Fabrizio D'Errico

The QFD4Mat User Manual

Ver.0.2 (TESTING)

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Annex to:

F.D'Errico, Material Selections by a Hybrid Multi-Criteria Approach

Springer

NOTE: Only the white colored cells are editable

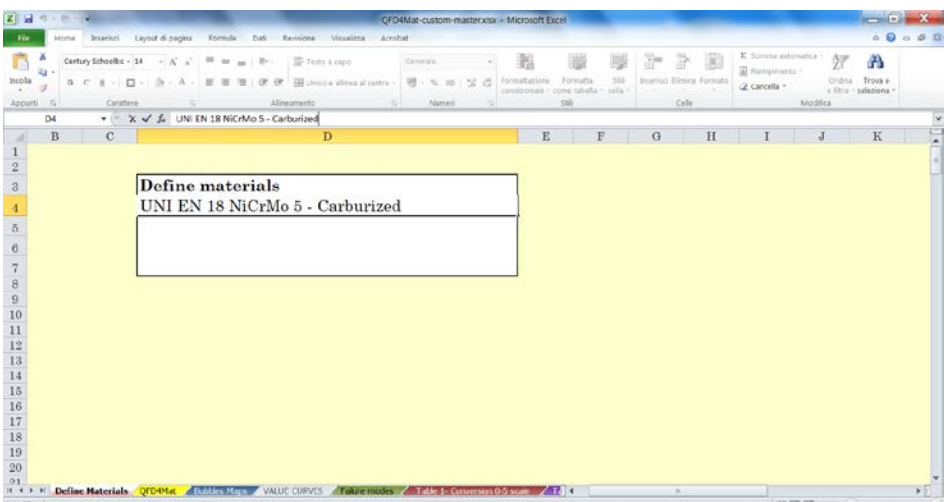
Active sheets:

- Define materials
- QFD4Mat
- Bubble Maps
- Value Curves
- Failure Modes
- Table 1 – Conversion 0-5 scale
- Table 2 – ASHBY Indexes
- Table 3 – Symbols for Ashby Indexes

Step 1:

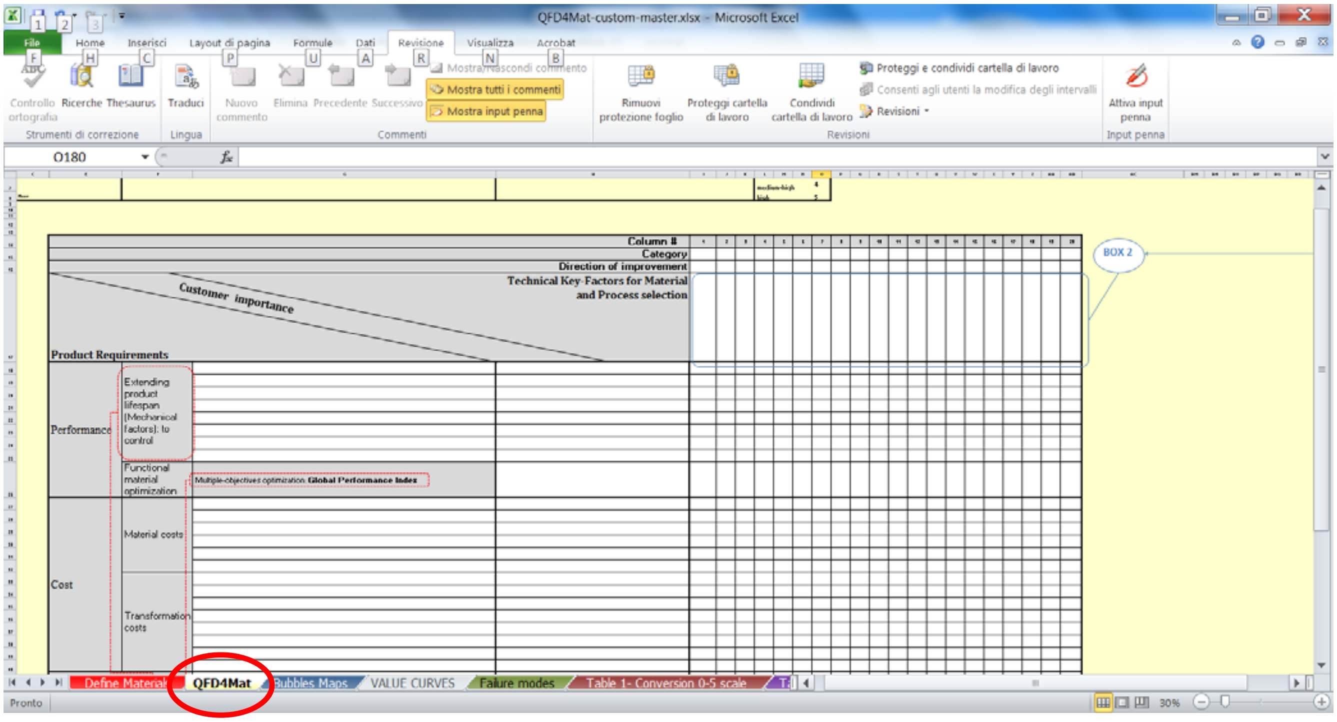
1.1) Activate “DEFINE MATERIAL” sheet

1.2) Define candidate material; write in cell the candidate material to screen (UP TO 4 materials can be contemporarily screened)

