# Improvement tool idea. Creation of marking points in drawings.

30.09.2016

Miroslaw Dyduch

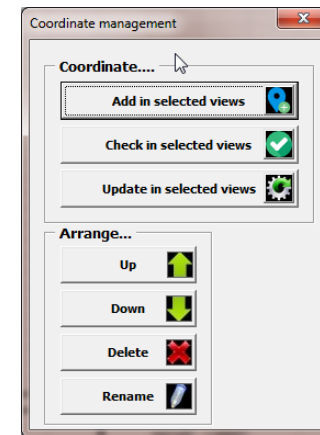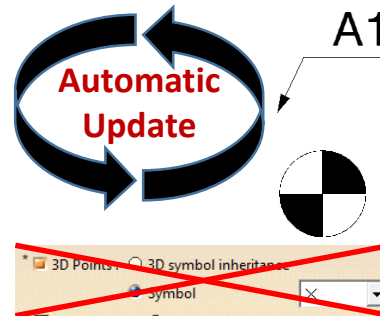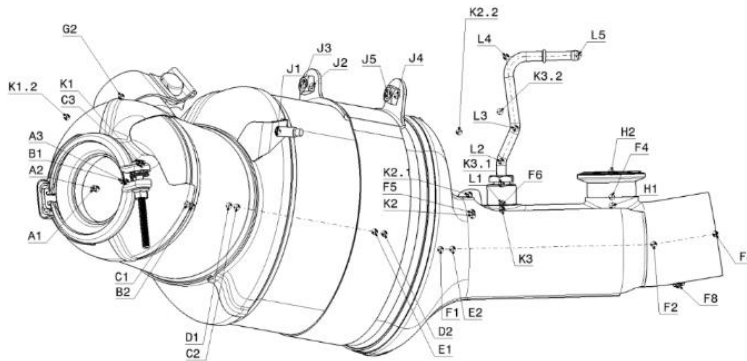| COORDINATES			
Name	X	Y	Z
A1	1679,99	-252,47	1545,41
A2	1682,32	-252,7	1542,79
A3	1706,96	-247,1	1511,91
B1	1704,06	-246,05	1517,06
B2	1761,56	-266,93	1414,98
C1	1757,69	-265,53	1421,85
C2	1798,99	-267,77	1362,25
C3	1717,51	-231,17	1369,42
C4	1736,6	-215,84	1325,71
D1	1792,33	-266,57	1366,53
D2	1921,58	-289,89	1283,46
E1	1913,29	-288,24	1288,81
E2	1978,06	-302,65	1272,16
F1	1968,13	-302,89	1273,39
F2	2144,79	-298,69	1251,54
F3	2195,65	-290,04	1250,41
F4	2110,11	-259,5	1256,12
F5	1994,25	-272,25	1250,03
F6	2019	-266,18	1267,98
F7	2053,2	-271,78	1282,6
F8	2165,35	-332,69	1244,94

A1
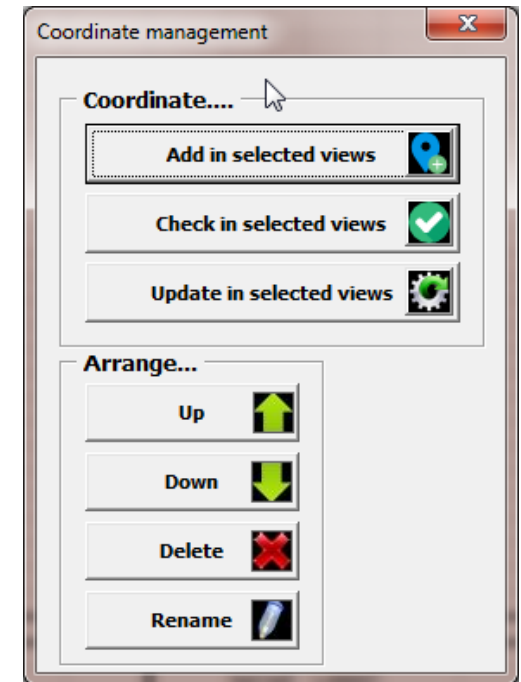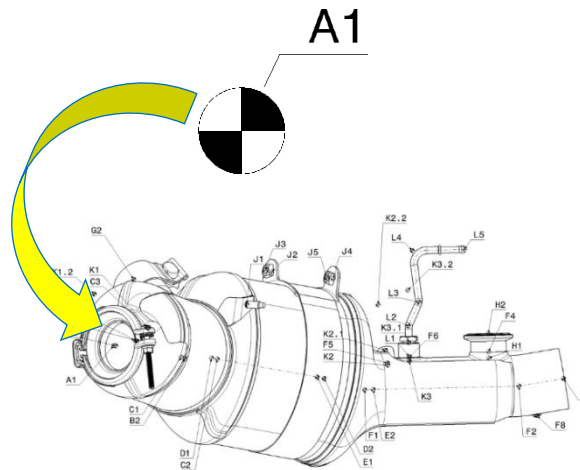
Current state.

