Conversion of optical prescription between Code V and Zemax optical modeling software packages

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ZEMAX
DEVELOPMENT CORPORATION

code V®

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Abstract

There are two contending optical ray tracing software packages that compete directly in their specific market, Zemax by Zemax Development Corporation and Code V by Optical Research Associates. They are a classical battle that can be easily compared to the fight between Window PC users and Mac OS users. This paper is written because of this fact, the fact that few people are competently trained on both packages, or even have access to both packages. This paper will attempt to easy the conflict by outlining how to use the built in conversion capabilities of both software packages to convert foreign prescriptions into their own format.

Chapter 1 - Step by step instructions

1.1 Conversion of a Zemax file into Code V:

There are two option in Code V to easily convert a save Zemax "X.zmx" lens prescription into a Code V file. Run the macro out of the macro directory and execute the macro from the command line. They both involve accessing the pre-made macros that are a part of the collection of macros available with the Code V software package.

1.1.1 Option One:

Default Code V Screen:

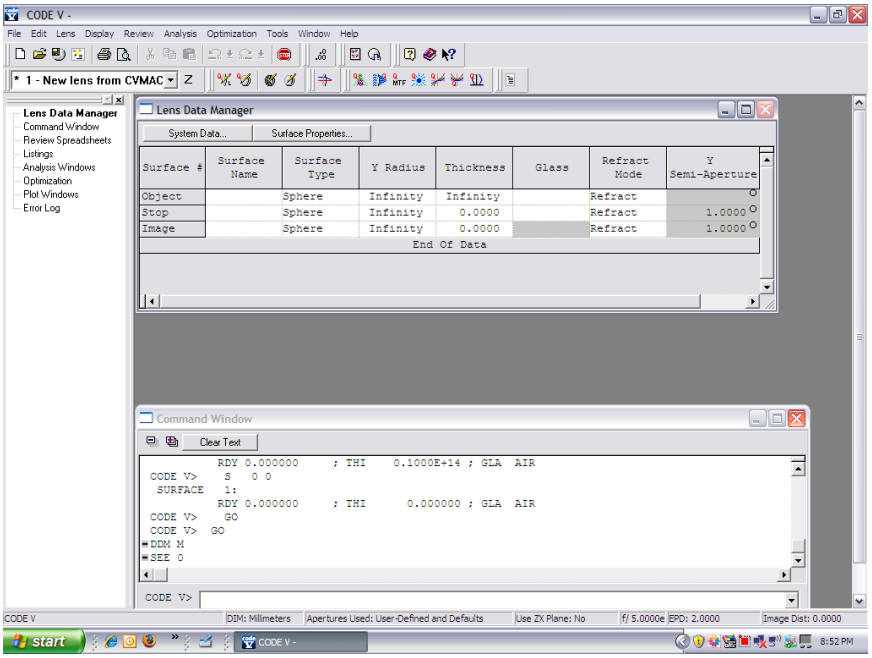


Figure 1 shows the default Code V new lens screen.

File Select:

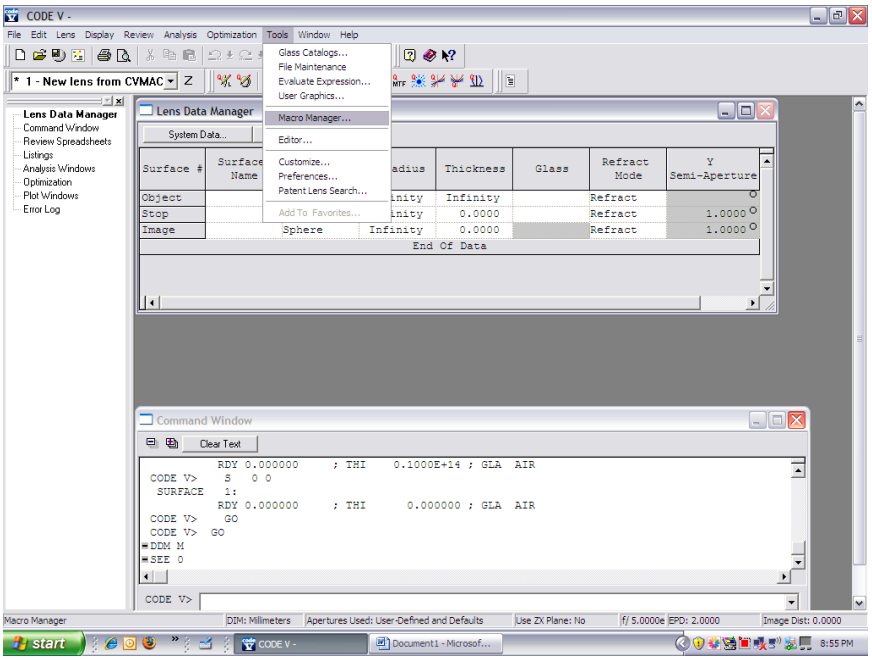


Figure 2. Shows where to access the "Macro Manager" tab in Code V.

