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3BV Limits on Trial

1. Introduction

Throughout the years the minesweeper community wrote quite a lot of chapters full of discussions on how the deal with the luck factor of minesweeping. As a result of that we've seen alternative rankings that allowed blasted records on a last click guess, we've banned the easiest boards on Winmine, we've created 3BV limits to get rid of insane time jumps on easy boards and we've even invented all sorts of alternative records like 3BVs, IOS and RQP to allow us to forget about the unfairness of getting time records for a while.

So far, the world record history of 3BV limits has mainly seemed to be an issue of intermediate with players making enormous leaps on their personal records and passing existed world records as lighting in a clear sky. On expert level things seemed a lot more calm, no Dreamboard, no evident board cycle and no significant records that were even close to the chosen 3BV limit. The community always seemed to be blessed that big jumps on expert were only made by relatively unknown players, but not by the dozen players that were within reach of a world record. This way we could sleep well at night and enjoy the world records being broken with small steps at a time by the current world fastest player, but as Murphy's law predicts that wouldn't always stay like that.

On September 29th 2009 this was proven correct when the community became flabbergasted about the news that Ian Fraser jumped forward almost 20% in 1 game with an almost unbelievable 33s on a expert board that most could only dream about.

After a week of near silence, during which nobody else seemed to ask any questions or dared to answer my questions I remained amazed about this board. How rare is this board? Is it a 1 in a thousand type of board or is it more like a 1 in a million? How long would an average player have to play to solve a similar board? Who else has an expert record on a board like this? Wasn't the 3BV limit supposed to prevent insane jumps like this? Are 3BV=30 and 3BV=100 equally rare? Is the current 3BV limit on expert effective? Is there a better method than 3BV? Do we need to adjust the 3BV rules for expert and/or intermediate?

A lot of question without clear answers. For this reason I've decided to investigate the 3BV limits and analyzed Ian's record board to find answers to these questions.

2. How rare is an expert board of 3BV=102 like the one of Ian Fraser?

Since that was the first question that popped up to me when Ian announced his amazing record. I'll first try to answer this question.

The easy answer would be to generate something like 10.000.000 random boards and see how many boards actually have 102 or less 3BV. The answer would be about **26 boards per million.** However that's rather irrelevant since it's not the reality.

Fact is that all clones available don't generate boards below 100 3BV due to the current 3BV limit, so if we would generate 10.000.000 boards we would also have to discard all such boards. After that the answer would be only **15 boards per million**. This may look amazing, but it's not the answer to my question either.

What's also important is that generally opening a low 3BV boards is easier than a high 3BV boards, because these have less squares that surround 0 mines. Also it depends on how you start a board. To exclude this factor I've looked at how Ian starts most of his boards (mostly he just makes 2 clicks near the center of a board) and then I discarded all boards that were blasted in the first 2 clicks near the center and the ones that didn't result in an opening. This resulted in about **22 per million** opened boards. A little less rare, but it still looked a lot like winning the lottery.

So I started analyzing some boards of top players and noticed, what I already knew, that they reach such high solving speeds by clicking almost only known squares by thinking 3 to 4

squares ahead. As a result they hardly ever really wait on the result of a click. However, when reaching an opening it was noticeable that on average they had to made 1 click to find the edge of the opening, at least 1 more click to open the opening and a 3rd click was wasted or delayed as a result of the human reaction time and the time find the nearest next square. Basically each openings (except the first) cost them the time of not 1, but at least 3 clicks. Knowing this I ran the test again, but this time I counted each opening as 3 3BV (besides the first opening) instead of the normal 1 3BV. The result of this was that a board similar or easier than Ian's (102 3BV + 8 openings) happened only a staggering **1 per million** boards.

