
Subject: Truncated Spheres

Posted by [Magic](#) on Tue, 21 Dec 2010 21:46:05 GMT

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Hi all,

After working with Orangery on this D32 (not numbered yet)

I decided to go on the idea of making dice from truncated spheres.

As you know, a round D6 can be defined as the intersection of a cube and a sphere:

Using the same method, I also designed a rounded D12 (intersection of a dodecahedron and a sphere).

As I originally wanted to make a D10, I put back two opposite portions of sphere to the D12 to get this round D10 with a 5-fold symmetry:

Then, instead of using the original portions of sphere, I replaced them by cones (tangent to the sphere) to get this pointed D10:

Another D10 with a 4-fold symmetry can be obtained by using a different underlying polygon with 10 faces (2 squares and 8 non-regular pentagons):

Note the strange way I had to numbered it: this is due to the fact that a face is not always opposed to another face but to an edge.

Finally, playing with truncated spheres and cones, I found this strange shape that is mid-way between a sphere and a cube.

Don't know exactly what to do with it (not a die anyway because it can stop on a "edge", even though it has no edge).

Currently I am working on a 3rd D10 with a 3-fold symmetry (not finished yet) and also on a D9... So, more news will come soon!

Subject: Re: Truncated Spheres
Posted by [clsn](#) on Tue, 21 Dec 2010 22:08:29 GMT
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Nice. I had made a d9 using the same technique. I was going to un-"hide" it, but looking at it I realize that I just numbered the faces even though it doesn't land with a face up. Woops. Well, something else to fix. I'd like to make a bunch of other odd-sided dice ("odd" both in the sense of an unusual number for sides of a die and also some that are odd and not even), and do some randomness tests on them, see if they're close to fair.

It looks like your method of intersecting spheres with dual polyhedra yields the same results as the one that I tried, with slicing identical circles off a sphere at the appropriate points (but yours is probably simpler).

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Tue, 21 Dec 2010 22:32:57 GMT
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Yes, I suspect that the 2 methods leads to the same result and our D9 are more or less the same (yours is actually "rounder" than mine, I think).
Feel free to show it in this thread if you wish, once it is finished.

For the numbering, I thought doing it as the D10 4-fold (with numbers in the edges) but another method would be to put the numbers near the bottom, on the adjacent faces, as in a standard D4.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Mon, 03 Jan 2011 13:52:18 GMT
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Hi all,

Here is my last family of truncated sphere D10. After 5-fold and 4-fold symmetry, these are the 3-fold D10s.

There are two models:

- the rounded D10 with 3-fold symmetry
- the pointed D10 with 3-fold symmetry

Both are based on a D14 non-regular cuboctahedron. This truncated sphere D14 numbered twice from 1 to 7 is also available.

To obtain the D10s, I add 4 portions of sphere (rounded version) or 4 tangent cones (pointed

version) to the D14 to "cancel" 4 out of the 14 faces. So the symmetry of those D10s is the same as the symmetry of a tetrahedron (regular D4).

Check this picture to see them or click the links above.

Next steps will be having the D14 with twice the days of the week, and finishing numbering the D32.

File Attachments

1) [D14_D10_3f.jpg](#), downloaded 2097 times

Subject: Re: Truncated Spheres
Posted by [clsn](#) on Mon, 03 Jan 2011 13:59:54 GMT
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I renumbered my d9, with numbers on the "corners", and un-hid it. Haven't bought a copy yet, so caveat emptor.

http://www.shapeways.com/model/189987/d9___nine_sided_die.html

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Thu, 06 Jan 2011 15:06:26 GMT
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Magic, the dice look great. I didn't think the D10 with four fold symmetry would work. It looks fair too! I have not seen anything like it before.

Look forward to seeing the D9.

Unfortunately I have still yet to decorate the D32's that you made for me as I have been bogged down with other things.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Thu, 06 Jan 2011 21:32:35 GMT
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Thanks Orangery. On my side, I have still to number the D32 and the D9.
I ordered all the other truncated sphere dice today. I will test their fairness as soon as possible.

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Fri, 07 Jan 2011 10:15:15 GMT
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Personally I think the number on a die should be read face up whether on a face or an edge. I don't particularly like the 'normal' D4 where you have to read along the bottom.

I like all your D10's except the ones with cones (I'm funny like that). My favourite is the one that is made up from 2 squares and 8 non-regular pentagons as it has the optimal surface area to land on and as far as I know, is unique.

I think It would be nice (as you have come this far) to finish off the set with a D4, D8 and D20 as an alternative to the usual D&D dice and give them a posh name.

The D9, D14 and D32 could be available as add-ons. I hope to buy most of these dice this year once some spare cash comes available.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Fri, 07 Jan 2011 18:02:38 GMT
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Yes you are right, I can do a D4 (numbered on the round part), a D8 and a D20 to complete the set.

And perhaps also a D12 based on a rhombic dodecahedron.

So many things to design, so little time...

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Thu, 13 Jan 2011 22:13:24 GMT
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They arrived!

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sun, 20 Feb 2011 07:52:20 GMT
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Another member of the Truncated Sphere family (asked by Orangery): the D4 Sphere.