Browse for Macro:

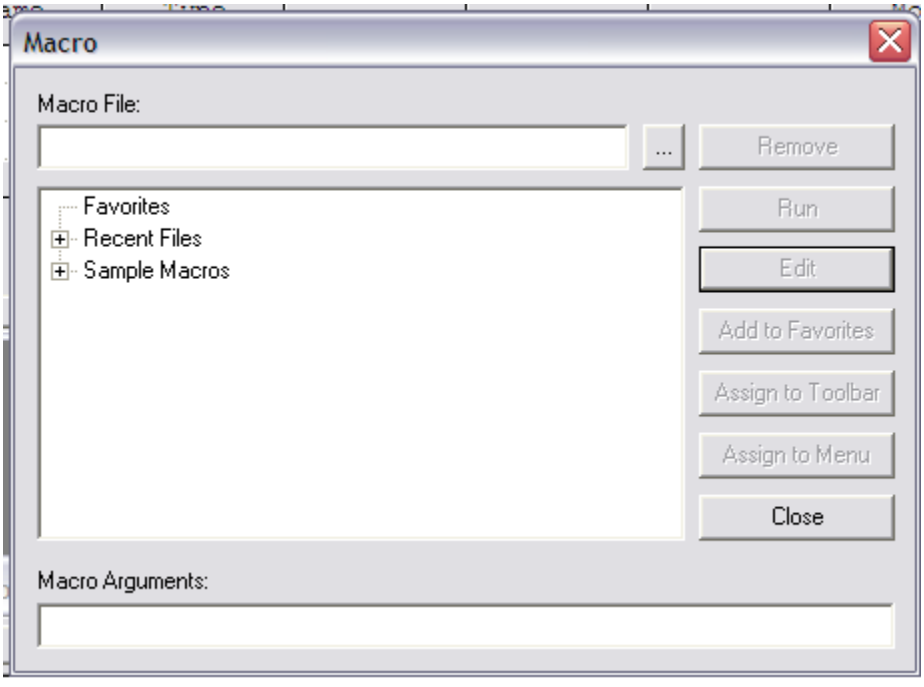


Figure 3. Shows the macros browsing pop up, that is use to navigate to the conversion file.

Select “zemaxtocv”

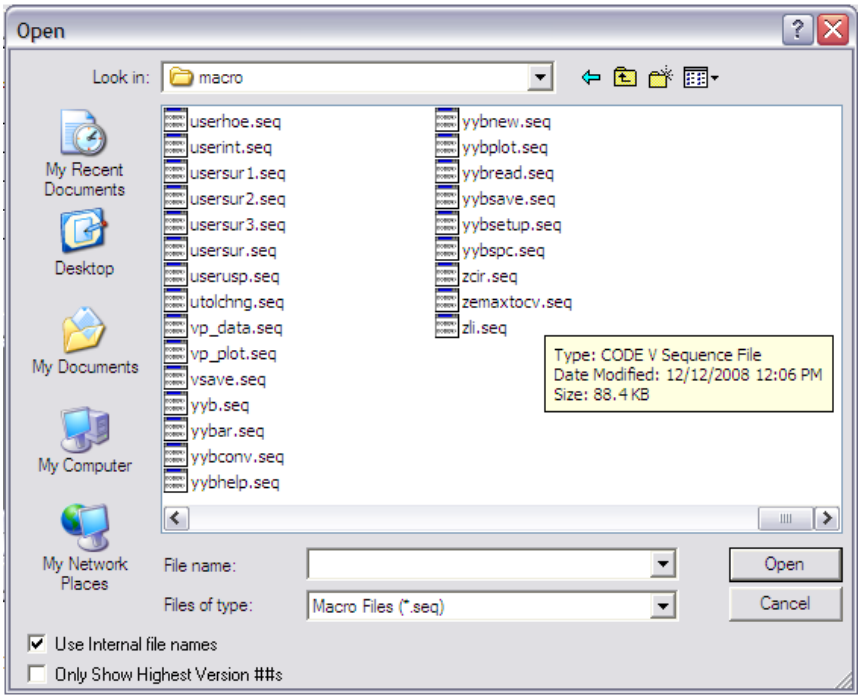


Figure 4. Shows the directory where the conversion macro is stored.

Run Macro:

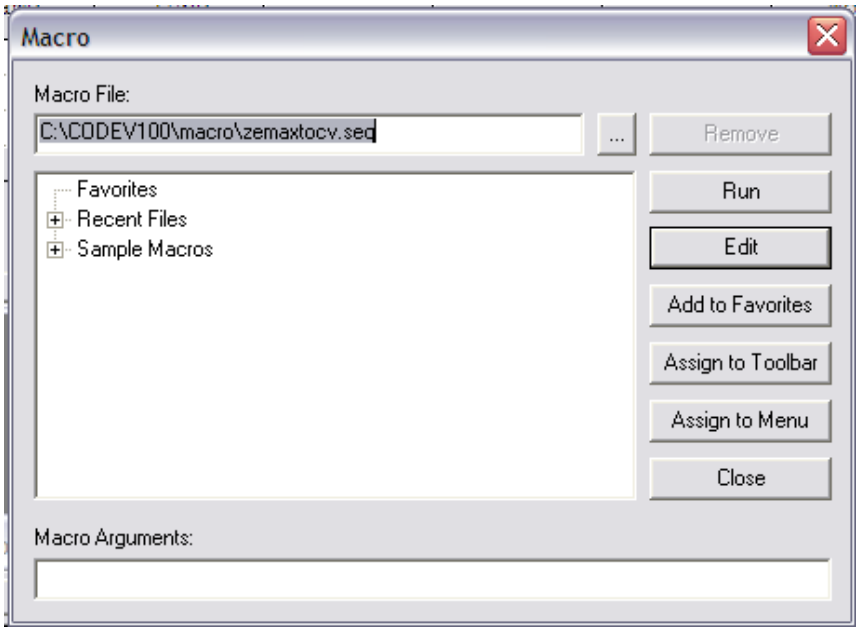


Figure 5. Show the selected macro file. Hit “Run” to activate the file.

