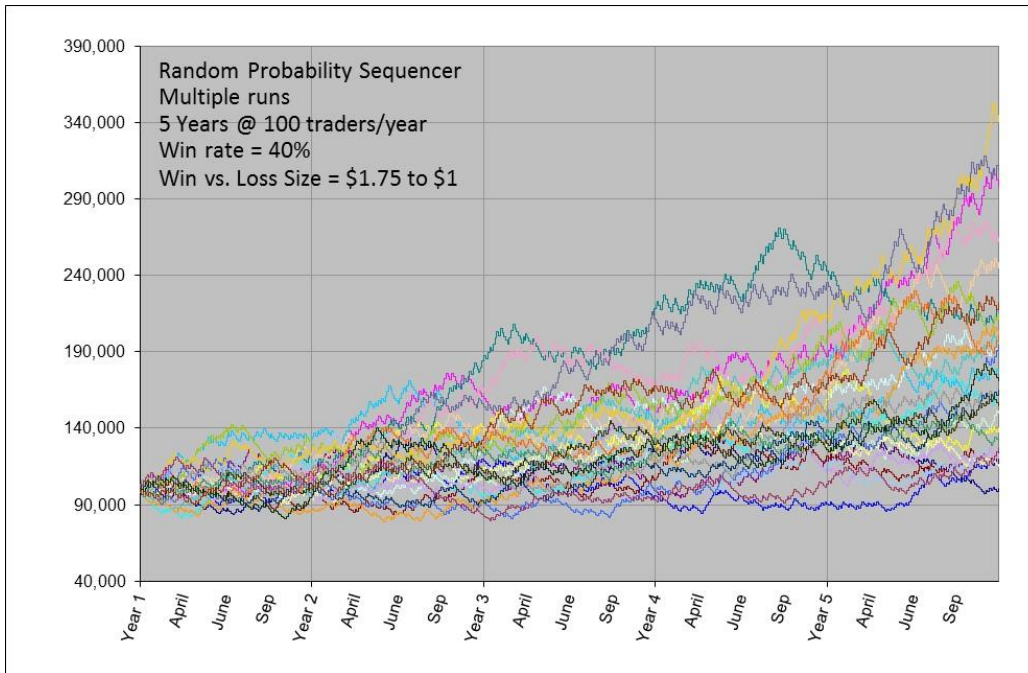
sequence runs) changed the win rate from 50% to 55% using the same win/loss values and bet sizes as the graph on the bottom of page 5. By changing the win rate from 50% to 55% in this graph, the AVERAGE of the 30 runs required 57 months for the initial equity to double and no sequence run ended up with a loss. What a difference a change of 5% in the win rate makes, other variables being constant!



As a further demonstration of the sensitivity of performance to changes in metrics, the graph of sequence runs shown to the right reduces the win rate from 55% to 40%, but increases the payoff to \$1.60 (wins) vs. \$1 losses). If you have paid attention, you would be able to determine that the arithmetic breakeven payout ratio at a 40% win rate is \$1.50 to \$1. The \$1.60 to \$1 provides an edge – and an edge is all a trader can expect to have.