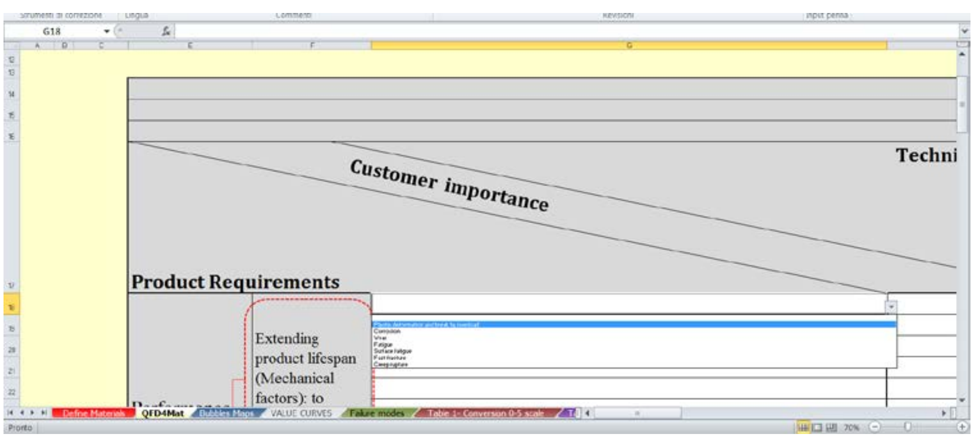


Step 2:

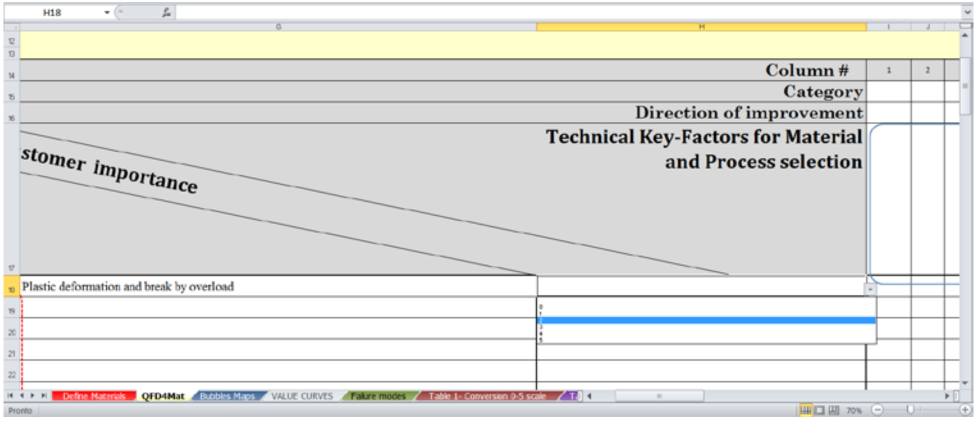
2.1) Activate the “QFD4Mat” sheet by click on the QFD4Mat tag;



2.2) Start to filling up white cells in the left shoulder of the matrix, the **Product Requirements** or **product key-features**; chose one of seven failure modes;



2.3) Insert the relative importance score (0 to 5 values are allowed);



2.4) Complete the left-shoulder of the QFD4Mat; a maximum of 29 product key-features are allowed in the free-excel version:

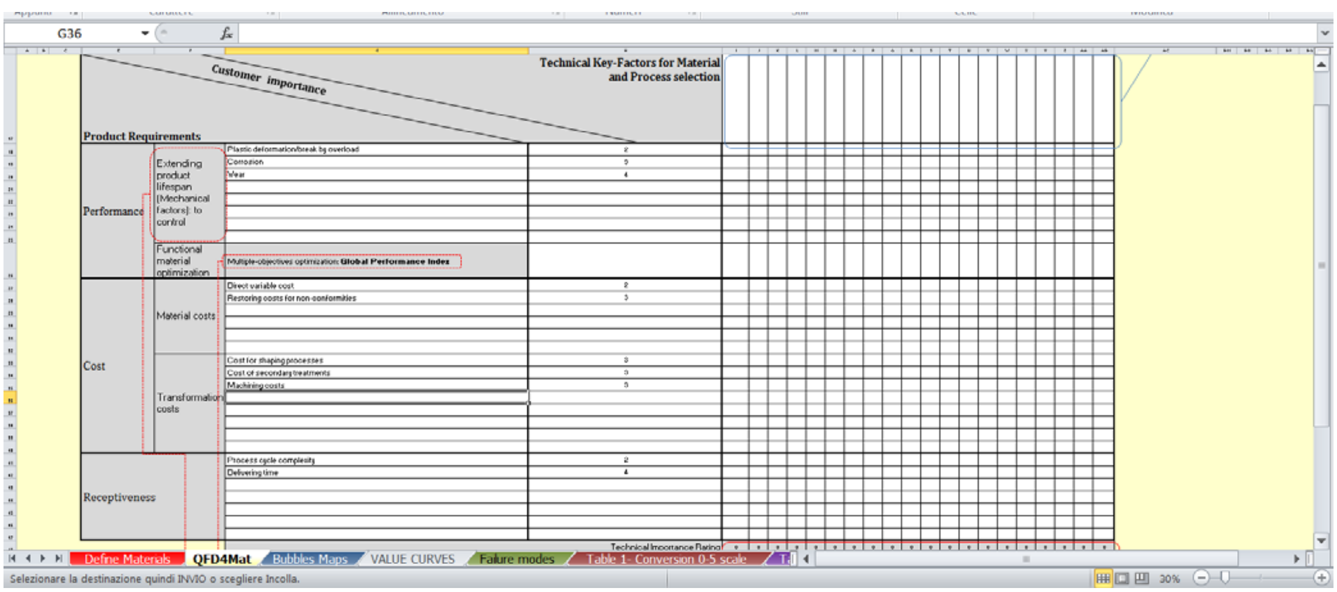
- 8 product key-features for Failure Modes;

- 6 product key-features for Material Cost subcategory;

- 8 product key-features for the Transformation Cost subcategory;

- 7 product key-features for the Receptiveness category;

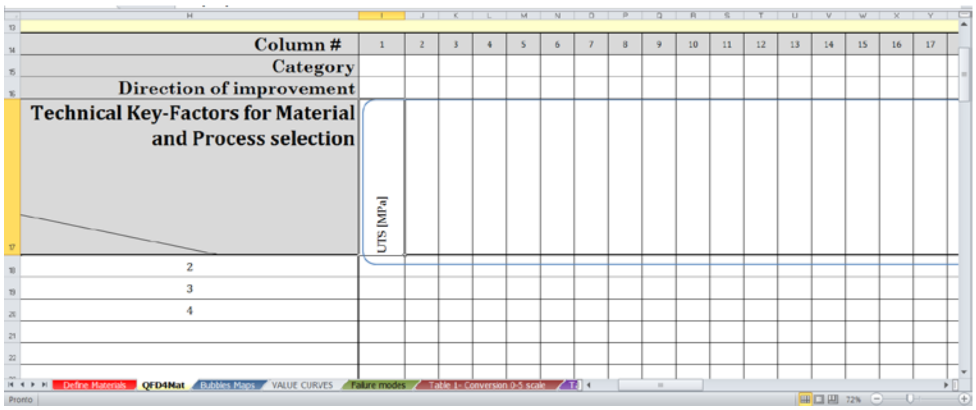
<u>NOTE:</u> To the above **product key-features,** further **GLOBAL PERFORMANCE INDEX** ca**n** be added. To calculate it, when needed, you may refer to file "**Global Material Index-custom.xls**" provided.



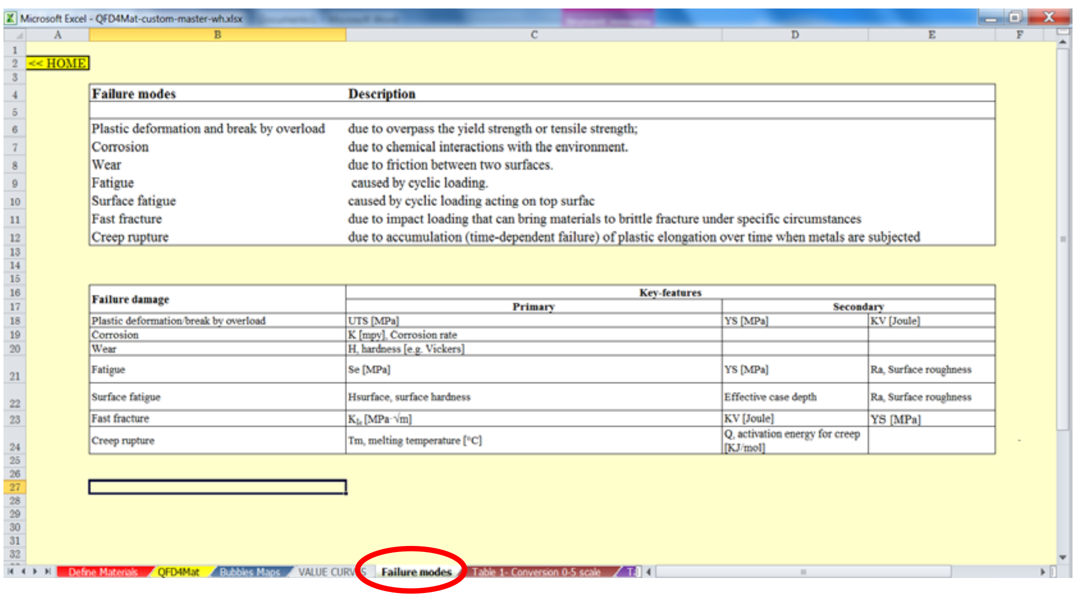
<u>Step 3:</u>

3.1) Start to fill up the top of the matrix by completing per column (20 columns are avaliable in this free-excle version) as it follows:

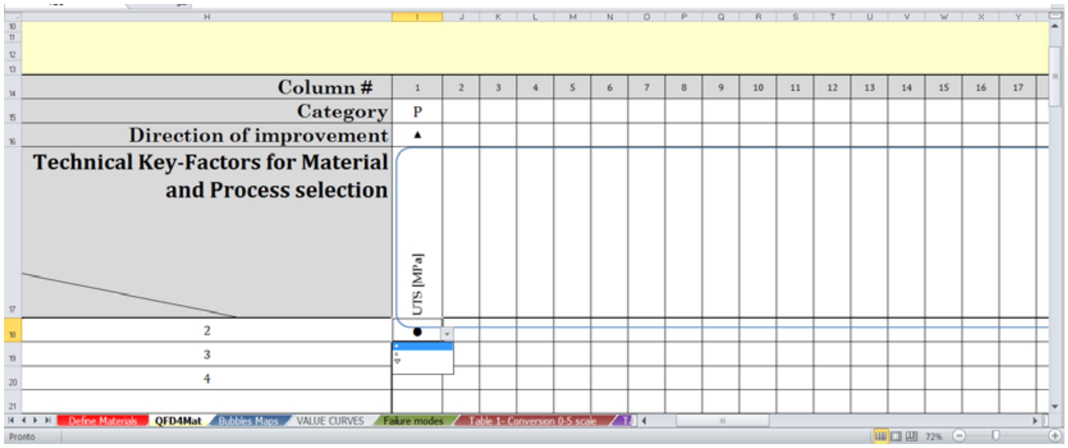
3.1.1) Write the **Key-Factors for Material and Process Selection** (hereinafter key-factors or key-features of material) of your interest.



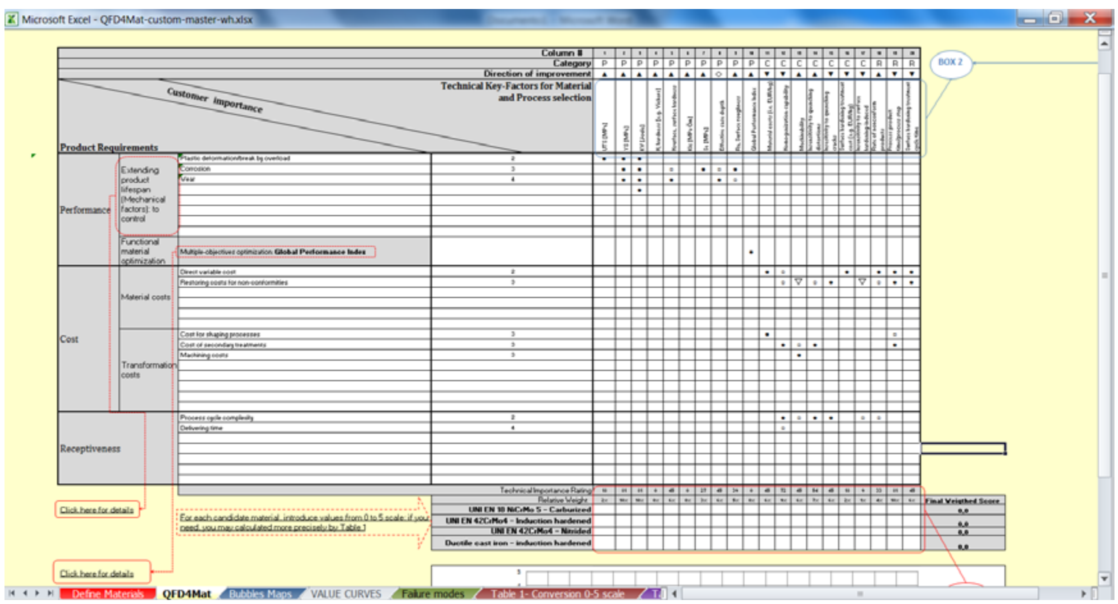
NOTE: For the "Failure MODE" subcategory category, it is suggested to refer to the sheet "FAILURE MODE" (see figure below);



3.1.2) Fill up for the **Key-Factors** identified the: a) the Direction of Improvement (choose "▲" if improvement increases as key-feature increase, or "▼" in the opposite case); b) the category of the key-factors, distinguishing in: P = Performance, C = cost and R = Receptiveness; c) in the cells that build the **correlation matrix space**, scrolling down the column for the specific key-factor you are addressing, define the type of correlation (i.e. strong "●", medium "○", weak "▽", left empty cell for no correlation) between the **key-Factor** (the column of correlation matrix space) of material you defined (e.g. UTS in the example here below) and the **Key-Product features** (the rows of correlation matrix space) defined at **Step 1**. Note that a multiple correlation is possible, since each key-factor (i.e. correlation matrix column) can be linked to multiple product key-features (i.e. correlation matrix rows).