Select Zemax file to be converted

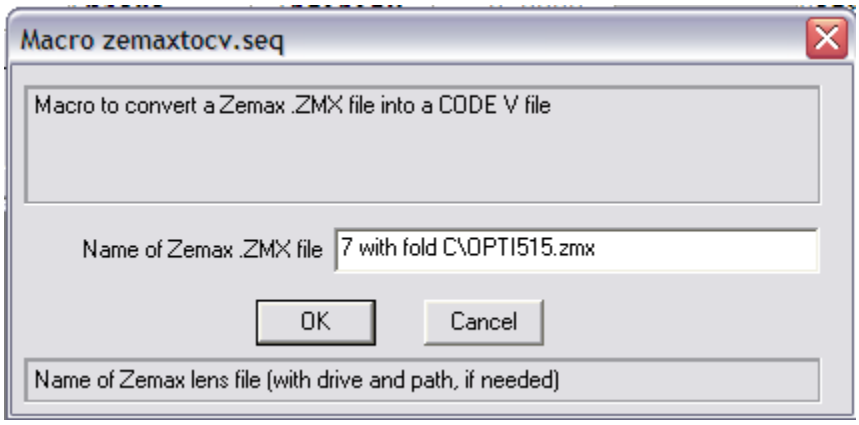


Figure 6. Shows the Zemax file path. Warning "There can be no space in the folder or file names".

Macro Run Complete

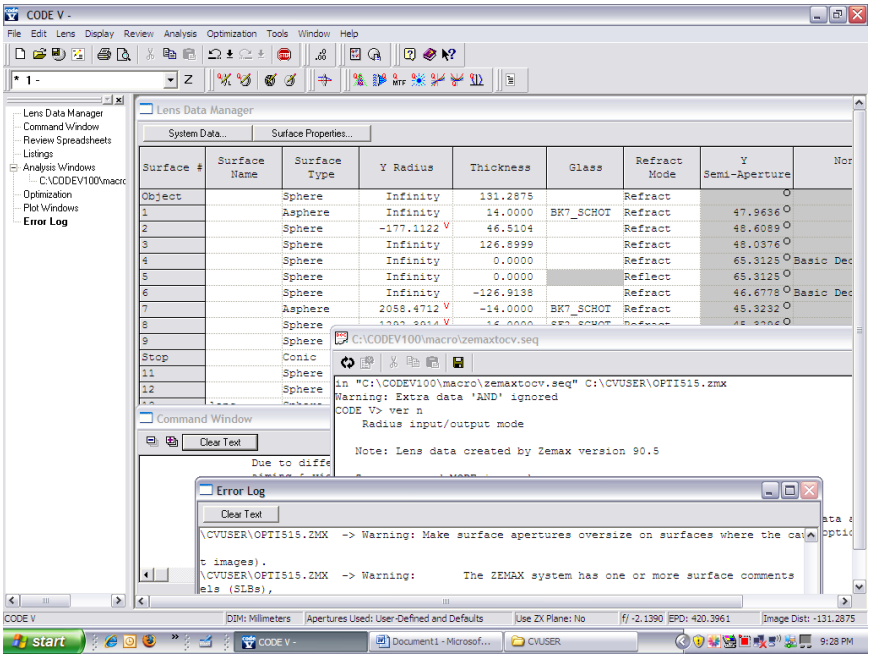


Figure 7. Shows the completed conversion of the optical prescription.

1.1.2 Option Two:

Open Macro file:

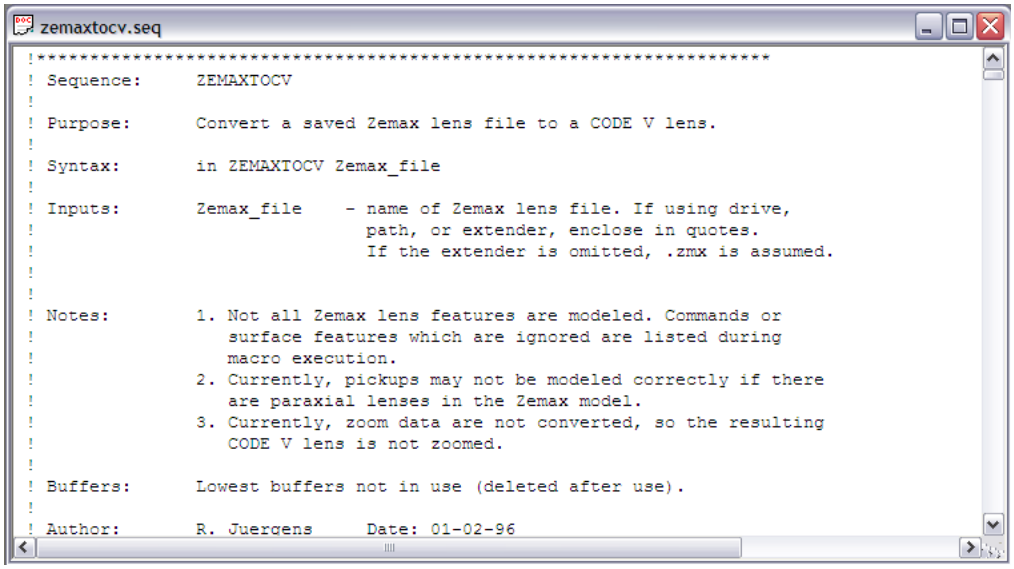


Figure 8. Open the macro in a text editor.

Copy Syntax line:

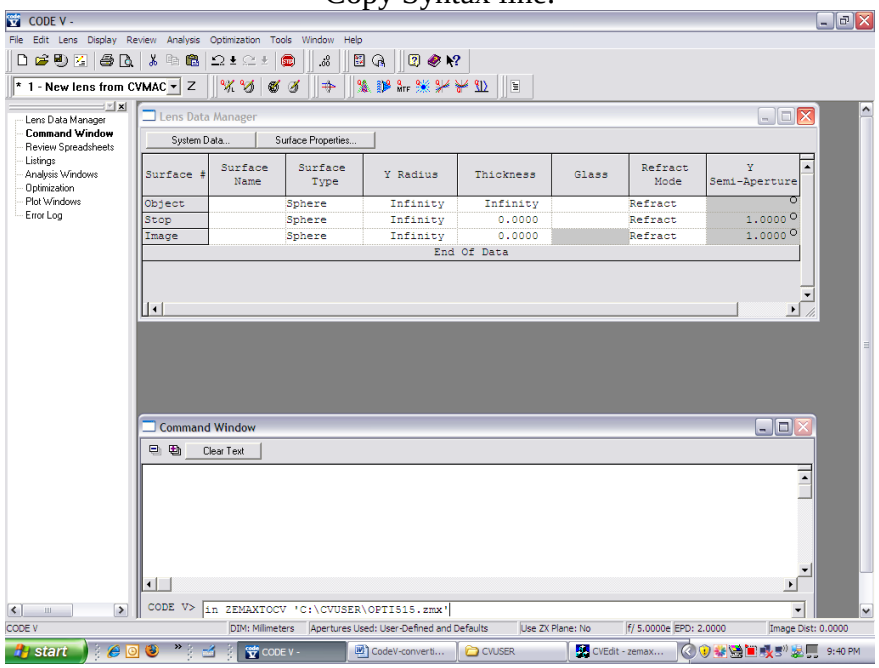


Figure 9. Shows the command line entry needed to access the conversion macro.

1.2 Outputs after Conversion:

1.2.1 Error Log:

Once the conversion macro is run Code V will print a running list of the items that were flagged during the conversion process. Items are flagged because they were correctly converted or because they were ignored and not converted.

Message:

> "Some information will not be converted. Changes in either CODE V or ZEMAX may invalidate converted information. Due to differences between CODE V & ZEMAX ray aiming & vignetting factors, it is recommended that you set vignetting for the converted system.
>
> A concise listing of conversion warnings appears on the Tabbed Output Window 'Info' tab and in the Error log."

Examples:

1. Temperature and pressure specified.
2. Glass catalog list ignored
3. Field weighting not used.
4. Pupil X shifts not used
5. Surface label 'surf' on S2 has been deleted.
6. Circular aperture pickup not specified
7. Please check converted lenses carefully.

1.2.2 Macro Run Log:

The macro run log that is printed is an extremely detailed log of every surface and change that happened while converting the prescription.

Message:

"The ZEMAX system has one or more surface comments (COMM) defined. CODE V has converted these to surface labels (SLBs), must be unique. If identical COMMs were defined on multiple surfaces, only the final instance will appear in the CODE V lens."

Examples:

Warning: Glass catalog list ignored

Warning: Ray aiming not used

Warning: Pupil shift for ray aiming not used.
Zemax command SDMA ignored
Zemax command XFLN ignored
Zemax command YFLN ignored

Warning: Field weighting not used
Zemax command FWGN ignored

1.2.3 Macro "ZEMAXTOCV"

```
!*********************************************************************
! Sequence: ZEMAXTOCV
!
! Purpose:  Convert a saved Zemax lens file to a CODE V lens.
!
! Syntax:   in ZEMAXTOCV Zemax_file
!
! Inputs:   Zemax_file    - name of Zemax lens file. If using drive,
           path, or extender, enclose in quotes. If the extender is
           omitted, .zmx is assumed.
!
!
! Notes:    1. Not all Zemax lens features are modeled. Commands or
!              surface features which are ignored are listed during
!              macro execution.
!           2. Currently, pickups may not be modeled correctly if there
!              are paraxial lenses in the Zemax model.
!           3. Currently, zoom data are not converted, so the resulting
!              CODE V lens is not zoomed.
!
! Buffers:  Lowest buffers not in use (deleted after use).
!
! Author:   R. Juergens     Date: 01-02-96
```

1.3 Conversion of a Code V file into Zemax:

The conversion process for inputting Code V prescriptions into Zemax is virtually the same process as the Z-C conversion. However, unlike the Z-C, the C-Z process take place in a DOS.exe outside of Zemax.

1.3.1 Step by Step Process:

1) Copy the Code V X.seq file into the common directory that Zemax uses as a default on your computer.

2) It is easiest if you copy the "seq2zmx.exe" into the same common directory that Zemax used.

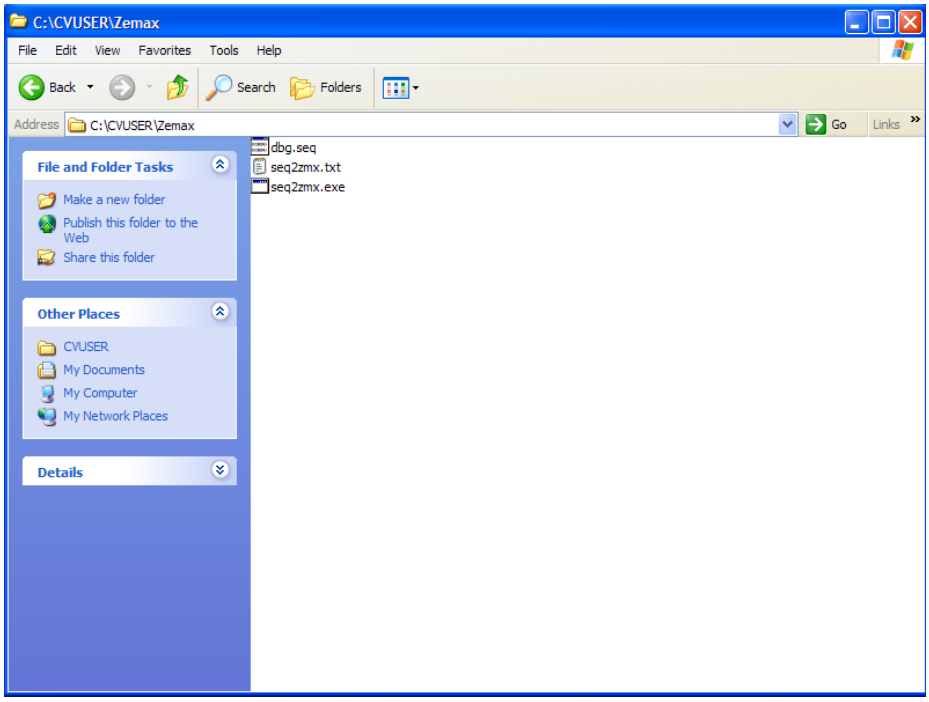


Figure 10 Shows the needed file in a common directory.

3) Go to the "Start" Menu on your windows desktop and select "run"
4) A window will pop up, enter "cmd" and hit enter.
5) You now have access to the DOS system for conversion
6) Change path into your Zemax common folder where you already copied the .seq file.

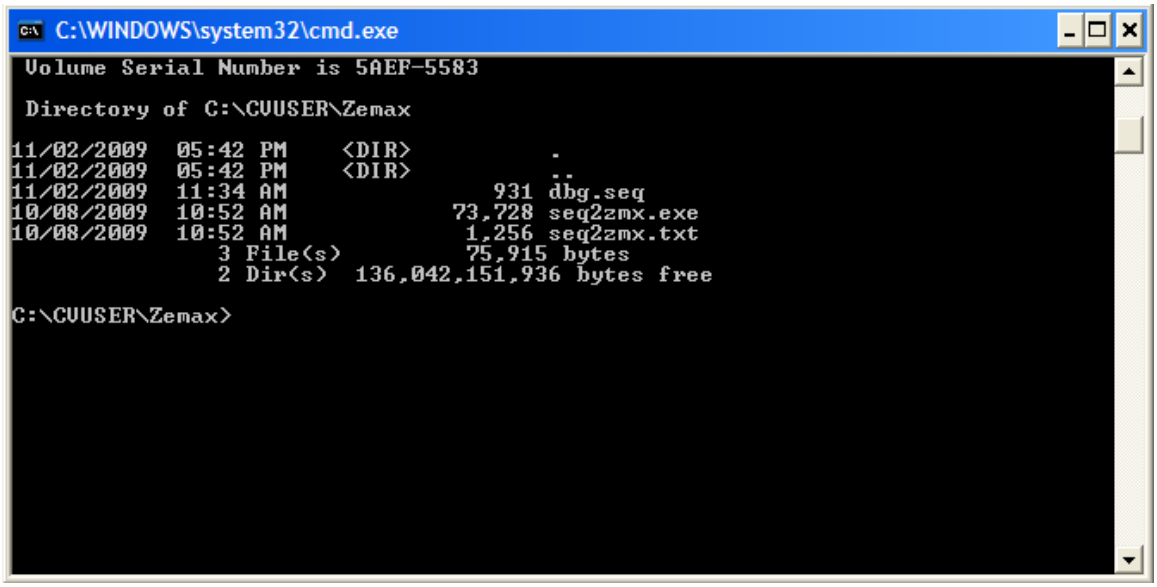


Figure 11 Show the DOS folder that the files are in.

7) There is a executable file called "seq2zmx.exe" run the file by typing "seq2zmx"

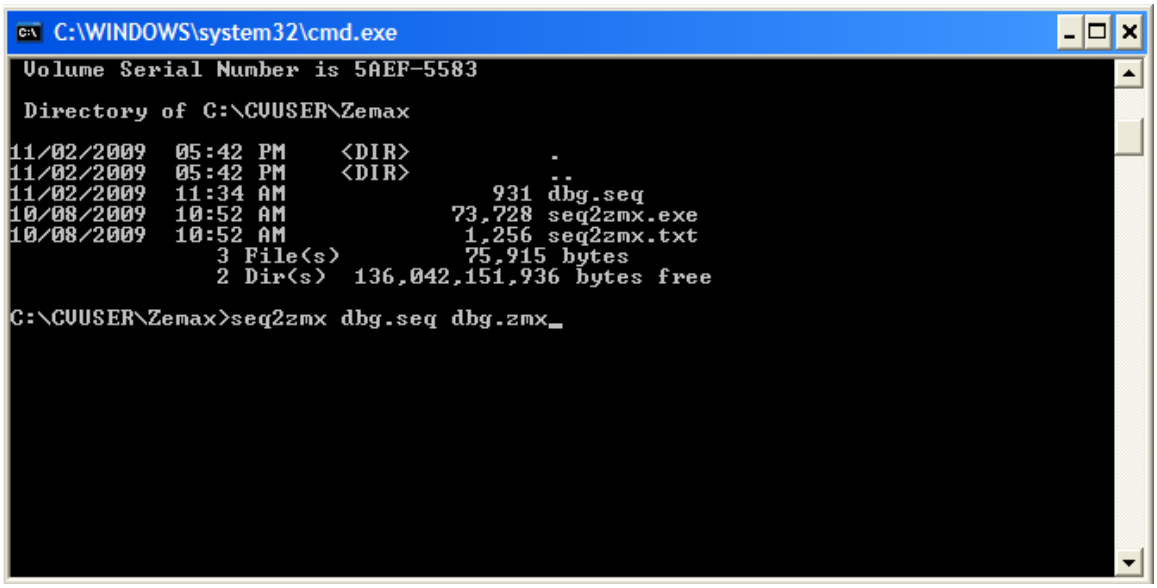


Figure 12 Shows the command line inputs

8) The command line to ask for a input/output and log name. Provide the X.seq name of the Code V file you are trying to convert. Provide a X.zmx for the Zemax file you are trying to create. Provide a name for the log file X.txt that will be where the conversion process and error messages will be stored.

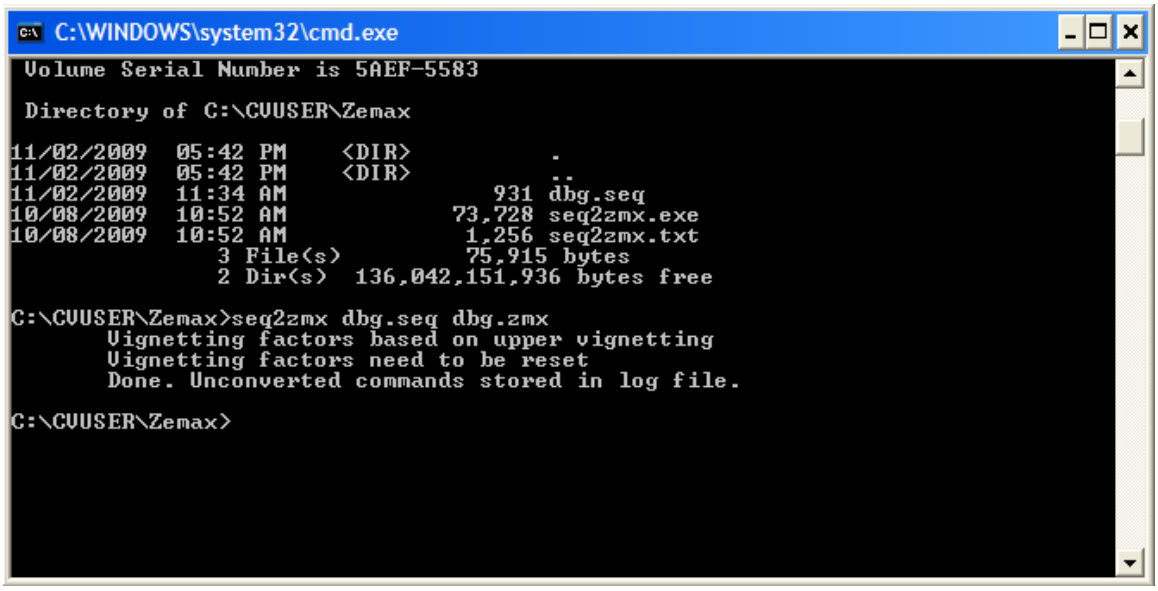


Figure 13 Shows the DOS output once the program was run.

9) The executable will run and convert as much of the prescription as possible, it is important to check the log file for what convert really took place.

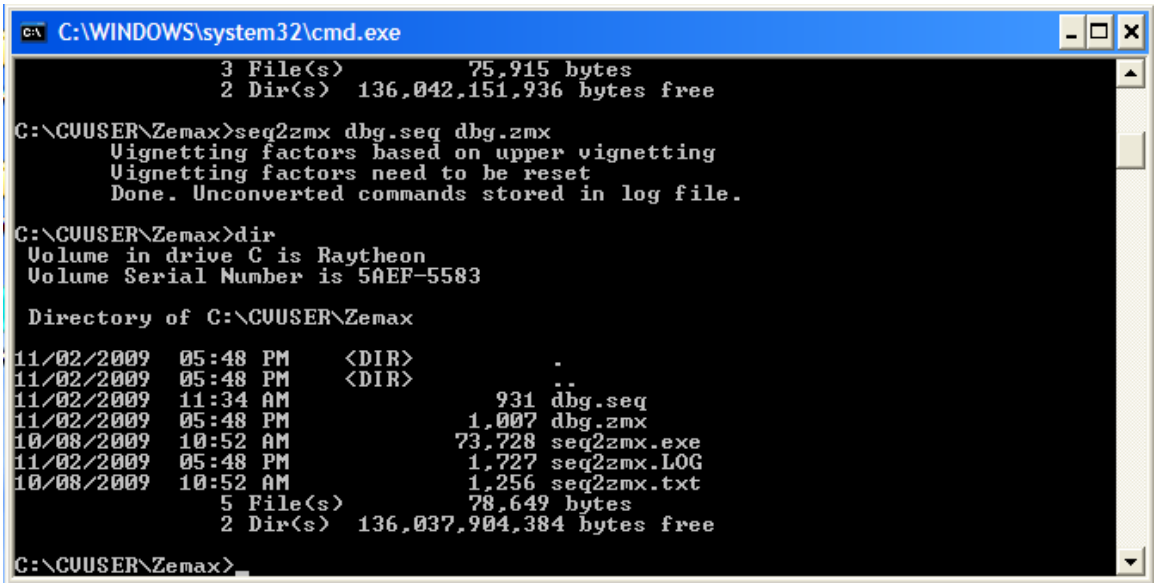


Figure 14 Shows the new X.zmx and X.LOG file that were created in the directory.

10) Open the new X.zmx file in Zemax, to verify the conversion worked.

1.4 Outputs after Conversion:

1.4.1 Run Log:

Once the conversion executable is run in DOS, the process will produce a running list of the items that were flagged during the conversion process. Items or surfaces are flagged because they were correctly converted from Code V to Zemax. This file is saved with a default name of seq2zmx.LOG and will contain all the information on the conversion.

Examples of LOG:

```
Input file : dbg.seq
Output file: dbg.zmx

Code V (TM) commands not converted or converted with warnings:
------------------------------------------------------------------
   INI
   WTF    1.0    1.0    1.0
   VUY    0.0    0.2    0.4
   VLY    0.0    0.3    0.4
---------------------------------------
Surface: 1 in ZEMAX,  1 in Code V
---------------------------------------
   CCY    0
---------------------------------------
Surface: 2 in ZEMAX,  2 in Code V
---------------------------------------
   CCY    0
   THC    0
---------------------------------------
Surface: 3 in ZEMAX,  3 in Code V
```

Unlike Code V conversion macro, you are very limited in the amount of information that the LOG file contains. You therefore must be suspect that the conversion worked correctly, because of the lack of information.

1.5 Executable "SEQ2ZMX.exe"

SEQ2ZMX v 1.3

Utility to convert Code V(TM) sequence files to ZEMAX files

Syntax:

SEQ2ZMX INPUTFILENAME OUTPUTFILENAME LOGFILENAME

Where
INPUTFILENAME is the input sequence file name, i.e. LENS.SEQ

OUTPUTFILENAME is the output ZEMAX file name, i.e. LENS.ZMX
LOGFILENAME is the optional log file name. Default = seq2zmx.LOG
File names may include the drive and path.

Supported Commands:

Aspheric surface type
Conic surface type
Cylindrical surface type
Grating surface type
Spherical surface type
Default dimensions
Numerical aperture, F/#
PIM solve
Radius or curvature, thickness, glass
Wavelengths, reference wavelength, and weights
Field angles, object height, and paraxial image height
Title
X,Y,Z tilts, decenters, BEN and DAR commands
Zooms on thickness

Disclaimer:
This utility is provided as is without warranty either expressed or implied.
The utility is intended to convert simple Code V ver. 8.1 sequence files to ZEMAX lens files. Not all Code V commands are supported. Complex systems may require additional editing within ZEMAX. Unconverted commands are stored in the log file. E-mail conversion suggestions to support@zemax.com .

Chapter 2 - Conclusion

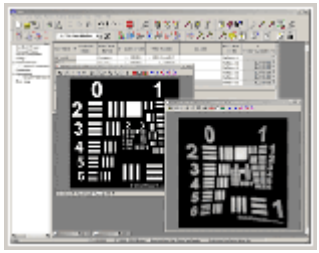
We have found during this paper that it is easy to convert back and forth between Code V and Zemax files. The conversion process for both software packages is very similar and produces about the same result, when comparing the prescription file itself. The conversion process does a solid 80% job in converting from one file format to another. Code V seems to have an edge in the number of things it converts from Zemax to Code V. Overall Code V seems to do a better job doing the whole process, mostly because of vast increase in information that the log file saves. Zemax requires a second step of run the conversion outside of Zemax, which could be seen as both good and bad. The final take away from this paper is that there are built in converter for both packages and they work as well.

Chapter 3 - Appendix

Product information:

3.1 Code V:

3.1.1 Key Features



In addition to such basic capabilities as lens modeling and spot diagrams, CODE V has a vast array of technical, graphical, and ease-of-use features. The following list of "key features" is just a small subset of what is available. See the technical description for a more detailed look at capabilities.

- Optimization (including Global Synthesis)
- Ease of use (GUI interface and commands)
- Extensive built-in libraries of optical system models (patents, etc.), components, and optical glass
- Extensive graphics (pictures, data plots, shaded displays), including 3D visualizations and diffraction-based image simulations
- Database/modeling Features
- Tolerancing (including extremely fast and accurate wavefront differential tolerancing)
- Interferogram interface (supports computer-aided closed-loop alignment)
- Non-sequential surface modeling for unusual systems
- Powerful command language (with Macro-PLUS programming)
- Fast 2D Image Simulation with an input bitmap file (including diffraction)
- The most accurate, efficient beam propagation analysis available

CODE V is the most comprehensive "tool box" for optical modeling, design and analysis available today.

3.1.2 General

CODE V is an integrated system of modules, allowing a wide variety of optical computations to be performed on a common input lens data base. The various functions and major capabilities of CODE V are grouped into what are referred to as "options"; this term does not imply that they are optional to the customer or licensee in terms of being able to obtain CODE V without them, but optional in the context of program usage.

Considerable attention has been paid to making the CODE V program easy to use, without sacrificing flexibility or power. A graphical user interface (GUI) is provided, allowing users to navigate around the program by the use of pulldown menus and toolbar buttons, eliminating the need to remember numerous commands; however, commands can be used as well, or a combination of menus and commands. Frequent CODE V users often migrate to command mode, at least for the options they use most often. A library of over 2400 lens models from patents and other sources also contribute to ease of use by providing many possible starting points for new designs.

Extensive on-line help is integrated into the program. This allows users to obtain help on any lens data topic, CODE V option, or immediate command (input/output, etc.). In addition, context sensitive help gives help on the screen currently active. The on-screen help includes all the information and graphics available in the three-volume reference manual in a convenient and easily searched format.

Lenses without symmetry, i.e., systems with three-dimensional tilts and/or decenters, are easily input and modeled in CODE V, and all the analyses, image evaluation options, and optimization are carefully designed to handle such systems.

A wide variety of surface types are available, including diffraction gratings, generalized aspheric surfaces, and holographic surfaces. In addition, the user can create a user-defined surface type, allowing optimization and analysis of specialized surface types that have not been anticipated in the program. Features such as solves and pickups simplify the definition of lens models. Visual Systems can be analyzed in angular units and accomodation can be varied during optimization.

Gradient-index materials can be defined and used as well as can lens arrays (such as GRIN-rod arrays). The capability to handle non-sequentially traced surfaces is also provided; in this case the surfaces are ray traced in the order they are encountered by the light rays rather than the order in which they are entered. A given physical surface is entered only once, but may be encountered many times by the same ray. This facilitates the ray tracing and analysis of a number of special types of optical systems; these include systems with roof mirrors or prisms, corner cubes, light pipes and light collectors of various types, segmented windows, and resonators.

Systems with up to 21 different configurations, each of which may contain up to 25 different object points, can be simultaneously optimized or analyzed. This multi-

configuration (zoom) feature can be used in the design of conventional zoom lenses as well as for many other applications. These include systems with interchangeable elements, reversible components, scanning systems, and systems corrected for multiple object and image conjugates. A general pick-up capability allowing coupling of different types of variables can be used to set up the system for analysis and optimization.

A very powerful programming language called Macro-PLUS(tm) is integrated with CODE V. This is a modern, high-level programming language within CODE V which encompasses the following separate but related aspects of CODE V command mode usage (macros can be written in command mode and run from either command or GUI mode):

- Storing of commands for later execution from a file
- Freedom to use an arithmetic expression in place of a numeric input item
- Access to a broad range of CODE V maintained and calculated data
- User-defined variables, arrays, and functions
- Conditional and looping constructs (FOR, IF, UNTIL, WHILE)
- User-controlled input/output statements with sophisticated format control
- Ability to read from and write to text files stored on disk
- Storing of any CODE V output in the Worksheet Buffer(tm) for later manipulation

A growing library of macros, some written by ORA and some by users, is provided with CODE

3.2 Zemax:

3.2.1 ZEMAX-SE

ZEMAX-SE contains most of the tools needed for sequential optical system design of imaging systems. More advanced features, like Physical Optics, Non-Sequential ray tracing, Polarization ray tracing and others are contained in ZEMAX-EE.

General Capabilities

3D placement of optical surfaces
Unlimited number of surfaces, variables, optimization targets etc
Multiple Configuration capability
Thermal Analysis
Point sources, extended sources, .bmp and .jpg sources
Telecentric sources

Uniform, Lambertian and Gaussian illumination
Source size define by subtended angle, height or image height (real and paraxial)
Focal or afocal operation

3.2.2 ZEMAX-EE

ZEMAX-EE contains all the features and capabilities of ZEMAX-SE, plus the following additional capabilities:

Sequential Surfaces

ZEMAX-EE supports the following additional surfaces:

Type	***Description***
Birefringent Surface	Models uniaxial crystal polarization components
Jones Matrix	Models idealized polarization components
Non-sequential components	Allows non-sequential objects and ray-tracing to be used in an otherwise sequential system. Ideal for prism modeling or incorporating CAD objects inside a sequential ray trace model
NURBS	Radial and Toroidal NURBS surfaces for freeform optical design
Optically Fabricated Hologram	Comprehensive modeling of optically fabricated holograms, in which two separate optical systems illuminate a common variable-line-space grating, which is then read out by a third optical system. Allows simultaneous optimization and tolerancing of the construction and playback opticla systems.
User-defined surfaces	A powerful capability to write surfaces that are not built-into ZEMAX. Several samples are provided, as examples of how to write such surfaces, and these can also be used just like a built-in surface. The supplied user-defined surfaces include: Lens Arrays (rotationally symmetric and cylinder lenses) Filter surfaces to modulate a surface's transmission Gradient Index surfaces

3.2.3 ZEBASE

ZEBASE is a collection of over 600 sequential optical designs in ZEMAX format on CD. ZEBASE includes a copy of Milton Laikin's book, *Lens Design*. ZEBASE includes designs from the book as well as many other sources.

The 360 page ZEBASE User's Guide shows a Layout, Ray Fan Plot, and Field Curvature and Distortion Plots, as well as useful data such as EFL, F/#, and Field of View for each lens.

How is ZEBASE used?

The toughest part of any optical design is knowing where to start! ZEBASE solves this problem by providing a comprehensive catalog of well designed lenses from which new solutions may be derived. To find a good starting point, simply look through the list of categories in the ZEBASE User's Guide. Then, load up a sample lens file in ZEMAX format, and begin your modifications!

What type of lenses are represented?

ZEBASE includes samples of singlets, doublets, achromats, triplets, eyepieces, magnifiers, afocal systems, beam expanders, air spaced triplets, inverse telephotos, retrofocus, wide angles, telephotos, Petzval lenses, microscope objectives, double Gauss lenses, endoscopes, periscopes, riflescopes, mirror telescopes, scanning lenses, projection lenses, zoom lenses, and more.

Requirements

ZEBASE is only useful if you have ZEMAX! Some designs require ZEMAX-EE.

3.2.4 2009 Price List

ZEMAX® Optical Design Programs - Single-User License

ZEMAX-SE (System Requirements) Includes one key, one year of support and upgrades via download from the web.	$2,000.00 Buy Now
ZEMAX-EE (System Requirements) Includes one key, one year of support and upgrades via download	$4,500.00 Buy Now

from the web.	
Shipping, United States / International	Free / $50.00
ZEMAX-EE - Available in 5-User, 10-User, and 25-User Licenses Includes one network key, one year of support and upgrades via download from the web. This product cannot be ordered online: please contact sales@zemax.com or your local distributor for ordering information.	$4,500.00 per User License
Shipping, United States / International	Free / $50.00

ZEMAX® support and upgrades

Support for ZEMAX (Single-User License) One year of support and upgrades via download from the web.	$700.00 Buy Now
Support for ZEMAX (Network License) One year of support and upgrades via download from the web.	$700.00 per User License Buy Now
Upgrade to EE Requires current support. Obsolete key types must be returned for upgrade.	$2,500.00 Buy Now
Conversion to Network License Credit given for returned single user license keys. This product cannot be ordered online, please contact sales@zemax.com or your local distributor for ordering information.	

ZEBASE™ database of 600+ optical designs in ZEMAX format

ZEBASE™ ZEBASE includes the database on CD, a printed catalog of the lens designs, and the book "Lens Design", by Milton Laikin.	$500.00 Buy Now
Shipping, United States / International	Free / $50.00

Chapter 4 - References

1) Code V Product content provided by http://www.opticalres.com/index.html
2) Zemax Product content provided by http://www.zemax.com/
3) Rick Juergens, a former ORA employee and current Raytheon modeling master.