- Controlling of points in drawing views belongs to standard responsibilities of designers.

- Points names ("Text with leader" and "Marking point") are to be created manually.

- Points position drawings is not obvious often.

- It needs usually to switch between 2d and 3d to visualise 3d points in views to update them in drawings later on.

- Generated elements in drawing views are not exposed in the VBA (Application Programing Interface).
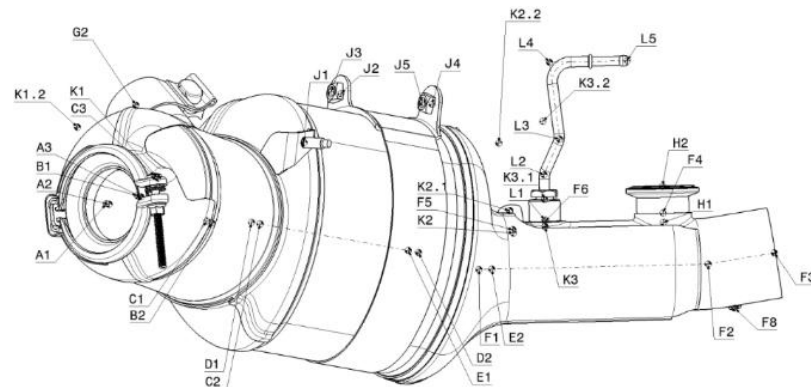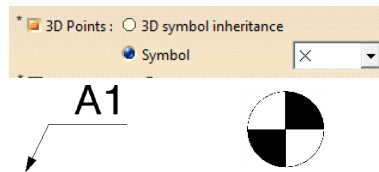
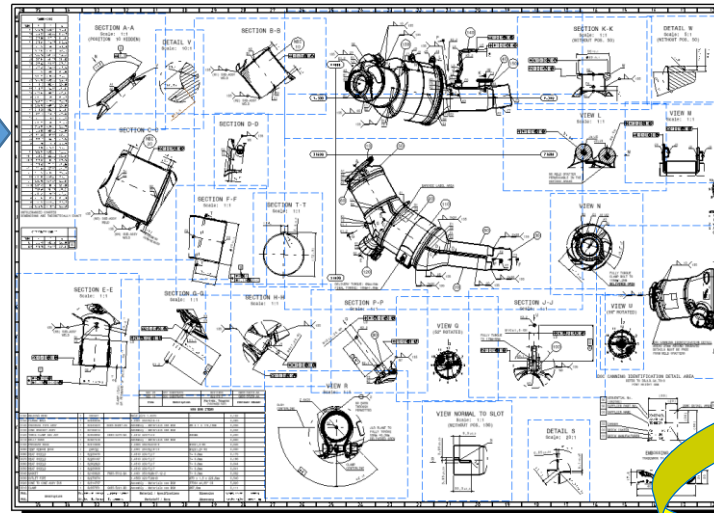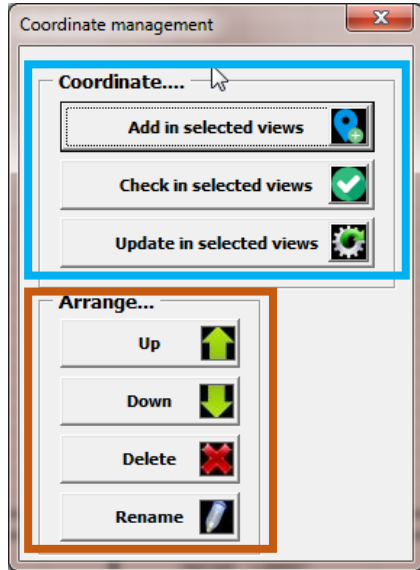| Name	X	Y	Z
A1	1674,68	-259,13	1537,18
A2	1677,12	-260,70	1531,37
A3	1707,90	-262,48	1480,86
B1	1705,98	-261,09	1484,07
B2	1763,22	-302,50	1388,32
C1	1759,37	-299,72	1404,76
C2	1809,78	-308,63	1322,73
C3	1756,17	-375,27	1283,74
C4	1737,98	-248,98	1248,10
D1	1802,70	-308,89	1328,45
D2	1940,14	-303,86	1254,11
E1	1933,95	-304,08	1257,37
E1.1	1943,68	-303,73	1252,24
E2	1960,41	-298,90	1249,33
E2.1	1975,99	-299,07	1251,66
F1	1976,68	-299,03	1251,19
F2	2009,83	-297,83	1233,64
F3	2171,24	-320,21	1231,30
F4	2343,72	-290,89	1227,45
F5	2100,18	-274,50	1226,36
F6	2133,15	-280,29	1223,26
F8	2225,22	-269,46	1231,41
G1	1737,98	-254,35	1250,78
G2	1737,98	-231,90	1239,60
G3	1710,98	-166,58	1232,77
H1	1784,51	-226,06	1371,93
H2	1790,21	-228,00	1416,43
J1	1859,70	-211,84	1290,26
J2	1862,35	-211,74	1289,85
J3	1926,39	-211,33	1291,34
J4	1929,05	-211,23	1289,94
K1	2099,66	-279,22	1226,30
K1.1	2102,55	-257,42	1226,66
K1.2	2110,81	-198,00	1227,71
K2	2132,77	-283,17	1224,00
K2.1	2135,35	-263,96	1219,08
K2.2	2143,11	-206,33	1204,31
K4	1751,83	-372,83	1284,26
K4.1	1740,78	-389,13	1280,80
K4.2	1707,62	-438,04	1270,40
L1	2100,35	-273,28	1226,38
L2	2105,85	-233,67	1227,08
L3	2072,19	-225,02	1229,60
L4	2075,19	-172,23	1230,60
V1	2226,23	-274,37	1291,20
V2	2220,29	-209,90	1292,44
N1	2307,74	-332,94	1240,69

