User's Manual

for

Edge 3D Condenser System

Model DAC 1.0

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LIMITED WARRANTY

PRODUCT:

Edge 3D Condenser System

Edge 3D Imaging, LLC ("Edge") warrants this product against defects in materials and workmanship for a period of two (2) years from the date of purchase subject to the following limitations:

- For a period of one (1) year from the date of purchase, Edge will repair or replace defective electrical parts contained in the EDGE 3D CONDENSER System at no charge.

Charges for parts and labor will apply to all work performed after the expiration of the specific warranty period set forth herein.

To obtain service during or after these periods, contact your local Edge distributor. Every effort will be made to provide service at the user's location. During the warranty period, EDGE will pay shipping charges if the product must be returned for repair. After the warranty period, any shipping charges will be the responsibility of the user.

IT IS SPECIFICALLY AGREED THAT THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED INCLUDING THE WARRANTY OF MERCHANTABILITY AND WARRANTY FOR PARTICULAR PURPOSE. EDGE SHALL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING FROM THE BREACH OF ANY EXPRESS OR IMPLIED WARRANTY ON THIS PRODUCT.

This warranty does not cover cosmetic damage nor damage resulting from acts of God, accidents, misuse, abuse, negligence, and normal wear and tear. This warranty is valid only in the United States of America.

No agent, employee, or representative of EDGE has any authority to bind EDGE to any representation or warranty concerning this product unless said representation or warranty is contained in this limited warranty agreement.

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Warning

Federal Communications Commission Radio Frequency Statement:

> This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.
>
> Changes or modifications not expressly approved by Edge 3D Imaging, LLC, may void your authority to operate this device.

Intended Product Use:

> The 3D Condenser System should be used only as a condenser system for microscopes with removable condenser lenses. Do not use the system for any other purpose. Furthermore, the 3D Condenser System should be used only in an indoor environment.

Do Not Disassemble:

> Disassembling any part of the 3D Condenser System could result in electrical shock or damage to the equipment. Disassembling the unit will void the warranty. Never disassemble any portion of the equipment unless you are following the procedure described in this manual for changing the dynamic aperture sector. If you have any problems with the equipment, contact

you Edge representative.

Check the Input Voltage:

Make sure that the input voltage is within the acceptable range (see Specifications); 100-240 volts AC with a frequency of 47-63 Hz. If it is not the same, do not use the 3D Condenser System and notify your Edge representative. Using the wrong input voltage for the power supply could result in a short circuit or fire, and could also damage the power supply and any equipment connected to the power supply.

Use Only the Specified Power Cord:

When connecting the electrical outlet to the power supply, use only the specified power cord supplied with the 3D Condenser System. Using any other chord may result in damage to the equipment or fire.

In order to avoid electrical shock, always turn off the power switch before connecting the power cord.

Caution

Do Not Wet the 3D Condenser System:

The 3D Condenser System should be used only in an indoor environment. If the unit gets wet, a short circuit may result that could damage the unit. If you accidentally spill a liquid on the equipment, immediately turn off the power switch on the Control Box and unplug the power cord. Then use a dry cloth to wipe away any moisture. If any liquid gets inside the equipment, do not attempt to use it. Instead, notify your Edge representative.

Specifications

Components:

- Turret-type Condenser Lens System
- Control Box
- Power Supply

- Power Cable
- Pair of polarizing filters for your microscope eyepieces
- User's Manual
- 3D Viewer

Electrical:

- AC line input for the switching power supply is 100 to 240 volts, with a frequency of 47-63 Hz, 0.7 amps.
- Output is 12 volts, 2.0 amps max.

