

Lesson 33 Importing a Zemax¹ file into SYNOPSIS™

SYNOPSIS can open most lens files created by the program Zemax. As is true with most conversions from one protocol to another, however, the results are often incomplete, and the user must often edit the lens file to restructure certain parameters according to the rules of SYNOPSIS.

But some things cannot be converted. The two programs utilize very different descriptions of the entrance pupil – although both in the end achieve much the same result. And not all surface shapes that can be defined in Zemax can be defined in SYNOPSIS (and vice-versa). Nonetheless, all of the most popular surface shapes work well in either program, so most users will not encounter difficulties for that reason. And while a Zemax file contains a whole lot more information than does a SYNOPSIS file – such as definitions of variables, the merit function, tolerances, and the like – the conversion will capture only the basic lens data, since the RLE file in SYNOPSIS is just a lens description and nothing more. Variables and the merit function are defined in separate files, declared with the headers PANT..., AANT and so on, and anyone converting from one program to the other will naturally want to exploit the advantages of SYNOPSIS and will create their own data files. So makes no sense to attempt to import those other data.

A more common question is properly identifying the names of commercial glass types. The two programs have extensive glass tables – but the names often differ. So the most common user task, after importing a .zmx file, is to edit the RLE file and insert the correct glass names. We will illustrate some of these issues with an example.

(You are encouraged to read Section 5.42 of the User's Manual, before importing a file, where you will find much more information than we can include in this short lesson.)

To illustrate this feature, we will convert a file describing a diffractive optical element that we have previously stored in the USER directory with the name doe.zmx. This file contains the following lines:

```
VERS 91012 185 25430
MODE SEQ
NAME Achromatic singlet
NOTE 0 Notes...
NOTE 4
NOTE 0
NOTE 4
NOTE 0
UNIT MM X W X CM MR CPMM
ENPD 5.0E+1
ENVD 2.0E+1 1 0
GFAC 0 0
GCAT SCHOTT
RAIM 0 0 1 1 0 0 0 0 0
PUSH 0 0 0 0 0 0
SDMA 0 1 0
FTYP 1 0 3 3 0 0 0
ROPD 2
PICB 1
XFLD 0 0 0
XFLN 0 0 0 0 0 0 0 0 0 0 0
YFLD 0 3.5 5.0
YFLN 0 3.5 5.0 0 0 0 0 0 0 0 0
FWGT 1 1 1
FWGN 1 1 1 1 1 1 1 1 1 1 1
ZVDX 0 0 0
VDXN 0 0 0 0 0 0 0 0 0 0 0
ZVDY 0 0 0
```

