What a Shock! I

Sir Isaac Newton meets bowling

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Over the past six months, along with the staff at Kegel, we have stepped up the topography testing of years prior by performing revolutionary experiments and gathering data from all over the world. We have been closely studying different lane shapes, creating formulas, having late night jams sessions, and watching 1000's of bowling balls go down the lane trying to disprove and prove how topography affects the motion and the direction of the bowling ball as it rolls from foul line to off the end pin deck. Notice we didn't write head pin. As you read the full series, you'll come to understand why.
This series of articles may be the most important subject players, proprietors, tournament organizers and administrators of the game have ever read regarding the technical side of the modern day sport of bowling.

Newton Correct!

The "thought experiments" we, along with a very few others, have been executing in our minds for over 20 years, finally took to the lanes early November 2009 in the form of actual measured real life situations of lane topography, on which actual real life bowlers of various styles threw shots, which produced observable and CATS™ measured ball reactions.
The initial tests were exciting and invigorating to John Davis, Bill Mongeau, Ted Thompson and me, but probably not so shocking to Sir Isaac. Indeed, it appears that Newton's First and Second Laws in fact apply to the game of Bowling.

The less momentum (P) a bowling ball has, the less force is needed to change the path of the ball. Example: A 14 pound bowling ball traveling at 18 mph has less momentum than a 16 pound ball traveling at 18 mph.

In layman's terms, these experiments involve three basics: **Momentum**, (and the law of conservation of momentum): a body's momentum equals it's mass times it's velocity **p=mv** (**p** is the symbol for Momentum), **Newton's First Law of Motion**, which states in the absence of force, a moving body will move in a straight line at constant speed, and **Newton's Second Law of Motion**, which states when a force is applied to a body, acceleration will result in the direction of the force.
Most important with regard to Newton's Second Law for our experiments, is that the net force on an object is equal to the time rate of change of its linear momentum.

For example, the more momentum a ball has, the more force will be needed to act upon the ball, in order to change the ball's path by a certain distance.

In bowling, the gravitational force on a bowling ball comes from a lane's tilts, depressions and crowns. And mind you, there is not a perfectly flat lane anywhere on this planet.

Most everyone in the bowling industry considers the lane surface as a two dimensional surface. A flat plane, or an X and Y axis, with the X axis being the width of a lane, and the Y axis being the length of a lane. If the lane was merely two dimensional, gravity would simply be a constant throughout any bowling ball's journey down any lane. That is simply never the case, and the often unconsidered Z axis – the change in elevation – has a significant amount of influence on ball motion.

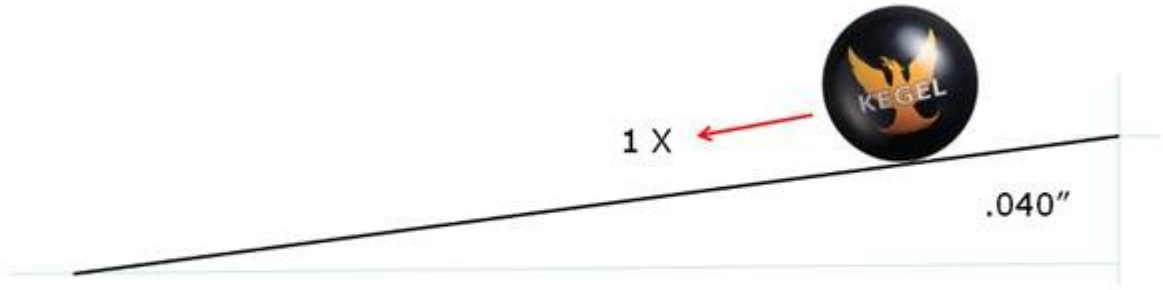
For our experiments we considered the force, momentum and inertia situations. The constants on repeated shots were mass (ball weight), lane surface, gravity, oil type and oil pattern, which combine to produce a certain ball path shape for a certain bowler with a certain ball on a flat surface. Then we changed only the topography, and that's where the "shock" began. And it was shocking to us, but not to Sir Isaac Newton.

