

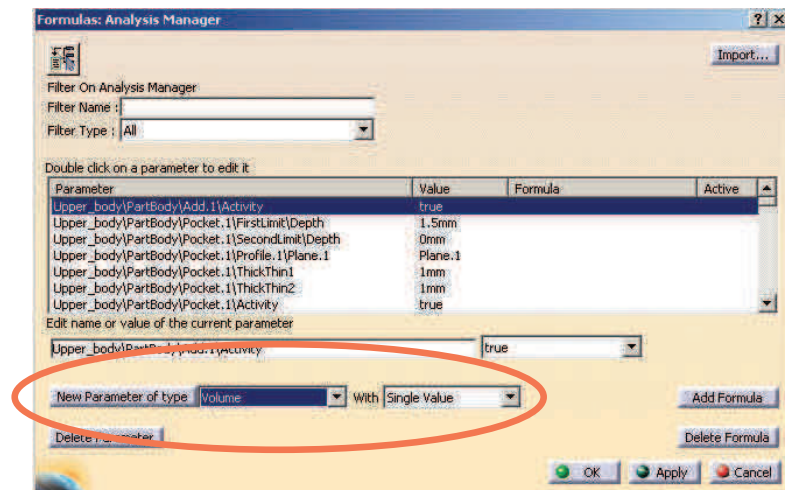
Tutorial 3E

We know we can get a stronger metal arm by shortening its length and/or increasing its diameter. But what are their best values so that we can use the minimal material to support the load? (Less Volume Less Cost)

**** File/Open... Analysis_a.CATAnalysis ****

To Define a User Parameter “Volume”:-

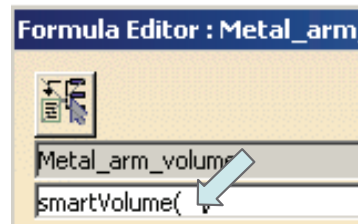
- Click “**Formula**” icon
- Select “Volume” as Type
- Select “Single Value”
- Click “New Parameter of Type”
- Rename “Volume.1” to “Metal_arm_volume”
- Click “Add Formula”



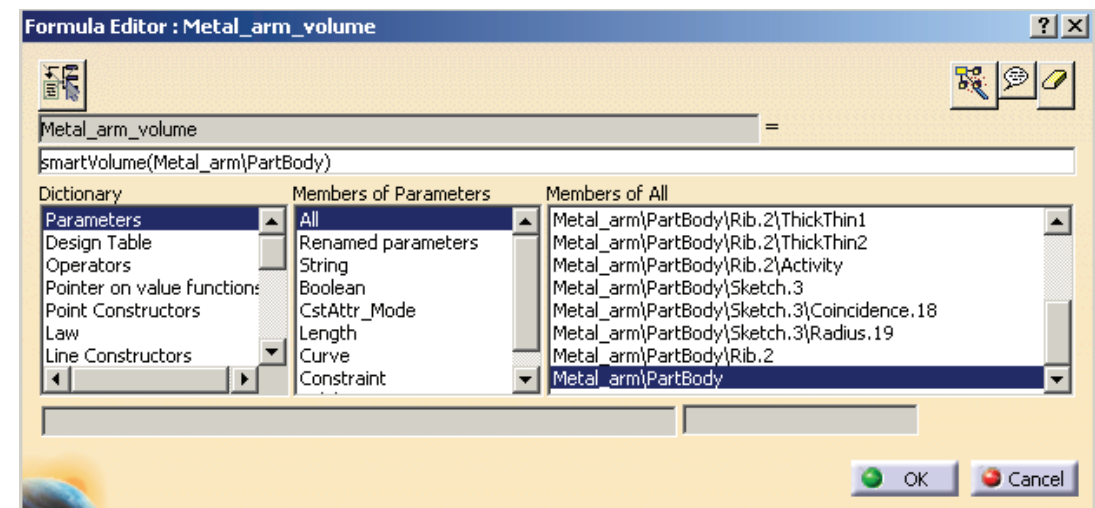
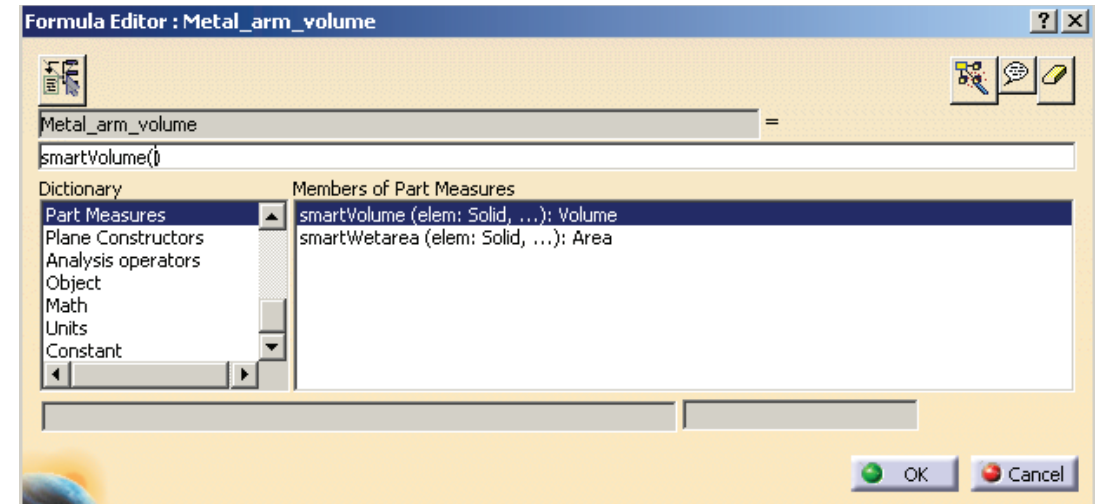
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(Con't):-

- Select “Part Measures” on the list of “Dictionary”
- **Double Click** “smartvolume(elem:solid,...)” under the list of “Members of Part Measures”
- (now Metal_arm_volume=smartvolume())
- Then click the space between two blankets



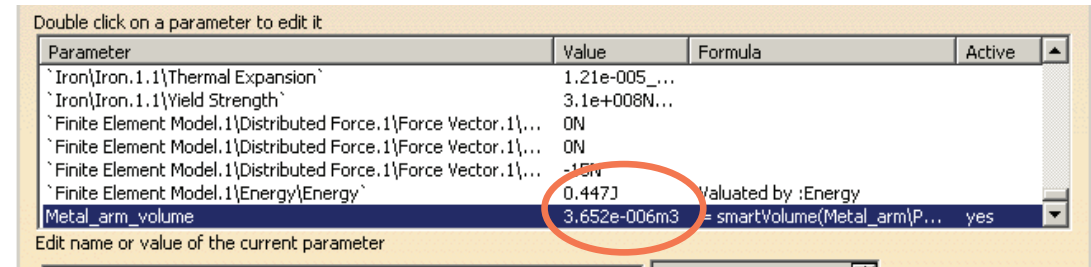
- Maximize the product tree and maximize the part tree of Metal Arm
- Click “Partbody” under *Metal_arm* once
- **Double-click** “Metal_arm/Partbody” on the list of “Member of all”
- Click ok to complete



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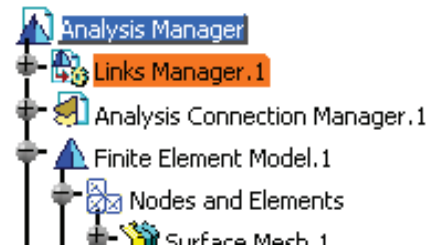
(Con't):-

- (The system measured the volume of “Metal_arm” and return the value as $3.652e-006m^3$)
- Click ok to complete