Since we are looking only at boards that were opened at the start, the next question would be: how many boards can one player open and play per minute? Well, this highly depends on each player, but let's assume Ian plays very aggressive and deliberately blasts boards that feel slow or seem to have high 3BV making it possible to open and try to solve more boards then most players, so about 5 boards per minute, being ~300 per hour. Considering that people can't play 24 hours per day I assumed that playing 3 hours per day on average would be a good estimate.
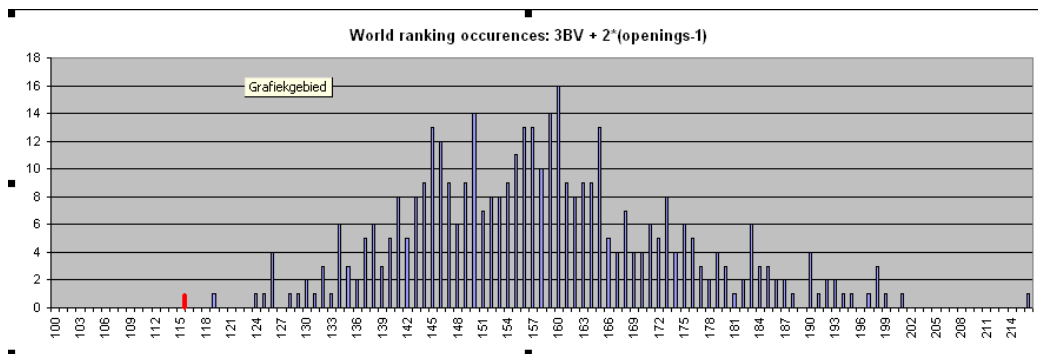
The result of that equation would be that a player would get a **chance** on a board like Ian once every :   1.000.000 / 1 / 300 / 3 = 1111 days (=roughly one chance per 3 years)

Since this was just a chance to solve a board like that and I didn't include the facts that this board should also not be blasted on mistakes or on forced guesses it seemed likely that most players would never solve a board like that. But to confirm this assumption I've also looked at it from another perspective, which was done by trying to answer the following question below.

Who else got a record on an easy board like this?

So we now got a rough answer on how a rare a board like this is for a player, but how rare is it if we look at a community that consists of a large group of players? Therefor it's useful to check how many others in the world ranking also have an expert record like this

To find out if more people in the world ranking ever got a board like this I've downloaded all expert boards of the current world ranking. This resulted in 404 readable boards (only *rmv, *avf and *mvf) and then I counted the "3BV+2*(Openings-1)" values for all of these boards using an existing program that I've modified for this purpose. *

The result of this is displayed in the graph above. As you can see only 3 boards got a (3BV+2*(Openings-1)) score of 125 or less and the current lowest is 119. After that I've then manually added Ian's board to the graph with a score of 116 (=102 + (8-1)*2), which makes it the lowest score in the current world ranking.