Operating environment:

- Indoor use only
- Temperature range from 10^0 C to 32.5^0 C (50^0 F to 90.5^0 F)
- Humidity range from 20-80% (no condensation)

Storage environments

- Temperature range from 0^0 C to 35^0 C (32^0 F to 95^0 F)
- Humidity range from 10-80% (no condensation)

Dimensions:

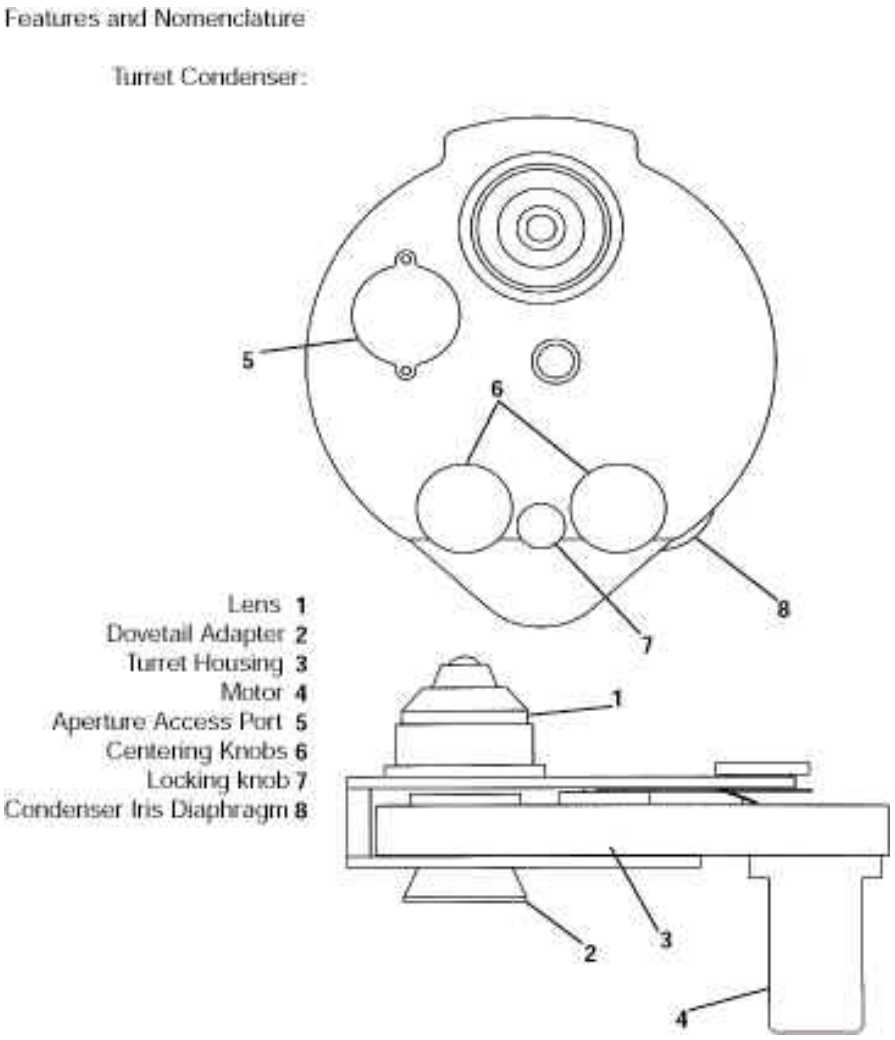
- Turret Condenser 5.0W x 6.2D x 3.75H inches (12.7 x 15.7 x 9.5 cm)
- Control Box 5.12W x 7.25D x 3.67H inches (13 x 18.4 x 9.3 cm)

Weight:

- Turret Condenser 6.8 ounces (0.2 kg)
- Control Box 3.8 ounces (0.1 kg)

