OPTICS FOR ARTISTS
NOTES AND OBSERVATIONS UNIT THREE, SUB-UNIT TWO
IMAGING OPTICS
LENS ABERRATIONS AND PICTURE-MAKING APPLICATIONS
FOREWORD

This Second Sub-Unit of **IMAGING OPTICS** discusses how the aberrations of simple lenses were conquered by various combinations of optics, and how these systems are applied to imaging optics for photo, cinema, and video applications.

IN THIS SUB-UNIT, you will learn about:

* How the aberrations of a lens affects the image spot;
* How the diaphragm of a lens controls depth of field;
* The categories of camera lenses and their applications.

BY THE END OF THIS SUB-UNIT, you should be able to:

* Identify the effects of the different aberrations;
* Apply the principle of Test Targets to lens evaluation;
* Predict the effect of focal length on image size;
* Identify pictures taken by wide, normal, telephoto lenses through their perspectives;
* Look at a photographic print in true perspective;
* Compare the large versus small f/stop sizes as far as their size, amount of light let in, the ratio of that amount, depth of field characteristics and resolving power.

OUTLINE OF LECTURE-DEMONSTRATION: (The lecturer reserves the right to vary.) You will experience the following phenomena right in front of your eyes!

SPECIAL SECTION: **THE ABERRATION DEMONSTRATIONS**

SPHERICAL ABBERATION

1. With BBO, show the miss angles of the marginal rays.

Identify the LSA and TSA.

2. Show the effect of stopping down with the BBO.

3. Send a Spatially Filtered beam onto the Big Lens and watch the light converge. Show the extent of the LSA by passing the Groundglass through the image planes.

4. Observe the real image of the pinhole with the naked eye. Watch the image point move toward and away from the lens.

5. Stop down the Big Lens with a variety of Waterhouse stops. Watch the focus change.

6. Multiply a laser beam by passing it through a couple of *diffraction gratings*, send them through the big lens and watch the rays come out. Place Groundglass or White Board in the plane of the rays.

7. Swap the object and image sides of the lens.

COMA

1. With BBO, show coma through the lenses and off the mirrors.

2. Show the effect of stopping down with stops in front of and behind the lens with the BBO.

3. Send a Spatially Filtered beam onto the Big Lens at a slight angle and watch the light converge. Show the extent of the coma by focussing onto the Groundglass and viewing the image with an Agfa Loupe.

4. Stop down the Big Lens with a variety of Waterhouse stops, in front of and behind the lens, and watch the coma flare shrink.

5. Place the Toric Zone Stops on the flat side of the lens and watch the rays come out. Place Groundglass or White Board in the plane of the rays. (Optional)

6. Swap the object and image sides of the lens and try some of

the tests again. (Optional)

ASTIGMATISM

1. Send a Spatially Filtered beam onto the Big Lens at a big angle and watch the light converge in the two planes. Show the extent of the astigmatism by focussing onto the Groundglass and viewing the image.

2. Map out the shape of the tangential and sagittal foci with a tall groundglass on a stand with a line pointng down to some graph paper. (Optional)

3. Focus image of radial test target to see the spoke paradox. (Optional)

5. Look at the test for astigmatism on the Aberration sheet through a cylindrical lens.

CURVATURE OF FIELD

1. Focus the image of a wall or Johnson Tester onto a groundglass and watch the focal plane shift from center to edge.

DISTORTION

1. Focus the image of a grid or chicken wire on a groundglass. Put stops in front and behind the lens to show the change in shape of the distortion.

CHROMATIC ABERRATIONS

1. Look at Color Stereographic Illusion Slide and Jefferson Airplane graphic.

2. Light up a small hole drilled in metal in front of a halogen lamp and watch the blue and red foci change in the Longitudinal Chromatic Aberration. Use Color Separation Filters to show the difference.

3. Light up a groundglass with a black dot on it to see the Transverse Chromatic Aberration. Use filters again. (Optional)

SHOW DIFFERENT SIZED IMAGES WITH DIFFERENT FOCAL LENGTH LENSES ON SLIDE MOUNT SHEET
FOCAL LENGTH SLIDES
OVERHEADS OF LENS GUTS
DEPTH OF FIELD SLIDES
DRAWINGS ON OVERHEADS GIVE DEPTH OF FIELD EXPLANATION
WHY THOSE F/#'S DRAWING
TRACING f/# RAYS
APERTURE DIMENSIONS

SLIDE SHOW: You will view the following phenomena vicariously through the magic of photographic transparencies:
PINHOLE AND K-MART LENS ABERRATIONS (10)
ABERRATIONS (11)
FOCAL LENGTHS (8)
PERSPECTIVES (8)
DEPTH OF FIELD (12)
SCHEIMPFLUG (3)

READING: The Articles or Handouts which you will read in the following pages are:

ABERRATIONS
OPTICAL ENGINEERING NOTE #3: THE GREAT 100mm LENS EXPERIMENT
OPTICAL ENGINEERING NOTE #4: OPTIMAL PINHOLE SIZES FOR PHOTOGRAPHY
SCIENTIFIC AMERICAN ARTICLE: THE PHOTOGRAPHIC LENS
VIEWING A PRINT IN TRUE PERSPECTIVE
OPTICAL ENGINEERING NOTE #7: VIEWING A PRINT IN TRUE PERSPECTIVE
OPTICAL ENGINEERING NOTE #17: IRIS DIAPHRAGMS AND OTHER APERTURES
WHY THOSE f/#'S
DEPTH OF FIELD
SUPPLEMENTARY LENSES

SLOGANS: You will be hearing these sayings in your sleep!

"The shorter the focal length, the smaller the image."
"The longer the focal length, the larger the image."
"The smaller the aperture, the less light."
"The smaller the aperture, the bigger the f/number."
"The smaller the aperture, the greater the depth of field."