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```

VDYN 0 0 0 0 0 0 0 0 0 0 0 0
ZVCX 0 0 0
VCXN 0 0 0 0 0 0 0 0 0 0 0 0
ZVCY 0 0 0
VCYN 0 0 0 0 0 0 0 0 0 0 0 0
ZVAN 0 0 0
VANN 0 0 0 0 0 0 0 0 0 0 0 0
WAVL 4.861E-1 5.876E-1 6.563E-1
WAVN 4.861E-1 5.876E-1 6.563E-1 5.5E-1 5.5E-1 5.5E-1 5.5E-1 5.5E-1 5.5E-1 5.5E-1 5.5E-1 5.5E-1
WWGT 1 1 1
WWGN 1 1 1 1 1 1 1 1 1 1 1 1
WAVM 1 4.861E-1 1
WAVM 2 5.876E-1 1
WAVM 3 6.563E-1 1
WAVM 4 5.5E-1 1
WAVM 5 5.5E-1 1
WAVM 6 5.5E-1 1
WAVM 7 5.5E-1 1
WAVM 8 5.5E-1 1
WAVM 9 5.5E-1 1
WAVM 10 5.5E-1 1
WAVM 11 5.5E-1 1
WAVM 12 5.5E-1 1
WAVM 13 5.5E-1 1
WAVM 14 5.5E-1 1
WAVM 15 5.5E-1 1
WAVM 16 5.5E-1 1
WAVM 17 5.5E-1 1
WAVM 18 5.5E-1 1
WAVM 19 5.5E-1 1
WAVM 20 5.5E-1 1
WAVM 21 5.5E-1 1
WAVM 22 5.5E-1 1
WAVM 23 5.5E-1 1
WAVM 24 5.5E-1 1
PWA 2
POL 1 0 1 0 0 1 0
GLRS 1 0
GSTD 0 100.000 100.000 100.000 100.000 100.000 100.000 0 1 1 0 0 1 1 1 1 1 1
NSCD 100 500 0 1.0E-6 5 1.0E-6 0 0 0 0 1 1000000 0
COFN COATING.DAT SCATTER_PROFILE.DAT ABG_DATA.DAT PROFILE.GRD
SURF 0
TYPE STANDARD
CURV 0.0 0 0 0 0 ""
HIDE 0 0 0 0 0 0 0 0 0 0
MIRR 2 0
SLAB 1
DISZ 2.5E+2
DIAM 5.0 0 0 0 1 ""
POPS 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0
SURF 1
STOP
TYPE STANDARD
CURV 7.576293461853999900E-003 0 0 0 0 ""
HIDE 0 0 0 0 0 0 0 0 0 0
MIRR 2 0
SLAB 2
DISZ 2.5E+1
GLAS BK7 0 0 1.69673 5.6419998E+1 -7.4E-3 1 1 1 0 0
DIAM 3.0E+1 1 0 0 1 ""
POPS 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0
FLAP 0 3.0E+1 0
SURF 2
TYPE BINARY_2
CURV -6.6766952605729999700E-003 0 0 0 0 ""
HIDE 0 0 0 0 0 0 0 0 0 0
MIRR 2 0

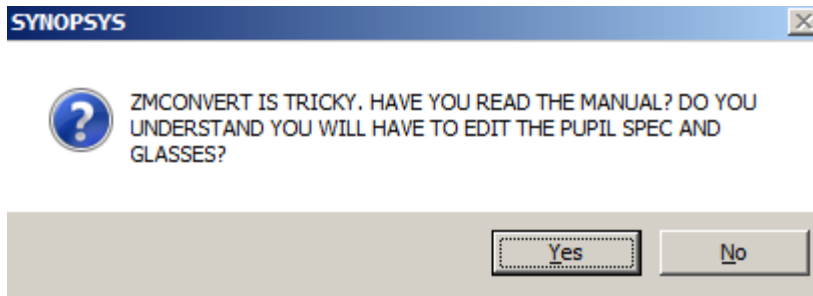
```

```

SLAB 3
PARM 0 1
PARM 1 0
PARM 2 0
PARM 3 0
PARM 4 0
PARM 5 0
PARM 6 0
PARM 7 0
PARM 8 0
XDAT 1 3.000000000000E+000 0 0 0.000000000000E+000 0.000000000000E+000 0 ""
XDAT 2 3.000000000000E+001 0 0 0.000000000000E+000 0.000000000000E+000 0 ""
XDAT 3 -2.993832387049E+003 0 0 0.000000000000E+000 0.000000000000E+000 0 ""
XDAT 4 1.135544608547E+003 0 0 0.000000000000E+000 0.000000000000E+000 0 ""
XDAT 5 -5.932105454300E+001 0 0 0.000000000000E+000 0.000000000000E+000 0 ""
DISZ 2.5073834507E+2
DIAM 3.0E+1 1 0 0 1 ""
POPS 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0
FLAP 0 3.0E+1 0
SURF 3
TYPE STANDARD
CURV 0.0 0 0 0 0 ""
HIDE 0 0 0 0 0 0 0 0 0
MIRR 2 0
SLAB 4
DISZ 0
DIAM 5.175465768436 0 0 0 1 ""
POPS 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0
BLNK
TOL TOFF 0 0 0 0
MNUM 1 1
MOFF 0 1 "" 0 0 0 1 1 0 0.0 ""

```

We begin by typing the command ZMC (ZeMax Convert). A warning message is displayed:



(This is to prevent naïve users from blindly selecting a file and expecting the lens to open every time exactly as it does in Zemax. Yes, some users are that naïve! But life is not simple.) If you click the No button, you go immediately to the help file describing ZMC.

When we click the Yes button, we are shown a list of the .zmx files in the current directory, and we select that one. (The file to be imported must reside in the current directory.) The above lines scroll past on the Command Window, and we notice a warning message:

```

*****
*****      WARNING      *****
*****  THE DOE EMULSION INDEX IS NOT GIVEN  *****
***  IN THE ZEMAX FILE AND MUST BE ENTERED BY **
***  HAND IN THE RLE FILE AFTER CONVERSION  ****
*****  IN WORD THREE OF THE DOE ENTRY  *****
*****

```

This is an example of the difference in protocols. In a SYNOPSIS RLE file, the exact index data of a material are given along with the glass-catalog name, if any, and then the properties of the DOE are listed. Because of this protocol, anyone reading an RLE file created by SYNOPSIS knows the index of the material, even if, years from now, that glass type has become obsolete and is no longer in the catalog. Zemax lists the glass name but not the index values. So when the DOE input is read (and converted by ZMC) the index data are not yet known. The glass name shows up later, but the conversion is then way past that stage already. Since the DOE specification in SYNOPSIS requires the index of the emulsion, the program has inserted a dummy index of 1.517 just to avoid input errors. It turns out that this DOE is in fact made from BK7, so the index, just by chance, is correct. Otherwise we would want to edit the file and change that number to the correct index for the correct glass. (In SYNOPSIS, the index values are retrieved from the glass tables *after* the RLE file is completely processed, and are not available while ZMC is running.)

At the end of the conversion, the program displays an informative message:

```
NOTE: OBJECT AND PUPIL DEFINITIONS MAY DIFFER. THE PROGRAM PUTS THE
WAP 3 PUPIL IN EFFECT TO BE SAFE. BUT THIS LENS MAY OR MAY NOT REQUIRE
THAT OPTION. YOU SHOULD DELETE IT IF IT IS NOT NECESSARY.
IF ANY GLASS-TABLE GLASSES WERE NOT FOUND, IT MAY BE DUE TO DIFFERENT
SPELLINGS. CHECK THE LISTING ABOVE TO SEE WHAT THE NAME WAS, AND CHANGE
TO THE APPROPRIATE SPELLING IF THAT GLASS IS IN ONE OF THE GLASS TABLES.
```

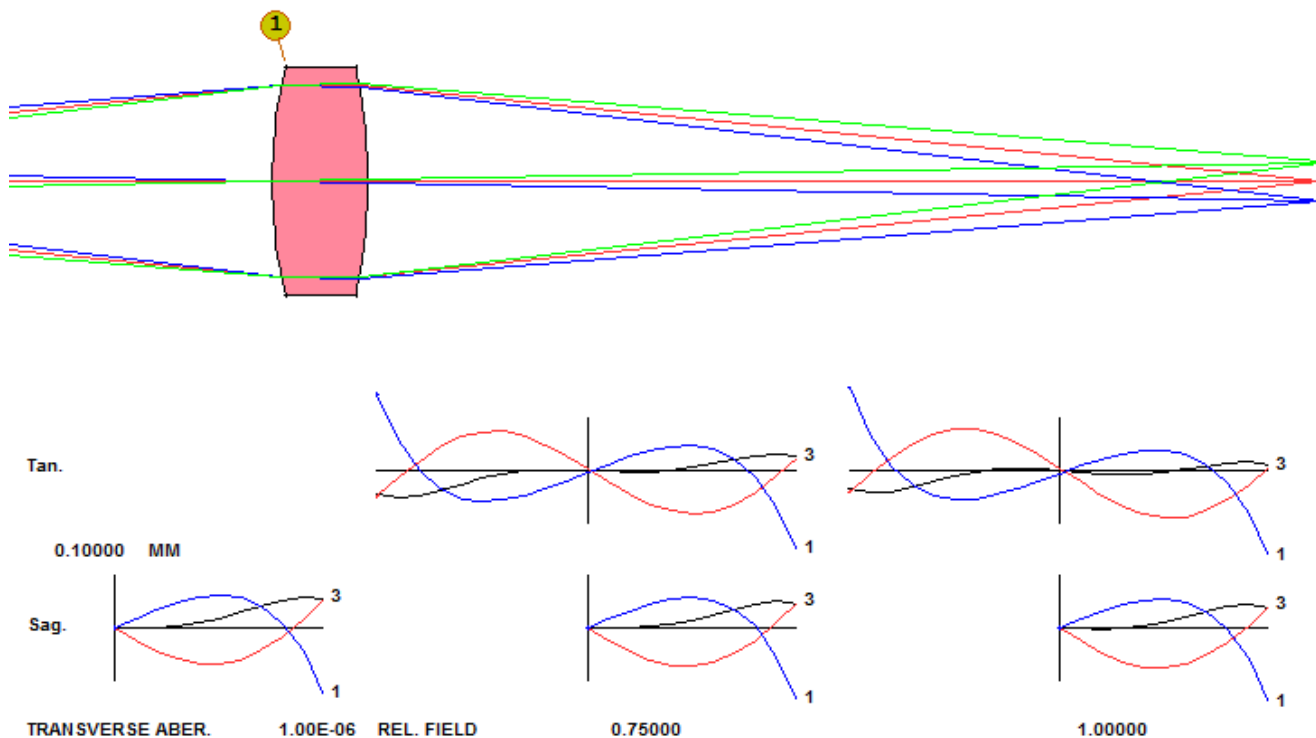
Here we learn that the program has (by default) implemented the WAP 3 option, which is often a safe bet but is usually not required. By all means try to understand the geometry that underlies the pupil definition used in Zemax, and if it does not really require WAP 3, try the simpler WAP 0 instead.

Our next job is to look at the RLE file it has created and loaded into a MACro editor.