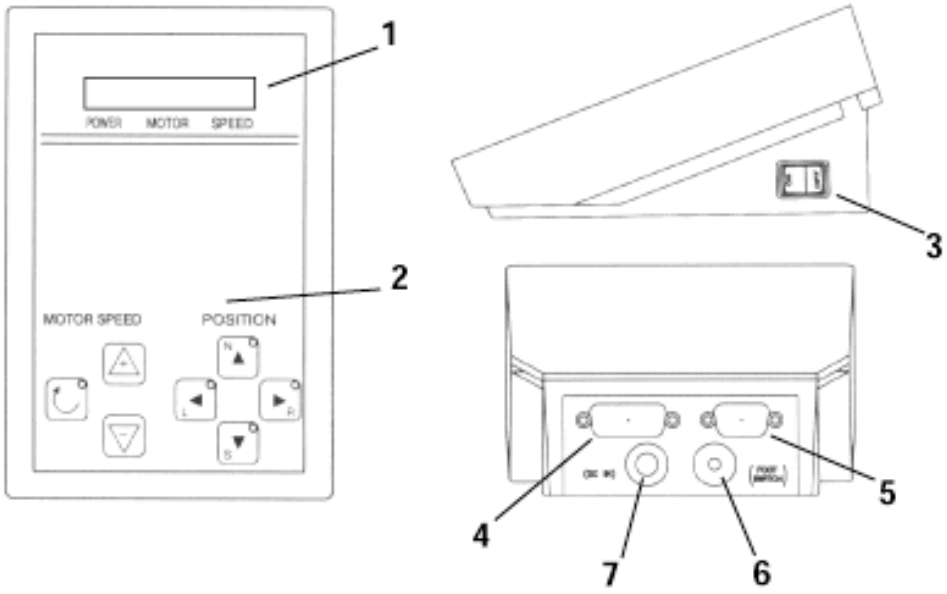
Features and Nomenclature

Turret Condenser:



1. Lens
2. Dovetail Adapter
3. Turret Housing
4. Motor
5. Aperture Access Port
6. Centering Knobs
7. Locking knob
8. Condenser Iris Diaphragm

Control Box:



1 LCD Display
Power - Will display ON when running
Motor - Will display RUN when oblique aperture motor is on
Speed - Will display the relative speed of the oblique aperture motor on a scale of 0 to 100 in increments of 5

2 Control Pad
Motor - turns on/off the rotation of the oblique aperture mask
Up Arrow - increases the speed of rotation of the oblique aperture mask
Down Arrow - decreases the speed of rotation of the oblique aperture mask
L - positions the oblique aperture to create a left-eye view of specimen
R - positions the oblique aperture to create a right-eye view of specimen
N - positions the oblique aperture to create a North view of specimen
S - positions the oblique aperture to create a South view of specimen
3 On/Off Switch
4 Multipin Connector
5 RS-232 Port
6 Foot Pedal Port
7 Power In

1. LCD Display

   · Power - Will display ON when running

   · Motor - Will display RUN when oblique aperture motor is on

   · Speed - Will display the relative speed of the oblique aperture motor on a scale of 100

2. Control Pad

   · Motor - turns on/off the rotation of the oblique aperture mask

- Up Arrow - increases the speed of rotation of the oblique aperture mask
- Down Arrow - decreases the speed of rotation of the oblique aperture mask
- L - positions the oblique aperture to create a left-eye view of specimen
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- S - positions the oblique aperture to create a South view of specimen

3. On/Off Switch
4. Multipin Connector
5. RS-232 Port
6. Foot Pedal Port
7. Power In

Installation

Depending on which type of microscope has been selected for the 3D Condenser System, whether it is an existing instrument or purchased specifically for the 3D Condenser System, the condenser will be fitted with the dovetail attachment appropriate for that microscope. Ensure that you have the correct dovetail adapter for the microscope you are using (see the sticker on the outside box). If you wish to use the condenser on more than one type of microscope, additional dovetail adapters are available and can be purchased from Edge 3D web site (www.edge-3D.com) For questions or details pertaining to a specific microscope please contact your microscope dealer or contact Edge 3D Imaging directly.

- Remove the standard condenser lens from your microscope.

- Using the supplied 3D Condenser System adapter for your microscope, attach the turret-like condenser lens where the traditional condenser lens would normally attach. Ensure the condenser unit is positioned squarely and not at an angle. Tighten the condenser lens system into place. You will not have to replace your standard condenser lens again because the 3D Condenser System can also function as a conventional condenser lens for standard brightfield microscopy.

- Position the Control Box close to one side of the microscope.

- Connect the multipin cable between the Control Box and the turret condenser unit.

- Connect the power cable between the power supply and the electrical outlet (100-240 volts, 47-63 Hz).

- Connect the smaller cable from the power supply to the Control Box.

- Turn on the power switch on the Control Box. The unit will take a few seconds to initialize.