Improvement tool idea.

- Main assumption of the proposed tool was to make points creation as automaticly proces.

- All related actions i.e.: points insertion, names applying, marking points creation, removing points out of views, points arranging, were integrated to the tool.

- Finally, it improved drawing quality, less effort during drawings creation and saving in time.
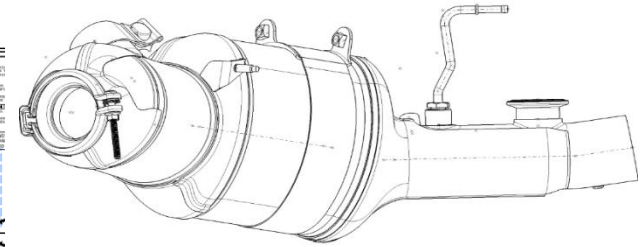
Improvement tool idea.

Coordinate management

Coordinate....
- Add in selected views
- Check in selected views
- Update in selected views

Arrange...
- Up
- Down
- Delete
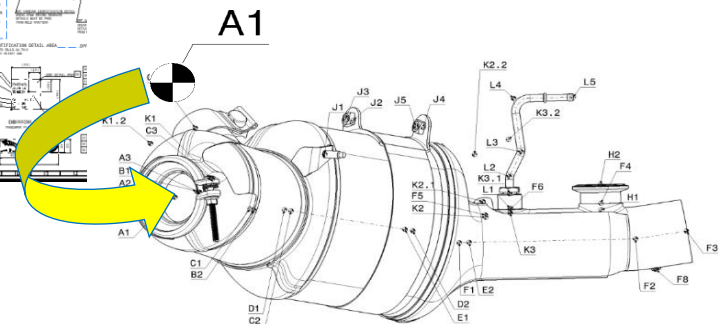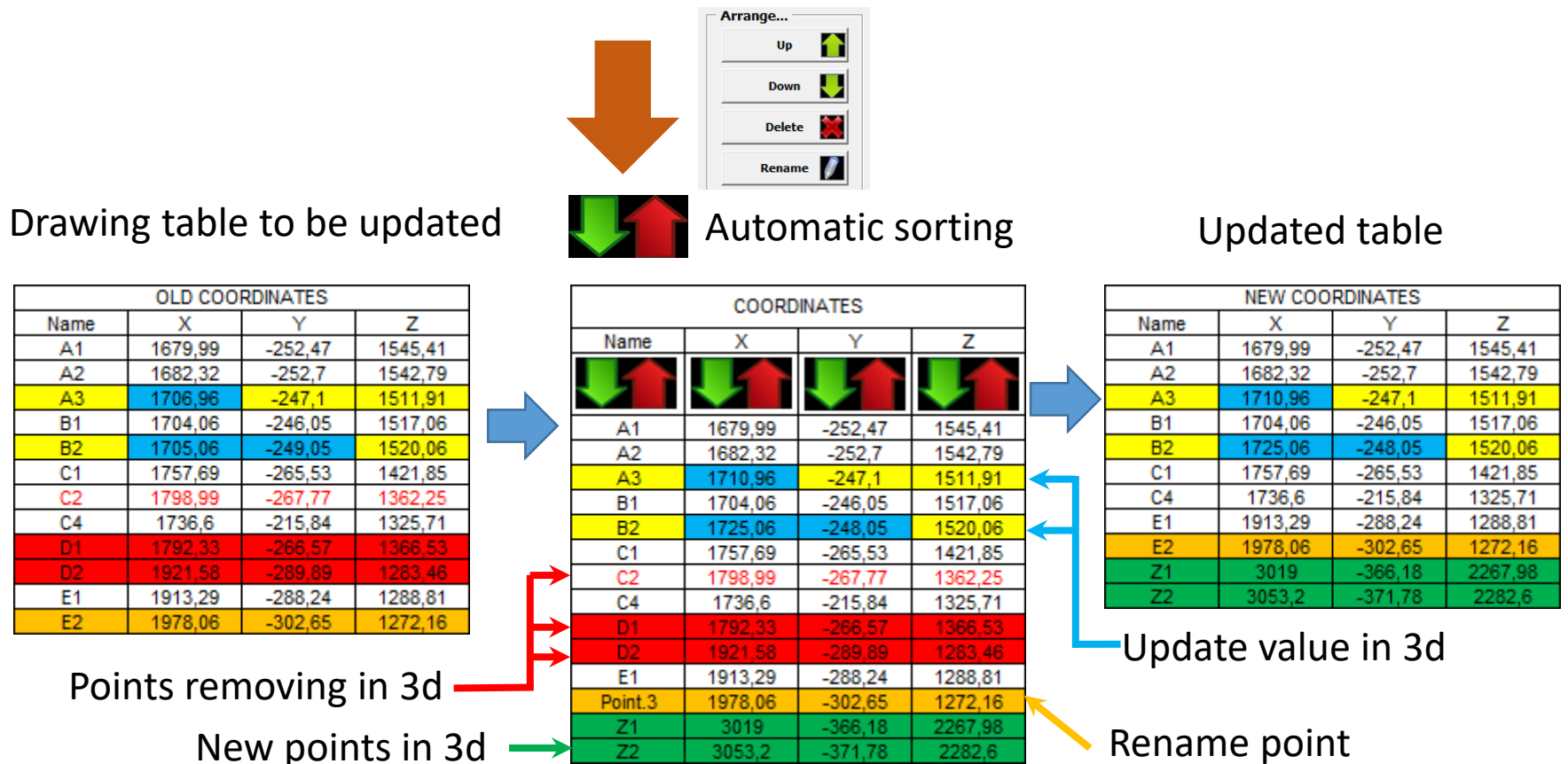- Rename