Slope per Board is the Key!

The first thing we must explain is the creation of a brand new term in bowling called, **Slope per Board**. With the invention of the Kegel Lane Mapper, and by taking crown and depression readings of each and every board across the lane, and then adding the single crosstilt reading to each board, we can calculate the slope of each board at any distance on the bowling lane.

To fully understand the significance of this reading, we must understand that as the bowling ball travels down the lane from foul line to pin deck, it simply reacts to whatever gravitational force is acting on the ball on whatever specific board it is on at any one moment in time, and it doesn't care about the slope of surrounding boards.

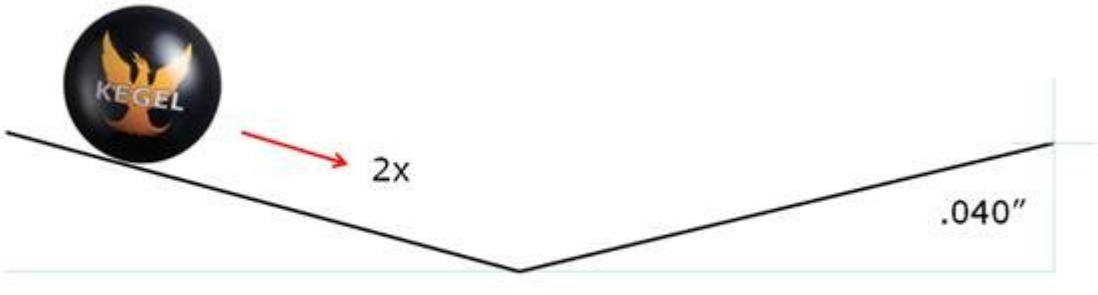
For instance, we know a bowling lane consists of 39 boards, and if a bowling lane is tilted high right 40/1000" (1 mm), which is the maximum allowable amount under the specification rules, that would give us a slope per board value of about 1/1000" (.025 mm) for each board on the lane.



Slope per board ~ .001″ (.040″ across 39 boards)

If we double that crosstilt to be 80/1000” (2 mm), which is two times the allowable amount under the specification rules, that would give us a slope per board value of 2/1000” (.050 mm) for each board.

Another instance that would give us that same slope per board value, but be within current specification, would be a 40/1000” v-shaped crown or depression directly to the center of the lane (.040” slope/20 boards = .002” slope/board.)



Slope per board = .002″ (.040″ across only 20 boards)

The ball doesn’t care about the specification. It feels the exact same gravitational influence of .002” under each scenario – one scenario twice the allowable amount, and one perfectly within specification.

Further, as soon as we introduce crowns and depressions into the equation, that crosstilt slope per board value can increase significantly, or even decrease, and depending on which way the gravitational slope is, it will influence the bowling ball to the left or to the right as it travels down and across the lane surface.

With synthetic lane installations, it is common to see crowns or depressions combined with tilts to produce a slope per board value at points on the lane well over 5/1000", which is equal to a crosstilt that is five times the legal specification limit.

What did we do?

