CREATING THE PLAYING SURFACE

The playing surface is what has to be created every day, ideally for every game, on top of the ice pad. Considering that the ice pad is perfectly level and consistent, the playing surface must also be perfectly level and consistent, and achieving this is not as easy as it might seem. After all, you're taking a can of water and splashing drops everywhere, some bigger than others, some areas more than others, and within a few layers of this pebble there could easily be discrepancies in level of five millimetres! So much for the ice pad that is level within 0.05mm! To combat this problem the pebble is cut off with a sharp blade, which may or may not be perfectly straight and level, and this blade floats on the surface, totally ignorant of highs and lows and cutting only where it can. Within the week the perfectly level surface of the ice pad has been ruined, and the only remedy will be another flood or two. So the question has to be asked: what is the point in creating a perfectly level surface, only to ruin it?
It is therefore clear, the pebble has to be very even and consistent, covering the entire width of every sheet in a population of one tiny drop per square centimetre. The drops have to be small enough to allow the blade to cut them off easily, yet large and strong enough to last for a full game of curling. This requires exact control of temperatures and humidity, and a very special technique of distributing the pebble. Get this right and the floor will look like a field of little diamonds, silky smooth to play on and so durable that every stone, from the first to the last through the game, will behave in the same way.
BUT. There are TWO playing surfaces. There is the pebble, and then there are the running bands of the stones, and the latter have more say in the behaviour of a stone on its path from hack to house than the pebble, yet the pebble can be manipulated to control the behaviour of the stones. In this relationship the stones are the constant factor, while the pebble is the variable factor – only if the pebble can be nurtured to become a constant factor as well, can the relationship provide the proper conditions for a game of curling.
What follows in this file is not gospel. It is simply the result of what we managed to learn over many years of asking, testing, experimenting, and spending thousands of pounds of our own money. Everyone had a better idea, but no-one had supporting evidence or proof of what they claimed. It worked for them, yet it didn't work for us, and we needed to know why so we had to learn by ourselves. With the help and input of one Shorty Jenkins (who never lied to us), one IcePOD (which cannot lie) and one mind of "let's go where it takes us", we found something that worked for us, anywhere, everywhere. What is put down in writing here is my own opinion, because I can't have anyone blaming my colleagues for something that might not work in Canada, Sweden, Switzerland or anywhere else. Blame me, if you think I have it wrong.

1. Pebble

There was a time when Leif and I had managed to complete *Curling Ice Explained* for the WCF, and Italy wanted to translate the manual. Of course, I volunteered to help in any way I could. The first email from them asked me how to translate "pebble" into Italian. I didn't have an answer. So what is pebble? According to Wikipedia, "A **pebble** is a clast of rock with a particle size of 4 to 64 millimetres based on the Krumbein phi scale of sedimentology. Pebbles are generally considered to be larger than granules (2 to 4 millimetres diameter) and smaller than cobbles (64 to 256 millimetres diameter)". By this definition we are dealing with granules here, not pebbles. In curling terms, I define, pebble is simply frozen drops of water resembling lumps on the surface of the ice pad, upon which the modern game of curling is played.
To produce these lumps requires equipment, as I discovered, far more sophisticated than would be immediately apparent. I tried the over-shoulder-water-holder, that barely pebbled two sheets once and left me with a sore back after four sheets. The pebblehead I had (the only one in stock!) was a 72, big and flat, dented and buckled, filthy, didn't fit properly (spewed water at the joints). I knew it was a 72, but only because someone had scribed the number on the back – to be honest, I'm sure the holes were more like 62, they were huge. Then I heard of a guy who pebbled with a head that had ¼" holes drilled into it, four of them, worked a treat. I obviously had to learn more! The modern description of sizes is this:

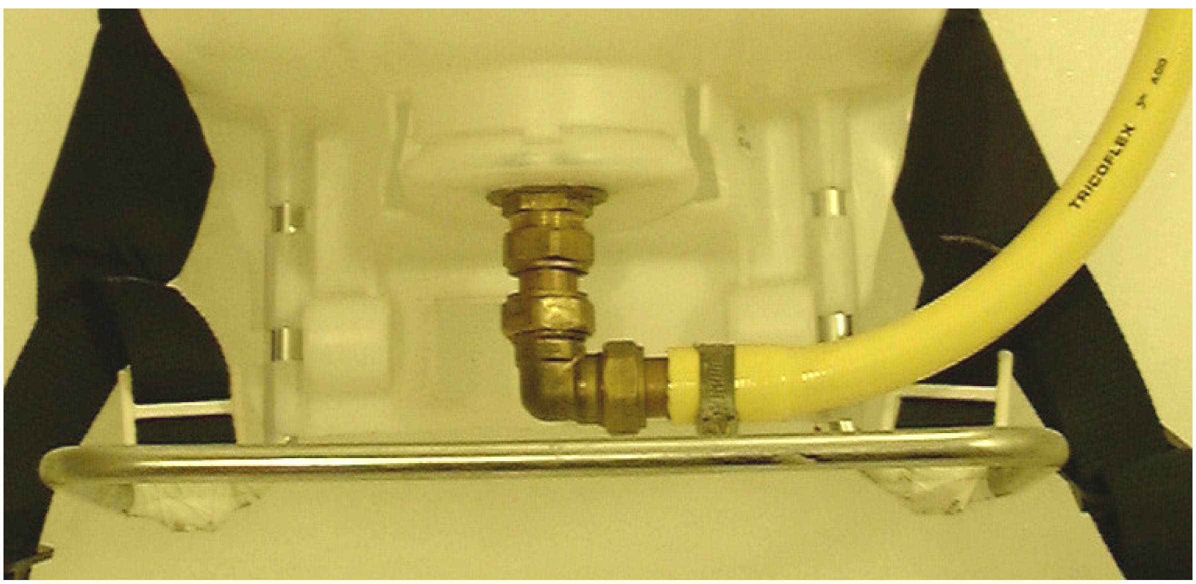
Present identification	Wire drill number	Convert to mm	Metric drill diameter mm	Example of holes	International (metric) identification
Extra fine (XF)	77	0.46	0.45	59	59/0.45
Fine (F)	76	0.51	0.50	59	59/0.50
Medium	74	0.57	0.55	59	59/0.55
Large	73	0.61	0.60	59	59/0.60
Coarse	72	0.64	0.65	59	59/0.65
XF/F Combination	77/76	0.46/0.51	0.45/0.50	59	59/0.45&0.50

Columns one, two and four in the table are relevant, the rest can vary quite a bit. At the time of looking for a good pebblehead, I had no idea of what I was looking for, and the ones available through various agents were expensive and looked no different to the one I had, the one that didn't work so well. By coincidence Shorty was in town, as it were, and he sold me two pebbleheads from his pocket, paid for by money from my pocket. XF and F, they were, but they had Canadian fittings on them and wouldn't fit onto what I had. Not to worry, out with the soldering iron, change them, and I was left with something that worked but was very heavy (after two sheets, never mind four!). I bit the bullet and pebbled away for the remainder of the season with the over-shoulder-water-holder and Shorty's pebbleheads, and survived like most ice technicians seem to survive.

During the summer I bought a backpack pebble can distributed by Thompson of Canada. To be honest, any backpack spray container will do the job, but this one appealed to me because it travels high on the back, and from some years of carrying backpacks up and down mountains I knew this was a good idea. This pebble can of Thompson's had a piece of formidable red hose attached to it, at the end of which was a fitting that, would you believe it, actually fitted Shorty's pebbleheads. So out came the soldering iron, back went the original fittings, and tada!!!! I decided to take the whole outfit for a practice in the car park just to celebrate, what an achievement, I was the proud owner of a curling-ice pebble can with Shorty's pebbleheads!

Sadly, it didn't work too well. The can leaked like a sieve, the hose was as stiff as a steel rod, the water went all over me and not the car park and all I wanted to do was cry. Wherever Thompson got the can from before they stuck their sticker on it and trebled the cost, it didn't work.

To cut the story short, below is an enlargement of the bottom of that same can, AFTER I had set my mind to it and systematically cured the problems. The white bit that is fixed to the can itself, and to which the outlet was fixed, leaked badly. It was a very poor joint. I cured it with silicon sealant on the inside, forced into the groove of the joint. Then I replaced the pathetic plastic coupling that connected this white bit to the hose with a serious brass coupling and elbow, with added silicon to prevent any leaks. The reasons are twofold: the inside diameter of their coupling was barely 15mm, and the plastic was so poor that it would never have lasted a month, let alone the season. The new diameter was 19mm (I/D), straight on to 22mm copper tubing, an elbow, copper tubing, and Tricoflex hose. The clamp was not really necessary, but I thought it would be better than a wet back. For more details, see the report on *Pebble Can Tests*.