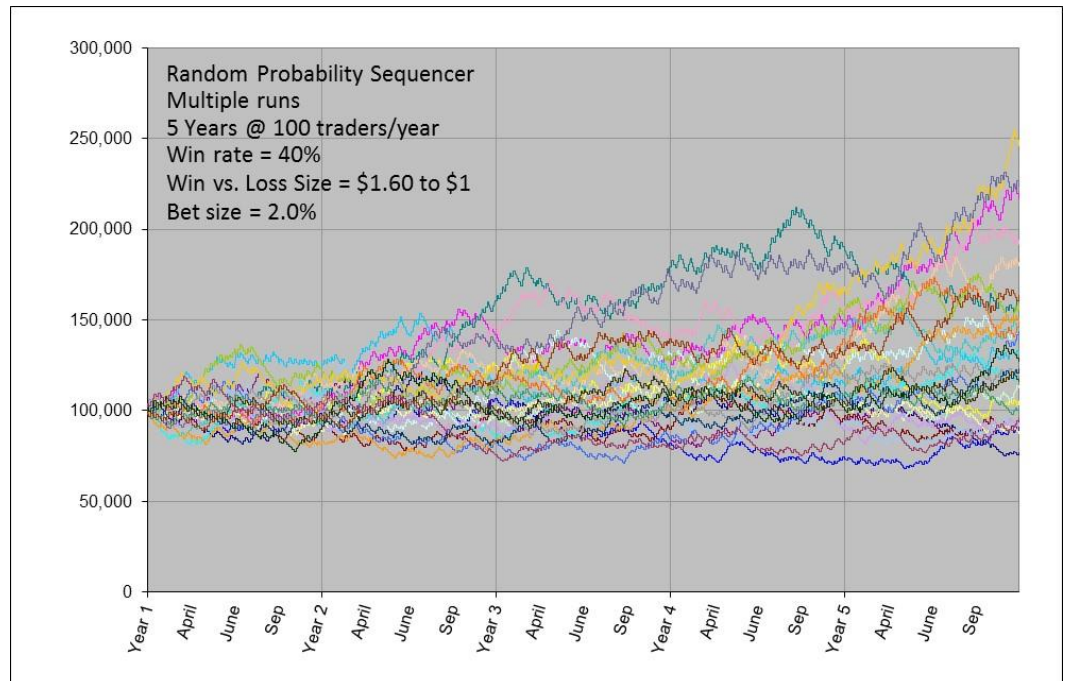
Next, I keep the win rate at 40%, but increase the payout ratio to \$1.75 win size vs. \$1 loss size. By changing the payout ratio slightly, the change in the results are significant. You will note that not a single runs lost money over the five year period.



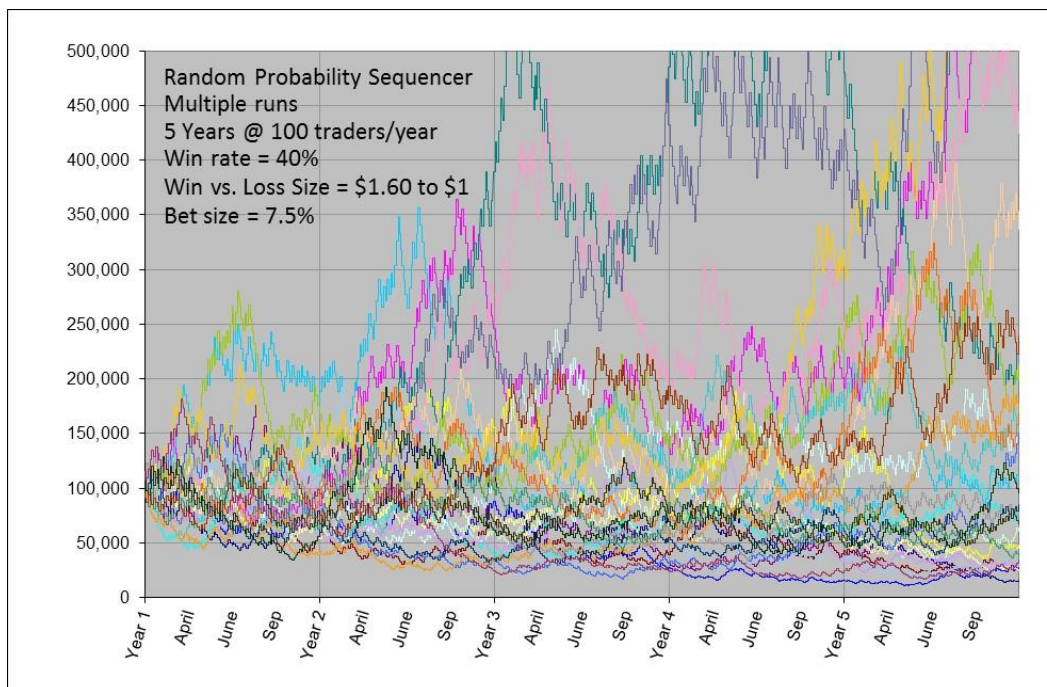
Increase your bet size, cripple your performance

Next, I want to demonstrate the dangers of betting too much on individual trades. The runs on the previous graphs and the one to the right were based on a 2% bet size.

Most professional traders limit their risk per trade to 1% to 2% of capital and reduce this size to as low as ½ of 1% during losing periods. In contrast, I have spoken to many novice traders who routinely bet 5% to 10% of their capital per trade. This is a recipe for disaster.