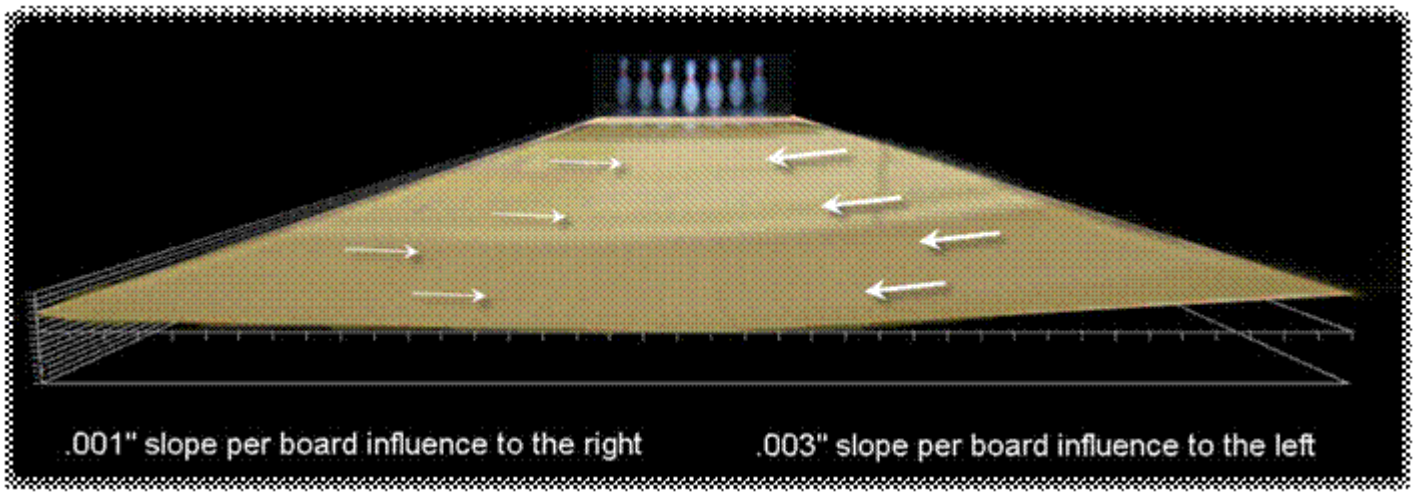
We, so far had introduced a "force" to the ball, a Gravitational Force. We shaped a few of the adjustable Kegel Training Center lanes with consistent gravitational shapes relative to the lane, yet contradicting gravitational forces relative to the ball's inertial path.

On one pair of lanes, we created as near a non-imbalanced gravitational force as we could, as flat as possible. This gives us a benchmark ball motion reaction where there is constant gravitational force on the bowling ball as it rolls down the lane.

On another pair, we created two opposite shapes.
One lane had a legal gravitational imbalance of approximately .003" slope per board (SPB) low left for a righty playing anywhere from 1-20 board. We did this by creating a .040" low left crosstilt (.001"SPB), plus a .040"

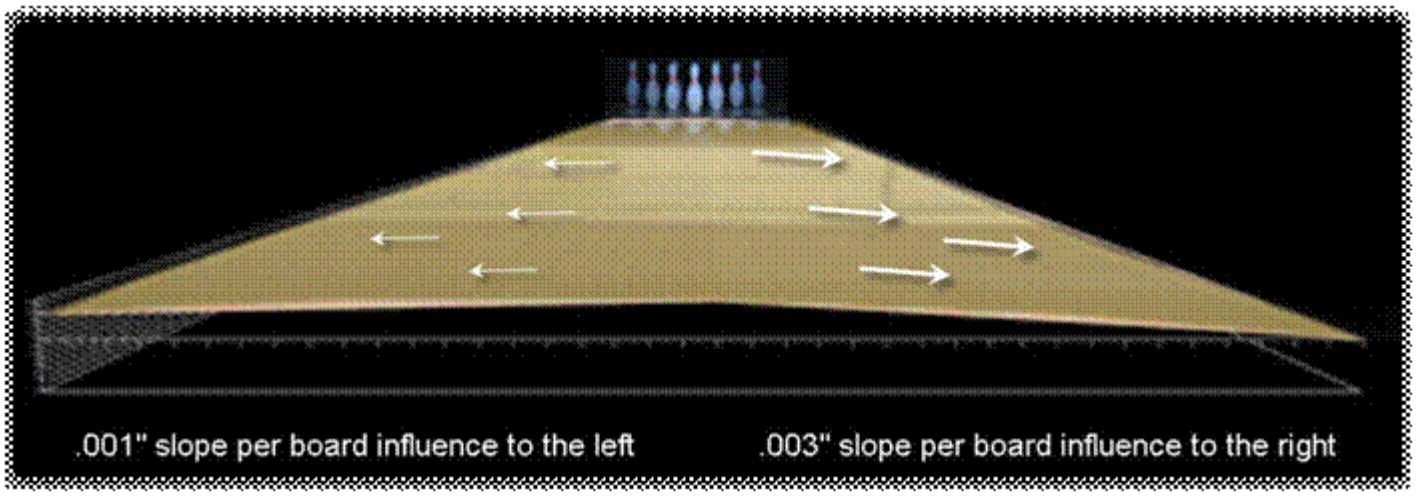
smooth V-shaped depression from both 1 boards to the 20 board (.002" SPB) which gives us that .003" per board slope effect toward the center of the lane for a right-handed player.