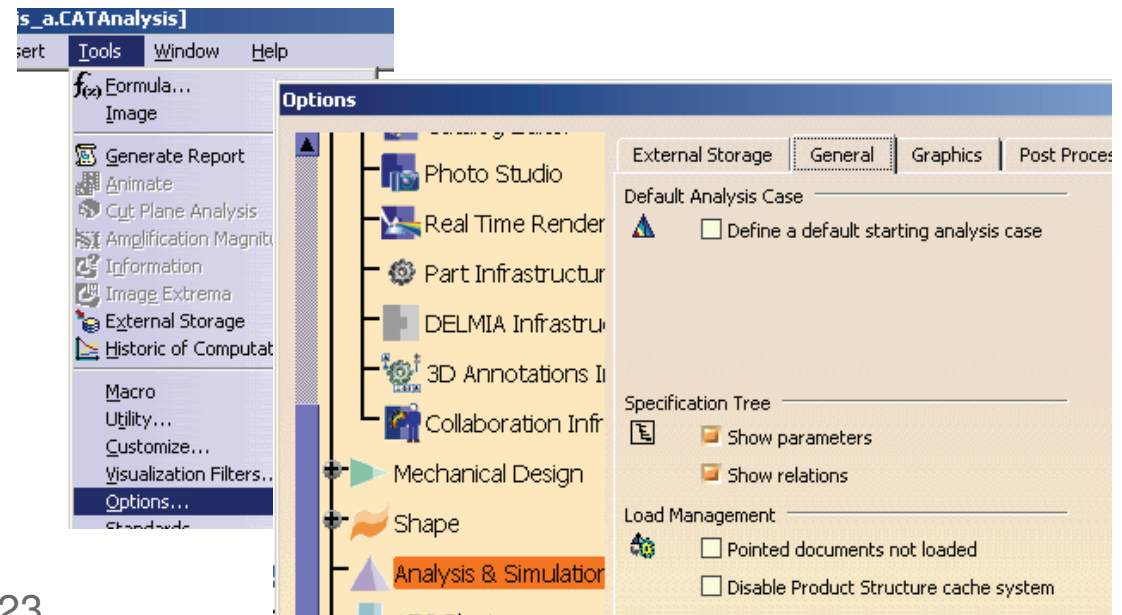
To minimize the tree:-

- Click “+” next to “Link Manger.1”



To Display the User-defined Parameter “Volume” on the tree:-

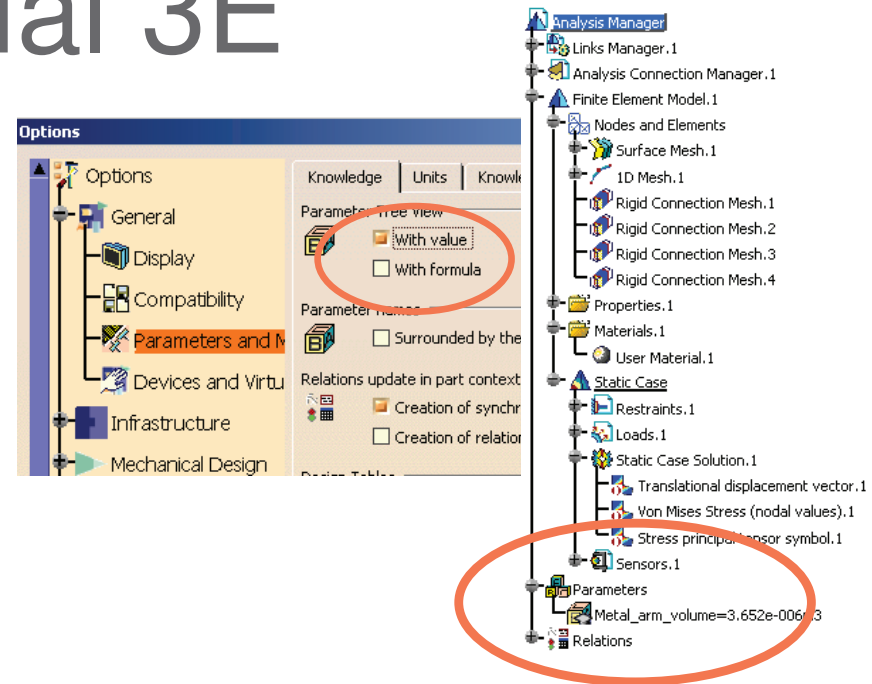
- Select Tools/Options... on the menu bar
- Select “Analysis & Simulation” on the left list
- Select the tab page “General”
- Select “Show parameters”
- Select “Show relations”



Tutorial 3E

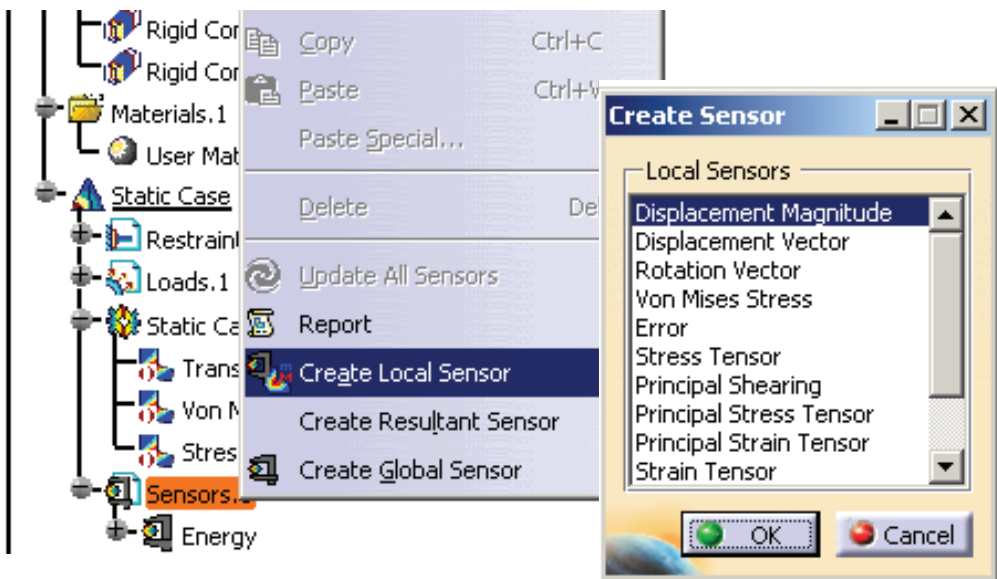
(Con't):-

- Select “Parameters and Measures” on the left list
- Select the tab page “Knowledge”
- Select “With Value”
- Click ok to complete (Now we can see the user-defined parameter “volume” with its value on the tree)