Next slide

View before the tool was used.

View updated with the tool.

A1

Improvement tool idea. Example.

- Points C2, D1, D2 were removed from the 3d model.

- A3, B2 coordinates were based on the 3d model.

- Point.3 was renamed.

- Z2 was added to the 3d model.

Arrange...

Up		
Down		
Delete		
Rename		

Drawing table to be updated

Automatic sorting

Updated table

OLD COORDINATES

Name	X	Y	Z
A1	1679,99	-252,47	1545,41
A2	1682,32	-252,7	1542,79
A3	1706,96	-247,1	1511,91
B1	1704,06	-246,05	1517,06
B2	1705,06	-249,05	1520,06
C1	1757,69	-265,53	1421,85
C2	1798,99	-267,77	1362,25
C4	1736,6	-215,84	1325,71
D1	1792,33	-266,57	1366,53
D2	1921,58	-289,89	1283,46
E1	1913,29	-288,24	1288,81
E2	1978,06	-302,65	1272,16

COORDINATES

Name	X	Y	Z
A1	1679,99	-252,47	1545,41
A2	1682,32	-252,7	1542,79
A3	1710,96	-247,1	1511,91
B1	1704,06	-246,05	1517,06
B2	1725,06	-248,05	1520,06
C1	1757,69	-265,53	1421,85
C2	1798,99	-267,77	1362,25
C4	1736,6	-215,84	1325,71
D1	1792,33	-266,57	1366,53
D2	1921,58	-289,89	1283,46
E1	1913,29	-288,24	1288,81
Point.3	1978,06	-302,65	1272,16
Z1	3019	-366,18	2267,98
Z2	3053,2	-371,78	2282,6

Points removing in 3d

New points in 3d

NEW COORDINATES

Name	X	Y	Z
A1	1679,99	-252,47	1545,41
A2	1682,32	-252,7	1542,79
A3	1710,96	-247,1	1511,91
B1	1704,06	-246,05	1517,06
B2	1725,06	-248,05	1520,06
C1	1757,69	-265,53	1421,85
C4	1736,6	-215,84	1325,71
E1	1913,29	-288,24	1288,81
E2	1978,06	-302,65	1272,16
Z1	3019	-366,18	2267,98
Z2	3053,2	-371,78	2282,6

Update value in 3d

Rename point

Improvement tool idea. How it works.