```
RLE
ID ACHROMATIC SINGLET
ID1 NOTES...
ID2
ID3
UNITS MM
TEMPERATURE 20.000
PRESSURE 100.000
GTZ
WT1 1.00000 1.00000 1.00000
WA1 0.486100 0.587600 0.656300
CORDER 2 3 1
POLAR OFF
0 CV 0.0
OBA 250.000 5.00000 25.0000 0.00000 0.00000 0.00000 0.00000
APS -1
WAP 3
1 RD 131.991
1 TH 25.0000
1 GTB S
BK7
1 CAO 30.0000
3 RD -149.775
3 TH 250.738
3 CAO 30.0000
2 PIN 1
2 DOE 0.587600 1.51700
RNORM 30.0000
A11 476.483 -180.728 9.44124 0.00000 0.00000
3 DC1 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
4 CV 0.0
```

4 TH 0.00000
 END

To see this lens, we change WAP 3 to WAP 0, run the RLE file, and then open PAD.



Converting this file was rather simple (as it should be). If we now ask SYNOPSIS to create a proper RLE file (with the command LEO) we get...

```

RLE
ID ACHROMATIC SINGLET          378
ID1 NOTES...
ID2
ID3
LOG      378
WAVL .4861000 .5876000 .6563000
CORDER  2  3  1
APS      -1
GTZ
UNITS MM
OBA 250.  5.  25. 0 0 0 25.

0 AIR
1 CAO      30.00000000      0.00000000      0.00000000
1 RAD      131.9906634000000 TH      25.00000000
1 N1 1.52237223 N2 1.51679274 N3 1.51431609
1 CTE      0.710000E-05
1 GTB S    'BK7'
2 N1 1.52237223 N2 1.51679274 N3 1.51431609
2 CTE      0.710000E-05
2 GID 'BK7'
2 DOE      0.587600      1.517000      55.000000
RNORM      30.0000
A11 4.7648E+02 -1.8073E+02 9.4412E+00 0.0000E+00 0.0000E+00
A12 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
  
```

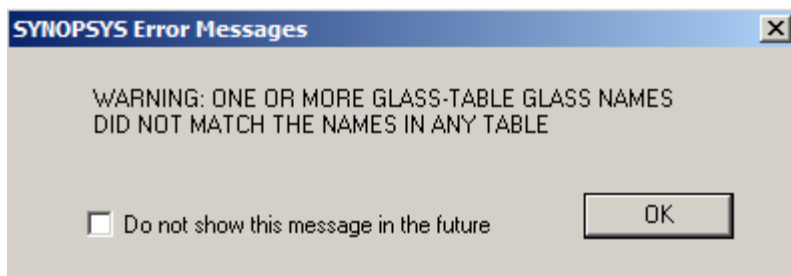
```