To Create a measurement sensor:-

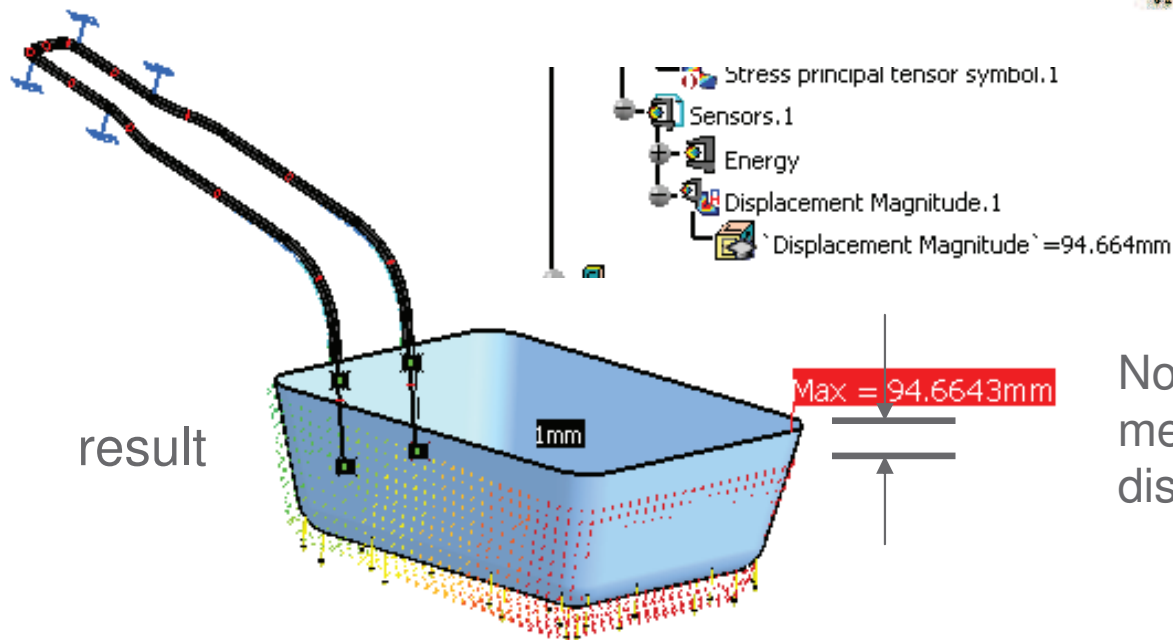
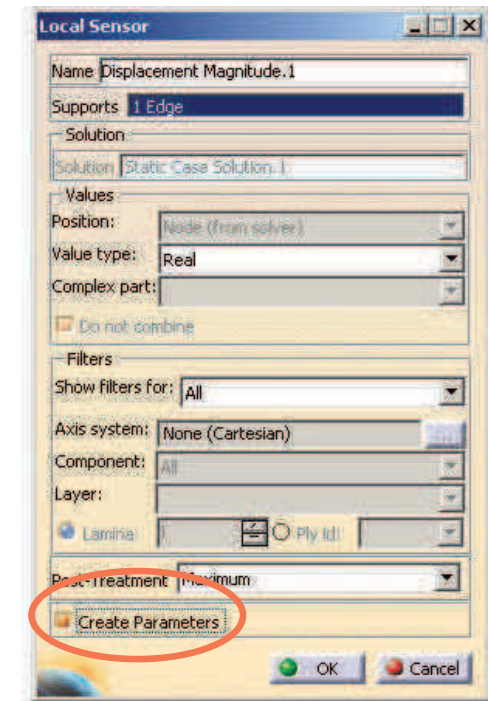
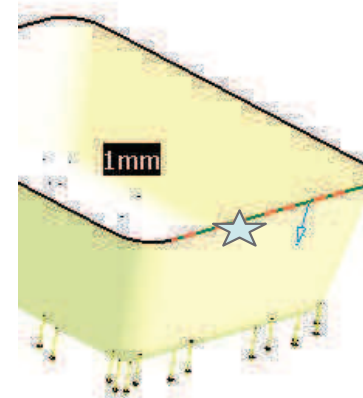
- Right-click “**Sensors**” on the tree
- Select “Create Local Sensor”
- Select “**Displacement Magnitude**” on the list
- Click ok to complete



Tutorial 3E

(Cont'):-

- Double-Click “Displacement Magnitude.1” on the tree
- Unhide the whole assembly
- Select the edge ★ as Supports (Test point)
- Select “Maximum” as Post-Treatment
- Select “Create Parameters”
- Click ok to complete

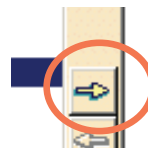
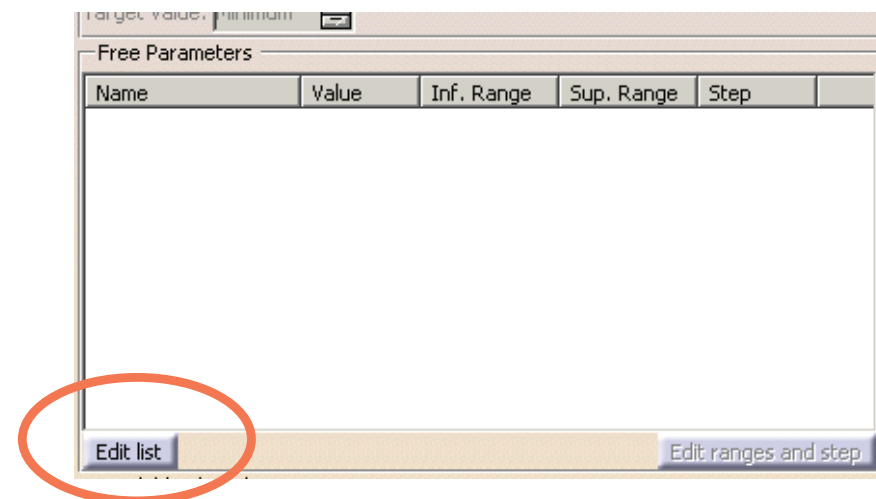
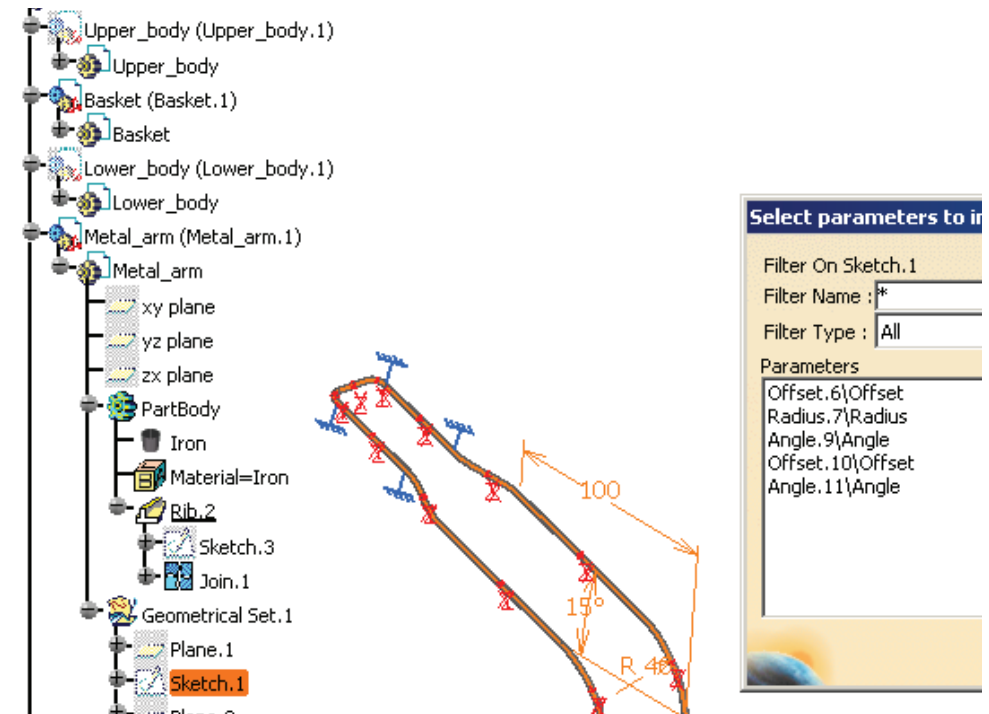