1. Insert and update of coordinates in the drawing table according to 3d models.

2. Based on the coordinates points table, position of marking points **X', Y'** (**X", Y"**) is computed.

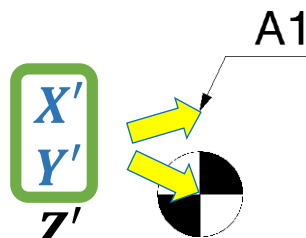➤ See attachments.: „**Test Drawing.CATDrawing**" (Test Drawing.pdf).
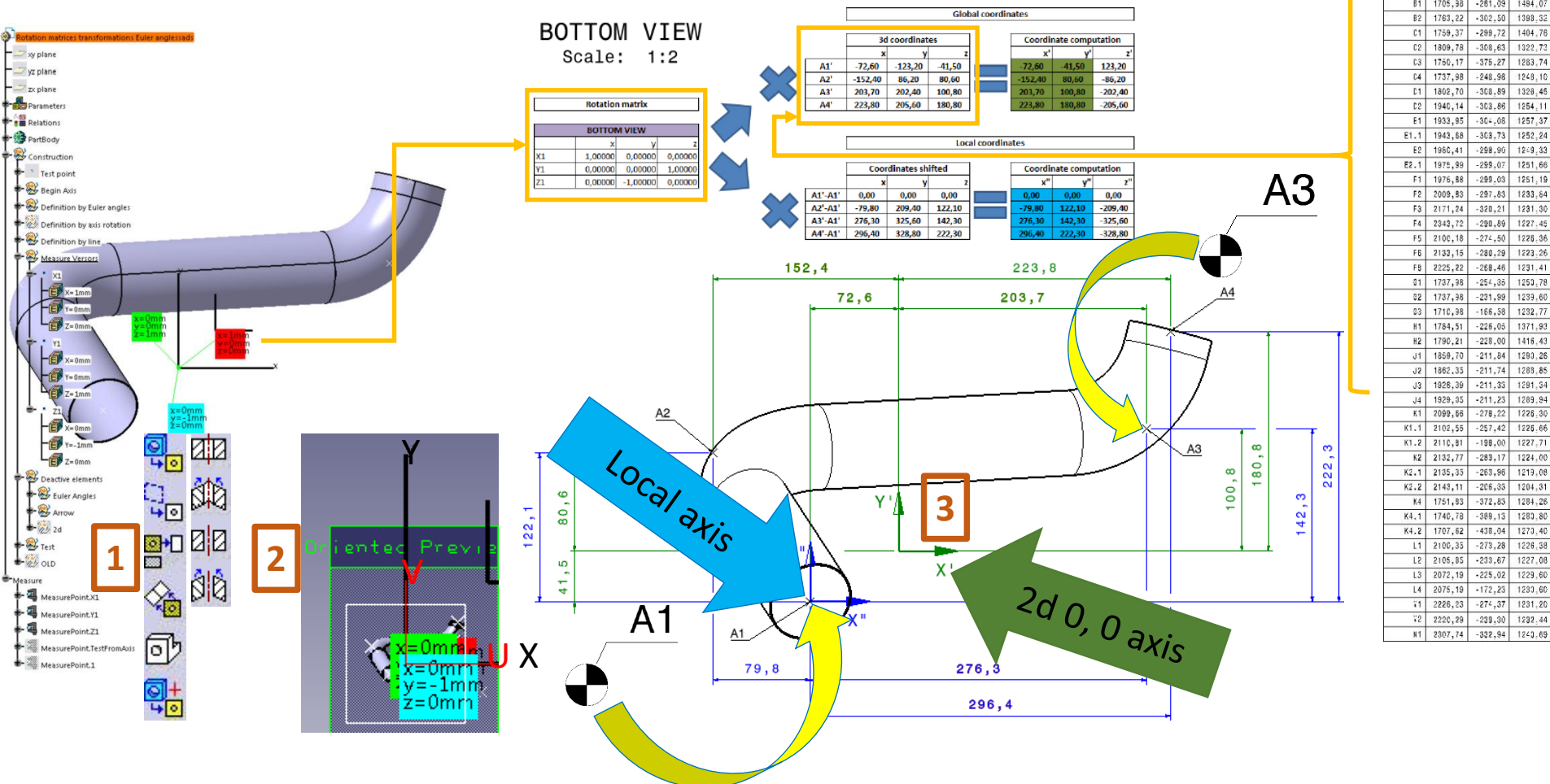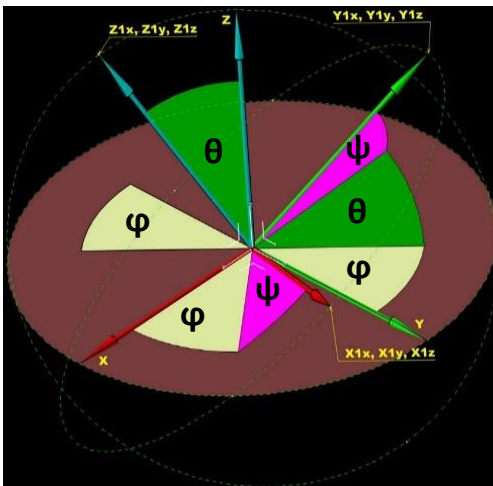
Improvement tool idea. How it works.