The chart at the bottom of page 7 and the graph to the right use the same 30 sequencing runs, same win rate and same win/loss values. The bet size on the graph right is 7.5% of capital. All but four of the 30 sequence runs at a 2% bet size were profitable at the end of five years. With a bet size of 7.5%, the equity curve of the majority of the sequence runs got tanked and never recovered, while is a small number of big winning curves – but with volatility that would likely send a trader to the sidelines.



There is a big lesson in these two graphs: **Increase your bet size and increase your probability of loss, all other metrics being equal.**

One other topics is worth of note at this point in the discussion. There is much talk about the Kelly Criterion among new traders. I think the discussion is a bunch of bunk. The Kelly Criterion makes for much better discussion than for a means to determine bet size. I have never met a trader with extensive experience that would utilize the Kelly Criterion. The Kelly Criterion is a statistical construct, but I know of no trader who could emotionally deal with the asset volatility inherent in using the Criterion for actual trade sizing.

How does Factor LLC use sequencing in its proprietary trading

I have traded classical chart patterns over the course of five different decades. My experience with trading futures and forex markets based on classical charting principles is deep and wide. Additionally, my understanding of my trading approach in all aspects is detailed and intimate. I know the personality quirks of the various chart patterns I like to trade. I do not always know what trade will work before I put it on, but I do have a strong sense when a trade is not acting right.

Since 1975 I have been involved in many thousands of trades. My basic approach to trading has remained relatively unchanged over the years (read my 1989 speech to the Market Technicians Association).

My benchmark metrics are well established. Over an extended period of time I have a realistic expectation of my win rate and win/loss size ratio. Over any series of trades (less than 150) or shorter period of time (12 months or less) I do not have a clue what might happen to my equity curve due to the random distribution of results, or trade sequencing.

I maintain rolling 12-month stats on key metrics. Should all traders maintain stats? Trading is a business. Shouldn't all serious businesses maintain key metrics?

While I have no control over the equity curve for shorter-term time periods, I do have control over certain variables in my trading. Here is what I can and cannot control in my trading:

Can exert control	Cannot exert control
<ul style="list-style-type: none">• Type of pattern I will trade – impacts number of trades per year• Size of average loss• Size of worst loss• Bet size	<ul style="list-style-type: none">• Win rate• Average win size

From time to time I have modified certain aspects of my risk and trade management in an attempt to alter certain metrics. These changes have been mindful of the impact of implications on sequencing alternatives.

Some examples include:

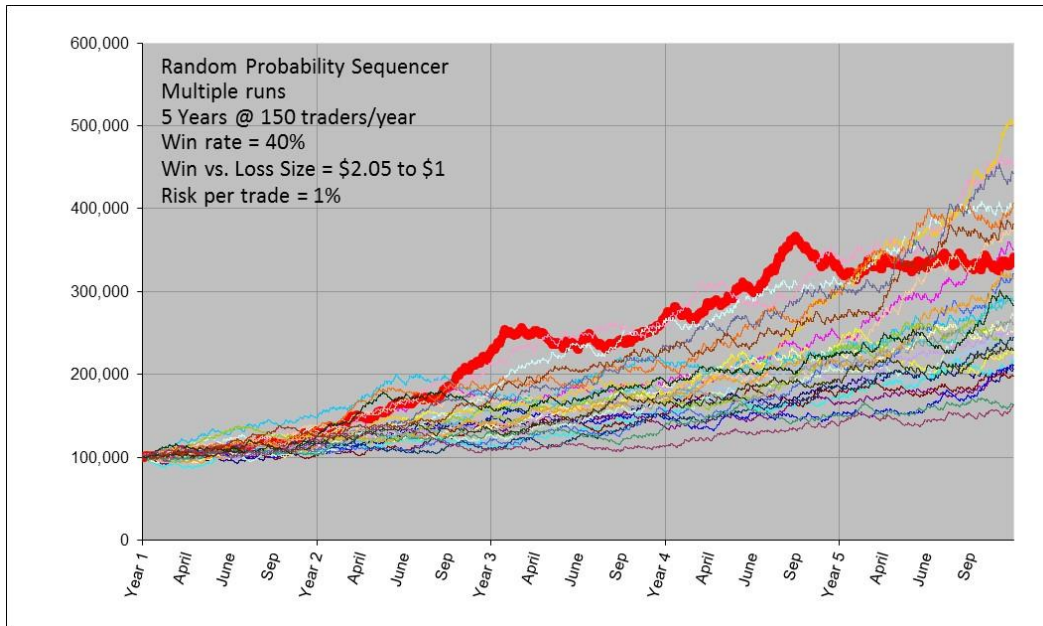
- For years my win rate was in the area of 35%. Increasing win rate provides a trader with many good options. I wanted to increase my win rate to 40% to 42.5%. I believe I have accomplished this – although it may or may not show up in the metrics over shorter time periods. My attempt to increase win rate has taken several forms:
 - Taking quick profits on a portion of certain trades (QP Unit) – the negative tradeoff is a decrease in the average win size.
 - Lowering trading frequency by focusing on horizontal patterns (greatly reducing diagonal patterns) – there is no negative trade-off, although it reduces the number of trading events.
 - More aggressively tightening stops on certain trades (QP and Swing) with the goal of lowering the size of the average loss – the negative tradeoff is that this practice can decrease win rate.