This graph confirms the earlier calculations that the chance of a specific player ever solving a similar board is very small. Also the fact that it's the only record board with such a low (3BV+2*(Openings-1)) score seems to suggests that a personal record on a similar board is likely to occur to only 1 player once every few years.
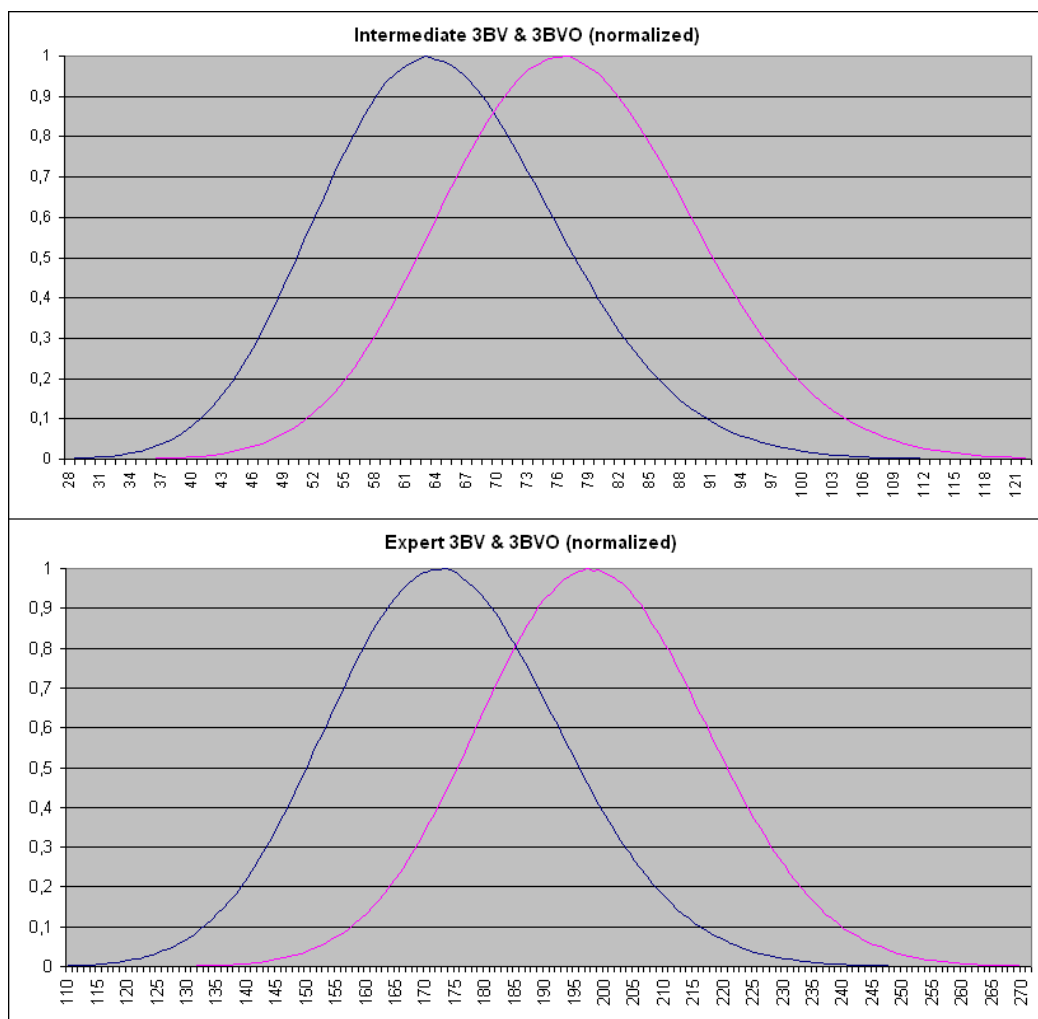

The software to load boards and count 3BV & openings was based on ZiniCalc02 from Cryslon.

Are the 3BV limits of intermediate and expert equally rare?

Note: In the following chapters I'll shorten the notation: 3BV+2*(Openings-1) to 3BVO, being 3BV with 3 clicks per openings (-2 clicks). All following calculations and results will still be made with the original formula.

The world record history of intermediate seems flooded with records that were made on boards with a 3BV equal or less than 30 and in the Chinese ranking we still regularly see players getting records on such boards. Strangely enough on the expert world record history we only find a 3BV=109 as lowest, which is almost 10% above the current 3BV limit of 100. On top of that we've already determined that boards with 102 3BV or less are extremely rare (especially combined with a small number of openings). This raises the question whether or not the 3BV limits of intermediate and expert are equally rare.

To answer this question I've generated 10 million boards on both intermediate and expert and counted both the 3BV as well as the 3BVO occurrences. After that I've scaled all the counters between 0 and 1 to normalize the results and I've cropped the resulting graphs to give then a relative equal bell curved shape. The results of this experiment are shown below. The blue lines are the 3BV counts and the purple lines are the 3BVO counts.

If we look at the 3BV graphs we can already see that 3BV=30 and 3BV=100 don't seem to be equally rare, since 3BV=100 isn't even on the chart. This isn't an illusion since the amount of 3BV<30 boards was 1750, while the the amount of 3BV<100 boards was just 112. With other words we can expect about 15 times more intermediate boards with <30 3BV than expert boards with <100 3BV. If we would make the 3BV limits for expert level as rare as 3BV=30 for intermediate, the 3BV limit should be 109 or 110 instead.

When looking at the 3BVO graphs we can find similar results. Since we can't exactly convert 3BV limits to 3BVO limits I'll use the 3BVO values of all discarded world record boards on intermediate over the years. Looking a those boards and dreamboards we will find that all of them ranged between 33 (Andrew Lee, 3BVO=25+8) and 37 (Damien Moore, 3BVO=27+10), so I will use a 3BVO of 37 as reference.

