

What a Shock! VI

Newton's Laws Apply to Bowling!

The 6th paper (and summary) in the "What a Shock" Series on Gravity and Ball Motion

The First Law of Bowling: Flatness = Fairness

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Many years ago, we were "measuring" the amount of oil on a lane by the dreaded "tactile smear test." That's right. We would smear our finger across an oiled lane (outside-to-in of course) and decide whether a lane had an adequate "dressing" for whatever desired affect we conjured, by some divine anointment of inspiration and judgment. Needless to say, opinions varied in the matter.

Then, along came the pick-up device and tape reader. Oil manufacturers were mandated to incorporate a specific amount of UV material in their oil products, so that the oil on a lane could be trapped and analyzed to determine the oil pattern on any lane at any location. Once an accurate way of measuring a lane's oil pattern was established, then a rule to limit the use of oil in aiding a ball's path could be negotiated. I was the Chairman of BPAA's Equipment and Products Committee at that very time in bowling's history and took part in the negotiation.

The BPAA of course wanted oil application to be as painless as possible for its members, while the ABC wanted certain parameters attached to oil application, which intruded on BPAA's position. BPAA proved the better negotiator (in retrospect) and the three-unit rule emerged (maybe should have been the 6-unit rule then and the 12-unit rule now – but that's another story).

The point is that the lane dressing rule was made possible **only** after a device was invented to accurately measure oil on a lane. We now stand at that same crossroad, with the invention of Kegel's LaneMapper™ - a device to measure lane topography. Now we can study how topography effects ball motion and eventually pass a rule that makes sense for the industry.

A New Beginning

In previous papers I have described the work undertaken to determine gravity's role in any given bowling shot. The current rules regarding bowling lane flatness, were written in the 1930's (with a few minor changes since), when all lanes were made of wood, usually maple and pine. I recall my early experience in building lanes: subfoundation installed level via a transit for leveling...lanes nailing together with screw nails...board by board...minding where the joints fall...making perfect splices at the pindeck and arrow maple-to-pine transitions. Building up 39 boards high then laying horizontal - leveling and sanding and coating - true craftsmanship.

Today we have sophisticated rotary laser levels and "engineered" wood products like I-joists, Medex (called a SDF – Sustainable Design Fiberboard - a high grade of MDF – Medium Density Fiberboard, and PSL - parallel strand lumber). They are amazingly consistent and long lasting. Considering Melamine products, engineered lumber, and leveling technology, bowling lanes of today should be the flattest ever in the history of bowling. Yet, today's lanes are the **least flat** in the history of bowling. How can this possibly be so?

Unintended Consequences

In the 1980's this phenomenal invention called a "synthetic" lane began to propagate. As the industry's "craftsmen" bowling lane builders looked on in disgust, these "Erector-Set" lanes became more and more popular. What's not to like? Proprietors buying these lanes were sold on their many attributes. ESPECIALLY, the part about no resurfacing! The smell, the shut-down time, the cost, the clean-up of all that saw dust – ALL GONE!

But that is exactly when the flatness problem started. Centers were no longer visited by these bowling lane craftsmen, and yet the rule in place on the ABC books didn't change, and the rule depended upon this craftsman's visit.

Wooden lanes were required (in the old days) to be resurfaced regularly. The volunteer ABC grass roots workforce would "spot check" lanes annually inside three measuring windows, to double-check the resurfacers' work. This procedure provided adequate checks-and-balances to more than reasonably ensure a fair and equitable playing environment. The problem is, the annual lane checking rule continues to this day virtually unchanged, while the regular visits by lane craftsmen stopped 25 years ago in synthetic centers.

Climate, abuse, and normal wear and tear has overcome flatness in this absence of regular attention from skilled lanemen, and the flattening of all 62' 10 3/16" of a lane when failing a spot-check, has been replaced by flattening a tiny spot within each of the three measuring windows, while ignoring what may be horrendous deviation from flatness on the other 95% of the lane. Further, some of today's synthetic lane installers, under pressure to maximize profits,

don't even bother to do the costly and time consuming careful leveling of every inch of newly installed synthetic lanes. They are certain that they will only be checked in three tiny areas, so why waste all that time and labor cost? USBC comes in for a certification inspection of the new center, and gives the installer a "punch list" of spots to level. The installer does so, and the center is certified while possibly being colossally unlevel over the other 95% of each lane that was not scrutinized. We have strayed way off course.

Gravity was, for the most part, a non-issue on lanes that were regularly flattened by resurfacing, and so for years, it was rightly ignored. Then came 25 years of synthetic lane atrophy and installation indifference, and with the invention of the LaneMapper™, we now know that lanes are less flat than ever, despite big advances in wood and leveling technologies. So, here we are today, with monumental random un-flatness being the rule rather than the exception.

Prior to our research into how gravity effects ball motion these past 2 years, no one that I know of had even considered the subject, let alone studied it. Today, I feel confident that we have actually **quantified** the gravitational effect on a bowling ball for an average weight and material ball, with an average moment of inertia, thrown at an average speed and spin, on an average lane surface, coated with average lane oil.