As I hope you can see, change one component of a trading plan to address one metric, and other metrics can be affected. Every decision in market speculation has trade-offs.

My present trading scheme, as constructed, attempts to accomplish the following long-term metrics:

- Average annual ROR = 30% non-compounded
- Win rate = 40%
- Trades per year = 150 (three per week)
- Bet size = 75 to 100 basis points
- Average win/loss size ratio = \$2.05 to \$1

The graph on page 10 provides 30 sequences using the metrics above:



If I did another 100 runs, the equity curves would mostly fit into the band width shown above, with a few upside and downside outliers.

In addition to the graphic representation of possible outcomes, the sequencing program provides a wealth of statistical information. For example, the average worst drawdown of all 30 sequence runs is (13.3%). I am all but guaranteed a 10-15% drawdown with the metric goals established. I also know the standard deviation of certain drawdown possibilities and the corresponding win rate, as shown below.

		Standard Deviations					
2%	6%	9%	13%	17%	21%	25%	Drawdowns
- 3	- 2	- 1	AVG	+ 1	+ 2	+ 3	
34%	36%	38%	40%	42%	43%	45%	Win %

If my actual win rate is 43%, for example, experiencing a 21% drawdown would be at 2 standard deviations. Within the first standard deviation, the range of drawdowns is 9% to 17% with a 40% win rate.

Please notice the thick red equity curve on the sequence graph. This equity curve is within a single standard deviation with a 15% worst drawdown and a 41% win rate – thus, this equity curve is NOT an outlier. Yet, notice that this equity curve includes a 10-month peak-to-valley-to-new-peak drawdown in Year 3 and drawdown starting in the 3rd quarter of Year 4 that remained in the trough for the final 16 months of the run.

I MUST MAKE ONE MORE IMPORTANT COMMENT ON MY PROPRIETARY TRADING RELATIVE TO SEQUENCING. Random probability theory supports the concept of mean reversion. If I enter a particularly hot trading streak, it means one of two things:

1. The long-term metrics of my trading approach have experienced a sizable and permanent shift, or,
2. Mean reversion will occur sooner or later.

Guess which one of these alternatives I vote for?

Converting the Red Equity Curve into real emotions

I would like to have you think through the emotions of the thick red equity curve line. Let's say you initially fund an account at \$100,000 to trade a system consistent with Factor's metric goals. At the end of Year 1 your account is worth \$132,000 and you are thinking things are wonderful. At the end of Year 2 your account is worth \$268,000 – a 168% return in just two years. You are now invincible.

Next, your father-in-law is so impressed with you that he gives you \$250,000 early in Year 3 to trade on his behalf. Over the course of the next seven months you lose 11% and he decides to bail out before the loss grows large enough to affect his relationship with you. You send him a check for \$222,000. The trade after you send him his money back you get a hot hand again. During the course of the next 12 months you achieve a 59.3% return. You are BACK!