Looking at the 3BVO graphs it already shows that a 3BVO of 37 isn't nearly as rare as Ian's famous 116 (102+14) board. When looking at the exact numbers we see that confirmed, because the number of intermediate boards with a 3BVO<38 was 2026, while the amount of boards with 3BVO<116 was just 14. With other words we can expect about 145 times more non-allowed intermediate boards then expert boards using these 3BVO limits. If we would make the 3BVO limit for expert level as rare as 3BVO=38 for intermediate, the 3BVO limit should be 134 instead of 116, which basically means a 22 clicks difference.

One might argue that people don't solve/start the same amount of boards on expert as on intermediate or that it's easier on intermediate to determine whether a board looks promising or not. However, both these arguments only widen the gap, since it would make easy intermediate boards less rare instead of easy expert boards.
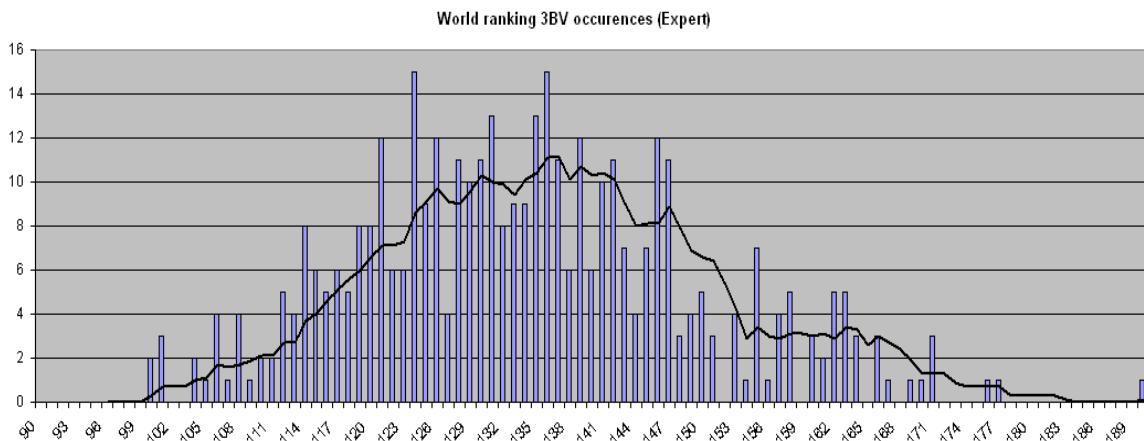
Looking at those enormous differences between the intermediate and expert limits using both the current 3BV limits and 3BVO limits the answer to why only intermediate world records below and near the 3BV limit occurred regularly and (almost) never with expert boards is now easily to answer: they simply aren't equally rare at all.

What has been the effect of the current 3BV limits on the world ranking?

In the previous chapters we've already seen if you create millions of random boards it results in 3BV and 3BVO graphs with a nice bell shape. This phenomena is known in statistics as 'normal distribution'. Since all personal records in the world ranking are also made on random boards, that are positively influenced by low 3BV and negatively influenced by the increasing rareness of lower 3BV values we would still expect to find a (slightly deformed) bell shaped graph. Also we would expect a similar shape for both expert and intermediate. To confirm this we would have to show all world ranking records in graph showing the 3BV counts.
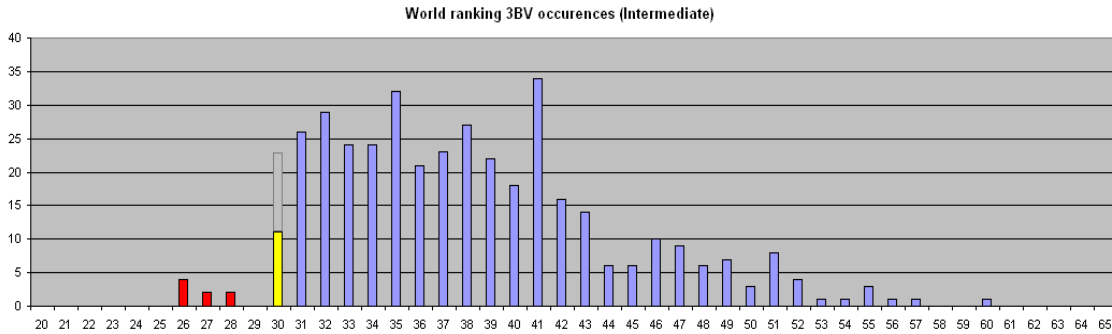
If the 3BV limits have had any significant effects on the world ranking we would also expect to see a sharp edge in the graph exactly on the 3BV limits of 3BV=30 and 3BV=100.

