MeX 3D Image Construction from SEM Images:
Profile, area, and volume measurements

Note: In order to utilize MeX, you must have two or three stereo images of your sample. To learn how to obtain these, please look at the "Capturing Stereo Images for MeX" document. Another document, the "Stereoscopic Images in the SEM" Powerpoint provides a brief description of what stereo images are.

1) Log into the MeX computer using username: Semuser and password: Semuser.

2) Open MeX 5.0
   Username: EPIC
   Qualification: Normal User
   Leave password blank

3) Import your images:
   a. On the left side of the screen, right-click on **new project folder**
   b. Select **new** then **new project**
   c. Label your project and click **OK**
   d. Right-click on your project and select **Open Project**.
   e. Right click on your folder which is now on the left side of the screen, and select **new**, then **creator dataset**.
   f. Two options are available: Stereo creator uses two images with known angle of separation/tilt to create a 3D image, and Auto Calibration which uses three images with known degrees of tilt to create the 3D image. If you have three good stereo images, **Auto Calibration** recommended.
   g. After selecting stereo creator or auto calibration you will be taken to the setup wizard which will allow you to import your images

4) In setup wizard click on the folder icon to import your images. If you took three images and tilted negatively for one, import the positively tilted image on the far left, the flat image in the center, and the negatively tilted image on the right. If you have two positively tilted images and one zero tilt image, open the image with the greatest amount of tilt in the center, the lesser tilted image on the left, and the image taken at 0° tilt in the right. If you are importing two images, import the flat image on the right and the tilted image on the left.

5) Below the images enter in the tilt angle used as described (you will have to subtract the tilt angle from one image from another), and the projection/working distance in mm. The horizontal measure point is the pixel calibration. This will automatically be entered for you, as the computer takes this information from the .Tif file.

6) Click on the red and black button next to where it says "proportional" ("proportional" should be checked by default). This brings you to an image with a style marker on it.

7) Use the style marker to draw a line along the length of the scale bar associated with the image. Once you have done that, enter in the line length under where it says "measurement." Make sure to select the proper units, select **add**, then **OK.**

8) Now you will be taken back to the setup wizard window. Select **Next** at the bottom right of the window.

9) The two images are now superimposed and the dataset is completely imported. To align the superimposed images at the bottom of the import dialog box, select **auto offset.** You can also manually align the images by clicking and dragging the top image.

10) When you are satisfied with the alignment click **Next.**

11) In the stereo creator box that comes up you can type in a description of your sample if you like, or just click **Next**

12) You will see your image with a green box around it. Define the region of interest using the style cursor. The region MUST be within the green box, and make sure you don't include the data zone, then click **Next**.

13) The software will now create a low-density digital elevated model (DEM). This produces a preview of the 3D image. If the image looks acceptable, proceed to create the final higher resolution DEM that you can use to make measurements.
Note: You may get a warning that says that there were problems creating the DEM such as inaccurate tilting, or that the image needs to be rotated. If you get this warning, just ignore it and continue. When using auto calibration, tilt problems can be corrected by the software, and the DEM may still be OK. If the DEM does not look OK in the end, then you should consider rotating your images 90°. This can be done in the setup wizard window after you import your images.

14) You will be presented with the dataset. If you click on the dataset you can see the properties of the data set. You can now view the right image, the left image, the pair of images, or the 3D image by clicking the face icons at the top center of the screen (for the 3D image you need the blue and red glasses)

15) To view the complete 3D model, click on the DEM icon (the upper left-hand side of the screen, it looks like a colorful mountain). You can grab the 3D model and move it around, you can also zoom in and out

16) Right click on the background and select "background color" you get a color pallet that you can chose background colors from. You can export this image as a Tif under the file menu.

17) By clicking the blue and red face at the bottom of the screen you can make the image a colored image to be viewed with the 3D glasses (this is called an anaglyph).

18) You can grab the scroll bar on the right and drag it down, it will allow you to add color in relation to height to the image. The corresponding color scale bar will also then pop up on the right. To remove the color, just bring the scroll bar back up.

19) When you don't have color selected to show height, you can right click on the image and go to draw style, wire frame, and see how the image is a dataset made up of 3D data points
20) To go back to the original 3D image, right click, go to draw style and select polygons

Analysis of Various Parameters

A) Primary Analysis: Measure Distances and Heights (profile analysis)
Note: page 44 of the MeX manual provides profile analysis instructions and tips in great detail.
1) Leave the image in polygon style and go up to the toolbar and select profile analysis. You will be brought to a workflow screen that tells you what you can achieve with the software. Click "ok."

2) You can now measure distances, roughness, or waviness. Select which one of these you chose to measure under Filtering on the right-hand side of the screen. Select Primary for distance measurements.

3) Under measure mode, make sure it says measurement, and that automatic robust is selected.

4) Click on the image with the style cursor and draw a line where you would like the profile taken, and left click. The profile will show up as a line at the bottom of the box.

5) Measure distances between features by moving the vertical bar and horizontal bar (the cross-hair) along the profile. Click to set the cross-hair position and then click another area and the distance between the two will show up as the relative measurement. The same procedure can be done to measure the height of features.

6) There are other possible measurements that you can select to do from a scroll down menu under Measure Mode on the right hand side of the screen. Results of these modes are shown in the result box below the Measure Mode option (See page 48 of the instruction manual for more detail)

Line Measurement: Allows you to click on the profile analysis and draw point to point with a fitted line to determine distances on the surface of a feature
Single Height and Double Height Step: Measure undulations in the surface
Two Lines Angle: Allows you to select more than just two points and draw and measure angles
Circle: To draw a circle and make circular measurements

7) By clicking the parameters tab down at the bottom of the screen, you can see the primary profile in a bar graph. There is also measurement information listed such as average height.

8) If you select the Bearing Ratio tab at the bottom you can see a Firestone-Abbott Curve of the primary profile.

9) The Table tab will show you information for each data point on the line you drew

B) Roughness Analysis:
1) In the profile analysis window locate "Filtering" on the right side of the screen and select Roughness

2) Bring the mouse over the 3D image so that you get the stylus cursor. Draw lines back and forth close together over the surface of the sample in a zig-zag pattern. Double click at the end, and the roughness profile will appear in the analysis window.

3) Grab the scroll bar below the analysis window and drag it to the left to condense the profile. This will give the Bearing Ratio curve a better shape (this curve is accessed by clicking the Bearing Ratio tab at the bottom of the screen).

C) Measuring Waviness: Surface
1) Under Filtering on the right hand side of the screen, select Waviness

2) The waviness profile will show up below in the analysis window

D+E) ***Please reference the MeX Manual for detailed instructions on how to find area and volume.***