Now we have a sensor to measure the maximum displacement of the basket

Tutorial 3E

To Create a case of Optimization:-

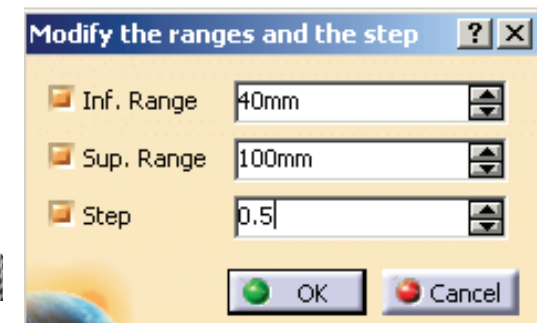
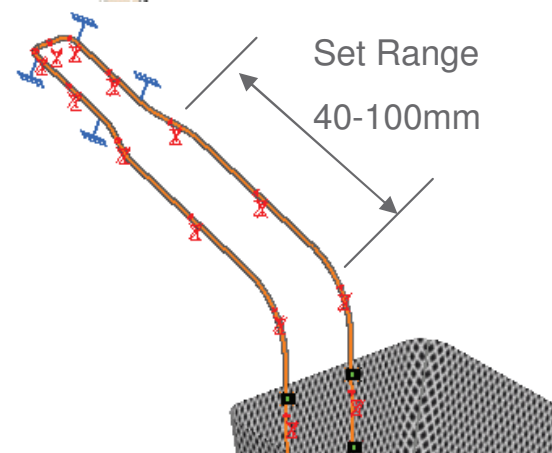
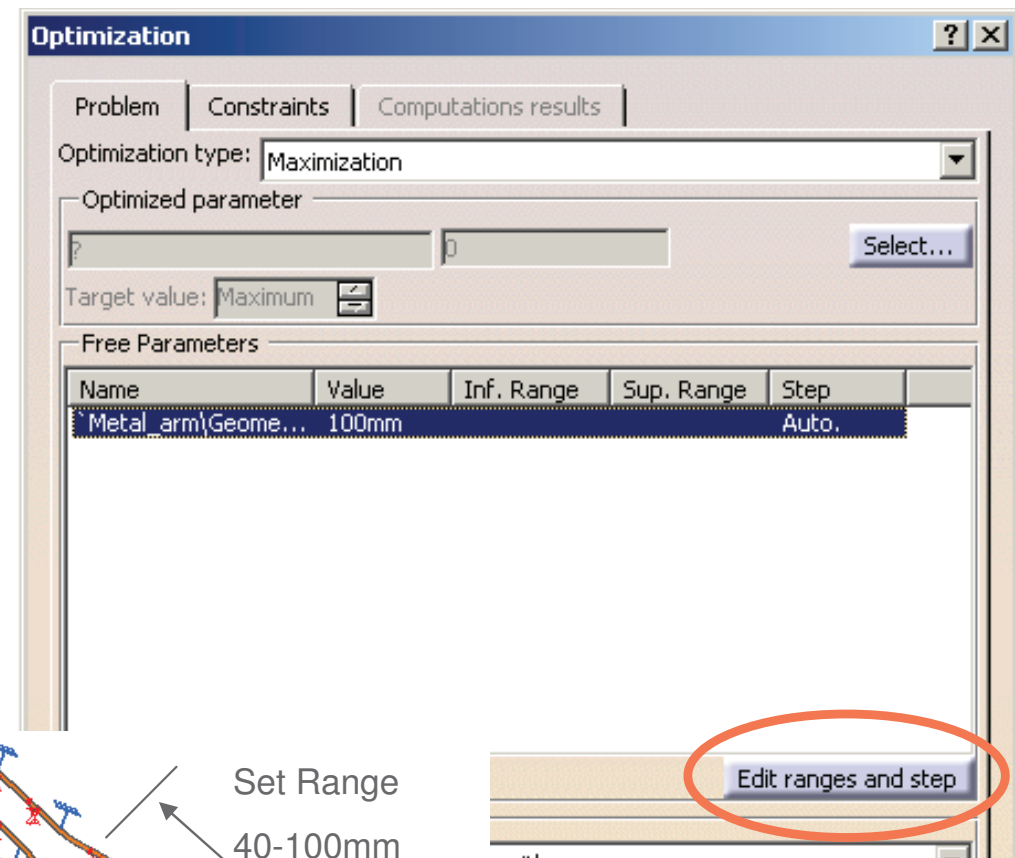
- Select “Start/Knowledgeware/Product Engineering Optimizer” on the menu bar
- Click “**Optimization**” icon
- (1) To define Free Parameters:-
 - (For this case, we choose
 - Diameter of the metal wire
 - Length of a portion of the metal arm)
 - Click “**Edit List**” icon
 - Maximize the tree so that we can see the Geometrical set.1 of Metal Arm
 - Click “**Sketch.1**” once (only related parameters are shown on the list)
 - **Click on the dimension “100”** or click “Offset.10” on the list (They are the same)
 - Click the arrow icon
 - Click ok to complete



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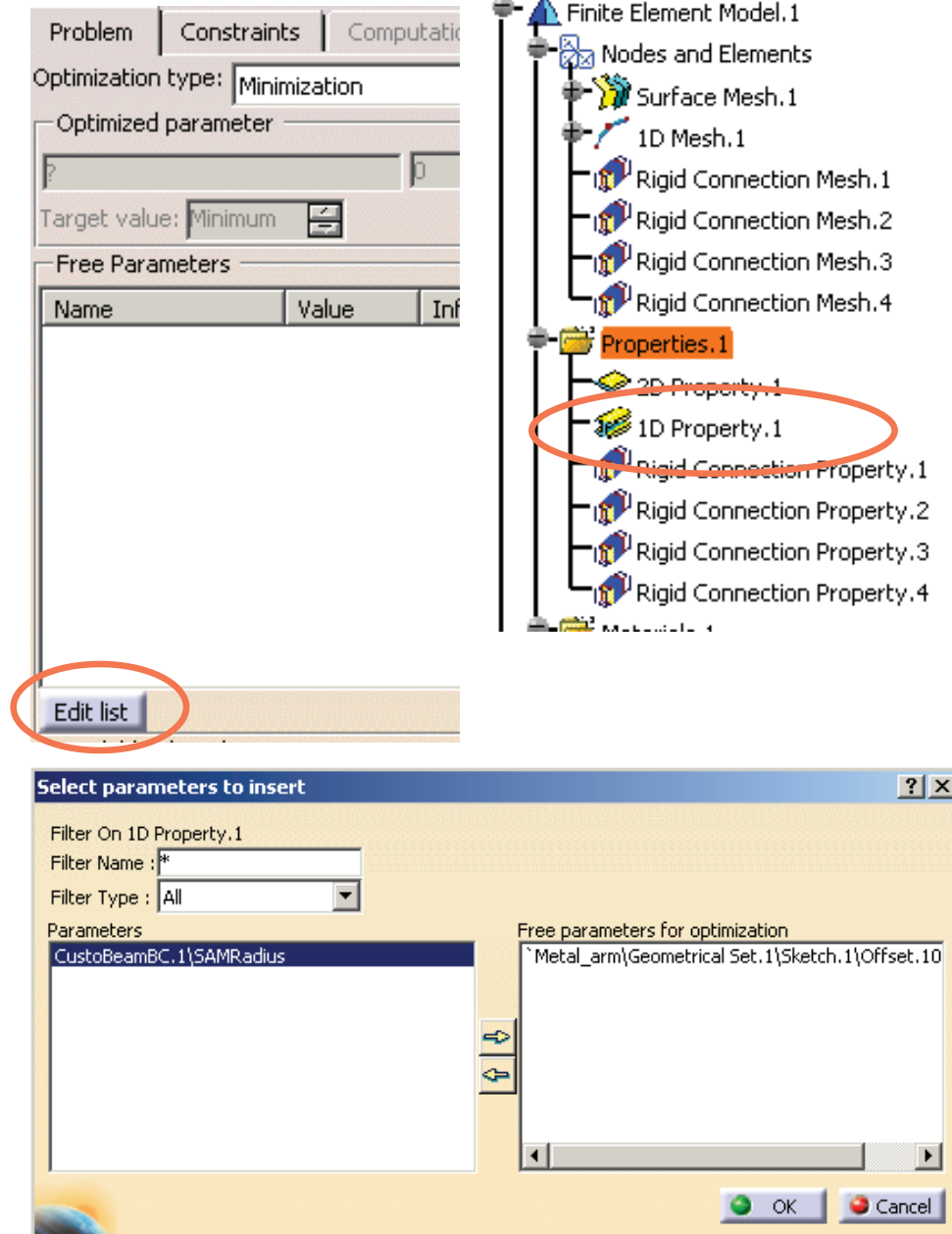
Tutorial 3E