3.1.3) Proceed by this way to complete the analysis for each column, namely for each **Key-Factor** you might consider, the direction of improvement (e.g. either ▲ or ▼), the category (**P, C or R**) and the correlation type (strong "●", medium "○", weak "▽", strength, no correlation). See the final result in the example just below.



Step 4

Now you need to score the 4 candidate materials per each key-factor by a 0-5 nondimensional scale. To this scope, for each column representing the key-factor you included in the analyses at STEP 3 (see the task 3.1.1), and per each candidate material you have to express the rate basing on a 0-5 scale. Because key-factor are usually measureable or quantifiable, you may use the **conversion module** provided in the sheet **"TABLE 1 – Conversion 0-5 scale"**, as shown in the example just below (as usual, consider white cell as the only editable cells):

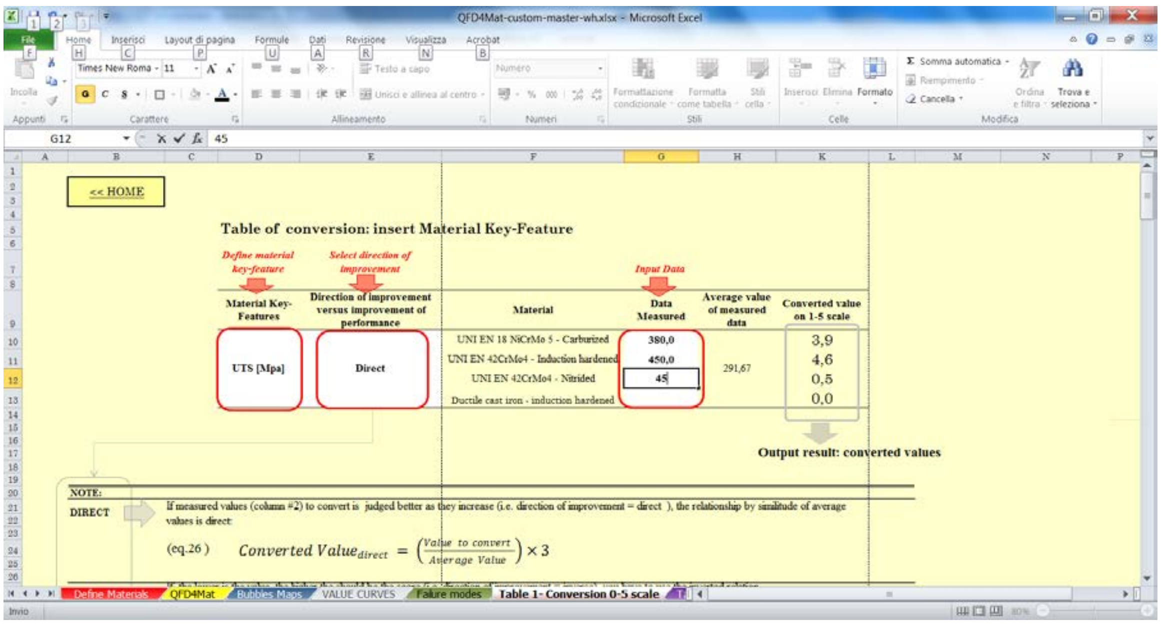
4.1) Activate the **"TABLE 1 – Conversion 0-5 scale"** that reports the conversion table module;

4.2) Define from left to right:

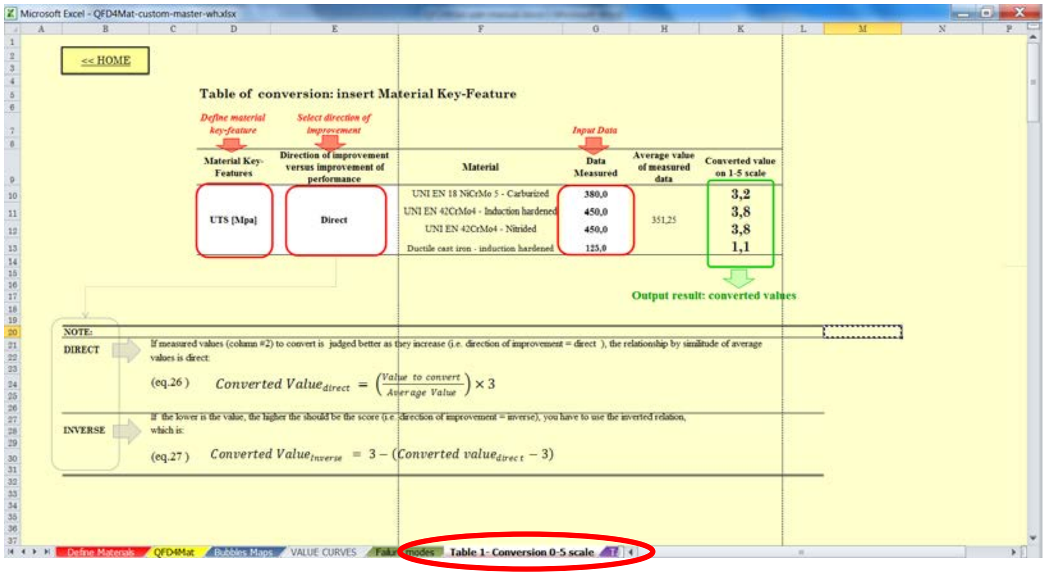
4.2.1) the quantifiable key-factor you want to convert in 0-5 non dimensional scale (in the example we set the UTS measured in MPa);