Because the numbers are written exactly on the vertices, it is much easier to read the result than on traditional D4 (tetrahedron). And it should also roll better.

File Attachments

1) [D4Sphere.jpg](#), downloaded 1888 times

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Sun, 20 Feb 2011 10:01:37 GMT
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This looks a fun die... nice work. Do you think you will get round to making up a 'set'?

By the way have you tried 'Uni Posca' pens. They are great for colouring the dice. I tried them out on the D32's you made (pictures to follow). I painted the numbers in by hand (still have three to do). The colours look good (they still need to be varnished) but I want to try and improve on the numbering as I like things to look consistent (may try rubber stamp blocks).

Numbering of a normal D32 from 0-31 might be used for days of the month. If the die lands on a zero the player could choose any day of his/her choice (or throw again). Just a thought.

I started on my web site... <http://the-orangery.weebly.com/>

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sun, 20 Feb 2011 11:17:12 GMT
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Hi Orangery,

You mean a set including the still missing D8 and D20?

Well, I am in the process of beginning the D8, but it will take some time. In the meantime, if you wish a special set of existing dice, just PM me.

The numbering of the D32 is a nightmare for me: each time I begin to look into it, I see new

problem. I have to find the exact angles between the faces and, say, the horizontal plane if I want to do it properly (well, basically I need some courage).
Numbering from 1 to 31 with an extra symbol (like a star) to represent either 0 or 32 or "replay" can be an idea.

I didn't try Uni Posca pens, but I heard about them in this forum. I have to see if they are available in France.

For now, I let Shapeways dye the dice and for inking the numbers, I use "Hybrid Gel Grip Metallic", some gel ink rollers with 0.8mm balls from the Japanese Pentel. The white in particular works very great. Then I finish them with some coats of acrylic varnish.

Good luck with your website!

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sun, 20 Feb 2011 17:11:08 GMT
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D8 Sphere added !

It was quite easy to do the first time, but there were not enough polygons in the rounded part. Adding more polygons made the process of "extruding" (should I say intruding?) the numbers fail quite often...

But finally, I did it!

File Attachments

1) [D8Sphere.jpg](#), downloaded 1864 times

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Wed, 23 Feb 2011 20:26:24 GMT
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I wasn't sure what you meant about the numbers failing as I don't think you have mentioned having trouble with any of the other die. I'm okay with 2D stuff, not 3D,

Anyway, another great dice (over 50 downloads). Will you be getting these made (D4, D8)?

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Wed, 23 Feb 2011 21:10:42 GMT
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Carving numbers on dice, as any boolean operation (union, intersection, substration...) is a very... "random" operation. Sometimes it works, sometimes it fails...
It is (and has always been) a pain to do...

I will probably order the D4 and the D8 but not immediately: as an anti-addiction policy, I do not place a new order as long as the current one has not been delivered. And my latest order has not arrived yet and does not include dice, sorry...

PS: the downloads are just people reading the message, not peple ordering the die, unfortunately...

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Fri, 18 Mar 2011 11:09:12 GMT
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I have just received the three different versions of the D10's. They are brilliant! Every dice collector should have these. Now I just need to paint them without messing up.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Fri, 18 Mar 2011 19:26:00 GMT
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Thanks Orangery: I am very happy that you like them (and I can only agree with you: any dice collector should have them).
After dying or painting them, I recommend to ink the numbers with some gel ink pen. Gel is important so that the ink stay in the indentation instead of diffusing in the neighbourhood... And then some varnish...
Let us know the outcome.

I take advantage of this post to show you a die I did for Kevin Cook: this is a D33 to celebrate his 33333th die.

File Attachments

1) [D33Kevin.jpg](#), downloaded 1658 times

Subject: Re: Truncated Spheres
Posted by [Youknowwho4eva](#) on Fri, 18 Mar 2011 19:29:53 GMT
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wouldn't that be 33333rd? Keep up the good work. These are definitely different.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Fri, 18 Mar 2011 20:24:12 GMT
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I should have pronounced it mentally to avoid my mistake...
Thank you for the kind words, Mike.
The D9 and D11 are already available. Other will probably come later.

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Fri, 18 Mar 2011 21:19:47 GMT
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Wow, that D33 is the weirdest die I have even seen. I thought my eyes were going funny when I first saw it. I also looked at the D9 and D11... they are also mad things. You seem to be on a roll

I painted the D10's but I got in a mess with them. I didn't have a gel pen. Will try a different technique.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sun, 20 Mar 2011 16:26:49 GMT
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Thanks again.
If you like my designs (in particular the ones you received), do not hesitate to rate them!
Good luck with your painting!

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Mon, 11 Apr 2011 05:57:52 GMT
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The long awaited Truncated Sphere D20 is now available!

This is the intersection of an icosahedron with a sphere. As you can see, due to the fact that a vertex is surrounded by 5 triangles, the rounded area is larger than in other Truncated Sphere dice. So the faces are smaller and the numbers too.

The distance from one face to the opposite one is 2 cm. This die is hollow, with a thickness of 1.5 mm (suitable for Alumide for instance).

