Using the CMM machine and
MCOSMOS software

By: CSU East Bay Group (Michael Krunic, Guanhao Su, Trent Rosenquist)

Part 1: Creating the environmental setup

Step 1: Begin by opening the **MCOSMOS version 4.1** software. From "PartManager" page, select "Create New Part" on the left sidebar. Create a name for the part and a folder will be created with the part name.

Step 2: From "PartManager" locate and select the desired part name and enter "CMM SystemManager" on the top tab towards the middle. A new page will pop-up and you will need to build a configuration of the machine.

Step 3: Select "Add CMM configuration" on the top tab and name your configuration (eg, CSUEB/ATLAS) and create it in machine builder. A "MachineBuilder" window will pop-up.

Step 4: On the right side under "Add Machine," add the **CRYSTA APEX 9166**.

Step 5: Click <<continue>> for the rotary table because no Rotary Table is present.

Step 6: Under "Add Masterball," select the masterball **MB_20_141**.
   Note 1.6.1: The numbers (20_141) correspond to the diameter and the height of the masterball (in mm), respectively. Then drag the masterball to the desired location on the CMM table and click continue. The dimensions are located physically on the masterball near the stem. Also, a window will pop up to ask for the Ball diameter and Stem diameter. Ball diameter is written on the masterball. Stem diameter can be measured directly under the ball.

Note 1.6.2: Make sure the masterball is placed within the volume compensation. In other words, place the masterball somewhere in the middle.

Note 1.6.3: when moving a part you must select update to ensure changes are saved. This is necessary for specifying the location of various parts (eg, step 6).

Step 7: Under "Add Changers/Rack," select the **Renishaw SCR200** and the **ACR3**. Click on the one desired and drag to the location on the CMM table.

> *Note 1.7.1:* In the bottom right corner, ensure that the rack is oriented correctly. That is, change the rotation in degrees until it matches the physical object's actual orientation.

> *Note 1.7.2*: **ACR3** is not on the items list, might have to update parts on the software side. (MRS600_SB

Step 8: Select "Port 1" and construct the Probe Head. The "Configure Probe System #1" window will pop-up.

> *Note 1.8.1:* Here is where the "Tree" will be build. Each port will be used to build different probes.

Step 9: For the first port, select **probe head PH10MQ** and enter the collar length.

> *Note 1.9.1:* The collar length should already be there, if not the measurement is 73 mm.

Step 10: Select **PAA1** adaptor and "Add selected component" or double-click.

Step 11: Select **TP200** extender.

Step 12: Select **TP200_SF** (standard force).

> *Note 1.12.1:* Others will be TP200_LF and TP200_MF

Step 13: Select the extension piece being used. For example, **K651038** is the one used by the CSUEB group.

Step 14: Select the stylus. When finished click "OK" to complete the probe building process.

Note 1.14.1: To find the correct component, it might be necessary to measure the length and diameter of the probe head being used. **K651020** (stylist picture is blue line with red dot).

*The table below contains the part numbers of the stylist and extension piece for the Renishaw autochange rack system; the rack installed as of (7.17.2018) is the ACR 200. Keep in mind the parts will be interchanging with the machine and it might be different then the data provided below. Reference the manuals for further instruction or here <u>Renishaw Website</u>.

Part Name	Extension/stylist part number	diameter (mm)	stylist length (mm)	extension length(mm)
1827x3	K651038/ K651019	2	20	10
1828w2	K651039/ K651012	1	10	20
1828t4	K651038/ K651021	3	20	10
0185u2	NA/ K651022	4	20	0

Step 15: In order to use the changer/rack, the other ports (2-6) will need to be configured. Under "Configure Racks & Trees" right click on the desired port, say port 2, and "Define probe tree."

Step 16: You will be in the "Define probe tree" window. "Define Tree #" as No. 2. **REPEAT** steps 7-14 for all of the other ports.

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We will now have to Define each probe by adding or removing probe orientations. We will remain in "CMM SystemManager" window.

Step 17: Highlight the part, **PH10MQ (Tree 1)**, right click and select "Define Probes". The "Define Probes #1" window will pop-up.