- (Con't) :-
 - (Now a parameter is added on the list of Free Parameters)
 - Single Click on this parameter
 - Click “Edit ranges and step”
 - Select the box next to Inf. Range
 - Enter 40mm as Inf. Range (lower limit)
 - Select the box next to Sup. Range
 - Enter 100mm as Sup. Range (upper limit)
 - Select the box next to Step
 - Enter 0.5mm as Step
 - Click ok to complete



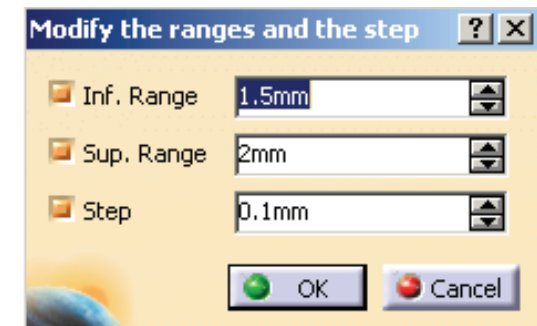
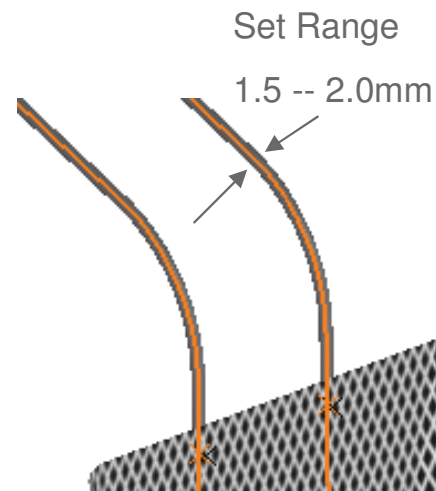
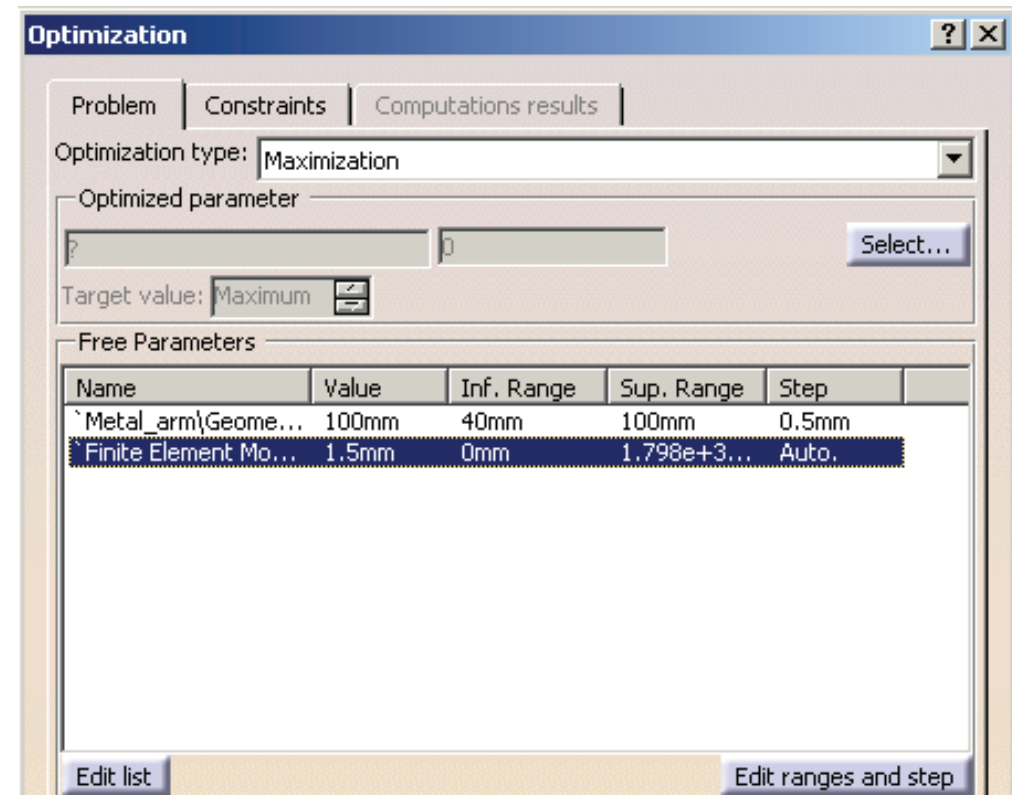
Tutorial 3E

- (Con't):-
 - Click “+” next to “Link Manger.1” to minimize the tree
 - Click “**Edit List**” icon again
 - Maximize the tree so that we can see the Properties.1 of Finite Element Model.1
 - Click “1D Property.1” once (only related parameters are shown on the list)
 - Click the one and the only parameter on the left list, which is the radius of the 1D mesh
 - Click the arrow icon 
 - Click ok to complete



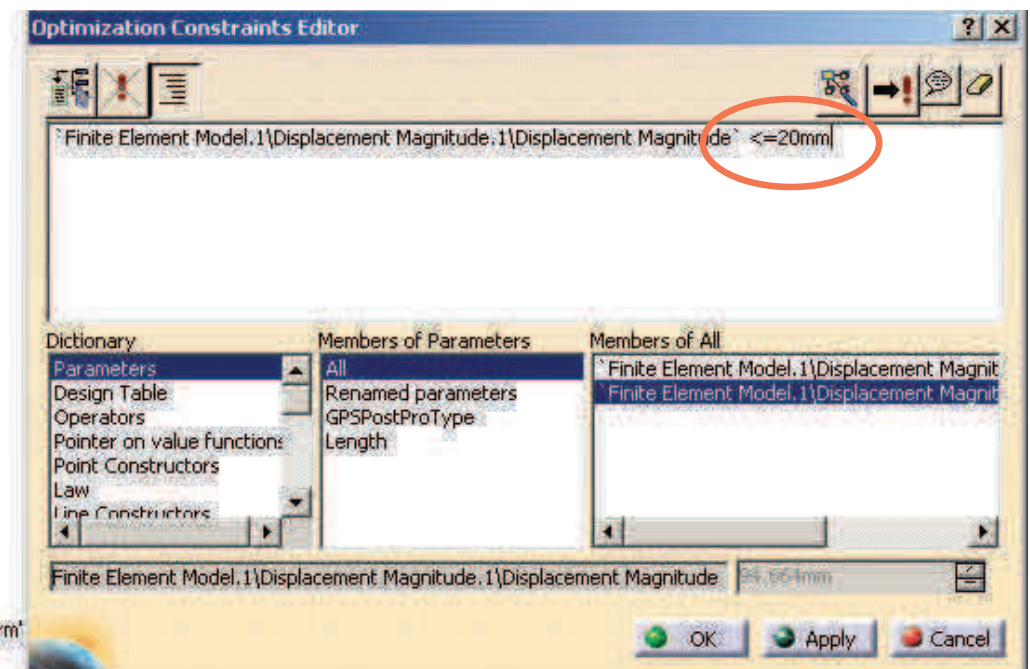
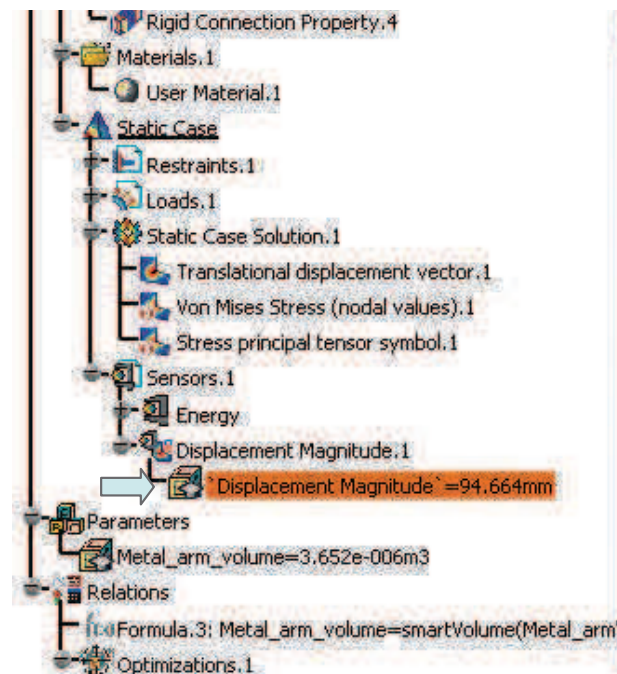
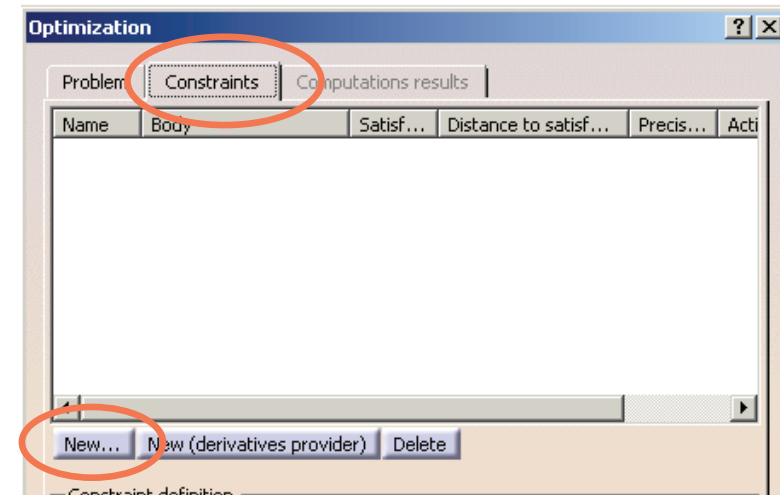
Tutorial 3E