File Attachments

1) [D20.jpg](#), downloaded 1556 times

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Mon, 11 Apr 2011 06:12:21 GMT
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I also designed a D10 for percentage and a new version of the D6 (circle faces nearly in contact and wall thickness of 1.5 mm only).

As a consequence the Truncated Sphere Dice Set is now available !

This set is composed of 7 regular Truncated Sphere Dice:

- D4
- D6
- D8
- D10
- D%
- D12
- D20

Ideal for dice collectors and RPG players!

I will probably create later another set for unusual Truncated Sphere dice (D9, D11, D17 etc.)

File Attachments

1) [SphereDiceSet.jpg](#), downloaded 1561 times

Subject: Re: Truncated Spheres

Posted by [Orangery](#) on Mon, 11 Apr 2011 06:53:27 GMT
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I wish these dice could turn out exactly as the 3D CAD drawings (not a mark on them), .

I think there is only the Rhombic Dodecahedron left. I'm assuming it will have different properties than the regular shape?

The two D10's you made (not the one with the 14 sides) roll really well and for about the same length of time (on average) even though they are constructed quite differently.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Mon, 11 Apr 2011 21:15:44 GMT
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I have seen outstanding results in metal after sanding and polishing, but my post-production skills stop at inking and varnishing plastic...

The Rhombic Dodecahedron is definitively different from the regular Dodecahedron and will come with the Rhombic Triacanthron (D30).

By the way, the Rhombic Dodecahedron is from the same family as the D9 and the future D15 (because $9=3+3+3$, $12=4+4+4$ and $15=5+5+5$)

I plan also to make a different D8.

Concerning the D10s, you are speaking of the D10 with 4-fold symmetry (polyhedron with squares and pentagons) and the D10 with 5-fold symmetry (derived from a regular dodecahedron), right? Is there a problem with the 3rd one (D10 with 3-fold symmetry, derived from the D14) or is it just that you did not test it?

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Tue, 12 Apr 2011 07:29:13 GMT
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Re D9 family of dice, does this mean there is a D3 ($1+1+1$)?

Going off on a tangent, I thought I had read somewhere that the D11 was constructed using the ' $1+n+n+n+1$ ' formula ($1+3+3+3+1$). Same with the D17 ($1+5+5+5+1$). Does this mean that a D5 might be possible ($1+1+1+1+1$) and also the 'different' D8 you mention ($1+2+2+2+1$)?

As for the D10 (fourteen flat sides), there is no problem with it. I didn't mention it simply because it rolls for longer than the other two (as expected). My favourite D10 is the one made up of squares and pentagons.

Subject: Re: Truncated Spheres
Posted by [henryseg](#) on Tue, 12 Apr 2011 15:07:27 GMT
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Have you looked at circle packings on the sphere? That is, finding the arrangement of n identical non-overlapping circles on the sphere so that the circles have maximum radius.

This website looks like it has some data you might be able to use (although not much in the way of pictures):
<http://www.buddenbooks.com/jb/pack/sphere/intro.htm>

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Wed, 13 Apr 2011 10:35:15 GMT
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@Orangery No, unfortunately, n cannot be 1 or 2. Or more precisely when it is 2 the polyhedron is degenerated.

For instance, $1+3+3+3+1$ implies that the face of the poles are triangles (because $n=3$). If you put $n=2$ then the poles degenerate into simple edges (a polygon with two vertices is a "double-edge") and what you actually get is $2+2+2$ which is a simple cube (D6)...

Same thing for $1+n+n+1$ ($n=4$ gives your favorite D10)
For $n=3$ you get the regular octahedron (D8) and for $n=2$ you can consider that the poles degenerate into perpendicular edges and you obtain the regular tetrahedron (D4).

The new D8 will actually be a $4+4$, like the regular octahedron, but with a twist of 45° on the four lower faces.

I also have some ideas for a D3...

@Henryseg Yes, I had a look at them and at the repulsion force polyhedra of Martin Trump, but basically I found it difficult to take advantage of this information (maximum angle for the cones or coordinates of the center of the points). So, sometime I use them to find a good approximate

position for the face but then I try to solve equations to maximize the radius of the circles.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sun, 17 Apr 2011 08:38:52 GMT
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As announced in the previous message, I am glad to present the Alternative D8 Sphere. It is not based on the regular octahedron but on an trapezohedron ("antidiamant" in French) that are dual of the antiprisms.

It is a co-creator, so you can choose your numbering.
With numbers on edges, the number will be on top of the die, when it lies on a horizontal plane. With the numbers on the bottom faces, you will have to look under the die to find out the result. Choose no numbers if you prefer contemplating the shape or if you would like to take care of the numbering by yourself!

File Attachments

1) [D8Alt_poly.jpg](#), downloaded 1472 times

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Sun, 17 Apr 2011 13:30:56 GMT
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I like the look of this one. Could this configuration work for a D6 (instead of a cube?).

Subject: Re: Truncated Spheres
Posted by [dizingof](#) on Sun, 17 Apr 2011 13:42:29 GMT
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Very clever

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sun, 17 Apr 2011 16:49:00 GMT
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@Orangery: I knew you would like it: it is like the D10 with 4-fold symmetry but without the top and bottom faces (and the angles are different). Unfortunately for the D6, the trapezohedron that maximize the diameter of the circles is precisely... the cube! So, this method gives nothing new. For n=5, I think you would get the D10 with 5-fold symmetry and for n=6 the rounded part would probably become too large (larger than a face).