Previously I had already created such a graph using the 404 readable expert boards in the world ranking to find out if anyone else had an record on a very easy expert board like Ian's. This resulted in a graph that, with a little imagination, looked bell-shaped as expected. It also didn't show any 3BV<100 boards, but looking at the slopes of the graph only a couple of those boards at most were to be expected hadn't there been a 3BV limit.

World ranking 3BV occurences (Expert)

Since I hadn't created a similar graph using all intermediate records of the world ranking, I've downloaded the intermediate records as well. After that I've used my program again to read and analyze all the 396 readable intermediate boards (*rmv, *avf and *mvf).

This resulted in the following graph made from the intermediate records of the world ranking.

World ranking 3BV occurences (Intermediate)

It's immediately clear that this graph is shaped differently than the previous graph from the expert records. On the right side we still find a similar slope as we saw on the previous graph, but on the left we find 3 differences that can be easily explained. First of all we see a handful of boards below the 3BV=30 limit, which are old records from 2004/2005 that were allowed to stay in the world ranking by Damien Moore since it are inactive player. Secondly we find a noticeable lower bar on 3BV=30, which can be explained by the fact that the popular Clone2007 doesn't generates boards with 3BV=30 due to a known bug. And finally we se a sharp drop in front of 3BV=31, which is clearly the direct result of the 3BV limits.

When comparing the 2 graphs it becomes immediately clear that the effect of the 3BV=30 limit has been much bigger than the 3BV=100 limit. In fact, the intermediate graph is missing a big portion of its left half, which should now be distributed on top of the the remaining part of the graph.
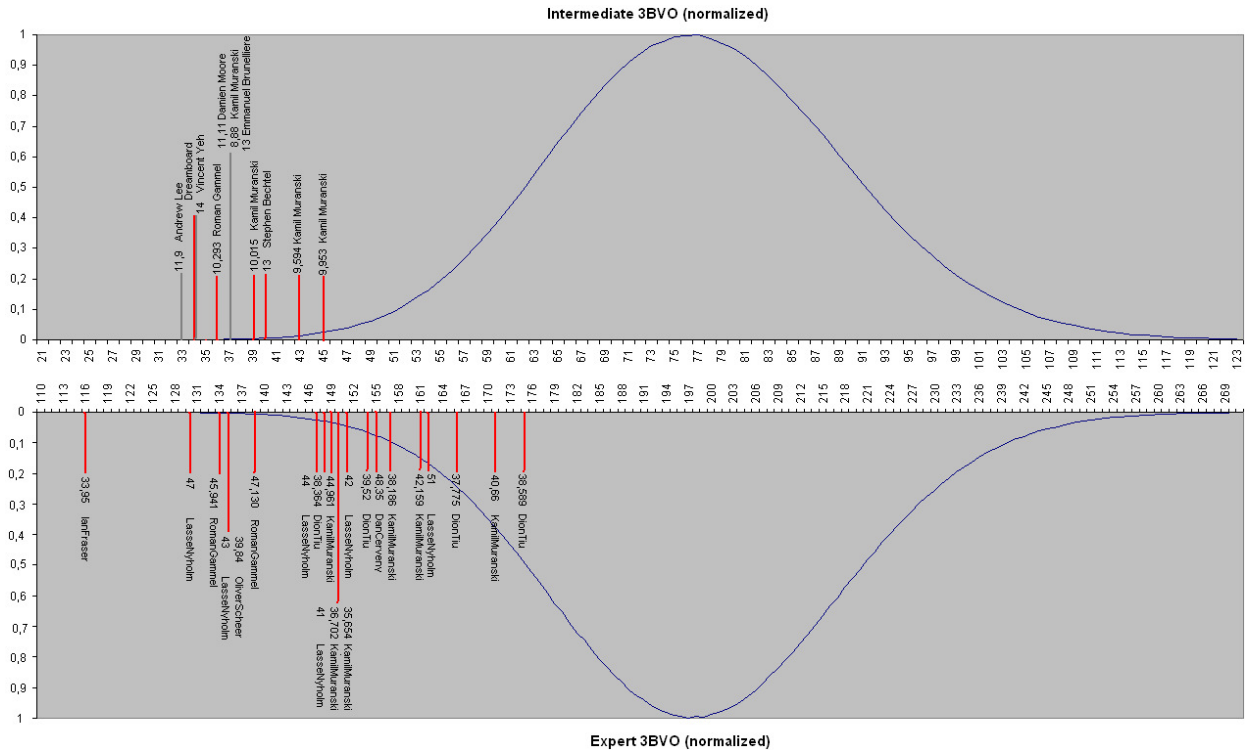
So we can conclude that the 3BV limit of intermediate did reduce the differences between a lucky player and a less lucky player, because the maximum 3BV difference between players has been greatly reduced. However, on expert this effect seems pretty much non-existent.