4.2.2) the direction of improvement, by selecting **"direct"** in case the higher is the quantified key-factor, the higher is the product performance (e.g. ultimate tensile strength, UTS, of material for a structural component) or "inverse" in case the higher is the key-factor value, the lower is the performance of product (e.g. material density for lightweight component).

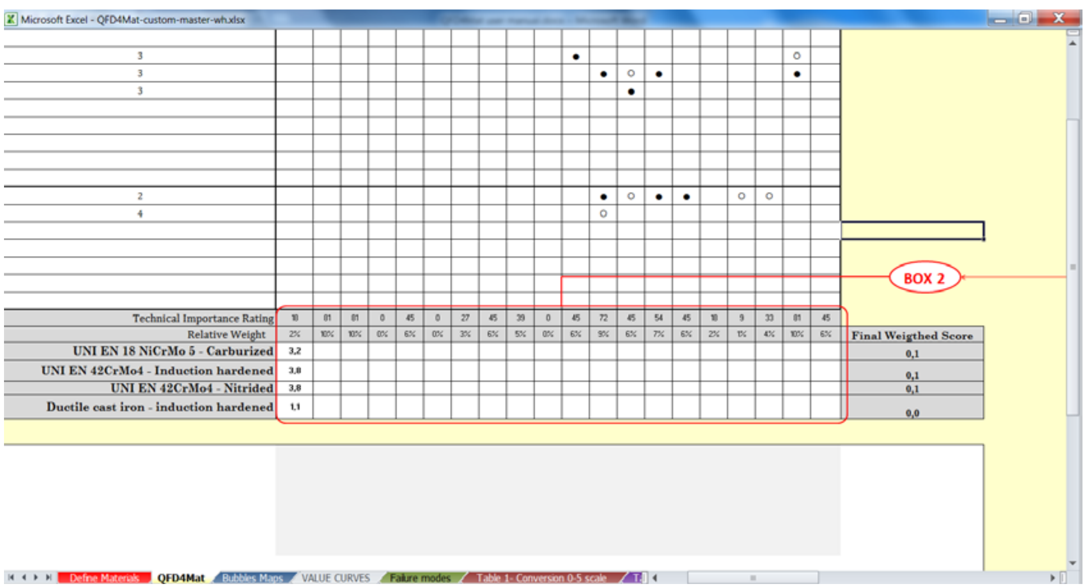
4.2.3) The data values (from table, database, etc.) for each candidate material;



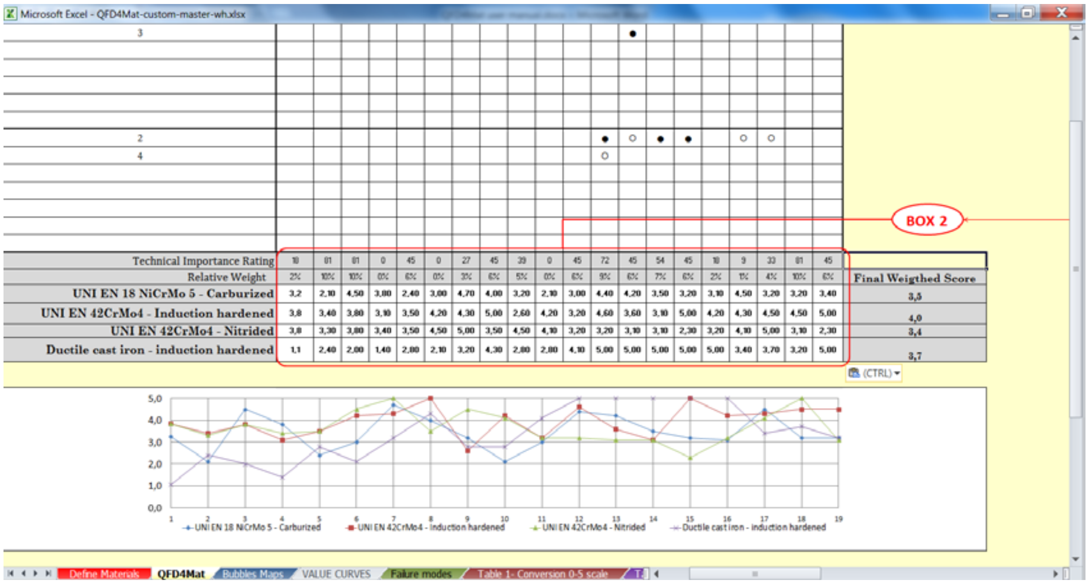
The final result is shown in figure below.