- Place the turret into the conventional 2D position.

- Turn on your microscope, place a specimen on the stage and focus the image.

- Focus and center the condenser lens as you would a conventional condenser.

Alignment

Two different alignment procedures must take place: 1) the oblique aperture mask must be aligned and centered, and 2) the polarizing filters must be installed into your eyepieces and aligned.

Centering the Oblique Aperture Mask:

- Focus on a specimen using a fairly high magnification objective lens (NA between 0.5 and 0.95).

- With the turret in the conventional 2D position (counter-

clockwise) ensure the condenser lens is properly centered and focused for Köhler illumination.

· *Köhler illumination procedure: a) focus on specimen, b) close the field stop at the base of the microscope, c) focus the condenser lens so that the image of the iris in the field stop is sharp and the polygon shape is clearly visible, d) center the image of the iris by adjusting the condenser centering screws attached to the condenser holder, and then e) open the field stop iris.*

· Place the specimen in a position just past its edge so that there is nothing in the field of view (do not change the focus).

· Rotate the turret into the central position to engage the oblique aperture mask.

· Rotate the aperture mask by pressing the control marked Motor.

· Remove one of the eyepieces from the microscope and replace it with a telescope eyepiece. If you don't have a telescope eyepiece then look straight down the eyepiece tube to observe the rotation of the oblique aperture mask.

· If the sector-shaped mask is not visible, make sure that all diffusing filters have been removed from your microscope.

· Release the Locking Knob on top of the turret and center the apex of the pie-shaped sector of light using the two Centering Knobs. If you are not using a telescope eyepiece, ensure that your eye is observing the motion from optical center of the eyepiece tube. Place the apex of the sector-shaped mask at the optical center. If you are using a phase contrast objective, then use the image of the phase ring as a target to center the apex of the oblique aperture mask.

· Once the rotating aperture mask is centered, then tighten the Locking Knob.

· The oblique aperture is now centered, however please note that the centering may vary when different objective lens are used.

Installing and Aligning the Eyepiece Polarizing Filters:

Install the polarizing filters into eyepieces. Depending on the microscope selected for 3D Condenser System, the appropriate polarizing filters for that microscope will be included. The polarizing filters must be properly oriented within the eyepieces.

- Hold a piece of black paper (or some other opaque material) under the opening in the bottom of the condenser lens. Hold the paper as close as possible to the opening at the condenser dovetail. Hold the paper so that only the light entering the *left* half of the condenser lens is blocked.

- At the same time, rotate the polarizing filter in the *left* eyepiece so that it is oriented is such that the image becomes the darkest. Then fix the polarizing filter and eyepiece into that position. It is preferable to have non-rotating eyepieces (locking eyepieces). If your eyepieces can freely rotate within the body tube, then either tape them in place or label the appropriate position with a marker.

- Then do the opposite for the *right* eyepiece and polarizing filter (i.e., obstruct light coming into the *right* side of the condenser and rotate the polarizing filter to darken the *right* eye image).

- If these filters are oriented incorrectly, the result may be either a reversed sense of stereo or a lack stereo. If the stereo is reversed, i.e., if the foreground appears to be in the background, then reverse the procedure.

Operating the 3D Condenser System

The Edge 3D Condenser System replaces the traditional condenser lens on optical microscopes. The system may be fitted to upright microscopes that utilized transmitted light. All this is required is the appropriate dovetail adapter to retrofit to your existing microscope.

The Edge 3D Condenser System is multifunctional and has 4 modes of operation: 1) conventional 2D imaging, 2) direct-view stereo 3D imaging, 3) oblique illumination, and 4) 3D imaging by motion parallax.

Conventional 2D Imaging:

Turn the turret counter-clockwise to engage the position for

standard 2D imaging. In this mode of operation, the condenser performs the same as a conventional brightfield condenser lens. There is a small thumb wheel on the right side of the turret housing. This adjusts the iris diaphragm in the condenser lens. Use it as you would with a standard condenser. Normally the iris is opened all the way, and then it is slowly closed until the image darkens slightly. This is the usually the best setting. The iris diaphragm setting changes when different objective lenses are employed.