How do the intermediate record boards compare with the expert record boards?

On intermediate level we've seen that quite a lot of records with 3BV<30 are 'missing' in the world ranking due to 3BV limit, so it is likely that we would have seen more intermediate world records on 3BV<30 boards hadn't we had any 3BV limits. Also looking at the number of records in past on such boards seems to confirm this.

On expert level we've hardly seen any influence by the 3BV=100 limit, because boards near the 3BV=limit on expert were so extremely rare. Therefor all lucky records should probably still be present in the world record list.

To try to compare these boards as fair as possible I've placed the scaled 3BVO graphs from both intermediate and expert directly above each other and placed all world records (from which the boards were available) into this graph. The result of this is shown below.

(To indicate which record boards are currently no longer allowed due to the 3BV limits and other reasons, I've marked all the banned boards with a gray line and the remaining with a red line)

On intermediate it shows that Andew Lee (3BV=25+8) got the rarest board, followed by the famous 'dream board' and Vincent Yeh's allowed (3BV=30+4), then Roman Gammels allowed (3BV=32+4) and finally 3 non-allowed boards from Damien (27+10), Kamil (29+8) and Emmanuel (29+8).
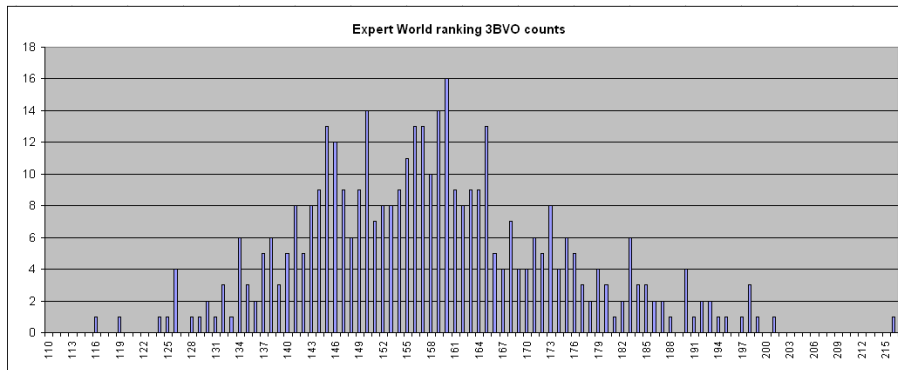
Looking only at these result, one might argue that, for instance, Damiens 11,11 shouldn't have been called too lucky and Vincent Yeh's should. (Kamil & Emmanualles board were on the famous 6-circle board that's been banned for being too easy and repeating, so those can be ignored). In the middle of this gray area of allowed and non-allowed boards we find Roman Gammels 3BVO=36 nicely in between. (Notice how both Winmine dreamboards are now located left of this value, while with normal 3BV limits the 3BV=30 dreamboard would still be allowed when getting a similar board on an official clone.)

Because a 3BVO=36 seemed to be a fair divider between too lucky and allowed, I'll use that board as reference when looking at the expert graph. Directly below that 36 we find 134 on the expert graph. Looking at this dividing line we only find 2 boards that are more rare then 134, being:

- Lasse's record jump from 50->47 (which is about as rare as Andrew Lee's 3BV=25 board and the Dreamboard)
- Ian's record jump from 39->33 (which is about as rare a 3BV=21 + 3 openings)

Roman Gammel once again acts as divider between the too lucky and the rest with exactly 134.