In September of Year 4 you talk your father-in-law into giving it one more chance. He cashes out of a REIT and sends your broker a check for \$365,000 – the same amount you have in your account. Within five months his account loses \$51,000 -- in the same period the REIT he liquidated gained 18%. Once again he bails out, this time wondering what his daughter saw in you. Ouch!

You discover you are in a prolonged drawdown. At the end of Year 5 your account has been in a 15 month drawdown with no end in sight. All the hope you had in your trading system is disappearing. You are not sure you will ever be profitable again. You have a couple of nice trades, then the markets slap you down. During the process your account declines \$48,000 off its high. You are seriously thinking about switching to an entirely different way to trade.

This is the world traders live in – traders can suffer even with a trading program that has proven to work in the past and will likely prove to work in the future.

I went through my most prolonged (but not severe) drawdown in 2013 into early 2014. In about the middle of the drawdown I started to tinker with some of my signaling and risk management. BIG MISTAKE. Looking back I realize the drawdown was nearly twice as deep and twice as long as it would have been had I not changed a single thing in the way I trade.

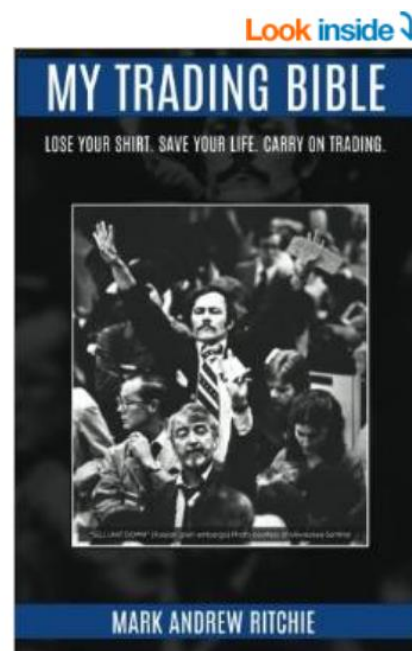
The concept of sequencing presents a huge challenge to aspiring traders. How does a trader determine if a drawdown is due to sequencing or due to the fact his or her trading approach is likely a loser? There is no easy answer to this question – and herein lies a dilemma. What if you, as a trader, want to go all in on your approach to trading. You are willing to monetize a large portion of your assets to capitalize a trading account and quit your day job to pursue full time trading. Can you really be sure that the previous success you had in your trading was real? What if you immediately enter a drawdown when you enter full time trading? What then? Will you trust your trading approach enough to persevere?

I will revisit this topic again – not sure when. But for now I have given you some things to think about.

Free autographed copy of a new book by Mark Ritchie, a Market Wizard, will be mailed to a random sampling of Factor members

Mark Ritchie is a Chicago Board of Trade legend. Mark was one of the featured traders in Jack Schwager's *New Market Wizards* (1994). As one of several family members finding success at the CBOT, the Ritchie clan was the driving force behind Chicago Research and Trading Group, one of the original high frequency trading operations. Mark is a wealth of wisdom on commodity futures speculation as a human endeavor.

It is my honor to recommend *My Trading Bible*, not simply because Mark is a peer and friend – and not because he gave me the real-time privilege of reviewing the book one chapter at a time as he wrote it – but because the book is an important philosophical narrative about the emotional, financial and spiritual struggles that are part of a trading drawdown. The book will not be published until later this summer. Only a limited number of the books have been pre-released at this time. Mark provided me with 20 autographed copies to give to Factor members. The rest of you will need to wait until the book is officially released. I will select 20 names with the random sequencer. I will let you know if you were selected.



At the root of Mark's narrative is the unpredictable impact of random probability upon the best laid plans of an aspiring trader. Mark and I both have a real interest in the havoc (or blessings) random probability theory can have upon a trading system.

I must honestly tell you that *My Trading Bible* is not an easy read – how can it be? The book explores the human struggle of going through a period in the life of a trader when to simply give up might be the most attractive option. As the book concludes, Mark offers his best advice for those of us who are and those who want to be professional market speculators – namely, that one's hope and value must transcend the marketplace and be placed in things of lasting worth.

Good News for All – The Ritchie Rule Ap

Mark Ritchie has released an itunes application that allow you to play around with different metrics and generate sample equity curves. This ap is much less robust and comprehensive than the sequencing program used herein, but it can give you a taste for the concept.

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