- (Con't) :-
 - (Now the 2nd parameter is added on the list of Free Parameters)
 - Single Click on this parameter
 - Click “Edit ranges and step”
 - Select the box next to Inf. Range
 - Enter 1.5mm as Inf. Range (lower limit)
 - Select the box next to Sup. Range
 - Enter 2mm as Sup. Range (upper limit)
 - Select the box next to Step
 - Enter 0.1mm as Step
 - Click ok to complete



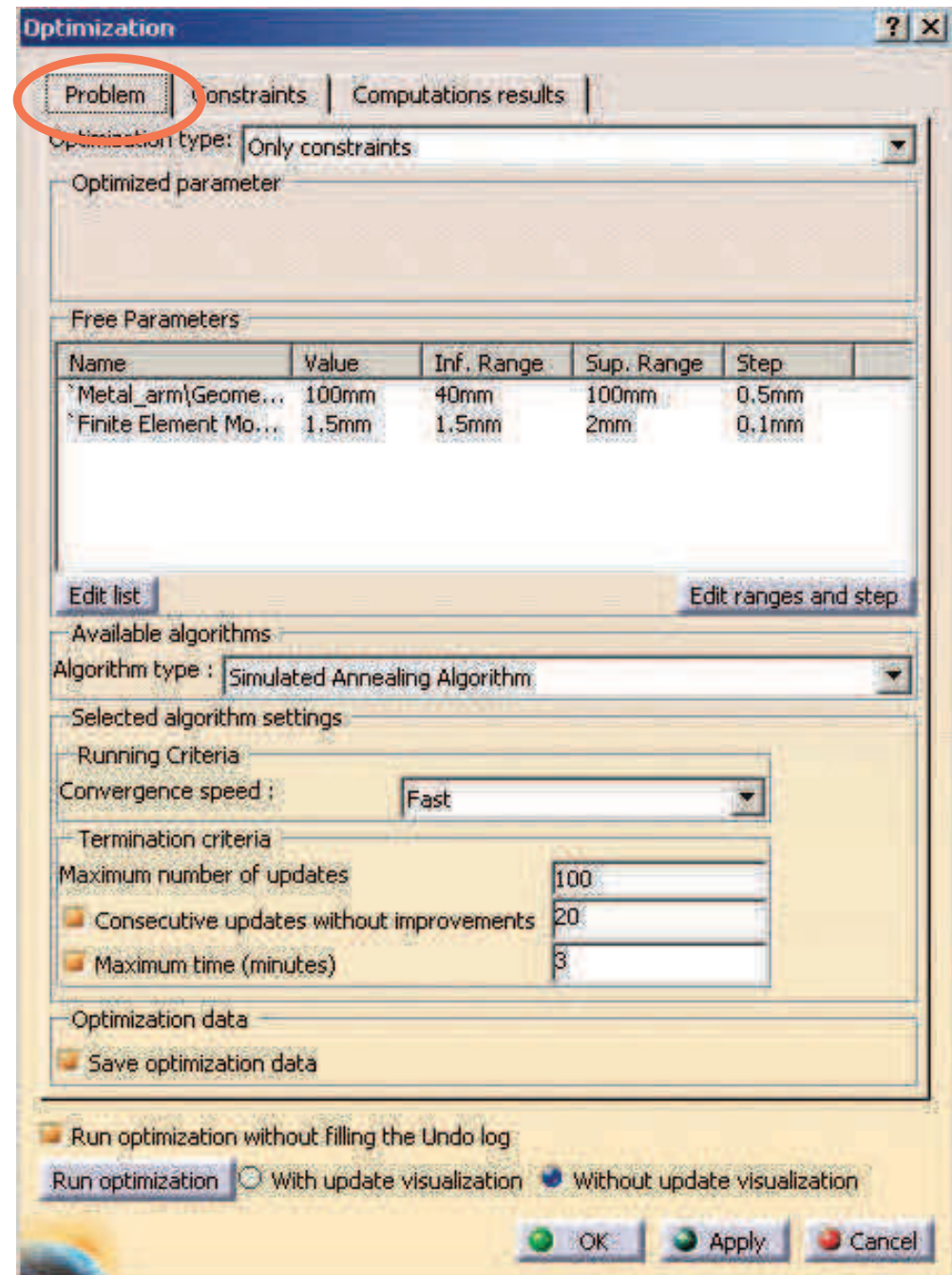
Tutorial 3E

- (2) To define Constraints:-
 - Select the tab page “**Constraint**”
 - Click “New...” icon
 - Select “Displacement Magnitude” under Sensor.1 on the tree
 - Then add “<=20mm” after the words
 - Click ok to complete



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- (3) Define computation method:-
 - Select the tab page “**Problem**”
 - Select “**Only Constraints**” as Optimization Type
 - Select “Simulated Annealing Algorithm” as Algorithm type”
 - Set Termination Criteria:
 - a. Enter 100 as Maximum number of updates
 - b. Enter 20 as Consecutive updates without improvements
 - c. Enter 3 as Maximum Time (minutes)
(If any of these is fulfilled, the computation will stop)
 - Select “Save Optimization data” (so that we can see all raw data after computation)