- Developed macro gets view directional vectors (versors) and returns rotation matrix as output. See attachment in Excel „**Example 2-3**".
  - ➢ GetProjectionPlane **X1x, X1y, X1z, Y1x, Y1y, Y1z**.
  - ➢ GetProjectionPlaneNormal **Z1x, Z1y, Z1z.**
  - ➢ Attachment VBA Macro „**GetVectors**"

- Rotation matrix allows to compute 2d/3d markings positions in global and translated local axis.

$$
\begin{array}{ccc}
X1x & X1y & X1z \\
Y1x & Y1y & Y1z \\
Z1x & Z1y & Z1z
\end{array}
\; * \;
\begin{array}{c}
X \\
Y \\
Z
\end{array}
\; = \;
\begin{array}{c}
X' \\
Y' \\
Z'
\end{array}
$$

Rotation matrix * **3d Point** = **New Point**
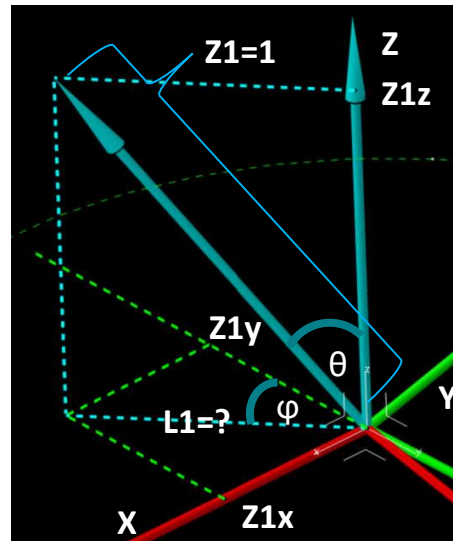
A1

Improvement tool idea. Some theory.

Marking angles

* Euler angles visualization (movie) is available in full-screen mode.
* Comparing to analysis, angles names in movie are:
φ was replaced with ψ.

$$\begin{matrix} X1x & X1y & X1z \\ Y1x & Y1y & Y1z \\ Z1x & Z1y & Z1z \end{matrix}$$

Rotation matrix

$$\sqrt{X1x^2 + X1y^2 + X1z^2} = 1$$
$$\sqrt{Y1x^2 + Y1y^2 + Y1z^2} = 1$$
$$\sqrt{Z1x^2 + Z1y^2 + Z1z^2} = 1$$

$$\cos\theta = \frac{Z1z}{1} = Z1z$$

$$\boldsymbol{\theta = arccos(Z1z)}$$
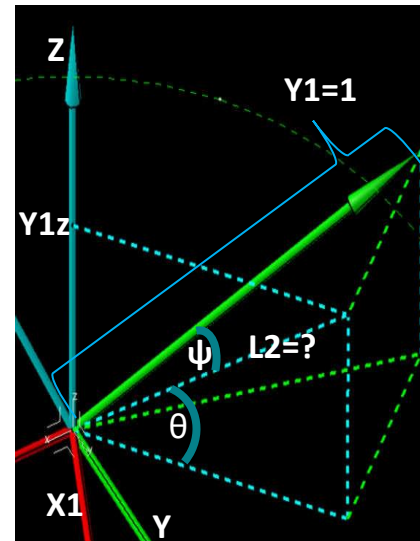
$$\sin^2\theta + \cos^2\theta = 1$$
$$\sin\theta = \sqrt{1 - cos\theta^2}$$
$$\sin\theta = L1$$
$$\cos\varphi = \frac{Z1y}{L1}$$

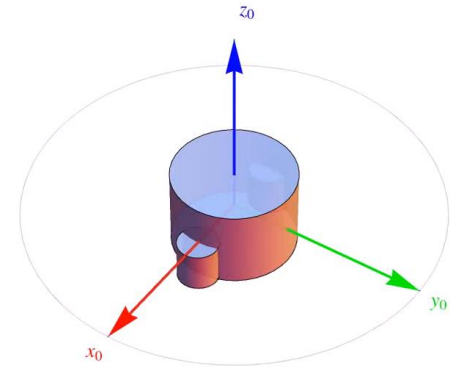$$\boldsymbol{\varphi = arccos(\frac{Z1y}{\sqrt{1 - Z1z^2}})}$$