Smooth V-shaped depression plus low left crosstilt



On this lane's mate, we created the low right equivalent. We did this by reversing what we did on the companion lane.

Smooth V- shaped crown plus low right crosstilt



It is important to note that this very shape yields only a .001" slope for a lefty playing anywhere from boards 1-20 on his side, since the combination of the tilt and the crown/depression compound the slope for the righty but are partially counterbalancing for the lefty.

And finally, just like the pictures above, we created two lanes with real world situations of a net gravitational imbalance of approximately .005" slope per board. One lane with a gravitational force towards the center of the lane, and the other gravitational force towards the right gutter for a right handed player, which was again opposite but nearly flat for the lefty because of the counter-balancing combination of the crosstilt plus the crown and depression.

What did we see?

Newton would be proud. The lefty's had all pairs about the same. The righty's certainly did not. The relative effect on the bowling ball was proportional in three ways. First, there was nearly double the effect on a ball's path at .005" slope per board as there was at .003" slope per board in the direction of the slope.

Secondly, the effect was proportionally less for higher ball speeds and greater for slower ball speeds. The faster the ball was thrown, the less boards the ball missed the intended breakpoint because of the gravitational effects of the lane topography.

Remember that the displacement caused by a gravitational influence is a function of the time spent on the influence, so it stands to reason: faster speed = less time on the influence = less displacement.

***DISPLACEMENT** means the amount of movement of an object measured in a particular direction from its original path.*

Sure enough, the differences in the two opposite gravity force lanes were proportionally greater for slower ball speed players. And third, lighter weight balls were proportionally more effected by a certain slope.

So at this point, what we had tested so far, were bowling lanes with a consistent gravitational force, either inward or outward, and bowlers of various speeds and ball weights relative to themselves – comparing a bowler's data to his own data on the various shapes. Then we gathered data comparing bowlers to other bowlers. Bowler A playing straight up the 5 board and Bowler B playing 20 to a break point of 5.

***VECTOR** expresses a quantity that has both direction and magnitude.*

For Bowler A, where the ball hit the pins was greatly different since his ball's translation was almost continuously at a 90 degree angle to the gravitational force vector. The net change in impact position was greatest with this style on these opposite lane shapes.

Bowler B's net change in impact position was not as significantly different as Bowler A's, because Bowler B had the gravitational force displacing his ball at a slightly more obtuse angle (an angle greater than 90° and less than 180°).

The results for the two launch angles are very different and very significant.

It would appear that the nightmare pair for the down-and-in type player is one lane tilted left all the way and one lane tilted right all the way, because his ball is continuously influenced near perpendicular to his ball's path throughout its travel from foul line to pins,

so the impact point change is huge. As much as hitting the pocket on one lane and hitting only the 3 off the right (6-9-10 pins) on the other.
The boomer's ball (Bowler B) had less perpendicular gravitational effects on its way down the lane both to and from the breakpoint in this all left slope or all right slope situation. The impact point doesn't change as much as Bowler A, but the hitting power and shape of the ball path does.
Bowler B's ball path shape was more of a curve on the all left slope covering far less boards. It was easier to control the shot, and it was less speed sensitive, but incurred a lower percentage pocket carry. On the all right slope Bowler B's ball path shape was more of a skid-snap type reaction covering more boards but with less control. The ball was also more speed sensitive however it had a higher pocket carry percentage.

Newton would certainly agree, that to be fair to all players, all ball weights, all speeds and all launch angles, FLAT is the only fair situation.

The lighter bowling balls and slower ball speeds are influenced more in non-flat situations than heavier bowling balls and faster ball speeds.
Further, the gravitational effects of depressions, crowns and tilts have widely varied effects on varied launch angles. The more a bowling lane strays away from flatness, the more those gravitational effects influence different styles of play in a different way.
So now it's time to continue our testing by redoing each test over and over. The story continues.
Newton…what a guy.