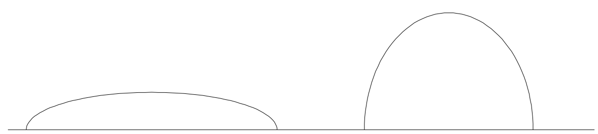


These modifications were not the end of the problem. Now I had to find the correct length of hose to suit my arm, which has to prevent kinking the hose and yet provide full movement for the pebble action. So, start with long and keep cutting a bit off, and soon the hose suited my arm. Then came the length of the extension pipe, same thing, start with long and keep cutting bits off until it feels balanced and delivers the water exactly where it should be, some nine inches over the sidelines. All I had to do now was practise, find the best temperature, relax the muscles, don't try too hard – not a word of a lie, suddenly Shorty's pebbleheads performed their magic, one drop per square centimetre achieved.

I recommend Thomson's pebble cans for the can and the height. I give them no points for the fittings or the hose, and they cost far too much for what they claim is worthy of curling-ice technicians.

The important points are these. The hose, fittings and entry into the pebblehead must not be smaller than 18mm I/D AT ANY STAGE. I admit, Shorty told me this, and I take full credit for remembering what he had told me. This simply means that a pebble can, carried high up your back with this continuous flow, will provide the same pressure to the head down to the last drop. Considering that this pebble can holds some 13 litres of water, that will give you four sheets pebbled twice. The pebblehead itself will obviously vary from make to make, but I understand that Shorty's designs have been copied and will survive for the future, and I have not found a better design yet. Sixty-five holes arranged around the bottom half of the head, and XF is certainly my favourite.
The size and shape of the pebbles are important. As the pebblehead is swung to and fro water is released through the holes, and the drops fly through the air to land gently on the ice pad. The thin copper of the head helps to cut the stream of water into drops, but most of the drops are formed – and their sizes decided – by the hydrogen bonding in the water, and temperature plays an important part. We have no data to support this, but over the years the consensus has developed that clean water at 40ºC (in the urn) works best, giving us drops at the ice surface of about 30ºC. These drops will remain liquid and settle until viscosity fixes their shape, and then they freeze solid into that shape. In the table below the heights of some pebbles are given, which we measured with the IcePOD, and in the diagram on the right is an illustration to show how the shape of a large drop compares to that of a small drop. This is exaggerated, but it is in fact what happens. (See the report on *Pebble.*)

Pebblehead	Hole size in mm	Height in mm
72 (coarse)	0.65	0.37
74 (medium)	0.55	0.66
77 (extra-fine)	0.45	0.99



Having solved the problems of the curling can, hoses, pebbleheads and temperatures, we could start work on the distribution or population of the pebble on the ice pad. The aim was to find a way to distribute the pebble so evenly that the entire ice surface would be evenly populated, from sideboard to sideboard and from hacks to hacks. It was too difficult to experiment behind the hacks so we didn't bother much, it is after all not an area in normal play, but we did pay particular attention to the sides and the overlaps on the sidelines. After many months we settled for eighty to-and-fro arm movements at a speed of forty seconds from backline to backline, using heads of 65 holes, either 76, 77 or even 78 in size, with Shorty's heads already our preference. This gave us a population of about one drop per square centimetre, which we could map and count by using carbonised listing paper (the same stuff used for printing the running bands of stones). We would scan these onto computer and by zooming in we could not only count the pebbles but also calculate their actual surface area in contact with a stone.
Of course, not all the pebbles were of the same size, or of exactly the same height. By shaving the tops with a Nipper the situation did improve and so the quality of the scans, and by repeating the nipping as if during normal play the surface areas did substantially increase. As will be obvious from the illustration above, the larger pebbles increased quickly while the smaller high pebbles increased slowly, and very soon not much at all. In other words the small and higher drops maintained their contact areas very well, while the large flat pebbles soon grew beyond three times their original surface areas. What was quite clear was that the small pebbles, typically the XF pebbles, would retain their curling characteristics very well when attacked by stones, sliders and brushes, while the large pebbles would not. All this depended also on the strength of the water involved and the careful control of temperatures, and for all these tests the pebble water was deionised water at 40ºC in the urn with the ice pad at – 3.8ºC. The air temperature was around 8ºC and the RH 60%, both taken at 1.5m above the ice surface.
From the scans we could also calculate the total contact area between running band and ice, which gave us another surprise. The stones used were naturally matured with a running-band width of 6.4mm, and the total contact area was less than a square centimetre, and often almost half that. This amounted to some 19Kg of granite on twenty pebbles, or say 1Kg per pebble, which allows for energy from either its mass or its velocity – or both, at certain stages – to melt the ice surface. See the report on *Why Do Curling Stones Curl* for more detail.
Although we had by this stage learnt some very important lessons and gathered much data, it very soon became clear that we had a problem: pebble alone did not provide all the answers, because it didn't work for other people. In the three rinks where we experimented with pebble there were no real problems and few discrepancies, because all the stones involved had been naturally matured. But we had forgotten that there are two playing surfaces involved, and that some people mess with stones.

2. Stones

By the Rules of the Game, curling stones must be of circular shape on plan and lighter than 19.96kg (44lbs). They must be of smaller circumference than 91.44cm (36in) and lower than 11.43cm (4.5in). The definitions do not specify the size, shape or texture of the running band, largely because these are relatively new refinements that improve on outdoor stones with a flat surface and no running band. In *Curling Ice Explained* there is a full section dealing with curling stones.

The creation of the running band was a good idea. The round sections of granite called "cheeses" are fitted to a lathe and a recess is cut into the stone, to which is glued a disc of Ailsa Blue-Hone granite, considered the most suitable granite for its hardness and durability. The body of the stone is of a softer granite, usually Common Ailsa or Green Ailsa (other granites are also used), to cope with the impact between stones on the striking band. So, the cheese is shaped, along with the Blue-Hone insert, and then a shallow cup is cut into the insert with a diameter of about 110mm. It is the edge of the cup that becomes the running band, now the only part of the stone in contact with the ice. When new the band will be about 5.4mm wide, and over the years this can become as wide as 9mm before refurbishment, while a naturally matured stone will have a band of about 6mm. The very edges of the band are carefully shaped to high specification to avoid or even create sharpness, while the surface of the band is prepared with sandpaper to have a certain specific texture. This is where the real problem lies.

If, as calculated, some 19Kg of granite is exerting a force of 1Kg per pebble, it is clear that the total contact area between stone and pebble can change this. A stone with a 5.4mm running band will have less contact area and therefore more mass per pebble, with more influence on the pebble, while a stone with a running band of say 7.5mm will go the opposite way and become "lighter". The only way to control what happens to the ice surface is to manipulate the temperature of the ice pad, the amount and the size of pebble, or a combination of all these. So, to save the surface under a "heavy" stone, the ice is made colder, and suddenly the stones don't curl so well. In order to make them curl some sandpaper is used to roughen the texture of the running band and increase friction, and usually a sanded stone will "dive" towards the end of its journey. But this sanding does not last more than a few weeks and has to be done again, and again, and again, and because this amateur refurbishment is irregular and inconsistent the entire set of stones becomes inconsistent, and quite impossible to play a good game with. Players blame the ice, because they know no better, but it doesn't matter what kind of ice is under inconsistent stones, they will still be inconsistent.

In the ideal scenario, a full set of stones is delivered from the factory with running bands to specification, shaped and sanded and ready to play. They will be very consistent and evenly matched, but they will be more aggressive than naturally-matured stones and the ice will be made colder to compensate for this. Gradually the sanding will wear off and the stones will naturally mature, so the ice will gradually be made warmer until the best optimum is reached for speed and curl (see *STRATEGY*). Now, and only now, can the stones be matched in pairs and sets to give the curlers the consistency they should expect from level ice and good stones, and the curling will be good. This process does however take time, weeks or even months, but once the stones have naturally matured they will remain so for many years.

When stones are refurbished, professionally or otherwise, they will be more aggressive, yet reasonably consistent. Players who are used to aggressive stones will want aggressive stones, and ice technicians can easily fall into the trap of refurbishment the moment the aggression wears off. This takes time and costs money, so they do it themselves and survive the competition, but things soon go wrong again. Often a full set of stones will be ruined and beyond anyone other than a professional, and full refurbishment costs even more. The problem is exacerbated in arenas where thousands of spectators provide a significant additional heat load, so the ice is made colder to survive, and the stones are sanded to make them curl, which will last the week but after that no-one really cares.

Arena ice is a special field, and the people who make the ice for serious competitions know what they're doing. Fortunately it is becoming the norm that a full set of stones will travel the world to be used at serious competitions, and because they are treated with respect they will be well looked after and not sanded in the middle of the night. But in an ordinary curling rink there should be no need whatsoever to sand stones, and every effort should be made instead to learn how to control the ice surface rather than the stones. If this proves impossible, have the stones professionally refurbished and simply try again. We have learnt from this by having two stones refurbished and see how they behave – in some cases lowering the ice temperature by less than 0.5ºC did the trick, in other cases the stones would still be drawing in excess of twelve foot and back they would go for refurbishment.

An additional problem, simply to complicate things yet further, is the formation of frost on the ice surface. Because this amorphous, non-crystalline ice melts easier under the mass of the stones, the stones do not travel as far and draw much more. Sweeping does of course help to remove much of the frost and so lift the burden, but after a full game the frost will win. This is essentially why the ice has to be pebbled for every game, and cut as well if possible, to maintain the consistent playing field. More on this in the next section.

Something we have always wondered about, but have been unable to study beyond the obvious, is the effect sanded stones have on the playing surface. The running band is rough, or rougher than it would have been, and this will damage the ice surface. On the other hand, once the stone has travelled down the ice, many of the scratches will have been filled with ice, creating a smooth – or more smooth – surface again. While we know that it helps to have the ice colder to combat this, we also know that sanded stones – combined with sweeping and sliding, of course – will wear the ice more than naturally matured stones. A close look at the pebble after a serious game of curling will confirm this, but one day perhaps someone will be able to help us learn more about the pros and cons of this particular relationship between stone and ice.

Nipping has become the standard in recent years, where the very tops of the highest pebbles are shaved off to provide a silky smooth surface to play on. There are many references available where "so many ounces" have been nipped, referring to the amount of ice shaved off and collected in a container to be reduced to liquid and then measured. There is no doubt that nipping works, but this kind of measurement is very imprecise, because it depends very much on the size and shape of pebble, the temperature of the ice pad and of course the sharpness of the blades. Nipping was designed to cut the tips off, and was then adopted to increase the contact area between stone and ice using a powered cutter, and this was measured in ounces. As far as I am concerned a Nipper should remove only the very tops, and if there is more ice collected than a small dustpan will hold after four sheets, too much has been taken off. The minimum is the rule, because the pebble has to last for a full game of curling.

In the days before the Nipper came into being (and before nipping became popular!), technicians had to "run the stones". This was a process where about eleven stones were put into a wooden frame and dragged over the fresh pebble in two directions to knock the tops off the higher pebbles and ease the way for normal play. The process also became known as racking, because of the "rack" the stones were placed in, so they could rotate freely within the frame, and a very good result was achieved. But of course it took time, around five minutes per sheet to also allow time to mop up the debris of shattered pebble tops, and it took additional effort. However, this is one way to speed up the naturally-matured option, because the stones travelled over the ice many more times than in your average game. Today it remains an option to do just that, as long as the stones from all the sheets are used in rotation, to improve the consistency of wear on the running bands of the whole rink.

For the game of curling to work at all the ice has to be kept clean, and so too the stones. The stones have to be at the right temperature, where the running band of the stone is as cold as the ice surface. This is easily achieved by placing the warm stones on plastic beer mats on the ice for a few hours, and then directly on the ice for several more hours, preferably where marks that might be melted into the surface can be cured.

3. Parameters

The relationship between stone and ice is intimate and complex, and it is easily affected by changes in the parameters. In *STRATEGY* some advice is given on instruments that can and should be used for reading these changes, because one small change can have a large effect and can often also point towards a developing problem. For instance, if the compressors are suddenly running for longer without any changes in the weather, there could be a small gas leak, and if it is not found and dealt with there could be an overnight meltdown. Should the humidity suddenly rise beyond the expected this could be because the dehumidifier has a problem, or someone has left a window open somewhere.

Controlling the parameters will be dealt with in the next file in more detail. At this stage the playing surface has been created and play can begin.

John Minnaar
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