$$\cos\psi = \frac{L2}{1} = L2$$

$$\sin\theta = \frac{Y1z}{L2}$$

$$L2 = \frac{Y1z}{\sin\theta}$$

$$\boldsymbol{\psi = arccos(\frac{Y1z}{\sqrt{1 - Z1z^2}})}$$

- Mathematical problems.: anlysis at 0° and 180°, gimbal lock, alternatively to use atan2 then arcos etc.
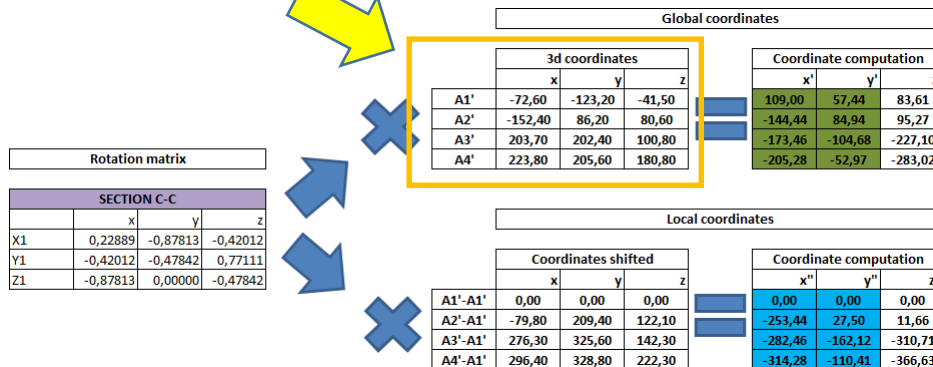- Consider the use quaternions.
- See atatchment „**Example 4**" in Excel.

Improvement tool idea. Example.

Macro „GetVectors"

1. Open Catia file „**Test Drawing.CATDrawing**" and Excel file „**Calculations.xlsm**".

2. Catia->Tools->Macro->Visual Basic Editor->Import File attachment "**GetVectors.bas**".

3. Mark „Microsoft Excel Object Liberty" in Catia VBA Editor.
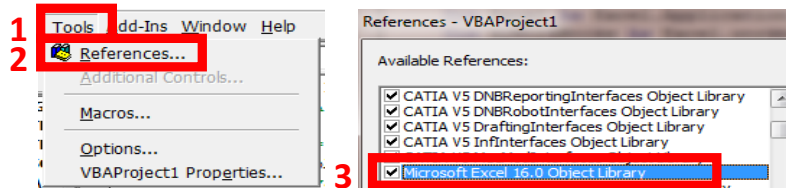
4. Active view in a drawing and run (F5) the macro.

5. In Excel: fill table coordinates with 3d points „**Example 1**".

Global coordinates

	3d coordinates			Coordinate computation		
	x	y	z	x'	y'	z'
A1'	-72,60	-123,20	-41,50	109,00	57,44	83,61
A2'	-152,40	86,20	80,60	-144,44	84,94	95,27
A3'	203,70	202,40	100,80	-173,46	-104,68	-227,10
A4'	223,80	205,60	180,80	-205,28	-52,97	-283,02

Rotation matrix

SECTION C-C

	x	y	z
X1	0,22889	-0,87813	-0,42012
Y1	-0,42012	-0,47842	0,77111
Z1	-0,87813	0,00000	-0,47842

Local coordinates

	Coordinates shifted			Coordinate computation		
	x	y	z	x"	y"	z"
A1'-A1'	0,00	0,00	0,00	0,00	0,00	0,00
A2'-A1'	-79,80	209,40	122,10	-253,44	27,50	11,66
A3'-A1'	276,30	325,60	142,30	-282,46	-162,12	-310,71
A4'-A1'	296,40	328,80	222,30	-314,28	-110,41	-366,63

6. When it is done, marking points position (**X', Y'**, **X", Y"**) are computed by the Excel.

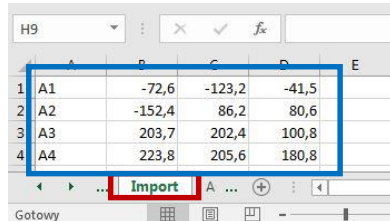7. For checking, compare a CAD drawing with computed coordinates.

Improvement tool idea. Example.

Macro „ ExportCoordinates3d"

1. Open „Example.CATPart" and „Calculations.xlsm".

2. Catia->Tools->Macro->Visual Basic Editor->Import File attachment "
   ExportCoordinates3d.bas".

3. Mark „Microsoft Excel Object Liberty" in Catia VBA Editor.
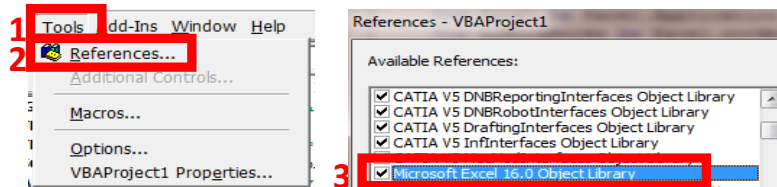
4. Run (F5) the macro and indicate „Geometrical Set" that contains coordinates only.