Tutorial 3E

To RUN Optimization:-

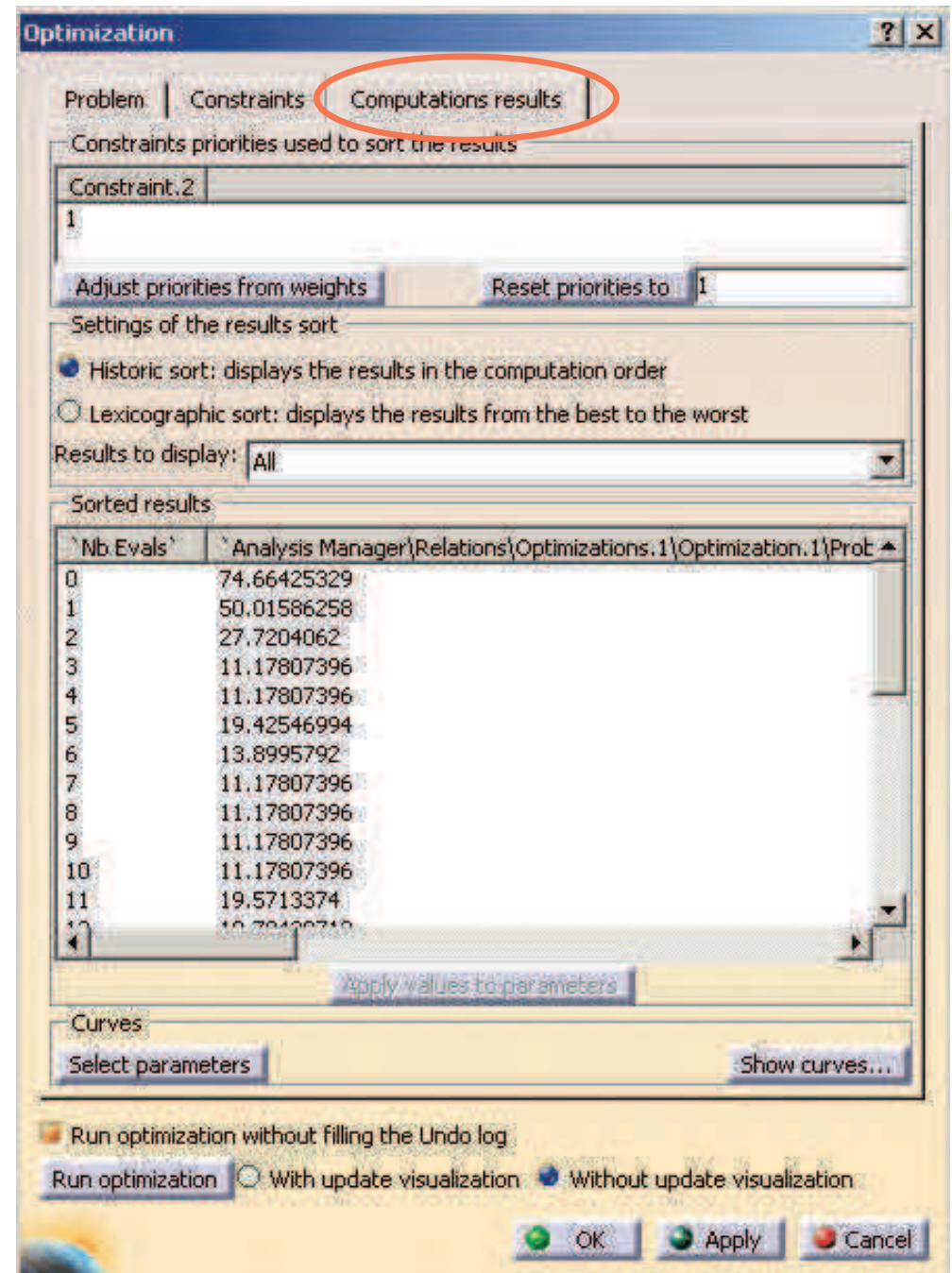
- Click “**Run Optimization**” icon
- Enter “Data” as file name (all the raw data will be stored in this excel file)
- Click “Save” to start computation

(The computer starts to search all possible values of the two free parameters so that the constraint can be met)

(After 3 minutes)

To review the results:-

- Select the tab page “**Computation Results**”
- On the list, all attempts failed until #19 (i.e. Result – Target = 0)



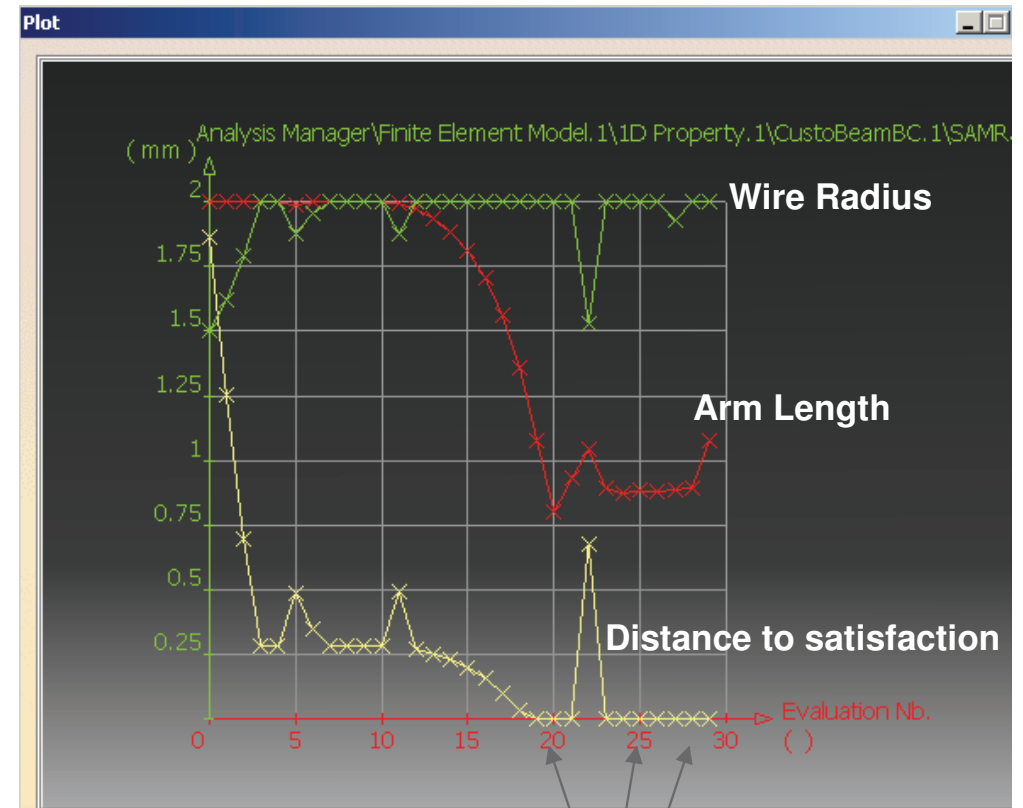
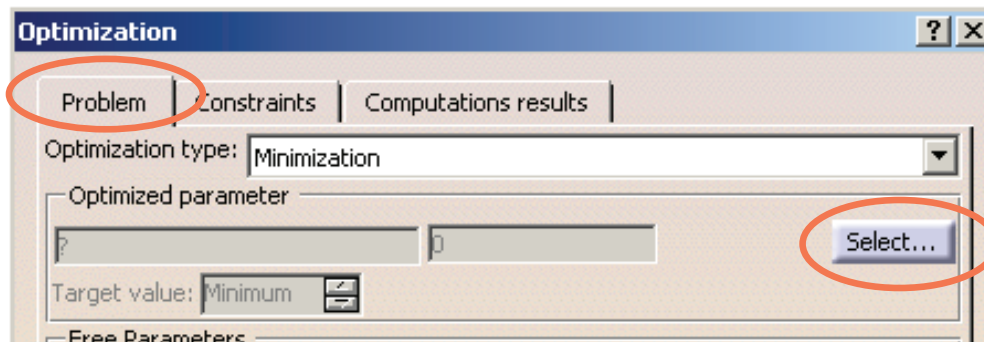
Tutorial 3E

(Cont'):-

- Select “Show Curve” icon
- On the list, the four attempts failed but the rest can meet the requirement (i.e. Result – Target = 0)

To Further optimize the parameters (for the minimum volume of metal arm):-

- Select the tab page “**Problem**” again
- Select “**Minimization**” as Optimization type
- Click “Select” icon



Only a few can meet the requirement. But which one can give the minimum volume?