Each of these factors changes the inertia tensor and gravity's effect slightly, but it appears that the change is small enough to be almost inconsequential, and that a general rule can be theorized. "**Slope-per-Board**" – a measuring formula we devised, was the key to unlocking ball motion separate and apart from the friction situation (oil pattern) on a given lane.

We invented more new phrases and truisms as we studied gravity and ball motion like; "the ball only cares about the slope of the particular board it happens to be on at a given time on it's way to the pins", and "you can't fix a gravity problem with a friction (oil) solution." This brings me to the point of this sixth edition of research notes on this matter of gravity as it pertains to ball motion.

A Modern Study of Timeless Proportions

As we threw different balls, thrown by different bowlers, on different lane surfaces coated by different oil, on different oil patterns, gravity didn't seem to care about any of these variables. Although there were minor variances, gravity changed the path of all of the balls by about the same amount, if the balls were thrown under the same gravitational circumstances.

Our slope-per-board matrix is a complicated spreadsheet into which the raw data from any lane measured with a Kegel LaneMapper™ is inserted. The matrix calculates the slope-per-board

situations and reports these gravity influences on a 7-color chart, making the heretofore invisible “bunkers and water hazards” clearly visible.

Simultaneously, the matrix calculates 1500 different strike-ball paths through the various gravity influences and declares for each, where the ball would hit the pins on a given ball-path vs. that same shot to the pocket (17 board) on a flat lane. A 3-D image of the lane is also generated.

The fact is, that gravity doesn't seem to care much about all of the friction variables mentioned above - certainly through the oiled portion of the lane and even in the backends. In fact, there is more displacement from gravity on the oiled portion of the lane vs. the dry backends because gravity has more friction to overcome in order to change the balls path on the dry portion.

This reeks of equivalency and that is where Albert Einstein meets Sir Isaac Newton.

Einstein stated in his General Relativity work that acceleration and gravity are different but equivalent forces. Separate forces indistinguishable from one another. The bowling ball is under both of these forces as it rolls down a lane.

Acceleration (a negative acceleration as it continually slows down from friction) and gravity are both at work it appears with equal potential in changing a ball's path and also equivalent potential energy depletion properties.

On a perfectly flat lane gravity is a constant – basically a non-factor. The more out of flatness a lane is, the more influence gravity will have, AND this force of gravity is separate and apart... in addition to, if you will, any and all other forces at work.

This seems to explain why the slope matrix can so accurately predict ball motion on one lane vs. another in the same environment. Because all else is equal - same environment, same person, same ball, same shot, same lane surface, same oil, and same oil pattern. The only thing different is the topography.

It seems ironic that today's amazing lane oiling machines are so consistent in applying oil, that they now GUARANTEE the fact that the lanes will play differently do to their topographical differences. The more equally that a ball is thrown under these nearly identical conditions, the more predictable gravity's effect on the ball's motion becomes.

Further, and even more interesting, gravity doesn't seem to “care” about the variables. They make slight differences, but even different shots, thrown by different bowlers, at different but similar speeds, with different balls, on the same line and lane are displaced almost identically. Gravity just does its own thing on a bowling lane, just like it does throughout the universe.

Also spellbinding, is the similarity between the ball motion and energy situations that a ball “feels” under certain gravity and friction circumstances. Every serious bowler has bowled on a lane with dry heads. That is a lane with very little oil on the first part of the lane. The ball will “hook early” because of the additional friction, and it’s energy will be spent much earlier than the same shot thrown on a lane with a lot of oil on the first part of the lane.

These **same results** of early hook and energy loss are displayed **independent from** the friction situation present, when a gravity influence is introduced. A ball thrown on a depression, or on an uphill situation, acts just like a ball thrown on a flat dry lane. That is to say, depression or uphill, act just like a dry spot to the ball, and crown or downhill act just like a wet spot.

The situations seem to be completely independent from one another. A ball thrown on a very wet but depressed head will act as if it was thrown on a much drier head. A ball thrown on a drier but crowned head, if on the downhill side of the crown, will act as if thrown on a much wetter head. The two forces at work: gravity and the negative acceleration due to friction seem to work identically and cumulatively on ball motion.

Time after time, if the ball hits a crown, it acts just like it would if it had hit a wet spot. A depression or tilt downward on the z-axis away from the bowler’s hand, acts just like a dry spot. This reminds me of what Pete Weber said to me, who along with other Storm staffers helped us with our testing – “I owe a lot of apologies to a lot of lanemen.”

The Physics of the Matter

The energy loss situation is easy to understand. On a V-shaped depression when a right-handed bowler is playing on the right side of the V, the gravity vector is to the left \leftarrow (toward the center of the lane) and his rotational friction vector is nearly opposite the gravity vector – it is to the right \rightarrow (actually sort of “east-southeast” – to the right and toward the foul line). The vectors are nearly opposite, so the energy loss is greater, and it acts “dry”.

On the left side of the V-shaped depression, his rotational friction vector is still the same \rightarrow , BUT NOW the gravity vector is ALSO \rightarrow . There is much less energy loss so it acts like a “wet” spot to the ball. It truly appears that the forces of gravity and friction are equivalent, independent, and cumulative.

