The Hypocycloid cam generated by Alex Lait, zincboy, zincland.com, on CNC Zone, which uses the “Russian formula, and Dascalescu paper, was very interesting. It uses PYTHON to generate DXF of the cam profile. I have reviewed several additional papers on the subject, including:

1. Design and machining of the epicycloid planet gear of cycloid drives, Ta-Shi Lai.
2. Theoretical and Experimental Analysis of a cycloidal speed reducer, Davoli, Goria, Chiozzi.
4. Gear geometry of cycloid drives, Chen BingKui, Fang TingTing, LiChaoYang & Wang ShuYan.
6. On the lobe profile design in a cycloid reducer using instant velocity center, Joong-Ho Shin, Soon-Man Kwon. The Excel (epi)cycloid cam generator spreadsheet I’ve made, is based upon this article. Only a one lobe difference between cam and ring gear is used.

The above papers use nearly the same coordinate transformation matrices to derive Surface Equation for the cylindrical rollers of the ring gear. The formulas seem to vary. Then the authors use various methods to derive Equation of Meshing. Some then vaguely mention some sort of computer program to generate cam profiles. (Attempts to create a spreadsheet, based upon two other of the above papers, generated weird non-profiles.)

Note that there are two orientations possible for the cycloidal profile, and the ring gear with cylindrical rollers:

1. The hypocycloid reducer has the rollers and ring gear in the center, with cycloid profile on the perimeter. This type has a slightly different set of equations. A slightly different Excel spreadsheet would be needed to generate the cycloid profile.
2. The epicycloid reducer has the cycloid profile cam in the center, with the rollers and ring gear on the perimeter. This type has its own set of equations.

The purpose of the attached Excel spreadsheet, is to describe the nomenclature of the variables, the three formulas used, and to generate the X and Y coordinates for an epicycloidal cam profile. The angle parameter $\Phi$ is used to generate 201 X and Y coordinates, (360 degrees, or 2pi). X and Y values are pasted to a sheet, separated by a column with one semicolon, as a delimiter. The three columns are then pasted to a Text file. The Alibre add-in POINT IMPORT, (by Renner), (2D portion), is used with the semicolon delimited Text file, to enter the 2D points, in Alibre 2011. A spline connects the points, which creates the 2D sketch, which is then extruded to the 3D (epi)cycloid cam profile. There are further details on the Alibre Forum. The POINT IMPORT add-in had quite a learning curve, perhaps due to upgrade to Alibre 2011, 64 bit. The points plus spline were imported, but the spline was not extrudable, due to “intersections,” and so the spline was deleted, and a new 2D spline added in Alibre, by clicking on all 200 points, using the 2D spline tool. Further work in Alibre is planned, to create a model, and generate STL or Step or DXF files, for CAM gcode, perhaps with Alibre CAM, or Aspire. A Visual Basic, or C program would be nice, but may be beyond the limits of time, and abilities. The introduction from
the Excel spreadsheet is shown below:

**Epicycloid planet gear of cycloid drive** by Brian McMillin, 10/22/2010


<table>
<thead>
<tr>
<th>Variables</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>R Radius of ring gear, which consist of many rollers</td>
<td>60 mm</td>
</tr>
<tr>
<td>r Radius of one cylindrical roller of the ring gear (&quot;R_sub_r&quot; in article)</td>
<td>9 mm</td>
</tr>
<tr>
<td>N Tooth (Lobe) number of the ring gear (&quot;pin wheel&quot;) (# of rollers)</td>
<td>15</td>
</tr>
<tr>
<td>E Eccentricity between ring gear and cycloidal-planet-gear (The eccentricity of the &quot;crank&quot; shaft driving the rotation.)</td>
<td>2 mm</td>
</tr>
</tbody>
</table>

note: \( \frac{R}{EN} > 1 \) (or \( E < \frac{R}{N} \))

note: Different reduction ratios, and different sizes for the 4 variables, generate different profiles.

note: For 2 stage reducer formula, see Alex Lait program, zincland/CNCZone

Z axis is not needed for a 2D profile. (Z=0)

\( m = 1 \) Tooth number difference between pin wheel and cycloid wheel. (Not a variable)

\( N-1 \) Tooth (Lobe) number of the cycloidal-planet-gear "cam" 14

\( \psi \) Calculated angle from the mathematics (of surface of meshing).

\( \Phi \) Rotational angle parameter, \( (0 \leq \Phi \leq 2\pi) \), used to generate profile

\( t \) Used to generate \( \Phi \) parameter (may be thought of as time of motion for a particle.)

\[
\psi = \text{atan}\left(\frac{\sin(1-N)\Phi}{R/EN - \cos(1-N)\Phi}\right)
\]

\[
X = R\cos\Phi - r\cos(\Phi + \psi) - E\cos(N\Phi)
\]

\[
Y = -R\sin\Phi + r\sin(\Phi + \psi) - E\sin(N\Phi)
\]

<table>
<thead>
<tr>
<th>t</th>
<th>( \Phi )</th>
<th>( \psi )</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.01</td>
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<td>58.18838057</td>
<td>0.976664545</td>
</tr>
<tr>
<td>0.02</td>
<td>0.0628319</td>
<td>-0.000138318</td>
<td>58.7060332</td>
<td>2.149397183</td>
</tr>
</tbody>
</table>