The setting of the iris can dramatically alter the quality of the image. Closing the iris increases contrast and depth of field but it also reduces resolution. The correct setting should be found for the combination of objective lens and specimen being observed. If the iris is too far open, then the image can be hazy with flare and glare. If the iris is closed too much then there will be a loss of resolution and the image will suffer.

Please note that in order to obtain a quality image it is important to make sure that the condenser lens is centered and focused for Köhler illumination. *Köhler illumination procedure: a) focus on specimen, b) close the field stop at the base of the microscope, c) focus the condenser lens so that the image of the iris in the field stop is sharp and the polygon shape is clearly visible, d) center the image of the iris by adjusting the condenser centering screws attached to the condenser holder, and then e) open the field stop iris.*

Direct-View Stereo 3D Imaging:

Turn the turret fully clockwise to engage the direct-view stereo 3D imaging mode. This will employ the special polarizing filter set into the illuminating beam. This special aperture creates two oblique views of the specimen, a left-eye view and a right-eye view. The left-eye view will be coded using polarized light at 90 degrees orientation with the right-eye view. The two different views of the specimen can be obtained if polarizing filters are installed in the eyepieces and properly oriented (see Alignment).

If the system is properly aligned the specimen will appear to be 3-dimensional. The foreground can be distinguished from the background. The orientation of structures can be easily observed, and the relationship of structures to one another in 3-dimensional space is accurately perceived.

Make sure that the left-eye and right-eye images are focused at the same depth into the specimen. To achieve this, focus the

microscope on a small detail in the specimen. Then focus each eyepiece on the same small detail.

Oblique Illumination:

Place the turret in the central position to engage the oblique aperture mask. This will create oblique illumination, which increases the depth of field, the contrast and the resolution of the image. Highlights and shadows are emphasized.

The direction of the apparent highlighting can be control by adjusting the position of the oblique aperture mask. Pressing the N button on the Control Box will create highlights on the top of structures and shadows below. Pressing the S button will have the opposite effect.

An important feature of oblique illumination is that it creates angled views of the specimen. Pressing the L button on the Control Box creates a left-eye view of the specimen, while pressing the R button creates a right-eye view. The L and R buttons are used to take stereo-pair images (see Documentation of 3D Images).

The angular size of the sector-shaped oblique aperture mask can affect the apparent angle of view of the image of the specimen. An oblique aperture mask that passes light through a smaller sector-shaped opening will increase the angle of view or parallax angle of the specimen, compared with an oblique aperture mask that passes light through a larger sector opening. The smaller the opening in the aperture mask the greater will be the contrast, depth of field and parallax angle (3D depth). However, when the aperture is too small there can also be a reduction in resolution. The effect of using different aperture masks is very dependent on the particular specimen being examined.

Several different size aperture masks are available and can be purchased from the Edge 3D Imaging web site (www.edge-3D.com). Sector-shaped openings of 180, 120, 90 and 60 degrees are available. The individual aperture masks are easily removed and replaced using a small jeweler screwdriver. There is an access port on the top of the condenser turret that allows access to the aperture mask. Unscrew the window and turn the turret to expose the oblique aperture mask. Unscrew the sector-shaped aperture mask and replace it with the desired size mask. Then replace the cover over the aperture access port.

3D imaging by motion parallax:

When the turret is in the Oblique Illumination position (central position) the Motor button can be pressed in order to rotate the oblique aperture mask. This creates a continuously changing angle of view and the image appears to move in 3-dimesional space like a movie loop. The 3D image is perceived by motion parallax cues. The speed of rotation can be increased or decreased by pressing the Up Arrow or the Down Arrow. Pressing the Motor button again will turn off the rotation.

The Motor can be turned on and off using a foot pedal. There is a foot pedal jack on the rear of the Control Box. This can be useful if you are repeatedly turning the Motor on and off, which is how the motor is intended to be used.