What a Shock II! Newton Still Correct!
Preliminary observations of Kegel and Bowling Installations topography testing, continued.

December 7, 2009, by Lou Trunk

One month ago, I wrote the first report on the ground-breaking topography testing we began. We have taken the process to unprecedented levels, producing the most interesting and thought-provoking results that I have ever heard of in bowling, let alone produced and witnessed, in my 40 years of bowling business research experience.

Intuitively, any person highly involved with lane research, repair, and installation, (me especially), has always had the notion that "flatter is better." However, at the same time, the tolerances for flatness developed and put in rule form prior to WWII by The American

Bowling Congress have been widely accepted (including by me) as a fair and reasonable approximation of “flatness.” A bowling center conforming to the flatness rule for these 70+ years was undeniably considered “fair.” Several things have happened in recent years and most especially this month, to change my mind set.

First, over the past several years, with the proliferation of synthetic lane installations, bowling centers are no longer visited every other year or so by resurfacing crews (skilled and thorough professionals for the most part), to sand the wood lanes back to levelness. Secondly, the nature of the annual USBC (ABC-WIBC) sanction certification inspection of a bowling center has led to “levelness atrophy” – that is, since inspections are only performed annually in three snap-shot locations, America’s lanes have become well out of specification elsewhere. Through settling, climate change, and ball abuse, - general wear and tear - lanes atrophy from levelness. Further, though the levelness rule calls for a lane to be level and without crowns and depressions exceeding .040” OVER THE ENTIRE LANE, everyone knows that levelness INSPECTION will NEVER take place outside of the three narrow snap shot “windows.” Less than craftsman-like crews, under pressure to maximize profits, have not emphasized levelness in areas they are CERTAIN, will not be scrutinized. As a result, lanes are generally not very flat. In fact, LESS THAN 1% of the “sanctioned” centers in this country are actually within the .040” tolerance as stated in the rule in place now - the same rule that has been in place since the late 1930’s.
BUT THAT’S NOT THE WORST PART!!!

Newton… what a guy.

The latest findings relating to ball path change as a function of gravitational forces on non-flat lane surfaces would have again made Sir Isaac proud. However, to my knowledge, he was not a serious bowler.

As if it wasn’t bad enough that “lane mapping” data has shown that the average “certified” bowling lane is not nearly in USBC specification, our tests have shown that the worst part of the situation, is that even legal irregularities have a **huge** impact on ball path.

In ground breaking work this month, we have been able to QUANTIFY the gravitational effect of non-flat lanes over relatively short distances. Thousands and thousands of shots have been analyzed over dozens of lane shapes.

In the report dated one month ago, I explained our test thoughts as it relates to

momentum, and Newton's First and Second Laws:

In layman's terms these experiments involve three basics: Momentum (and the law of conservation of momentum): a body's momentum equals it's mass times it's velocity ***P=mv*** *(P is the symbol for Momentum), Newton's First Law, his law of inertia: in the absence of force, a moving body will move in a straight line at constant speed, and his Second Law: when a force is applied to a body, an acceleration will result in the direction of the force. Most important with regard to Newton's Second Law for our experiments is that the net force on an object is equal to the time rate of change of its linear momentum. I.E. the more momentum (P=mv) a ball has, the more force will be needed (gravitational force from a tilt or depression) to act upon the ball, in order to change the ball's path by a certain change distance.*

These laws mandate that gravitational effects must be PROPORTIONAL. Examples: a certain ball traveling at twice speed will be influenced by topography half as much, a ball traveling at a certain speed will be influenced half as much as a ball twice it's weight.

As Newton whispered, "I told you so," our tests showed over and over that ball path change was in fact proportional. Through repeated testing and double checking, ball path displacement over short distances was QUANTIFIED for situations where all else was equal.