@Dizingof: thanks and welcome back!

Subject: Re: Truncated Spheres
Posted by [dizingof](#) on Sun, 17 Apr 2011 16:55:30 GMT
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Thanks Magic, good to be back

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sun, 01 May 2011 06:13:56 GMT
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I am glad to introduce the D15 Sphere:

3 rows of 5 faces (5 at each tropic, 5 at the equator).
The numbering follow the usual rule (as for the D9 for instance): the sum of each row is constant (it's 40 in this case), the sum of two numbers of the tropic symmetric to the equator plan, and the sum of two numbers of the equator circle symmetric to the "middle number" (8 here) is constant (it's 16 in this case). Note that there must be an exception (all the numbers cannot go by pair since there is an odd number of face) and that is 8: 8 cannot have a symmetric since the sum of two symmetric numbers is 16 (and only $8+8 = 16$).

File Attachments

1) [D15.jpg](#), downloaded 1360 times

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sun, 01 May 2011 06:35:38 GMT
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This a a die I designed a long time ago and that I forgot numbering.
So, after a long time on the drawing table, here is the D18 Sphere:

As the number of faces is even, each number is exactly on a face (sometimes, these dice look very usual).

Instead, the numbering is very interesting in this case.

Opposite faces numbers sum to 19, obviously. As a consequence any group of 8 numbers of a large diameter sum to 76. A more unexpected consequence is that any group of 5 numbers follows this strange rule: if you sum the double of the central number to the 4 other surrounding numbers, you obtain 57.

Example in the rendering image:

...4..

9 18 5

...3..

$$2 \times 18 + 4 + 9 + 5 + 3 = 57$$

But the most interesting property in this particular numbering is that the sum of the six numbers surrounding a spherical zone is always 57.

Example here: $18 + 5 + 7 + 11 + 13 + 3 = 57$

I had to use a computer to find the good combination (there are a lot of them, by the way).

I could number this die from 1 to 9 twice (I found a way of doing it where the 8 numbers of the large diameters always sum to 40) or from 1 to 6 three time or even from 1 to 3 six times. Let me know if you want some particular numbering.

File Attachments

1) [D18.jpg](#), downloaded 1376 times

Subject: Re: Truncated Spheres

Posted by [Orangery](#) on Sun, 01 May 2011 08:44:24 GMT

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I wasn't expecting a D18. I like the way it could be also set up to be a D9, D6 and D3... very interesting!

Going back to a previous post, I now understand how a cube is made up of six trapezohedrons... but what happens if you stick two (squashed) tetrahedrons together?

Subject: Re: Truncated Spheres

Posted by [Magic](#) on Sun, 01 May 2011 09:10:08 GMT

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Ah, yes, i understand what you mean. If you stick together two pyramids you obtain a "dipyramid" like this one from Friz. If you squash it and intersect it with a sphere you will indeed obtain a new D6. I had no plan to design this one though, because it is less optimal than the cube: for a given sphere radius, the circles would be smaller. So it is not a solution of the repulsion force polyhedra. But not all my Truncated Dice have as an underlying polyhedron the dual of a repulsion force polyhedron, so perhaps one day, you will see it coming...

I am not forgetting the Rhombic Dodecahedron and the Triacanthahedron, but I am currently working on a D24 and some other secret stuff...

Stay tuned!

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Tue, 31 May 2011 08:27:07 GMT
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I have sent along a couple of pictures of the D10's that I bought from you (3 sorts). The black and white one turned out pretty good but I hope to redo the other two (I didn't have a fine enough pen for the brown die).

File Attachments

1) [Dice 10.JPG](#), downloaded 1249 times

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Tue, 31 May 2011 08:40:34 GMT
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As for the D32 football dice, well I must admit I got in a bit of a muddle with the numbering. Some are not even finished. I tried using rubber number stamps for one of them but the white ink did not cover very well and it was difficult positioning numbers .

I used 'Uni Posca' pens for the base colours and the numbering (obviously hand written!).

File Attachments

1) [Dice 32.JPG](#), downloaded 1224 times

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Tue, 31 May 2011 18:10:38 GMT
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Happy to see the colored dice.

Good idea coloring the flat and the rounded part in different colors for the black and white D10. For the numbers, I use a gel ink pen to ink them. The gel stay in the numbers without expanding out of the indentation. The problem is finding a pen thin enough to reach the inside of the numbers...

For the D32, I love the vivid colors of Uni Posca. But I am curious to know which kind of numbering you are using (0-1-2-3, 1-2-3-5?)...

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Wed, 01 Jun 2011 15:30:18 GMT
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The football dice are numbered in such a way that they should produce realistic scores. There is also a chart you have to refer to determine which dice are used for a certain match. I can PM you with the details if you like. I made up a computer version of it some years ago which I'll dig out and send you although it was based on 14 sided dice and not 32.

This guy is making similar dice to yours...