Bowling’s Matrix

The gravity matrix we currently have in place can accurately predict where the ball will hit the pins for a given shot on any lane that we have mapped vs. the same shot on any other lane in the same environment. This is remarkable and ground-breaking.

Both shots on the two different lanes are judged against the same shot on a flat lane, and the difference between lanes is simply the sum of the differences if comparing each to a flat lane. That is, if on a certain lane A on a certain line, the ball would hit the 18.00 board vs. the 17.00 board (pocket) on a flat lane, and on the same line on another lane B in the same environment, the ball would hit the 16.00 board vs. the 17.00 board on a flat lane, THEN lane A and lane B would play 2 boards different from one-another at the pins if thrown on similar lines. This is hugely important and significant. This matrix can actually tell a bowler how his first frame on lane B will react compared to his just-completed 10th frame on lane A in the same environment.

I have introduced to the newest matrix, a formula to make a lane “play flat.” The matrix takes the raw data from a LaneMapper™ and calculates changes to crosstilt, lengthtilt, crown and depression that need to be introduced to six specific places on a given lane, two within each of the three lane “zones” – two in the wet zone (first 20’) two in the medium zone (next 20’) and two in the dry zone (last 20’).

The introduction of these opposing influences have been shown to negate existing gravitational influences by over 80%, making any lane very nearly “play flat.” This would seem to be a cheaper and faster solution to make all the lanes of a center play more alike vs. flattening the entire lane. We introduced equal and opposite gravity influence in each section, in an effort to make each section play flat, and it worked very well, but not perfectly.

The straighter-up the lane a bowler played the better (flatter) the lane played. As a bowler crossed more and more boards the fix became less and less effective, but still much better than before the fix. So the “play flat” fix resulted in a much improved environment.

However, the counteracting influences that had to be introduced to a lane in order to make it play nearly flat were almost always “illegal” according to the rules (more than .040” in tilt/crown/depression). So, since there were still differences for certain bowlers according to where on the lane that a bowler was playing, and because the counteracting influences we must introduce to negate the existing influences are almost always out of USBC specification, we see little use for this “Band-Aid” procedure.

In fact, it is rather counterproductive to our goal in this whole study of topography... to make lanes play the same without prejudice to any bowler’s style, and to get ENTIRE lanes back in USBC specification.

The “play flat” experiments did however prove to us that the gravitational effects are roughly cumulative. That is to say, that if a ball encounters a -2 Slope-per-Board for a foot of travel and then a foot of +2 SPB in the same section of the lane, that the ball would be in almost the exact same place exiting this 2’ area that it would be if this same 2’ area was completely flat.

The effects of flatness atrophy in the modern game

We see in today's game that the power-players rule. Why do you think that is? Well, it's the quadruple whammy!

First, the power player can play the "wet" side of the V-shaped depression which DOMINATES the average topography characteristics of the average synthetic head (almost all synthetic heads are depressed). So, the guy with more energy to start with (the boomer) LOSES LESS (%-wise) and the guy with less energy to start with LOSES MORE. The rich get richer and the poor get poorer.

Second, displacement (how much the ball moves toward the middle/bottom of the V-shaped lane) is a function of the TIME SPENT ON THE SLOPE. So the faster ball is displaced LESS and the slower ball is displaced MORE. Boomer wins again!

Third, if I set a ball bearing and a piece of rubber on a table and tilt the table, the ball bearing will be displaced by gravity almost immediately and it will roll off the table. You will have to tilt the table a lot before the piece of rubber will move. FRICTION is overcoming the gravity influence in the case of the piece of rubber until the gravity influence is greater than the friction influence. SO AS WE ADD OIL TO A NON-FLAT LANE, WE MAKE THE PROBLEM EVER WORSE for the slower player playing out on the V-shaped lane and EVEN BETTER for the faster player playing in.

And forth, the poor guy playing out -- if he makes two good shots which land 1/2 board apart, but the slope of the 1/2 board hit on the first shot is 1 and the slope of the half-board hit on the second shot is 3 (this can commonly be the case on depressed heads) -- he's going to get a much bigger "spark" on the second shot, which sixty feet later will make a big difference. Small differences in first ten feet of consecutive shots can yield widely different results at the pins since the force vectors are diametrically opposed and the effect is exacerbated. The boomer playing in, on the other hand, can have the same situation occur with negligible effect at the pins because his force vectors are in the same direction.

It's not a coincidence that bowling now favors the power player... it's simply Physics. As lanes continue to deteriorate and stray farther from flatness, soon there will be only two bowling styles: Boomer and Donator.

The not-yet conclusion

Our research continues. The information we have uncovered is fascinating and it motivates us to want to learn more. There is one thing that we know for sure - **flatter is definitely better**. It seems certain, that we have proven beyond doubt that the following equation, which I will call

the “First Law of Bowling”, is true: Fairness = Flatness. The farther a lane strays from flatness, the farther it strays from fairness. That too is simply physics.