Once a ball path change amount is known for a certain weight and speed on a certain quantity of non-levelness, one can calculate the ball path change for ANY weight, speed, and non-levelness, since all of these changes must be proportional. Softer balls, or shots on softer lane surfaces were slightly less effected by tilts while harder balls, or shots on harder lanes were effected slightly more by tilts, due to the fact that more slope is needed to overcome higher friction situations. Frictional slow-down and energy have now entered our experiment realm. The forgotten force though, is gravity. We have always known that friction has much to do with ball motion, but we have dismissed gravity, because the general conception was that all lane are basically flat. That is simply not the case, most especially today vs. pre-synthetic lanes.

We calculated Transitional and Rotational kinetic energy of a given shot, and the numbers were fascinating. In energy calculation of course, velocity has exponential effect. A ball thrown at 21 MPH has about twice the energy of a ball thrown at 15 MPH. The dual advantage of much more energy plus much less effect from non-levelness, goes a long way in explaining why "strokers" have a hard time competing with "boomers" in today's game. We are now deeply into the complicated analysis of energy dynamics, and are developing a rating system, where lanes are compared to their mates pointing out non-matched pairs, and an overall fairness rating for a center, as well as developing a "gravity chart" that can be used in conjunction with a oil pattern graph, to provide a bowler with the rest of the information needed to decide how to attack a certain bowling center.

Our testing continues.

What a Shock III! Newton Still Correct!
Kegel topography testing, continued further.

January 18, 2009, by Lou Trunk

In this the third report on the joint venture topography testing being done by Kegel and my company, Bowling Installations. We have incorporated Storm Bowling Professionals into the testing of our findings. Pete Weber, Norm Duke, and Rhino Page visited the Kegel test facility in Florida and spent two days testing topography situations. The results were 10 times more dramatic than even I expected. Video and CATS data was recorded on lanes of varied topography and the results were again verified, as, again, Sir Isaac softly whispered “I told you so.”

A road show, for introducing this groundbreaking data to the world has been developed and scheduled. We have now developed a slope system which serves at least two purposes. The first is to provide a “yardage book” for a bowler, and the second is to rate a lane regarding it’s relative fairness, compared to other lanes. This slope ratio, gives equal weight to three factors: crosstilt, lengthtilt, and deviation from flatness.

We have now discovered further amazing information. We have begun to relate non-flatness to energy loss or conservation, and related it to hitting power, and specifically to percentage pocket carry. The biggest factor in early energy burn is a depressed head. Depression in the head of the lane hastens precession change, in effect “rolling out” a shot earlier. Proprietors combat this condition, not even knowing why the need exists to do so, by lengthening and widening their oil patterns. Most of the time, throwing oil at a topography issue is a waste of time and oil. The reason, is that the ball displacement (movement from it’s Newtonian path) in any direction, is not only a FRICTION issue, but also a GRAVITY issue. Adding more oil will help a bit to not burn quite as much energy (the ball for a right-hander spinning essentially counter-clockwise on a depression in which the rotational friction force at the lane surface à is almost diametrically opposed to the gravitational force of the depression ß). BUT, the natural displacement will still take place as a function of Newton’s Laws. The CONSTANT we have quantified specifically, can never be denied. If the slope of the board on which the ball is traveling is downhill to the left, then the ball will go to the left according to the ball’s speed, weight, the amount of slope, and the length of time the ball is on such slope. The oil pattern and hitting power are the further focuses of our testing and observing work. It is obvious that the early energy loss associated with depression in the heads, has a huge effect on hitting power.