Step 18: We will Add 5 probes to the list. For Probe #1, the "Probe Orientation" will be A 0 and B 0.

> *Note 1.18.1:* Probe #1 will be defined when entering the window. You must define Probes #2-5, refer to the table below for the appropriate configurations.

Probe #1 (points down)	A 0	B 0
Probe #2 (points forward)	A 90	B 0
Probe #3 (points right)	A 90	B 90
Probe #4 (points back)	A 90	B 180
Probe #5 (points left)	A 90	B -90

Step 19: Verify the list and then select "OK"

> *Note 1.19.1:* Steps 1-3 must be completed for each "Tree" under the MachineBuilder window.

Step 20: Complete Probe Orientation for each Tree defined.

Now the machine is built, to modify, update, or remove, Right-click the machine,.

This step <u>completes</u> the process for building for one or all of the probe configurations being used for the experiment. Now we move on to the calibration of the probe.

Part 2: Calibration

Step 1: Select part name used in part 1.1 and enter "Learn Mode'. Learn mode is located on the top tab.

> *Note 2.1.1:* Learn mode is used to set-up and configure the CMM.

Step 2: From the menu part, select "Probe" → select "Probe Data Management" to configure the probe system.

> *Note 2.2.1*: Within the configure probe system display, ProbeBuilder is an alternative way to build the probes instead of using "CMM SystemManager".
> *Note 2.2.2:* There should be 5 Probes already defined.

Step 3: Select all probes (1-5) by click the multiple red-arrows. Select "Calibrate."

Step 4: Under the "Calibration Probe" window, use appropriate values.

> *Note 2.4.1:* There are two ways of calibrating the probe; Automatic and Manual calibration. Recommended is the automatic calibration because the machine will understand how to calibrate and take more measurements for better data.

Step 5: Under "Calibration settings", fill in the following values:

No. of masterball	1
Diameter	25.5 mm
No. of executions	1
Probe change dist. From Masterball	12.5 mm

Step 6: Under "CNC" Parameters, fill in the following values:

Movement speed	40 mm/s
Measurement speed	3 mm/s
Saf. dist. For first exec.	2.54 mm
Measurement Length	12.7 mm
Position Distance	0.254 mm

Note 2.6.1: These parameters are for when the machine operates automatically.

Step 7: Click "OK" and a new window titled "Calibration probe: Display" will pop-up.

Step 8: Using the Joystick, drive the probe manually over towards the masterball. Lower the probe until it is a few millimeters away from the masterball.

Step 9: On the joystick controller panel, press "MEAS" button and take a touchpoint on top of the masterball.

Note 2.9.1: After the completion of step 9, the machine automatically take the next few measurements.

Note 2.9.2: The probe data measurement now displays all of the defined probes with their actual diameter and XYZ offsets.

Step 10: Archive the data; name and click OK.

Note 2.10.1: This data will need to be loaded while in "Learn Mode."

*Now from this point the CNC Probe Head has performed automatically the differently configurations. Each angle should have touched the masterball for calibration.

Part 3: Alignment & Measurement

Step 1: Enter "Learn Mode." Select the appropriate options such as relearn, overwrite, etc.

Step 2: Under "Machine" trigger "CNC On" (computed numerical control). This enables the machine to accept user input and learn.

Step 3: Under "Machine" select "CNC Parameters". Set the parameters as follows:

Movement speed	40 mm/s
Measurement speed	3 mm/s
Saf. dist. For first exec.	1.5 - 2.5 mm
Measurement Length	12.7 mm (recommendation is 3X Safety distance min.
Position Distance	0.254 mm (recommendation 25% safety max)

Note 3.3.1: These parameters above in the table are for initial measurements. Adjust the movement speed as high as you feel comfortable. Pay close attention to the **safety distances**.

Note 3.3.2: For the Scanning probe section, use only if the scanning probe is installed in the CMM.

Note 3.3.3: For more on Safety, Reference page 29 here : MCOSMOS C1

Now from this point, the machine can be programmed different ways. The following is a tentative plan to align and make a measurement for a cylinder.

Step 4: This is the "Plane, Line, & Line" alignment. Click on "Plane" located on the top bar. Measure manually (un-click or click on the measure automatic). Enter 4 points for a plane and click OK.