Documentation of 3D Images

Documenting images using the Edge 3D Condenser System is simple and convenient. You may use film cameras, digital cameras or video cameras. You can use the same equipment you normally use to document images through your microscope. You can use the Edge 3D Condenser System to capture conventional 2D images. And, there are two methods for capturing 3D images; first and most popular, is the stereo-pair method that creates separate left-eye and right-eye images on two photographs, and second, is the Dynamic Aperture method that creates 3-dimensional perception through motion parallax "movie loops".

Photography:

- Looking at a specimen with a relaxed eye, focus the photo eyepiece reticule.

- Set the left and right eyepiece focus so that they are in focus with the camera eyepiece (i.e., look at a small spot in the specimen and ensure that all eyepieces are focused on the same spot)

Color Photography:

- If you are using daylight balanced color film, then you will have to insert an 80b filter (light blue) into the light path to increase the color temperature of the illumination from 3200^{0} K. to 5600^{0} K. If you are using tungsten balanced color film, such as Kodak 64T Ektachrome, then no color

correction filter is necessary.

· When taking photos with color film, press the button on the Control Box marked Photo. This will automatically set the lamp intensity to 10. This will ensure that the color temperature of the lamp is balanced to match the film.

Black & White Photography:

· For B&W film a green filter will improve contrast and sharpness on the film.

· When using B&W film, there is no need to press the Photo button on the Control Panel, because the color balance of the light source is not an issue when using B&W film.

2D Photography:

· Rotate the condenser turret counter-clockwise to engage the conventional 2D mode.

· Set the iris diaphragm for the best image.

· Frame the field of view through the photo eyepiece port (The camera can be rotated to frame the field of view as desired)

· Then take the photo in the usual way. For most microscopes, move the slider on the microscope head to send the light to the camera, and then press the camera exposure button.

3D Stereo-Pair Photography:

· Set the camera orientation for vertical or horizontal images, relative to the optical axis of the microscopes (the vertical or portrait format is preferred for stereo-pair images). Ensure that the camera orientation is straight and square.

· Rotate the condenser turret so that it is in it's central position. This will engage the oblique illumination mode.

· Frame the field of view in the photo eyepiece port, or in the eyepiece reticule.

- To take the stereo photographs, press the L button on the Control Panel and then push the camera exposure button. This will capture the left-eye image of the stereo-pair. Then press the R button on the Control Panel and push the camera exposure button. This will capture the right-eye image of the stereo-pair.

- When viewing the stereo-pair photos after processing, make sure they are viewed in the same orientation they were taken. If they were taken as vertical images then they must be viewed as vertical images. If they were taken in horizontal format, then they must be viewed that way or the 3D will be lost. If the stereo does not look correct, then turn the photos upside down or reverse their position in terms of viewing the left and right-eye images.

Motion Parallax "Movie Loops":

- In order to make 3D motion parallax movie loops, you will need to attach either a video camera or a digital camera that will capture sequential images very rapidly (greater than 15 frames per second)

- Rotate the condenser turret to its central position to engage the oblique illumination mode.

- Frame the desired field of view and focus the image onto the video camera (or digital camera)

- Press the button marked Motor on the Control Box to create the motion parallax movie loop in the microscope.

- Press the Up Arrow or Down Arrow on the Control Box to select the desired speed of rotation for the movie loop. If you are using a digital camera that captures images more slowly than a video camera, then select the slowest motor speed.

- Begin recording the movie loop on the video camera (you may want to start the scene with a still image of the specimen for comparison purposes).

- When you have finished recording the movie loop, press the button marked Motor on the Control Box to turn off the Dynamic Aperture.

Presentation of 3D Images

There are many ways to view and present stereo images. Here are the most popular methods.

For Publication, Render Side by Side Stereo-Pair Images:

In general, a vertical orientation is preferred for 3D presentation using the side by the side stereo-pair method. Prints should be photographed and presented in a vertical (portrait) orientation. They can be viewed through an image-merging lunette or experienced observers can merge the images without the aid of glasses. In order to successfully merge the images, ensure that the distance between the left and right images is no greater than 65mm center to center. That is the average inter-ocular distance for adults. It is important to make sure that corresponding features in the two images are aligned horizontally.