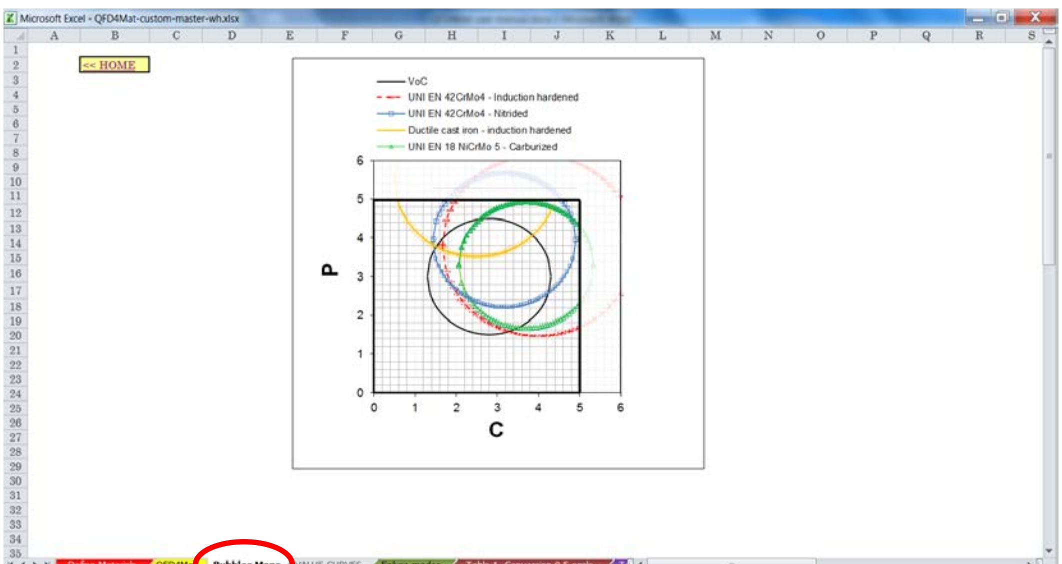


4.3) Copy the values obtained by task 4.2.3 in the sheet **QFD4Mat**, specifically in the first column of BOX 2, as it is shown below:



4.4) Proceed as for the task 4.3 to complete the BOX 2 data. The final result is shown below. **Final Score** are calculated, the **comparative diagram** is drawn and the **Bubble Maps** have been automatically drawn (carefully verify, before to check the **BUBBLE MAPS** by activating the “BUBBLE MAP” sheet that you have assigned to each Key-Factor (i.e. each column) the category **P, C or R**, as you should have done in task 3.1.3.