Step 5: Take 4 hits on the top of the cylinder.

Step 6: Go to "Coor. sys." and Align plane. Select the Alignment element as a Plane. Also it is crucial to check which Coor. Plane will be used.
> *Note 3.6.1:* Make sure the plane on the software corresponds to the plane on the table of the machine. Look at the Joystick for Reference.

RESET the coordinates of the machine before making another alignment. In other words, make the origin somewhere above the object to avoid collisions. This will be a bit tedious but teach the CMM to move step-by-step before making an 'alignment.'

Step 7: Click on "Line" located on the top bar. Again Measure manual and enter 2 points to construct a line.

Step 8: Take 2 hits on the front of the cylinder.
> *Note 3.8.1:* Define what the front of the cylinder might be.

Step 9: Go to "Coor. sys." and Align axis parallel to axis. Select line and appropriate axis and click OK. Again this will have to be W.R.T. the CMM table.

Step 10: Click on "Point" and select the "Intersection construction" button. Next select which two elements where an intersection should be located.

Step 11: Go to "Coor. sys." and "Create Origin." Select the proper Alignment element and axis to make the origin.

This should be the end of the alignment phase. Now onto the CNC Measurement for the Automatic Cylinder Measurement.
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Step 12: Click on "Cylinder." Select the automatic measurement and select 8 points. Click OK.

Step 13: Enter the approximate **diameter** of the cylinder and **total height** of the cylinder. Also select the **driving plane** and enter the coordinates of the center of the cylinder. Click OK.

EXTRA MATERIAL

Step 3: Select Define probes

Step 4: Define probe orientation by adding probe. Example: set probe #1 to A 0, B 0. View table below for the rest of the orientations:

Probe #1 (points down)	A 0	B 0
Probe #2 (points forward)	A 90	B 0
Probe #3 (points right)	A 90	B 90
Probe #4 (points back)	A 90	B 180
Probe #5 (points left)	A 90	B -90

Note: The orientation for the probe has to be completed for each probe head and stylus

Step 5: Select ok when finished.

Step 6: Select the red check marks to select all of the probes. Select Calibrate to start probe calibration of the selected probes.

NOTE: The following steps have not been experimented in the Cleanroom i.e. proposed steps for calibration of the probe. (Note was made on 7.10.18 by Michael)

We need to figure out the steps for: (required for calibration)
- Masterball Definition

- Volume Compensation (FIXED)
- Defining probe or Probe selection?? Not quite sure…
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We have figured out the Volume Compensation issue. When building the CMM machine configuration in system manager, the masterball must be placed inside the provided box illustration. Before we placed the masterball on the very edge closest to the joystick (where we encountered the error) and now, placing the masterball mid-table, will fix this error.

Alignment Steps (the training macro for measuring your sample. This sets up the coordinate system. You enter the types of measurements you need.)
Measurement Steps (run the measurement on all the samples)

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Part 3: Alignment

NOTE: The followings steps will change later on. But for starters it should be good.

Step 1: Enter "Learn Mode" and go to "Settings" → "Input Characteristics"

Step 2: Verify inch/mm units and click "OK" **Choose either, be consistent!**

Step 3: Go to "Probe" → "Change Probe" and retrieve the calibration data in Part 2.

> *Note 3.3.1:* MCOSMOS is ready to measure or program. <u>These steps must be repeated every time learn mode is entered.</u>

BEFORE you start to measure the elements for alignment, make sure the part is fixed to the machine in such a way that it cannot move.

Step 4:

Part 4: Measurement

Step 1: Enter 'Learn Mode'

What we did tonight (8.5.18) was enter learn mode.

The simple way to teach the measure what to measure is by:

- Turn CNC mode on
- Type of measure (we did plane measurement today)
- Check the measure automatic box
- Click the position of the machine
- Select # of points to measure
- Finish element
- Turn CNC mode off
- Save (check save relearn mode)

Alignment Steps (the training macro for measuring your sample. This sets up the coordinate system. You enter the types of measurements you need.)

Measurement Steps (run the measurement on all the samples)