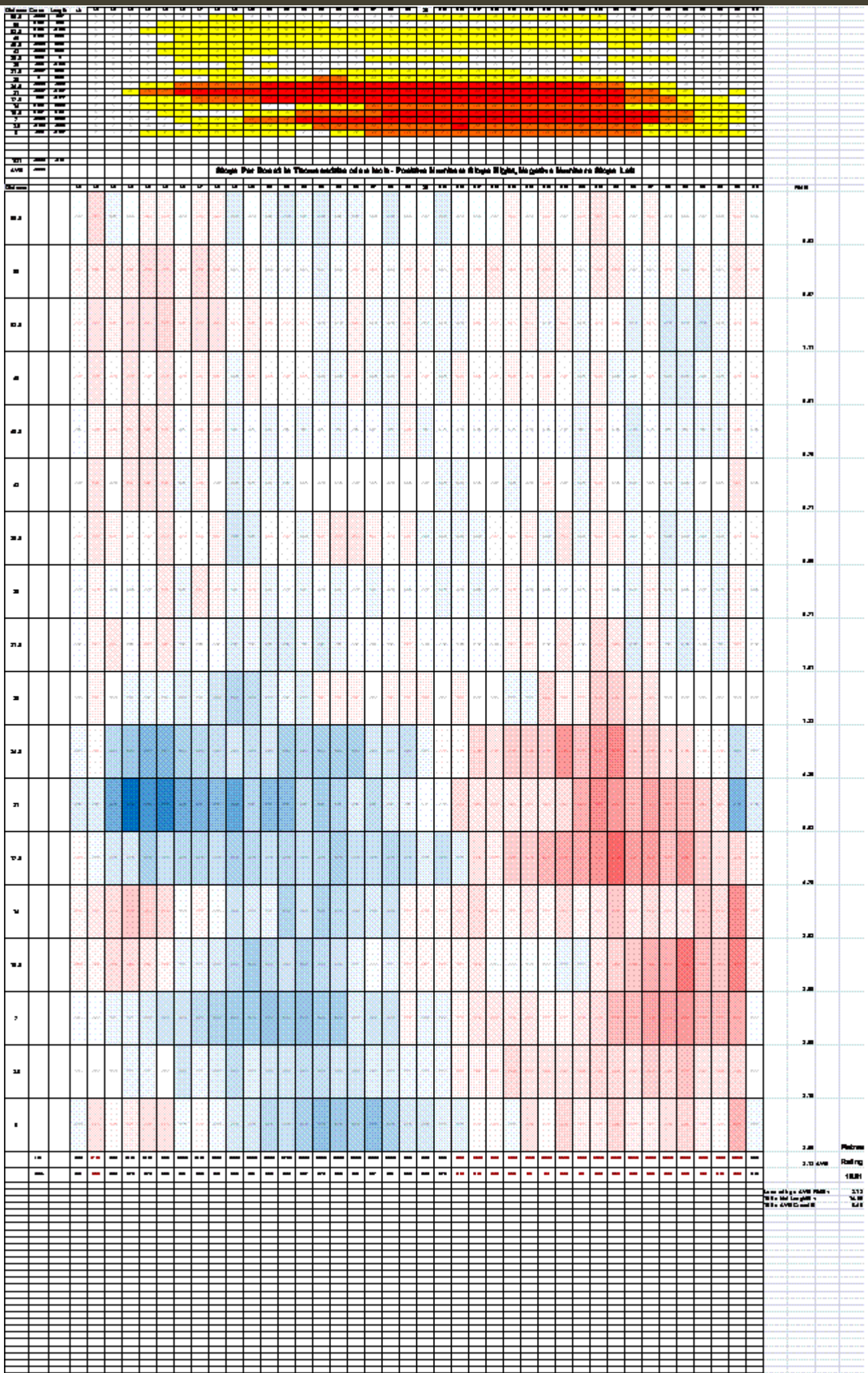
I have often wondered why some centers are such good “deep inside” centers for right handed bowlers. Now I know. Depressed heads.

On depressed heads, the depression is usually a bowl shaped depression with a relatively flat plateau in the middle of the lane. A bowler playing the track, encounters a large gravity influence and a huge energy loss due to the à and ß described above. When the bowler gets deep enough, he finds the FLAT bottom of the “bowl” and loses much less energy early in the shot. If the bowler goes even further inside, he actually finds the left side depression, WHICH IS A RIGHT-HANDER’S **CROWN** . Now, even less energy is lost because rotational friction and gravity are in the same direction (à à), so the ball hits better than a similar shot played in the track!

THIS IS HUGE! Newton again proud.

 (Can’t find a picture of him smiling).

We set off to fix the worst depressed heads we have ever found. Here is the before:



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