A13 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
2 PIN 1
3 CAO 30.00000000 0.00000000 0.00000000
3 RAD -149.774695599999 TH 250.73834510 AIR
3 DC1 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
3 DC2 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
3 DC3 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
3 DC4 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
4 CV 0.00000000000000 TH 0.00000000 AIR
END

```

Users with sharp eyes will note that the OPD coefficients have been altered. Zemax expresses the coefficients in units of *radians*, while all OPD expressions in SYNOPSIS are in units of *cycles*, or waves. So the values must be different, as you can see.

This example gave us little difficulty, so let us show a more difficult one. We open a file describing an IR lens, and see an error message when we run the conversion: (**IR_EXAMPLE.ZMX**)



Reading the listing that scrolled by, we see the details:

```

SURF 12
  COMM OBJ EL1
  TYPE STANDARD
  CURV -4.127115146513000200E-001 0 0.000000000000E+000 0.000000000000E+000 0
  HIDE 0 0 0 0 0 0 0
  MIRR 2 0.000000000E+000
  SLAB 4
  DISZ -2.362204724409E-001
  GLAS CLEARTRAN_WANDA 0 0 3.46217496 0.00000000 0.00000000 0 0 0 0.00000000 0.00000000
*****
*****      GLASS TYPE NOT FOUND      *****
CLEARTRAN_WANDA

*****  A GLASS MODEL (GLM) IS USED INSTEAD  *****
***  SOME GLASS TABLES USE DIFFERENT SPELLING  **
***  CHECK THE NAME CAREFULLY.  GLM DATA MAY  **
*****      NOT BE APPROPRIATE      *****
*****

```

This surface needs a material whose name is not found in the SYNOPSIS glass tables. The program assigns a glass model since it has no other information at this point, but when we edit the resulting RLE file, we have to change to the right material.

```

12 SID 'OBJ EL1
12 RD -2.42300
12 TH -0.236220
12 GLM 1.50000 55.0000
12 CAO 0.745000
13 RD 7.82870

```

If we did not know the name of the material to use, we might look at the Unusual glass catalog. We type HELP UNUSUAL and follow the link. In the list that opens we find a likely candidate:

```
...
NACL      Sodium chloride      0.2      22.3
NAFL      Sodium fluoride      0.186    17.3
PBFL      Lead fluoride        0.2909   11.9
SAPPHIRE  Aluminum oxide      0.193    5.263
SILICON   Silicon; see SILICON-NIR, below 1.4      16.0
ZNS       Zinc sulfide         0.42     18.2
CLEARTRAN Zinc sulfide, higher grade 0.4047   13.0
ZNSE      Zinc selenide        0.54     18.2
CRQUARTZ  Crystal quartz, ordinary ray 0.198    2.053
```

Now we can edit the RLE file:

```
12 SID 'OBJ EL1      '
12 RD  -2.42300
12 TH  -0.236220
12 GTB U
CLEARTRAN
12 CAO  0.745000
13 RD   7.82870
13 TH  -0.100000E-01
13 CAO  0.745000
```

The same error showed up on several other surfaces, and we correct them as well, perhaps with a PIN 12 directive. Yet another surface wanted a material with the name SILICON_FIT. Of course we change this to SILICON. Proceeding in this manner, we identify all materials whose names we must update, and then run the MACRO with the corrected RLE file.

Be especially wary of glasses in Zemax from the Chinese company Guangming. That company uses many of the same glass names as the Schott company, even though the index and dispersion are very different. Clearly, this is a disaster waiting to happen, and you must verify carefully which glass from which catalog you want to use. (SYNOPSIS identifies all of the Chinese glasses that have conflicting names with a prefix. Thus F2 becomes G-F2 and so on.)

So that covers the basics of this rather complicated conversion. We encourage you to try any .zmx files you have on hand, and let us know if you encounter problems that are not as obvious as those described here. We do not have a license for Zemax (and don't want one), so the only way we can uncover unexpected problems is if users like you send us examples. We have several dozen examples already, and all of them work. But we are looking for some that don't.