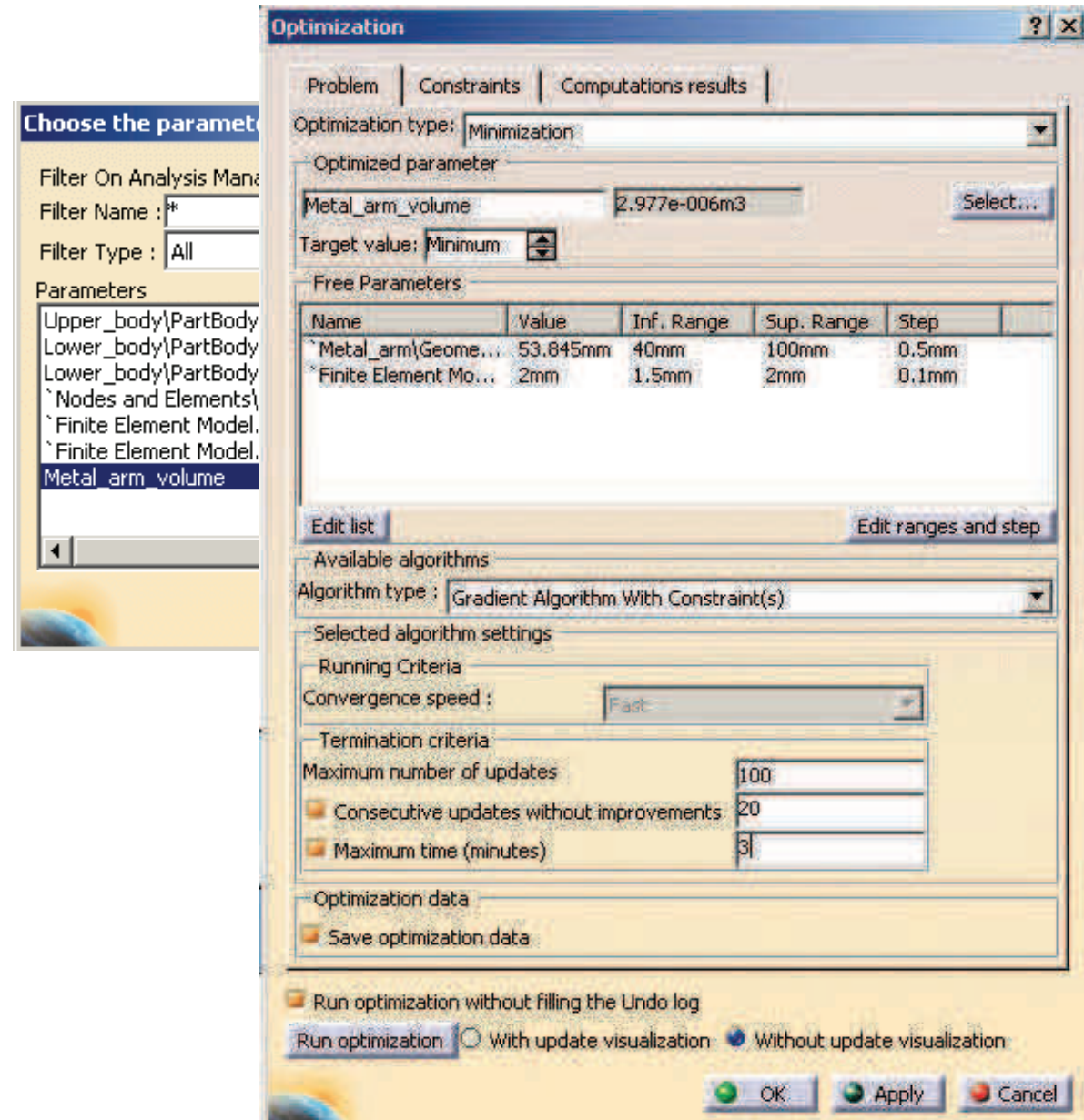
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(Cont') :-

- Select “Metal_arm_volume” on the list
- Click ok to complete
- Select “**Gradient Algorithm with Constraints**” as Algorithm type”
- Set Termination Criteria:
 - Enter 100 as Maximum number of updates
 - Enter 20 as Consecutive updates without improvements
 - Enter 3 as Maximum Time (minutes)
(If any of these is fulfilled, the computation will stop)

To RUN Optimization again:-

- Click “Run Optimization” icon
- Select Yes to overwrite the data file



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To review the result:-

- Select the tab page “**Computation Results**”
- Select “Select parameters” icon, then add “metal_arm_volume” onto the list “parameters to be displayed”
- Select “Show Curve...” icon

From the curve, the best values are:

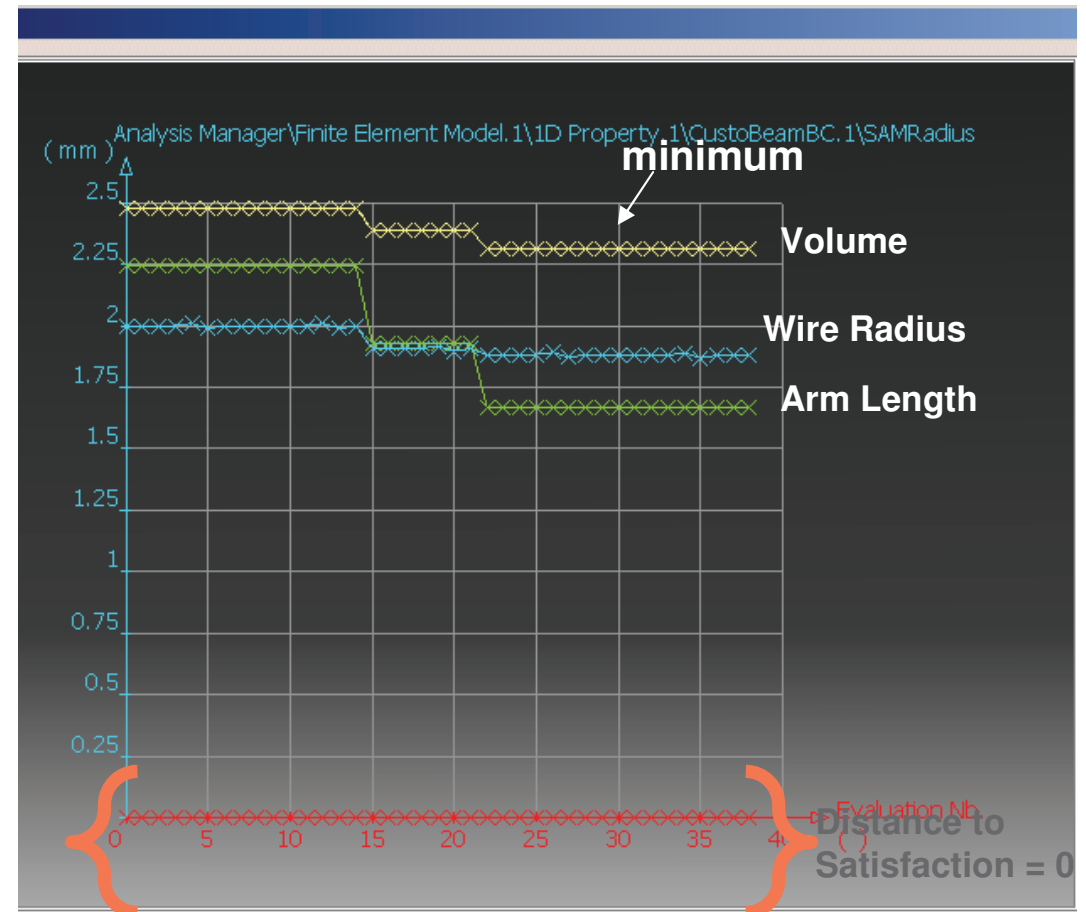
Wire Radius = 1.9mm

Arm Length = 40mm

Its volume is the smallest but it is still so strong that the deflection is lower than the required limit.

To Save all files:-

- Select “**File/Save all**”



In this revised optimization, all cases can meet the requirement (i.e. deflection of basket is smaller than 20mm)

END of Tutorial 3E

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