<http://www.shapeways.com/shops/propmodule?sg49347%5Bpage%5D=27#sg49347>. The circular faces on his have less surface area but are nice all the same.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Fri, 03 Jun 2011 17:37:13 GMT
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Ah, OK, they are football scores, I understand better.

I was just wondering what was the logic behind that.
You can PM me the charts for my own footballistic culture

And yes, the Truncated Sphere style is use by several dice designers at Shapeways (actually, we often discuss together) and elsewhere. You can see most of them here:
http://www.dicecollector.com/THE_DICE_THEME_SPHERICAL.html

Cheers,

Magic.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sun, 10 Jul 2011 08:36:28 GMT
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Just for reference, here is the logic behind the numbering of the D18 Sphere:

The faces can be viewed as following 3 large circles (here in yellow, pink and blue):

The sum of the 8 numbers lying on any large circle is 76 (that is 8 times the average value, which is 9.5). There is nothing extraordinary here, this is only due to the fact that numbers on opposite faces sum to 19 (twice the average).

The most tricky property is that the sum of the 6 numbers surrounding any of the triangular rounded areas sum to 57 (six times 9.5).

There are 8 triangular areas that are in white in the scheme (including the white zone surrounding the 3 large circles). Each traingluar are is surrounded by 6 numbers: 3 on the edges (yellow, pink and blue) and 3 on the vertices (orange, purple and green). You can check: if you make the sum of any of such 6 numbers you'll find 57.

I guess there are several ways of numbering the D18 while complying with these properties. But perhaps you can find another numbering with even more properties. Actually I tried also to have a nice symmetric numbering if you take the rest of the division by 3 of those numbers.

Let me know if you find something better! (but nothing to win this time)

File Attachments

1) [D18numbering.jpg](#), downloaded 1165 times

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sun, 24 Jul 2011 17:19:26 GMT
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Finally, the D32 has been numbered. It took a long time (it was designed in November 2010).

I decided this time to ignore the usual rule "numbers on opposite faces must sum to 33" and preferred the rule "difference between numbers on opposite faces must be 16". This allowed me to add interesting properties. In this case, you have faces surrounded by 6 faces and faces surrounded by 5 faces: if you take the number on a face surrounded by 5 faces and add to it the numbers on the 5 neighbours you will always get 99. This guarantees a certain fairness in the repartition of the numbers (basically, there is not an area of the die with more "value" than another).

As for the D33, there is a Regular Edition (diameter is 30mm, thickness is 1.5mm) and a Frosted Edition (diameter is 20 mm and thickness is 1.0 mm). Both version contain the support material.

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Mon, 25 Jul 2011 06:54:40 GMT
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Looks great!

A lot of thought has gone into numbering all of your dice. It is nice when the maths works out just as you want it.

Thank you again for helping out.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Mon, 25 Jul 2011 17:53:37 GMT
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Thanks Orangery.
For your reference, here is the layout of the D32 numbering:

There is just half of the die since the numbers on opposite faces can be deduced easily (the difference between numbers on opposite faces is 16).
For instance, around the number 24 that is on a pentagonal face, you have 5 numbers on

hexagonal faces: 6, 29, 32 and 3 (that are visible) and the number on the opposite face of the hexagonal face having the number 21, that is $21-16=5$.
And you can check that $24+6+29+32+3+5=99$.

File Attachments

1) [D32numbering.jpg](#), downloaded 1095 times

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sun, 07 Aug 2011 16:59:21 GMT
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Still work in progress: the D22 Sphere.

It is constructed by intersecting a sphere with an unusual polyhedron. This polyhedron is based on a tetrahedron (and as the same symmetries as it): there are 3 faces for each vertex, one face by edge as well as the 4 original faces ($3 \times 4 + 6 + 4 = 22$).

I have still to number it (as well as the D50)...

File Attachments

1) [D22.jpg](#), downloaded 1190 times

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Tue, 09 Aug 2011 07:27:55 GMT
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Impressive... do these shapes have names?

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Wed, 10 Aug 2011 19:44:50 GMT
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Thanks. No, no name that I know at least...
The D22 is based on the Repulsive Force Polyhedra from Martin Trump.

And so is this new D16:

This one has already been numbered and thus is available for sale.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sun, 21 Aug 2011 19:26:42 GMT
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I was looking for a nice design for a D7. Generally the Pentagonal Prism is used for this number of faces. Unfortunately, I don't like the Truncated Sphere that results from this polyhedron. So I was looking for something different.

For a long time, I thought no other interesting 7-sided polyhedron did exist, but after a lot of research with pen and paper and some calculations on Excel, I found out a polyhedron that leads to this Truncated Sphere D7:

I am more than happy with it. I think it has unexpected "partial" symmetries. It is difficult to explain, but as soon as I get a printed version, I will try to show you.

So, if you are bored with the pentagonal prism, this D7 is for you!

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Mon, 22 Aug 2011 13:15:54 GMT
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Do you think it is a new discovery? What did the shape look like before dissection? I'll be rating it!

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Mon, 22 Aug 2011 15:34:20 GMT
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Well, the shape before being intersected with a sphere looks like a rhombus for the upper face, 4 identical quadrangles as lateral faces and two triangles for the lower faces ($1+4+2 = 7$).

I don't know if it's new, but I know I have never seen it before...

In my opinion, it is less interesting that the corresponding truncated sphere, though...
And I think i should be able to create a new D7 with a 3-fold symmetry (based on the sum $1+3+3$ instead of $1+4+2$).
Stay tuned!

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Thu, 25 Aug 2011 20:44:41 GMT
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Well I'm not sure how you found this shape but I'm glad you did! It has to be new.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Thu, 13 Oct 2011 05:54:33 GMT
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Here is a new addition to the Truncated Sphere dice family:
The D13 Sphere.

It has a 4-fold symmetry and is based on a $1+4+4+4$ repartition of the faces (there is 1 single face surrounded by 4 faces at the bottom and 2 additional layers of 4 faces).

I had search along time how to make a D13 and there was no obvious solution: having this single face at one end allows new combinations, so expect more dice with odd number of faces to come...

File Attachments

1) [D13_top.jpg](#), downloaded 983 times

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Thu, 13 Oct 2011 06:02:47 GMT
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The Alternative D24 is another D24 Sphere Dice, based on the Pentagonal Icositetrahedra.

This shape is more efficient than the classical D24 Sphere: for a same sphere radius, the faces are bigger. But the numbers are not located on faces (unless you read them on the bottom face, that is under the die).

The shape is chiral, so it comes in two flavours: right-handed and left-handed.

It's good to have choice...

File Attachments

1) [D24Snub_R_Top.jpg](#), downloaded 961 times

Subject: Re: Truncated Spheres

Posted by [Orangery](#) on Thu, 13 Oct 2011 08:08:08 GMT

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Left and right handed dice - that's a new one on me... I think you should show them on mathpuzzle.com.

Subject: Re: Truncated Spheres

Posted by [Magic](#) on Thu, 13 Oct 2011 20:07:05 GMT

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Ahahah! Left-handed and right handed players can find the D24 that suit them properly, now... I will check if I can propose something on mathpuzzle.com (the numbering of the D50, for instance).

Subject: Re: Truncated Spheres

Posted by [Magic](#) on Sun, 16 Oct 2011 20:03:43 GMT

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A new D7 with a 3-fold symmetry:

There is one face surrounded by a layer of 3 faces and completed by an additional layer of 3 other faces (1+3+3).

It is different from the one already mentioned (that has a 2-fold symmetry: 1+4+2).
I will post a picture to show the difference.

File Attachments

1) [D7-3f_all.jpg](#), downloaded 957 times

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sun, 16 Oct 2011 20:36:32 GMT
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Here is the pictures that shows both underlying polyhedra:

The first one (in red) this the one with a 2-fold symmetry (1 rhombus + 4 quads + 2 isosceles triangles) and the second (in yellow) the one with a 3 fols symmetry (1 equilateral triangle + 3 irregular pentagons + 3 quads)

I hope that it is now easier to understand the difference...

File Attachments

1) [D7_compare.jpg](#), downloaded 1284 times

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Mon, 17 Oct 2011 08:04:22 GMT
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These polyhedra are interesting - how do you find them - trial and error? Anyway, the dice look great as usual.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Mon, 17 Oct 2011 20:37:44 GMT
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The first one was really designed on paper before doing the calculations and trying it on the modeling software. I was trying to put the 7 circles on a sphere in an optimal way.
The second one is more classical. You can compare it to the D11 (5 layers: 1+3+3+3+1) but with less layers and with the layers not being symmetrical (there is no ending 1): 1+3+3.
I did not try it before because the equations are difficult to write and most of all difficult to solve. So I had to do a program to find approximations.
But the efforts are rewarding once you get a nice shape...

By the way both models can be seen as a transformation of a cube:

- the first as a cube where one of the square face is cut into two in diagonal
- the second as a cube with one vertex cut to get an extra triangular face

Of course, this is just an initial construction: the vertices have to be moved to maximize the radii of the circles than can hold in the faces.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sun, 30 Oct 2011 10:22:01 GMT
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I used the same program I wrote for making the D13 to make the D19 Sphere:

Once again, the shape is inspired by the repulsive force polyhedra but is slightly different in order to maximize the diameter of the faces.

As for the D13 there is a face in one end that is "alone". The repartition of the faces by layers is 1+4+2+4+2+2+4.

There is only a 2-fold symmetry, but the underlying polyhedron is still attractive (even though its repulsive origin...).

File Attachments

1) [D19_poly.jpg](#), downloaded 982 times

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Tue, 01 Nov 2011 17:10:11 GMT
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I am currently working on two D21.
The red one has a 2-fold symmetry, the yellow one a 4-fold symmetry.

You can see the underlying polyhedra (wireframe and solid).
The interesting point is that, although different, these two arrangements of 21 circles around the sphere seem as efficient (the diameter of the circles is the same for a given sphere). This is quite unusual...

The repartition of the faces in layers of faces with the same angle is

- 2-fold: 2+4+2+4+2+2+4+1

- 4-fold: 4+4+4+4+4+1

File Attachments

1) [D21-compare.jpg](#), downloaded 948 times

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sun, 18 Dec 2011 12:11:30 GMT
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Before finishing the D21 (I still have to add the numbers), I wanted to make an alternative D6 Sphere.

Instead of being based on a cube, it is based on a double pyramid.
As a consequence, the numbers are not positioned on the faces but rather on the edges.

If you remove the faces, this model leads the the D6 Shell.

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Sun, 18 Dec 2011 13:36:53 GMT
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This looks good! I'm trying to work out whether it is a fair die or not.

I notice that you don't have a five sided die... impossible?

Season's greetings.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sun, 18 Dec 2011 15:03:17 GMT
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Hi Orangery,

Yes, I think it is fair. It made of two pyramids with an equilateral triangular base stuck together. In this case, the height of the pyramid is calculated to maximize the size of the circular faces obtained after the intersection with the sphere, but whatever the height, the double-pyramid is fair, so we can suppose that the truncated sphere is fair either. Of course this is true as long as the die does not stop on the rounded part...

For the 5-sided die, it is possible but it will not be a really surprising die: a triangular prism (once again with the appropriate height) intersecting a sphere: I looked for other shapes, without success.

I will make it very soon, I will finish the ones that are still unfinished (the two D21, the D22, and the D50) and I will probably make a pause with the dice in general and the truncated spheres in particular...

Cheers,

Magic

[EDIT] typos

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sat, 31 Dec 2011 12:29:43 GMT
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I was asked twice for a Truncated Sphere D5, so here it is:

Happy New Year!

Subject: Re: Truncated Spheres
Posted by [aleakybos](#) on Sat, 24 Mar 2012 08:26:52 GMT
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I have been following this blog on truncated spheres with great interest!

I like the idea of making dice out of truncated spheres. I would like to have dice that are "fair" or at least "optimum" in some sense.

In the strict sense, only isohedral dice are fair (platonic, catalan, dipyramids, trapezohedra and some strange cousins, <http://www.aleakybos.ch/sha.htm>). If a sphere is intersected with an isohedral polyhedron, I would call it fair, neglecting the rare case when such a die would stop on a curved part of the surface.

"Optimum" truncated spherical dice can be constructed by distributing the n circles on the sphere in some optimum way. There are plenty of choices, this is a good overview:
<http://www.maths.unsw.edu.au/about/distributing-points-sphere>

Some of Magic's designs are based repulsion force polyhedra
<http://members.ozemail.com.au/~llan/mpol.html> . In my view this corresponds to the optimization criterion "minimal potential energy", best known solutions are here:
<http://www2.research.att.com/~njas/electrons/dim3/>

Magic writes that he optimized some of his designs by maximizing the diameter of the circles. I think that this is the "packing" criterion, best known solutions are here:
<http://www2.research.att.com/~njas/packings/dim3/>

I got in touch with Bob who wrote the original visualization applet for repulsion force polyhedra and got his permission to modify it. I included various optimization criteria, the results of my endeavor are visible here: http://www.aleakybos.ch/sph_codes.htm

At this time the computation of the dual for some larger odd numbers is still buggy, but I will work on it

Comments are welcome. Play & enjoy!

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Sat, 24 Mar 2012 10:28:15 GMT
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Hi Alea,

I am very pleased to meet you.

Actually, I know your website and I wanted to contact you because you mention that some shapes (like the Pentagonal Icositetrahedron) are not usable as die because basically the opposite of one face is not one face: this did not prevent me from positioning numbers where needed on the truncated spheres including out of the faces

I know the program from Bob (I did not contact him instead I was in touch with Martin Trump). Basically Repulsive Force polyhedra are great for inspiration, but I had to recalculate all the values probably because as you mentioned they use repulsion forces and I need packing. Generally the shapes are very close, only the values of the angles and sometime the shape of the faces are different (like irregular hexagons instead of triangles).

That's why I am very happy you wrote this new program.

On my side, the biggest difference I noted between the two methods was for the D13.

With Repulsion Force Polyhedra, the D13 looks like a dodecahedron with an additional face replacing an edge (and repulsing all the other faces). This additional face is a rectangle, and the polyhedron has a 2 fold symmetry (identical when rotating it at 180°).

When I tried on my side to maximize the size of the face, this additional face turned square and the whole polyhedron had a 4 fold symmetry (identical when rotating it at 90°).

That's not what I obtain with your program... Perhaps I made a mistake in the design of my d13, when forcing the constraints.

What do you think?

Regards,

Magic

PS: is Alea your real first name? Alea sounds like $\text{al}\tilde{\text{a}}\text{a}$ to me, the root of " $\text{al}\tilde{\text{a}}\text{atoire}$ " meaning "random"...

Subject: Re: Truncated Spheres

Posted by [Magic](#) on Sat, 24 Mar 2012 17:57:32 GMT

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Oops! Sorry with the "packing" option and 13 points, I obtain in effect the same shape as my D13. But it is indeed very different from the one obtained by minimizing energy and coverage.

With 7 points, the result with "packing" is similar to my D7 with 3-fold symmetry. It is interesting to note that I think I got the same diameter for the face (that is the separation angle between the two nearest adjacent circles) with the D7 with a 2-fold symmetry...

I like a lot the shape obtained with 8 point minimizing covering. I should be able to make a new die

from this one.

And the D10 obtained by packing is different from any of the ones I have.

It seems that there are a lot of new shapes to explore...

Thank you for that!

Subject: Re: Truncated Spheres
Posted by [aleakybos](#) on Sun, 25 Mar 2012 08:28:07 GMT
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Thank you for your interest!

I like the way you put numbers on dice whose faces are not parallel, like the D24 you mentioned. Could you use the same approach for numbering the isohedral D24 Pentagonal Icositetrahedron and the D60 Pentagonal Hexecontahedron (I mean the regular shapes, not the truncated spheres), That would be unique.

Comparing the various optimization criteria with my applet, I observed that the optimum solutions are identical for 4,5,6 points.

For 7 points you get a 1+3+3 shape with 3-fold symmetry with packing, and a 5-prism with all the others.

For 8 points packing and energy yield a 4-trapezohedron (albeit with different edge lengths!), covering and volume yield a 2+4+2 shape with 2-fold symmetry, again with different edge lengths.

For 9 points the results are:

packing: 1+4+4 shape with 2-fold symmetry

others: 3+3+3, 3-fold symmetry (different but pretty close edge lengths)

10 points:

packing: 2+6+2 with 2-fold symmetry

others: 1+4+4+1 with 4-fold symmetry (different but pretty close edge lengths)

For 11 and 13 points things start getting interesting

For 12 points you get the dodecahedron for all 4 criteria.

For 24 points packing yields the Pentagonal Icositetrahedron (dual to the sub cube)!

Subject: Re: Truncated Spheres

Posted by [Magic](#) on Sun, 25 Mar 2012 10:55:05 GMT

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I did exactly the same investigation. Volume is not working for me (or it is very slow?). Very often Energy lead to the same result as Covering, sometimes as Packing, but with a better accuracy (more symmetries, less different lengths).

- I agree with your results for 4, 5, 6, 7 and 12.
- For 8 as I said the Covering result is very interesting. But I would call it 2-2-2-2 (not 2-4-2).
- For 9 if you turn your 1-4-4 shape (which I would rather call 1-4-2-4) in another direction, you will find the 3-3-3 again (with different sizes).
- 10 leads to a 2-4-2-2 for Packing (very interesting indeed) and a 1-4-4-1 for the others.
- 11 is hard to understand. Packing leads to a dodecahedron with a missing face (I did a D10 as a dodecahedron with 2 opposite faces missing). And with Energy two pentagons of the original dodecahedron have fused into one elongated hexagon. Covering is unclear...
- 13 leads to 1-4-4-4 (the one I did) for Packing and to something like 1-2-2-4-2-2 (not sure of the order) the the two others. I'd like to make this one...
- 14 is 1-4-2-2-4-1 for Packing (new one) and 1-6-6-1 for the others.
- 15 is very interesting. It always leads to a 3-3-3-3-3 shape but only Coverage has a 3-fold symmetry. The others are enantiomers.

I still have to look at the others, but i can say that this exploration is very exciting.

Subject: Re: Truncated Spheres

Posted by [Magic](#) on Wed, 25 Jul 2012 06:57:50 GMT

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Breaking news: D14 and D18 to be mass produced!

Subject: Re: Truncated Spheres

Posted by [Orangery](#) on Wed, 25 Jul 2012 07:29:41 GMT

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Hey, I only thought of you the other day. It all seemed to kick off with those D32's I forced you to make for me . I had one re-numbered, (picture to follow) although I am now thinking of downsizing to something like a D14 (curiously).

Although I am unable to donate at this time, I will try to make people aware of the KickStarter Project as I have recently joined the Board Game Designers Forum. It seems that most of the members in the group use dice of some kind.

Best of luck with it.

Dave.

Subject: Re: Truncated Spheres
Posted by [Magic](#) on Wed, 25 Jul 2012 11:56:41 GMT
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Hi Dave,

If you can make people being aware of this project on game forums, I would really appreciate, thanks.

And you are right, before the D32, the only truncated sphere I had done was the D6, which is not really original

So, thank you also for giving me this tricky problem to solve!

Vincent aka Magic

Ps: waiting to see your re-numbered D32!

Subject: Re: Truncated Spheres
Posted by [Orangery](#) on Wed, 25 Jul 2012 14:24:49 GMT
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Here is a picture of one of the higher scoring dice (D32). A friend of mine with a nice handwriting style was responsible for the numbers. I used small white self adhesive circles (yet to fall off). It is a vast improvement on the ones that I numbered.

By the way what is the circle diameter on the D14?

File Attachments

1) [008.JPG](#), downloaded 397 times

Subject: Re: Truncated Spheres

Posted by [Magic](#) on Thu, 26 Jul 2012 05:30:57 GMT

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Hey, nice trick! It looks great!

Sometimes I use varnish glue to coat the dice. I wonder if it could make the stickers more durable (unsure how the ink would behave though)...

For the D14 (which is 2cm high) the circles are circa 1cm, a little bit more than your D32 (which is 3cm high), so the stickers should fit