When looking at the 3BVO counts of the current world ranking on expert level we find that only ~4% of the players have a record on a board with a lower 3BVO than 134.

Expert World ranking 3BVO counts

Do we need to change the current 3BV rules?

When looking at the enormous gap between the 3BV limit on expert and on intermediate it's amazing that nobody noticed it before that 3BV<100 is many times more rare than 3BV<30. Probably everyone just assumed that it the limits were carefully chosen by calculations and considered the fact we hardly ever saw anyone get a near 3BV=100 board as a coincidence caused by forced guesses and bad luck.

If someone would have claimed a few weeks before Ian got his record, that 'if a 3BV=100 board with 9 openings would be allowed as World Record, then also 3BV=21 boards with 3 openings on intermediate should have just as much rights to be excepted', then he would probably have been called an idiot.

Reality however now caught up with us and it seems that the luckiest intermediate world record board that we've seen in the past (Andrew Lee's 3BV=25, 5 openings) is not nearly as rare as the easiest board that's been allowed on expert. Most likely because the 3BV limit on intermediate avoided records on even easier boards in the years following Andrew's record.

By simply looking at the scaled 3BV graphs of expert and intermediate its easy to recognize that 3BV=30 doesn't equal 3BV=100, but that:

- 3BV=30 on intermediate equals 3BV=109 / 110 on expert
- 3BV=100 on expert equals 3BV=25 on intermediate

Assuming that allowing 3BV=25 would basically mean that all boards that were ever discarded should be allowed again does not seem to be a realistic option, considering that it would be like going back to the time of no 3BV limits at all. Also it would be unfair to the people already in the rankings, because future players would have a big advantage of having a lower 3BV limit.

On the other hand, could disallowing 3BV<109 (or 110) boards be a more realistic option? Considering that people have gotten used to and accepted the more fair 3BV=30 limit over time as well, it can be expected that a evenly fair expert limit would be accepted in time as well if properly introduces.

We've also seen that the number of openings in a board has created a gray area on intermediate in which some boards just below 3BV=30 have been discarded, while relatively easier boards with exactly 30 3BV and 3 openings have resulted in allowed world records.

This same gray area also existed on expert as well, but since the 3BV=100 limit was so rare it took over 5 years before the first board with few openings landed in this gray area. If we would raise the 3BV limit on expert, then this problem would also become more regular, just like it happened on intermediate.

To fight this problem that's causing relatively easier boards to get allowed and lower 3BV board with more openings to be discarded, I've introduced the formula '3BV+2*(Openings-1) that seems to be a better divider to determine which boards were too lucky and which weren't.

While using this new formula we've also seen that a 3BVO value of 36 on intermediate nicely divided the easiest/banned boards and the boards that always have been allowed in the past. (With the exception that one old world record on a 3BV<30 board might have to be re-added to the record history due its larger number of openings.)

This intermediate 3BVO value of <36 equaled the same rareness as <134 on expert. Using this value on expert meant that only two world records had a lower 3BVO, which were both big time jumps (being 50->47 and 39->33). Also on the world ranking just 4% had a record on a 3BVO<134 board. So also on expert this 3BVO limit seems to rule out only the luckiest boards and leaves the rest unchanged.

There are off course difficulties that would have to be overcome when introducing a new standard, which are basically the same problems that the community dealt with when introducing the 3BV limits. For example: - It would have to be clearly introduces in the world ranking and world records. -It would have to be implemented in the existing Clones, just like it happened with the 3BV=limits in the past. Personal records of active players that are/will be made on old clones without 3BVO limits would have to be checked on their 3BVO value;

Even though it might be a little bit work to introduce a new standard or just to raise the 3BV limit on expert, I do believe it would be a big improvement for the minesweeper community, since it would make the game more fair and equal for all players, just like the intermediate 3BV limit has successfully done. Also it would reduce the amount of players that quit and/or get frustrated after getting a near unbreakable time record on a very easy board and it would improve the status of expert world records.

R.W.