5. Switch in Excel to the sheet „Import" where coordinates were exported already to.

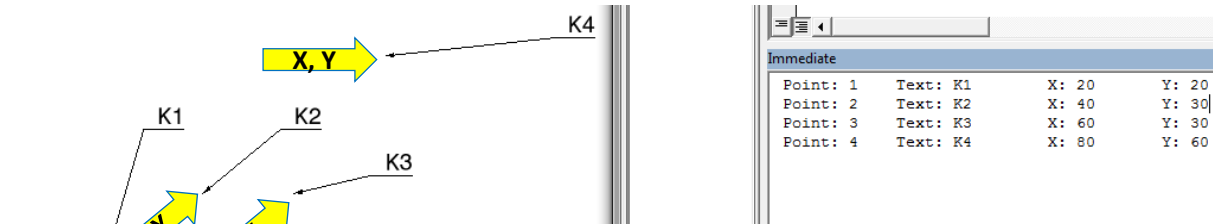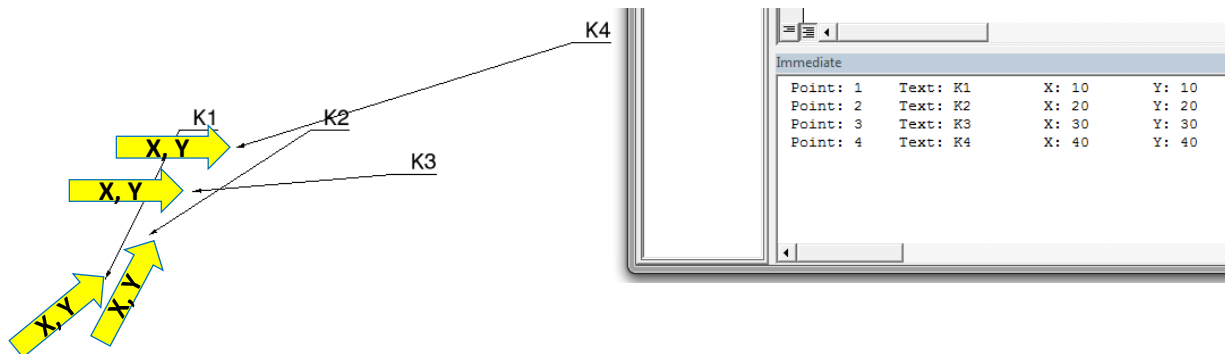6. Copy coordinates to the sheet „Recalculation".

Improvement tool idea. Example.

Macro „LeaderCoordinate"

- Catia->Tools->Macro->Visual Basic Editor->Import File attachment „**LeaderCoordinate.bas**".

- Run (F5) the macro to read positions of point name arrows.

Point: 1	Text: K1	X: 20	Y: 20
Point: 2	Text: K2	X: 40	Y: 30
Point: 3	Text: K3	X: 60	Y: 30
Point: 4	Text: K4	X: 80	Y: 60

- Change „bShowMove = false" and run macro again.

- Arrow at the end of text leader is moved.

- VBA commands „**GetPoint**" and „**ModifyPoint**" allow modification of marking positions in drawings.

Point: 1	Text: K1	X: 10	Y: 10
Point: 2	Text: K2	X: 20	Y: 20
Point: 3	Text: K3	X: 30	Y: 30
Point: 4	Text: K4	X: 40	Y: 40

Improvement tool idea. What is else to do?

1. Aggregate macros in a one.

2. Prepare a GUI and implement that tool in TEN-Tools accordingly.

3. Broken sections and broken views might be challenging.

4. ....

Bibliography:

- CAA V5 for CATIA - Getting Started - Dassault Systemes

- http://170.64.108.154/cd2/Catiav5r24doc/English/online/CATIA_P3_search.htm

- https://pl.wikibooks.org/wiki/Metody_matematyczne_fizyki/Obr%C3%B3t_uk%C5%82
2adu_wsp%C3%B3%C5%82rz%C4%99dnych

- https://pl.wikipedia.org/wiki/Macierz_obrotu,
http://www.dimmension3.spine.pl/modules.php?name=Tutorials&wtd=show_tutoria
l&nr=19

- http://mathworld.wolfram.com/EulerAngles.html

- https://en.wikipedia.org/wiki/Euler_angles

- http://www.slideshare.net/tm_ssau/ss-25992855

Attachment: „Test files and macros.zip"

- VBA macros: GetVectors, ExportCoordinates3d, LeaderCoordinate

- Excel file: Calculations.xlsm

- Catia files: Test Drawing.CATDrawing, Test Assembly.CATProduct, Example.CATPart,
Text with leader- arrow.CATDrawing