· *Wall-eyed viewing:* This is when the left eye views the left picture and the right eye views the right picture. Generally, stereo-pairs shown in print publications are arranged for wall-eyed viewing, unless otherwise stated. Cross-eyed viewing of these images causes the 3D information to be reversed. A mound becomes a pit and vice-versa.

1. Hold the stereo-pair images at a comfortable viewing distance, wearing your glasses if you normally wear them.

2. The stereo-pair should be approximately in the center of your visual field and evenly illuminated.

3. Looking "through" the paper, look into the distance. Do not converge your eyes, just relax and them drift apart as if you were looking into the distance.

4. A third image will appear between the left and right pictures, with the separate 2D images still visible on either side.

5. Allow your eye-brain complex to lock onto

the middle image.

6. Without converging the eyes, slowly focus on the third, center image. A 3D picture will emerge.

· *Cross-eyed viewing:* If cross-eyed viewing is more comfortable, then the images need to be switched. This is the standard arrangement for stereo-pair projection onto a large screen, since it is impossible to relax the convergence at large distances (most people's eyes will normally not diverge enough to fuse the pictures into a stereo image). Cross-eyed viewing is also the preferred method for fusing large stereo-pair photographs, i.e., greater than 65mm across. That is because the average distance between the left and right eyes is about 65mm, which is what limits to size of image that can be accommodated.

1. View the stereo-pair images from a straight-on point of view, with the images left/ right reversed (i.e., with the left image positioned on the right side and the right image positioned on the left side).

2. Hold your finger 4-5 inches in front of your nose, in the middle of your field of view.

3. Focus on your finger. In the distance, the two images become one stereo image (the middle image), with the separate 2D images still visible on either side.

4. Slowly focus on the center image, the center image becomes sharp and will appear in 3D.

Viewing 35mm Stereo-Pair Slides:

· For private viewing or small groups of people, use 35mm stereo-viewers. A complementary stereo viewer has been included with the Edge 3D Condenser System.

· For larger audiences, use stereo slide presentations. You will require:

1. Two identical slide projectors, with two identical lenses

2. Two polarizing filters over the lenses, orientated at 90 degrees to one another (each filter should be oriented 45 degree from normal)

3. A silvered screen or lenticular screen (A normal white screen, or a white wall, will not properly reflect polarized light and the stereo effect will be lost.)

4. Polarizing spectacles for the audience.

5. Place the left-eye views in one projector and the right-eye views in the other projector.

6. Project the images on the same screen so that they overlap one another. The vertical overlap must be fairly accurate, whereas there can be quite a bit of play with regard to the horizontal overlap. This is because it is fairly easy to converge and diverge our eyes, but it is nearly impossible to have one eye looking up while the other eye is looking down.

7. Focus each projector individually.

8. In order to properly orient the polarizing lenses on the projectors, turn on only the projector with the left-eye images and then, while wearing the polarizing spectacles, rotate the polarizing filter covering the projection lens so that the image is dark in the right eye. Then, turn on only the projector with the right-eye images and rotate the polarizing filter covering the right-eye projection lens so that the image is dark in the left eye. In other words, the left photograph is blocked by the right-eye filter in the polarizing spectacles, and vice versa for the right photograph.

9. Turn on both projectors and you will see a dramatic 3D image. If you are too far off to the side of the screen, you may loose the stereo effect, so position yourselves as close to the middle of the screen as possible.

3D Video Systems and 3D Computer Systems:

There are a number of emerging technologies that can interlace stereo-pair images onto a computer or television monitor. The audience wears lightweight polarizing glasses or liquid crystal shutter glasses to see the 3D images. Please refer to the list of "Links" in the Edge 3D webpage: www.edge-3D.com

References

Greenberg G, Boyde A, novel method for stereo imaging in light microscopy at high magnifications. *NeuroImage* 1:121-128 (1993)

Greenberg G, Boyde A, Direct-view 3-D microscopy using conventional Lenses. *Microscopy and Analysis* 22:7-9 (1997)

Greenberg G, Boyde A, Convenient and controllable direct-view 3D imaging in conventional light microscopes: Approaches via illumination and inspection. *Proceedings Royal Microscopical Society* 32/2:87-101 (1997)