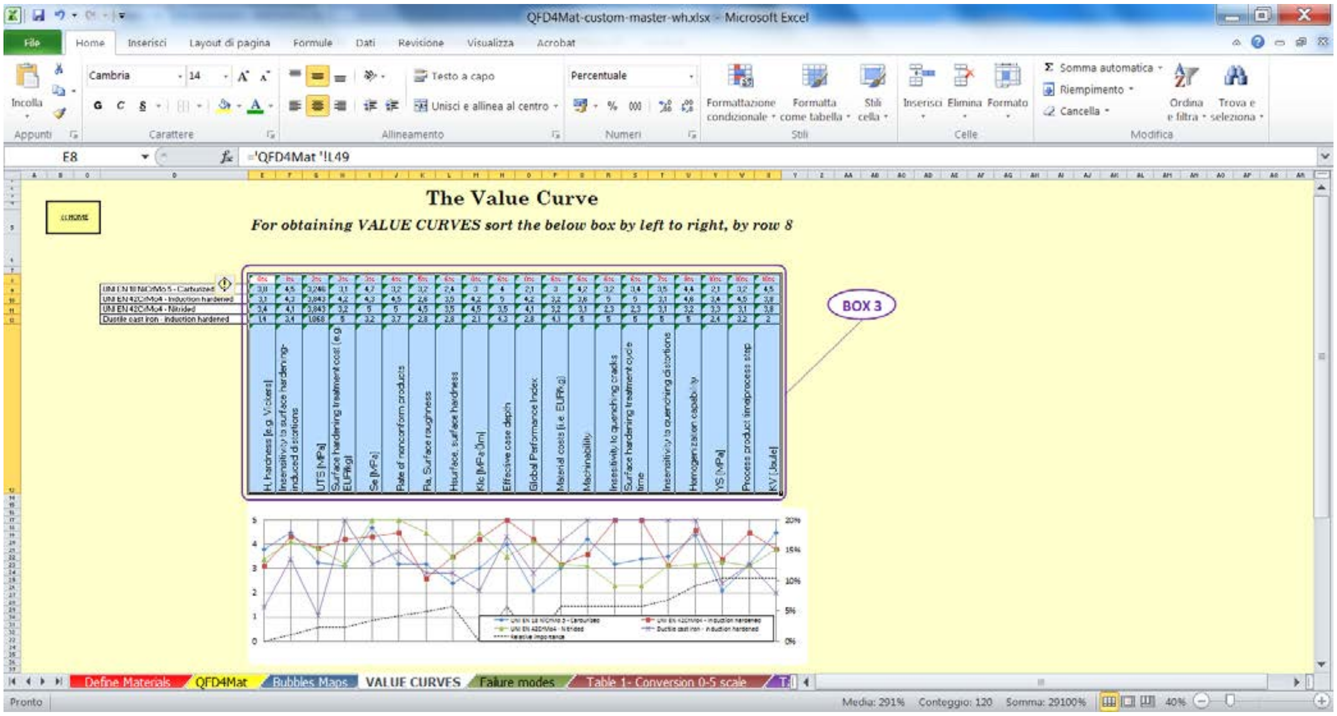




Step 5

To draw the product VALUE CURVE, proceed as follows:

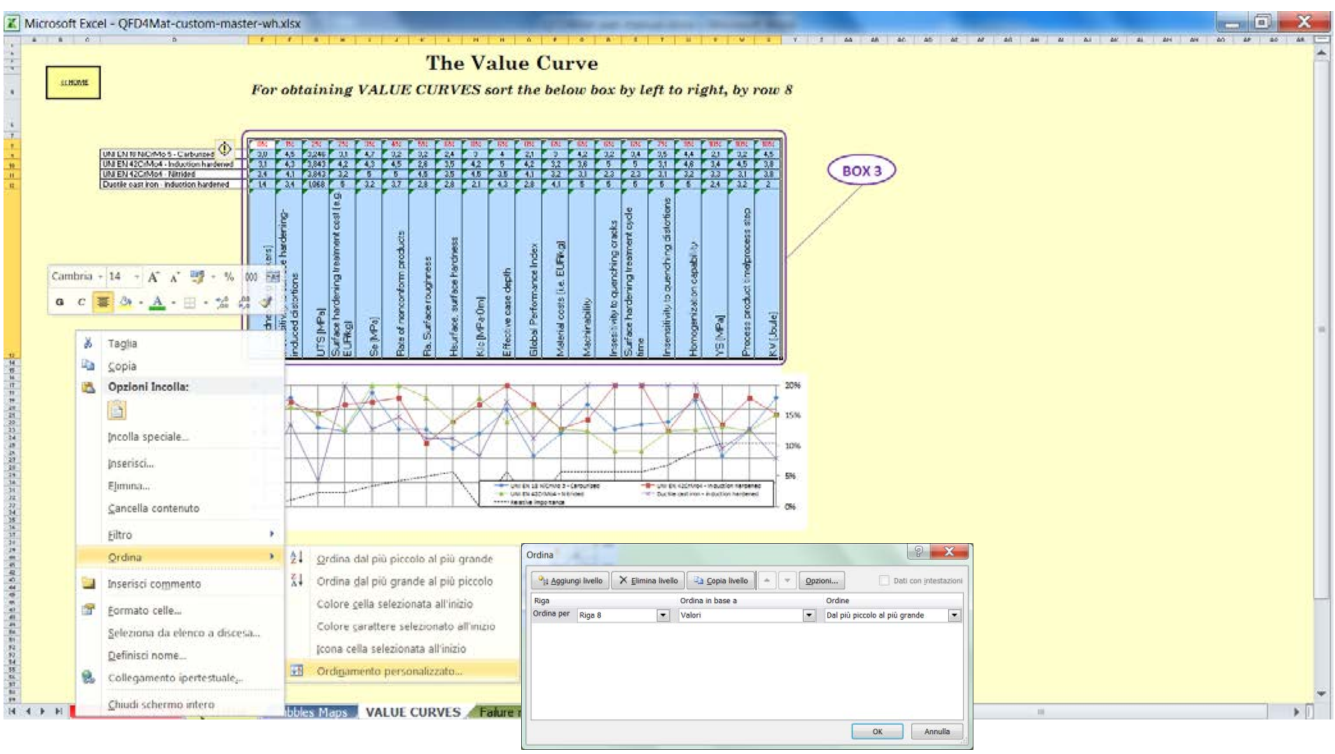
5.1) Activate the "**VALUE CURVES**" sheet (note that data in BOX 2 have been automatically reported in the VALUE CURVES sheet). These CURVES are not yet sorted by the lowest to highest value by the **RELATIVE IMPORTANCE** expressed in percentage. This is **clearly visible if you refer to dotted line ("relative importance" data series) in the diagram below.**



You just need to sort correctly data, as it is follows:

5.3.1) select all the data in the BOX 3 (see above);

5.3.2) sort them in column by row “8”, as it is shown in the example below:



The final result is shown in figure below: