GRADO EN INGENIERÍA MECÁNICA

TRABAJO FIN DE GRADO

2016 / 2017

TÍTULO DEL TFG

ESTUDIO DE COMPATIBILIDAD ENTRE LOS MÉTODOS DE MEDICIÓN DE PIEZAS POR CONTACTO Y FOTOGRAMETRÍA. DISEÑO Y FABRICACIÓN DEL ÚTIL DE MEDICIÓN.

nombre del documento

ANEXOS

DATOS DE LA ALUMNA O DEL ALUMNO	**DATOS DEL DIRECTOR O DE LA DIRECTORA**
NOMBRE MAITANE	NOMBRE ANTONIO
APELLIDOS ORMAZABAL VILLAMOR	APELLIDOS GORRIÑO VICANDI
DNI 79000689-J	DEPARTAMENTO INGENIERÍA MECÁNICA
FDO.:	FDO.:
FECHA: 24-04-2017	FECHA: 24-04-2017

5.- ANEXOS

5.1.- Programa de medición de los 10 puntos de la MMC

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DMISMN/'c:\capps6\capps\programs\test.bdm'
$$*** Created in CappsNT(c) Version 6.1.091 by AAT. www.capps-edges.com
***
UNITS/MM,ANGDEC
CAPPS/PROJOFF
PTTYPE/TYPE1
WKPLAN/XYPLAN
MODE/MAN
D(MCS)=DATSET/MCS
SNSET/APPRCH,5.0000
SNSET/RETRCT,5.0000
SNSET/DEPTH,0.0000
SNSET/CLRSRF,100.0000
SNSET/SEARCH,5.0000
FEDRAT/POSVEL,MPM,200.0000
FEDRAT/MESVEL,MPM,7.0000
PRCOMP/ON
CAPPS/REPORT,IJK,OFF
CAPPS/TEMPLT,AUTO,OFF
CAPPS/NOMREP,ON
T(LPROFPT)=TOL/PROFP,-0.0020,0.0020
T(LPROFSF)=TOL/PROFS,-0.0500,0.0500
T(LPROFLN)=TOL/PROFL,-0.0500,0.0500
T(xx)=TOL/CORTOL,XAXIS,-1.0000,1.0000
T(yy)=TOL/CORTOL,YAXIS,-0.5000,0.5000
T(zzz)=TOL/CORTOL,ZAXIS,-0.5000,0.5000
T(ar1)=TOL/CORTOL,RADIUS,0.0000,0.0000
T(aa1)=TOL/CORTOL,ANGLE,-1.0000,1.0000
T(d5)=TOL/DIAM,-0.2500,0.2500
T(r2)=TOL/RAD,-63.50000,63.50000
T(LLENGTH1)=TOL/LENGTH,-0.2500,0.2500
T(LWIDTH1)=TOL/WIDTH,-0.2500,0.2500
T(ANGLE)=TOL/ANGL,,
T(FLAT1)=TOL/FLAT,0.6000
T(LSTRGHT)=TOL/STRGHT,0.0500
T(LCYLCTY)=TOL/CYLCTY,0.0500
T(LCIRLTY)=TOL/CIRLTY,0.0250
T(LSPHCTY)=TOL/SPHCTY,0.0500
$$DATE:   12/28/2016
$$TIME:   09:53:07 AM
CO(1)=COMPNY/'EUITIBI'
OP(1)=OPERID/'MAITANE'
PN(1)=PARTID/'PIEZA'
CS(1)=CLMPSN/'123456'
R(1)=REPORT,DATE,TIME,CO(1),OP(1),PN(1),CS(1)
OUTPUT/R(1)
```

```
$$SELECT PROBE PA0B0 AT A=0.0,B=0.0
$$SNSLCT/VECTOR,0.000,0.000,-1.000
SNSLCT/S(PA0B0)
$$CALIBRATE PA0B0 AT A=0.0,B=0.0
S(PA0B0)=SNSDEF/PROBE,INDEX,POL,0.0,0.0,0.0,0.0,-1.0,83.124,3.9968
CALIB/SENS,S(PA0B0),FA(MASTER),5
PTMEAS/CART,142.5092,-67.7673,-284.0927,-0.0342,-0.9975,-0.0621
PTMEAS/CART,133.0471,-55.8991,-284.0370,-0.9803,0.1895,-0.0565
PTMEAS/CART,144.7568,-47.9955,-284.0352,0.1906,0.9800,-0.0564
PTMEAS/CART,152.8100,-57.0568,-284.0358,0.9957,0.0737,-0.0564
PTMEAS/CART,143.2726,-58.2862,-273.4928,0.0421,-0.0492,0.9979
ENDMES
F(PL1)=FEAT/PLANE,CART,$
   140.5651,-104.7284,-444.4902,-0.000,-0.000,1.000
MEAS/PLANE,F(PL1),3
PTMEAS/CART,105.8348,-83.4018,-444.5020,-0.0004,-0.0001,1.0000
PTMEAS/CART,153.9192,-152.6285,-444.4913,-0.0004,-0.0001,1.0000
PTMEAS/CART,161.9414,-78.1550,-444.4772,-0.0004,-0.0001,1.0000
ENDMES
OUTPUT/FA(PL1),TA(xx),TA(yy),TA(zzz)
F(PL2)=FEAT/PLANE,CART,$
   69.4628,-95.5793,-449.4005,-1.000,-0.000,-0.004
MEAS/PLANE,F(PL2),3
PTMEAS/CART,69.4760,-131.3531,-448.3391,-1.0000,-0.0005,-0.0040
PTMEAS/CART,69.4718,-96.0558,-451.5826,-1.0000,-0.0005,-0.0040
PTMEAS/CART,69.4404,-59.3289,-448.2798,-1.0000,-0.0005,-0.0040
ENDMES
OUTPUT/FA(PL2),TA(xx),TA(yy),TA(zzz)
F(PL3)=FEAT/PLANE,CART,$
   340.7194,42.6514,-391.3978,0.016,-0.004,1.000
MEAS/PLANE,F(PL3),3
PTMEAS/CART,333.9137,35.5696,-391.3190,0.0161,-0.0044,0.9999
PTMEAS/CART,348.0681,36.0346,-391.5454,0.0161,-0.0044,0.9999
PTMEAS/CART,340.1764,56.3498,-391.3291,0.0161,-0.0044,0.9999
ENDMES
OUTPUT/FA(PL3),TA(xx),TA(yy),TA(zzz)
F(CR4)=FEAT/CIRCLE,OUTER,CART,$
   341.2500,73.0980,-386.3345,0.000,0.000,1.000,12.6440
MEAS/CIRCLE,F(CR4),5
PTMEAS/CART,347.5747,73.0994,-386.3343,1.0000,0.0002,0.0000
PTMEAS/CART,343.0224,79.1627,-386.3343,0.2805,0.9599,0.0000
PTMEAS/CART,337.5457,78.2242,-386.3334,-0.5857,0.8105,0.0000
PTMEAS/CART,339.0029,67.1898,-386.3359,-0.3555,-0.9347,0.0000
PTMEAS/CART,345.1869,68.1524,-386.3348,0.6228,-0.7824,0.0000
ENDMES
OUTPUT/FA(CR4),TA(xx),TA(yy),TA(zzz),TA(d5)
DATDEF/FA(PL1),DAT(Z)
DATDEF/FA(PL2),DAT(X)
D(TMP)=DATSET/DAT(Z),ZDIR,DAT(X),XDIR
D(MCS)=TRANS/YORIG,FA(CR4)
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```
SAVE/D(TMP)
D(TMP)=TRANS/XORIG,FA(CR4),YORIG,FA(CR4)
D(TMP)=TRANS/ZORIG,FA(PL3)
MIRROR/XAXIS
MIRROR/ZAXIS
CAPPS/LOCKPART
F(CR10)=FEAT/CIRCLE,OUTER,CART,$
  -60.9935,133.6471,-4.6018,0.000,0.000,1.000,25.1199
MEAS/CIRCLE,F(CR10),5
PTMEAS/CART,-48.6102,131.5746,-4.5958,0.9863,-0.1651,0.0000
PTMEAS/CART,-55.8240,122.2015,-4.5990,0.4116,-0.9114,0.0000
PTMEAS/CART,-71.0518,126.1145,-4.6059,-0.8004,-0.5994,0.0000
PTMEAS/CART,-70.5737,141.7554,-4.6076,-0.7633,0.6460,0.0000
PTMEAS/CART,-56.4373,145.3605,-4.6004,0.3625,0.9320,0.0000
ENDMES
OUTPUT/FA(CR10),TA(xx),TA(yy),TA(zzz),TA(d5)
DECL/INTGR,I,
DO/I,1,3,1
GOTO/22.0845,74.3761,-248.6052
MODE/MAN
SNSET/APPRCH,10.0000
SNSET/RETRCT,10.0000
SNSET/DEPTH,0.0000
SNSET/CLRSRF,100.0000
SNSET/SEARCH,5.0000
$$CALIBRATE PA4B24 AT A=30.0,B=180.0
S(PA4B24)=SNSDEF/PROBE,INDEX,POL,30.0,180.0,0.0,0.0,-
1.0,83.124,3.9866
CALIB/SENS,S(PA4B24),FA(MASTER),5
PTMEAS/CART,181.2573,32.2715,-259.7764,-0.0682,-0.9812,0.1807
PTMEAS/CART,190.0245,36.4834,-259.7719,0.8085,-0.5599,0.1812
PTMEAS/CART,188.8487,49.0801,-259.7716,0.6910,0.6998,0.1812
PTMEAS/CART,182.4319,51.9062,-259.7760,0.0493,0.9823,0.1807
PTMEAS/CART,181.3743,42.6928,-251.6181,-0.0565,0.0610,0.9965
ENDMES
SNSET/APPRCH,5.0000
SNSET/RETRCT,5.0000
SNSET/DEPTH,0.0000
SNSET/CLRSRF,100.0000
SNSET/SEARCH,5.0000
GOTO/73.7125,30.4881,-242.3524
MODE/PROG,MAN
F(PNT15)=FEAT/POINT,CART,$
  17.5286,195.0453,25.3341,0.995,0.000,-0.096
MEAS/POINT,F(PNT15),1
PTMEAS/CART,17.5286,195.0453,25.3341,0.9954,0.0000,-0.0960
ENDMES
OUTPUT/FA(PNT15),TA(xx),TA(yy),TA(zzz),TA(LPROFPT)
F(PNT40)=FEAT/POINT,CART,$
  16.6519,155.0450,16.2291,0.995,0.000,-0.096
```

```
MEAS/POINT,F(PNT40),1
PTMEAS/CART,16.6519,155.0450,16.2291,0.9954,0.0000,-0.0960
ENDMES
OUTPUT/FA(PNT40),TA(xx),TA(yy),TA(zzz),TA(LPROFPT)
GOTO/22.0845,74.3761,-248.6052
MODE/MAN
SNSET/APPRCH,10.0000
SNSET/RETRCT,10.0000
SNSET/DEPTH,0.0000
SNSET/CLRSRF,100.0000
SNSET/SEARCH,5.0000
$$CALIBRATE PA1B-12 AT A=7.5,B=-90.0
S(PA1B-12)=SNSDEF/PROBE,INDEX,POL,7.5,-90.0,0.0,0.0,-
1.0,83.124,3.9939
CALIB/SENS,S(PA1B-12),FA(MASTER),5
GOTO/133.6863,51.5770,-156.0125
PTMEAS/CART,130.5632,52.3968,-249.9761,-0.9927,-0.0246,0.1184
PTMEAS/CART,133.6679,59.8562,-249.9752,-0.6823,0.7214,0.1185
PTMEAS/CART,142.8706,62.2839,-249.9746,0.2380,0.9640,0.1186
PTMEAS/CART,150.1560,54.9510,-250.0464,0.9666,0.2308,0.1114
PTMEAS/CART,140.3314,52.8367,-241.1634,-0.0159,0.0194,0.9997
ENDMES
SNSET/APPRCH,5.0000
SNSET/RETRCT,5.0000
SNSET/DEPTH,0.0000
SNSET/CLRSRF,100.0000
SNSET/SEARCH,5.0000
GOTO/-202.0614,30.7562,-227.8135
MODE/PROG,MAN
GOTO/-24.5222,-246.1046,-256.0878
GOTO/-102.9313,-242.0164,-5.000
F(PNT71)=FEAT/POINT,CART,$
  -102.5080,-230.7100,26.7900,0.000,-1.000,0.000
MEAS/POINT,F(PNT71),1
PTMEAS/CART,-102.5080,-230.7100,26.7900,0.0000,-1.0000,0.0000
ENDMES
OUTPUT/FA(PNT71),TA(xx),TA(yy),TA(zzz),TA(LPROFPT)
F(PNT82)=FEAT/POINT,CART,$
  -66.5080,-230.7100,13.4317,0.000,-1.000,0.000
MEAS/POINT,F(PNT82),1
PTMEAS/CART,-66.5080,-230.7100,13.4317,0.0000,-1.0000,0.0000
ENDMES
OUTPUT/FA(PNT82),TA(xx),TA(yy),TA(zzz),TA(LPROFPT)
GOTO/-20.000,-5.000,-220.1842
MODE/MAN
SNSET/APPRCH,10.0000
SNSET/RETRCT,10.0000
SNSET/DEPTH,0.0000
SNSET/CLRSRF,100.0000
SNSET/SEARCH,5.0000
```

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$$CALIBRATE PA0B0 AT A=0.0,B=0.0
S(PA0B0)=SNSDEF/PROBE,INDEX,POL,0.0,0.0,0.0,0.0,-1.0,83.124,3.9871
CALIB/SENS,S(PA0B0),FA(MASTER),5
PTMEAS/CART,140.6170,32.1490,-249.1170,0.0217,-0.9895,0.1430
PTMEAS/CART,131.2851,38.1864,-249.1162,-0.9115,-0.3857,0.1431
PTMEAS/CART,133.6953,49.3362,-249.1914,-0.6706,0.7293,0.1356
PTMEAS/CART,140.7494,52.0360,-250.7421,0.0349,0.9992,-0.0195
PTMEAS/CART,139.8879,42.2675,-240.5627,-0.0513,0.0224,0.9984
ENDMES
SNSET/APPRCH,5.0000
SNSET/RETRCT,5.0000
SNSET/DEPTH,0.0000
SNSET/CLRSRF,100.0000
SNSET/SEARCH,5.0000
MODE/PROG,MAN
GOTO/-79.3010,114.4856,-225.0239
F(PNT108)=FEAT/POINT,CART,$
   -42.5080,195.0453,-6.3090,0.000,0.000,-1.000
MEAS/POINT,F(PNT108),1
PTMEAS/CART,-42.5080,195.0453,-6.3090,0.0000,0.0000,-1.0000
ENDMES
OUTPUT/FA(PNT108),TA(xx),TA(yy),TA(zzz),TA(LPROFPT)
F(PNT107)=FEAT/POINT,CART,$
   -78.5080,195.0453,-6.3090,0.000,0.000,-1.000
MEAS/POINT,F(PNT107),1
PTMEAS/CART,-78.5080,195.0453,-6.3090,0.0000,0.0000,-1.0000
ENDMES
OUTPUT/FA(PNT107),TA(xx),TA(yy),TA(zzz),TA(LPROFPT)
F(PNT119)=FEAT/POINT,CART,$
   -30.5080,171.0430,-0.8000,0.000,0.000,-1.000
MEAS/POINT,F(PNT119),1
PTMEAS/CART,-30.5080,171.0426,-0.7570,0.0000,0.0000,-1.0000
ENDMES
OUTPUT/FA(PNT119),TA(xx),TA(yy),TA(zzz),TA(LPROFPT)
GOTO/-109.5000,-64.7474,-30.000
F(PNT127)=FEAT/POINT,CART,$
   -102.5080,-178.9550,-1.2730,0.000,0.000,-1.000
MEAS/POINT,F(PNT127),1
PTMEAS/CART,-102.5080,-178.9550,-1.2730,0.0000,0.0000,-1.0000
ENDMES
OUTPUT/FA(PNT127),TA(xx),TA(yy),TA(zzz),TA(LPROFPT)
F(PNT172)=FEAT/POINT,CART,$
   -54.5080,-198.9546,-6.9320,0.000,0.000,-1.000
MEAS/POINT,F(PNT172),1
PTMEAS/CART,-54.5080,-198.9546,-6.9320,0.0000,0.0000,-1.0000
ENDMES
OUTPUT/FA(PNT172),TA(xx),TA(yy),TA(zzz),TA(LPROFPT)
F(PNT230)=FEAT/POINT,CART,$
   -90.5080,35.0450,-18.4070,0.000,0.000,-1.000
MEAS/POINT,F(PNT230),1
```

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PTMEAS/CART,-90.5080,35.0450,-18.4070,0.0000,0.0000,-1.0000
ENDMES
OUTPUT/FA(PNT230),TA(xx),TA(yy),TA(zzz),TA(LPROFPT)
ENDDO
```

5.2.- Mediciones de los puntos con la MMC en las 5 piezas y las 3 veces.

	RPS 3		
	X	**Y**	**Z**
A	-42,506	195,059	-6,567
B	-42,509	195,059	-6,439
C	-42,506	195,052	-6,414
D	-42,509	195,052	-6,402
E	-42,505	195,059	-6,448

	RPS 4		
	X	**Y**	**Z**
A	-54,508	-198,975	-7,063
B	-54,509	-198,954	-7,086
C	-54,507	-198,956	-7,039
D	-54,509	-198,958	-7,055
E	-54,505	-198,951	-7,062

	RPS 5		
	X	**Y**	**Z**
A	-78,507	195,064	-6,478
B	-78,509	195,063	-6,425
C	-78,508	195,061	-6,411
D	-78,509	195,060	-6,399
E	-78,504	195,060	-6,451

	RPS 101		
	X	**Y**	**Z**
A	-90,506	35,069	-18,513
B	-90,509	35,055	-18,469
C	-90,506	35,054	-18,486
D	-90,509	35,071	-18,491
E	-90,505	35,056	-18,514

	PNT 1		
	X	**Y**	**Z**
A	-102,507	-178,956	-1,616
B	-102,509	-178,950	-1,718
C	-102,507	-178,950	-1,739
D	-102,509	-178,948	-1,752
E	-102,506	-178,957	-1,739

	PNT 2		
	X	**Y**	**Z**
A	-30,505	171,045	-0,981
B	-30,509	171,049	-0,972
C	-30,507	171,053	-1,026
D	-30,510	171,041	-1,026
E	-30,506	171,055	-1,069

	PNT 1 LATERAL		
	X	**Y**	**Z**
A	-66,508	-230,430	13,429
B	-66,510	-230,588	13,438
C	-66,507	-230,821	13,433
D	-66,510	-230,763	13,438
E	-66,507	-230,887	13,433

	PNT 2 LATERAL		
	X	**Y**	**Z**
A	-102,507	-231,203	26,797
B	-102,510	-231,431	26,796
C	-102,507	-231,431	26,796
D	-102,510	-231,221	26,797
E	-102,504	-231,393	26,796

	PNT 1 FRONTAL		
	X	**Y**	**Z**
A	16,598	155,038	16,236
B	16,610	155,049	16,238
C	16,655	155,047	16,230
D	16,657	155,037	16,234
E	16,648	155,040	16,231

	PNT 2 FRONTAL		
	X	**Y**	**Z**
A	17,497	195,058	25,339
B	17,493	195,053	25,343
C	17,493	195,061	25,340
D	17,472	195,068	25,346
E	17,480	195,049	25,341

5.3.- Mediciones de los puntos con HandySCAN.

	RPS 3		
	X	**Y**	**Z**
A	-42,508	195,046	-6,399
B	-42,508	195,045	-6,335
C	-42,508	195,045	-6,290
D	-42,508	195,045	-6,331
E	-42,508	195,046	-6,379

	RPS 4		
	X	**Y**	**Z**
A	-54,506	-198,949	-7,079
B	-54,507	-198,947	-7,110
C	-54,508	-198,954	-6,948
D	-54,509	-198,954	-6,954
E	-54,511	-198,949	-7,060

	RPS 5		
	X	**Y**	**Z**
A	-78,510	195,044	-6,121
B	-78,502	195,047	-6,052
C	-78,509	195,003	-6,081
D	-78,507	195,045	-6,103
E	-78,508	195,045	-6,174

	RPS 101		
	X	**Y**	**Z**
A	-90,508	35,046	-18,584
B	-90,507	35,044	-18,484
C	-90,507	35,048	-18,520
D	-90,508	35,045	-18,500
E	-90,509	35,047	-18,526

	PNT 1		
	X	**Y**	**Z**
A	-102,503	-178,957	-1,375
B	-102,503	-178,952	-1,346
C	-102,507	-178,956	-1,216
D	-102,508	-178,954	-1,282
E	-102,507	-178,955	-1,216

	PNT 2		
	X	**Y**	**Z**
A	-30,506	171,043	-0,779
B	-30,497	171,043	-0,873
C	-30,503	171,042	-0,835
D	-30,497	171,041	-0,902
E	-30,496	171,045	-0,913

	PNT 1 LATERAL		
	X	**Y**	**Z**
A	-66,508	-230,430	13,429
B	-66,510	-230,588	13,438
C	-66,508	-230,601	13,434
D	-66,508	-230,539	13,435
E	-66,511	-230,572	13,434

	PNT 2 LATERAL		
	X	**Y**	**Z**
A	-102,507	-231,203	26,797
B	-102,510	-231,431	26,796
C	-102,500	-231,245	26,770
D	-102,506	-231,030	26,783
E	-102,512	-231,132	26,794

	PNT 1 FRONTAL		
	X	**Y**	**Z**
A	16,908	155,035	16,211
B	16,896	155,035	16,202
C	16,836	155,042	16,211
D	16,805	155,040	16,215
E	16,783	155,044	16,217

	PNT 2 FRONTAL		
	X	**Y**	**Z**
A	17,802	195,049	25,286
B	17,816	195,054	25,307
C	17,643	195,046	25,326
D	17,595	195,045	25,328
E	17,559	195,046	25,333

5.4.- Desviaciones obtenidas en los equipos.

MMC

	PIEZA A		
	X	**Y**	**Z**
	σ	**σ**	**σ**
1	0,0006	0,0015	0,0000
2	0,0006	0,0108	0,0006
3	0,0006	0,0176	0,0000
4	0,0006	0,0031	0,0015
5	0,0010	0,0060	0,0006
6	0,0012	0,0087	0,0010
7	0,0006	0,0015	0,0021
8	0,0010	0,0012	0,0015
9	0,0006	0,0119	0,0000
10	0,0006	0,0185	0,0000
PROMEDIO	0,0007	0,0081	0,0007

	PIEZA B		
	X	**Y**	**Z**
	σ	**σ**	**σ**
1	0,0010	0,0072	0,0006
2	0,0020	0,0074	0,0000
3	0,0010	0,0078	0,0000
4	0,0012	0,0065	0,0006
5	0,0015	0,0166	0,0006
6	0,0000	0,0135	0,0006
7	0,0017	0,0021	0,0040
8	0,0015	0,0012	0,0038
9	0,0010	0,0150	0,0036
10	0,0010	0,0078	0,0042
PROMEDIO	0,0012	0,0085	0,0018

	PIEZA C		
	X	Y	Z
	σ	σ	σ
1	0,0000	0,0085	0,0010
2	0,0006	0,0215	0,0015
3	0,0006	0,0061	0,0006
4	0,0000	0,0079	0,0006
5	0,0006	0,0093	0,0000
6	0,0012	0,0150	0,0010
7	0,0006	0,0029	0,0000
8	0,0006	0,0031	0,0010
9	0,0015	0,0076	0,0006
10	0,0006	0,0064	0,0000
PROMEDIO	0,0006	0,0088	0,0006

	PIEZA D		
	X	Y	Z
	σ	σ	σ
1	0,0010	0,0108	0,0010
2	0,0015	0,0131	0,0015
3	0,0010	0,0067	0,0010
4	0,0015	0,0116	0,0015
5	0,0015	0,0121	0,0012
6	0,0010	0,0078	0,0015
7	0,0015	0,0006	0,0038
8	0,0012	0,0012	0,0040
9	0,0015	0,0098	0,0025
10	0,0012	0,0098	0,0036
PROMEDIO	0,0013	0,0083	0,0022

	PIEZA E		
	X	Y	Z
	σ	σ	σ
1	0,0006	0,0078	0,0006
2	0,0012	0,0062	0,0006
3	0,0006	0,0143	0,0006
4	0,0010	0,0218	0,0010
5	0,0012	0,0162	0,0012
6	0,0020	0,0020	0,0010
7	0,0006	0,0017	0,0000
8	0,0006	0,0042	0,0010
9	0,0020	0,0223	0,0006
10	0,0017	0,0123	0,0000
PROMEDIO	0,0011	0,0109	0,0006

PROMEDIO TOTAL	0,0010	0,0089	0,0012

HANDYSCAN

	PIEZA A		
	X	**Y**	**Z**
	σ	**σ**	**σ**
1	0,0018	0,0014	0,0233
2	0,0023	0,0037	0,0147
3	0,0049	0,0038	0,0148
4	0,0034	0,0024	0,0375
5	0,0031	0,0014	0,0309
6	0,0014	0,0006	0,0125
7	0,0050	0,0204	0,0012
8	0,0103	0,0063	0,0014
9	0,0097	0,0011	0,0033
10	0,0142	0,0046	0,0194
PROMEDIO	0,0056	0,0046	0,0159

	PIEZA B		
	X	**Y**	**Z**
	σ	**σ**	**σ**
1	0,0004	0,0003	0,0174
2	0,0005	0,0003	0,0056
3	0,0048	0,0066	0,0079
4	0,0013	0,0010	0,0162
5	0,0000	0,0007	0,0027
6	0,0040	0,0007	0,0125
7	0,0057	0,0059	0,0035
8	0,0085	0,0046	0,0068
9	0,0039	0,0005	0,0014
10	0,0088	0,0089	0,0055
PROMEDIO	0,0038	0,0029	0,0080

	PIEZA C		
	X	**Y**	**Z**
	σ	**σ**	**σ**
1	0,0003	0,0013	0,0381
2	0,0003	0,0000	0,0043
3	0,0015	0,0371	0,0139
4	0,0018	0,0013	0,0053
5	0,0031	0,0018	0,0092
6	0,0004	0,0002	0,0077
7	0,0003	0,0025	0,0015
8	0,0094	0,0069	0,0022
9	0,0030	0,0038	0,0018
10	0,0077	0,0009	0,0027
PROMEDIO	0,0028	0,0056	0,0087

	PIEZA D		
	X	**Y**	**Z**
	σ	**σ**	**σ**
1	0,0001	0,0006	0,0213
2	0,0006	0,0007	0,0365
3	0,0084	0,0030	0,0090
4	0,0021	0,0026	0,0107
5	0,0011	0,0007	0,0242
6	0,0010	0,0017	0,0019
7	0,0004	0,0186	0,0032
8	0,0021	0,0140	0,0017
9	0,0111	0,0008	0,0003
10	0,0105	0,0011	0,0019
PROMEDIO	0,0037	0,0044	0,0111

	PIEZA E		
	X	**Y**	**Z**
	σ	**σ**	**σ**
1	0,0015	0,0033	0,0048
2	0,0025	0,0030	0,0134
3	0,0032	0,0020	0,0116
4	0,0032	0,0029	0,0138
5	0,0016	0,0026	0,0154
6	0,0015	0,0040	0,0036
7	0,0031	0,0092	0,0009
8	0,0041	0,0207	0,0064
9	0,0096	0,0008	0,0016
10	0,0037	0,0006	0,0008
PROMEDIO	0,0034	0,0049	0,0072

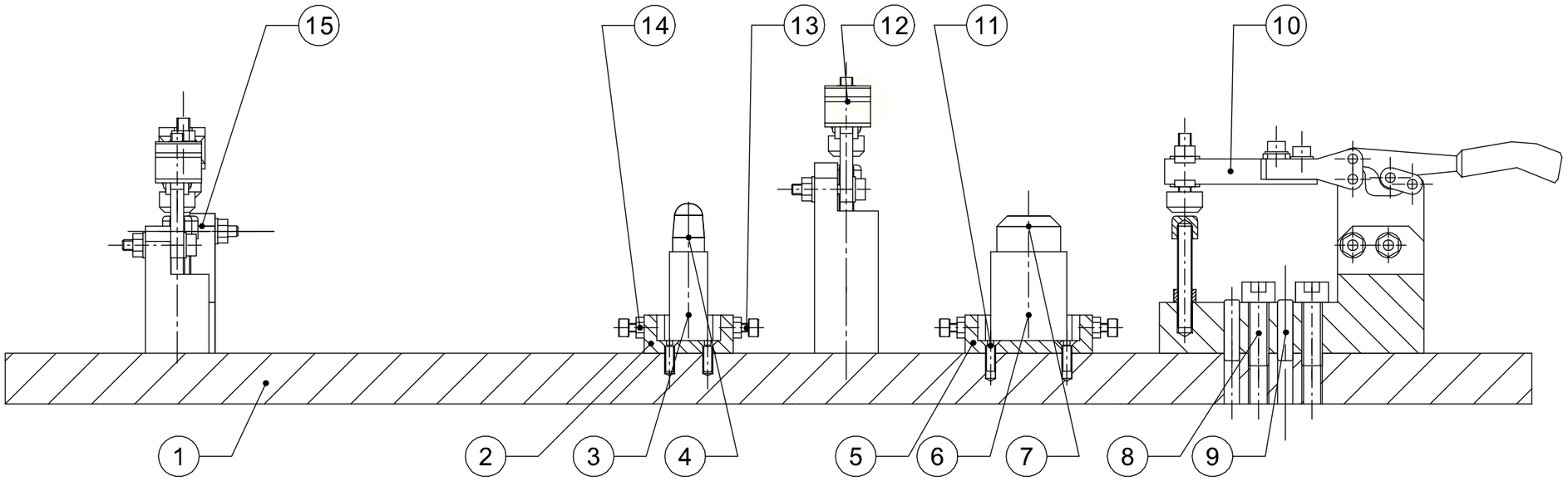
PROMEDIO TOTAL	0,0039	0,0045	0,0102

5.5.- Planos

5.5.1.- Planos Útil

5.5.2.- Plano Pieza Original

5.5.3.- Plano Pieza Ingeniería Inversa



Nº DE PIEZAS	DENOMINACION	MARCA	MATERIAL
1	Grupo de amarre largo	15	F-1200
8	Tuerca hexagonal M4 e/c 7	14	F-1200
8	Tornillo cilíndrico M4 x 16	13	F-1200
1	Grupo de amarre alto	12	F-1200
6	Tornillo avellanado M4 x 12	11	F-1200
3	Grupo de amarre bajo	10	F-1200
10	Pasador cilíndrico 6 x 24	9	F-1200
14	Tornillo cilíndrico M8 x 25	8	F-1200
1	Bulón diámetro 25	7	F-1140
1	Alojamiento bulón diámetro 25	6	L-3100
1	Cajera grande	5	L-3100
1	Bulón diámetro 12.5	4	F-1140
1	Alojamiento de bulón diámetro 12.5	3	L-3100
1	Cajera pequeña	2	L-3100
1	Base	1	L-3100

Apellidos: Ormazabal Villamor
Nombre: Maitane
Especialidad: Grado en Ingeniería Mecánica
Fecha: 12 de Enero de 2017

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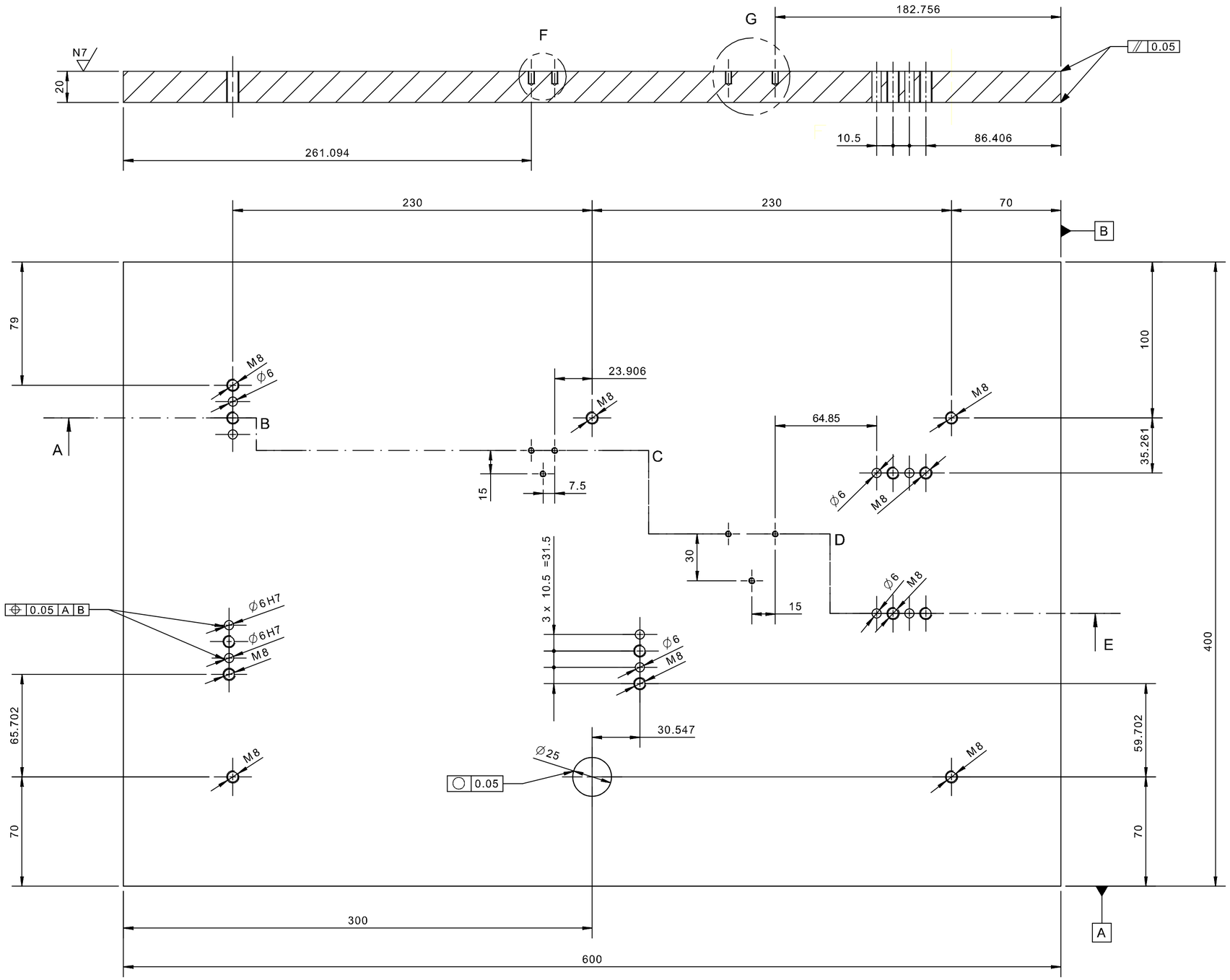
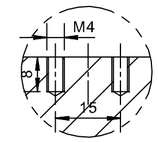
	ESCALA		
TOL. GEN m	1:2	**ÚTIL DE MEDICIÓN**	Hoja nº: 1 Total hojas: 5 Calificación:

1 N9 (N7)

CORTE A-E



Detalle F



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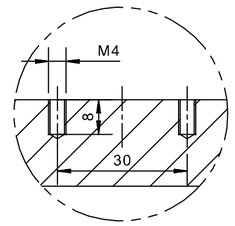
Detalle G



E=1:1

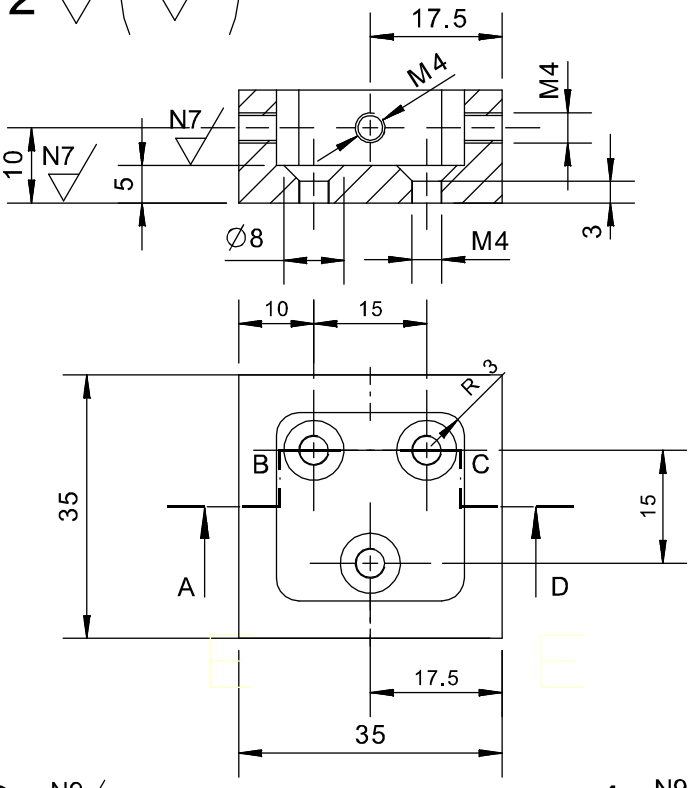
NOTA: Todos los agujeros de ∅6 van con ajuste H7. Tienen una tolerancia de posición de 0.05 mm respecto a las referencias A y B.

1	Base	1	L-3100
Nº DE PIEZAS	DENOMINACION	MARCA	MATERIAL

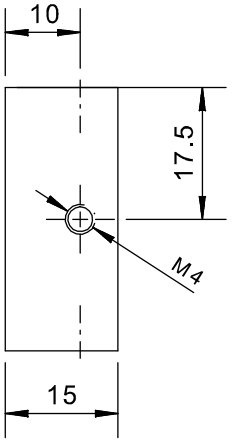
Apellidos: Ormazabal Villamor	U.P.V / E.H.U	
Nombre: Maitane	E.U. DE INGENIERIA TECNICA INDUSTRIAL DE BILBAO	
Especialidad: Grado en Ingeniería Mecánica		
Fecha: 13 de Enero de 2017		
ESCALA	ÚTIL DE MEDICIÓN	Hoja nº: 2
TOL. GEN m	1:2 (1:1)	Total hojas: 5
		Calificación:

2 N9 (N7)

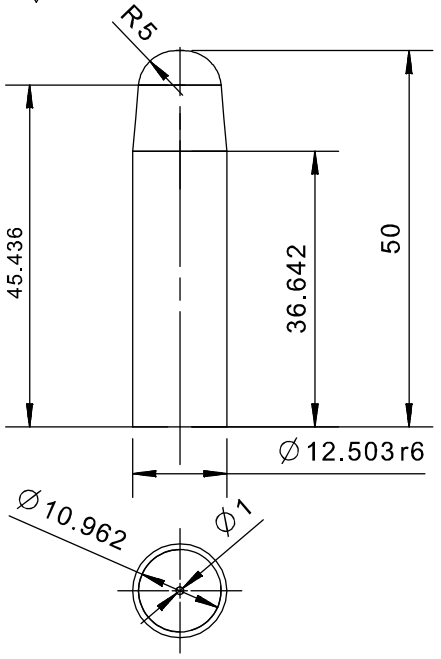
CORTE A-D



E= 1:2

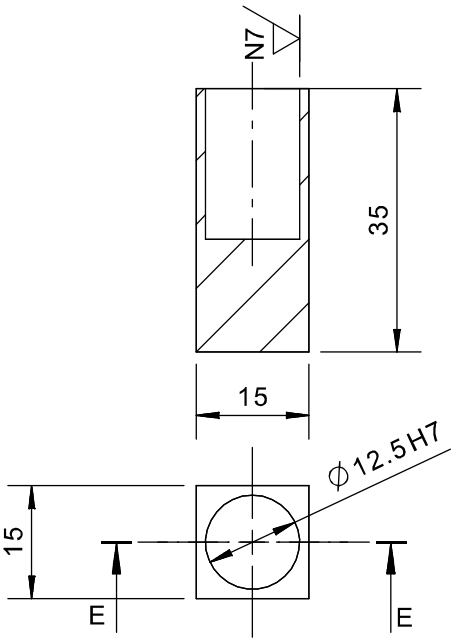


3 N9



4 N9 (N7)

CORTE E-E



1	Alojamiento Bulón pequeño	4	L-3100
1	Bulón Diametro 12.5	3	F-1140
1	Cajera pequeña	2	L-3100
Nº DE PIEZAS	DENOMINACION	MARCA	MATERIAL

Apellidos: Ormazabal Villamor	
Nombre: Maitane	
Especialidad: Grado en Ingeniería Mecánica	
Fecha: 14 de Enero de 2017	

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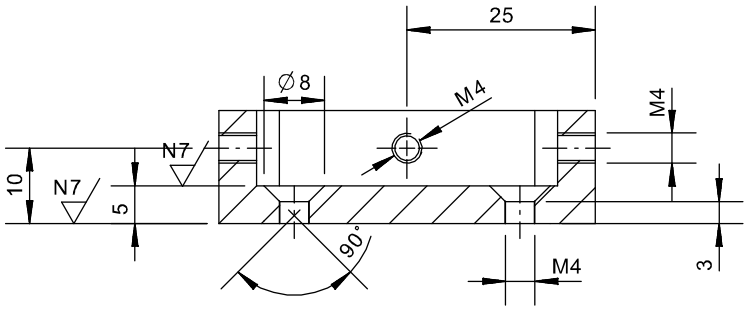
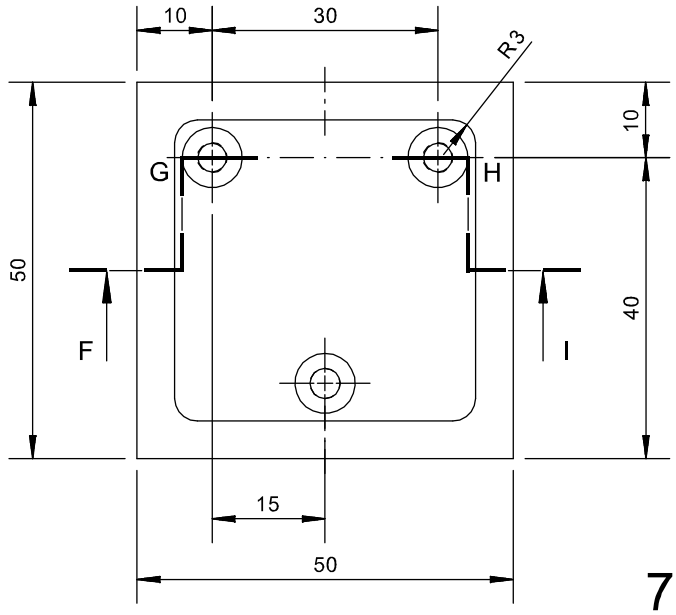
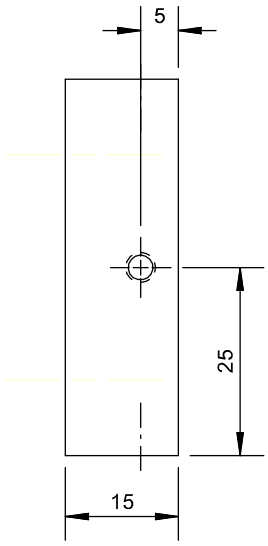
	ESCALA	# ÚTIL DE MEDICIÓN	Hoja nº: 3
TOL. GEN m	1:1 (1:2)		Total hojas: 5
			Calificación:

5 N9 (N7) CORTE F-I



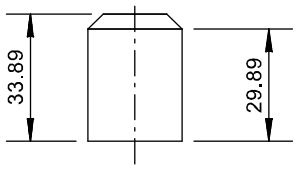
E=1:1

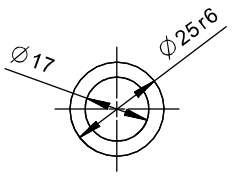


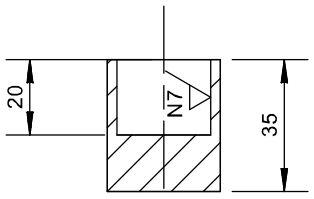


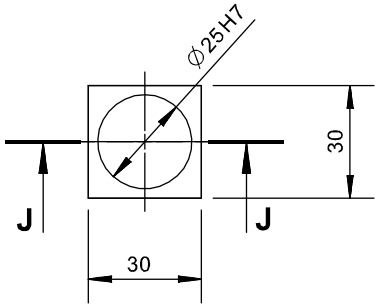
7 N9 (N7) CORTE J-J

6 N9









Nº DE PIEZAS	DENOMINACION	MARCA	MATERIAL
1	Alojamiento Bulón grande	7	L-3100
1	Bulón Diámetro 25	6	F-1140
1	Cajera Grande	5	L-3100

Apellidos: Ormazabal Villamor
Nombre: Maitane
Especialidad: Grado en Ingeniería Mecánica
Fecha: 15 de Enero de 2017

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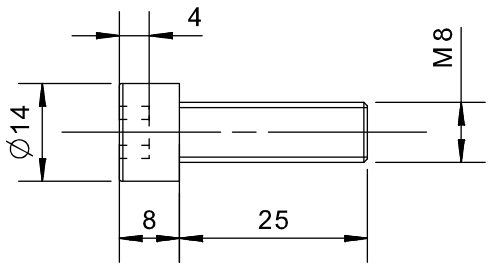
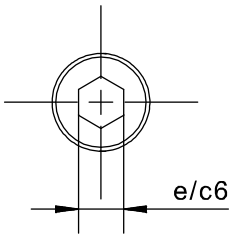
TOL. GEN	ESCALA	ÚTIL DE MEDICIÓN	Hoja nº: 4
m	1:2 (1:1)		Total hojas: 5
			Calificación:

8





9

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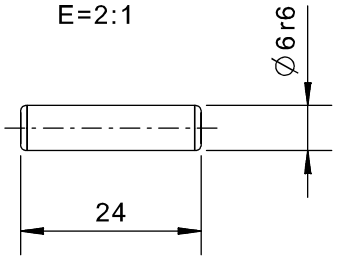

14

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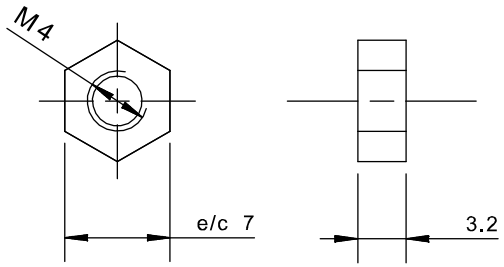
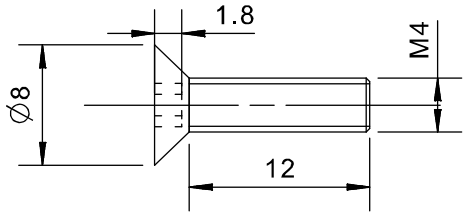
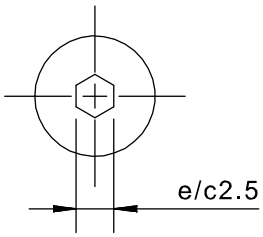
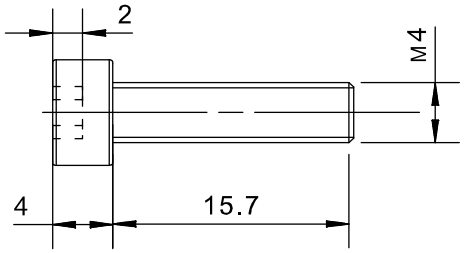


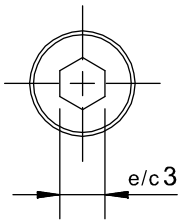
11





13





Nº DE PIEZAS	DENOMINACION	MARCA	MATERIAL
8	Tuerca hexagonal M4 e/c 6	14	F-1200
8	Tornillo cilíndrico con hexágono interior M4 x 12	13	F-1200
6	Tornillo avellanado M4 x 12	11	F-1200
10	Pasador cilíndrico D6 x 25	9	F-1200
14	Tornillo cilíndrico con hexágono interior M8 x 25	8	F-1200

Apellidos: Ormazabal Villamor

Nombre: Maitane

Especialidad: Grado en Ingeniería Mecánica

Fecha: 18 de Enero de 2017

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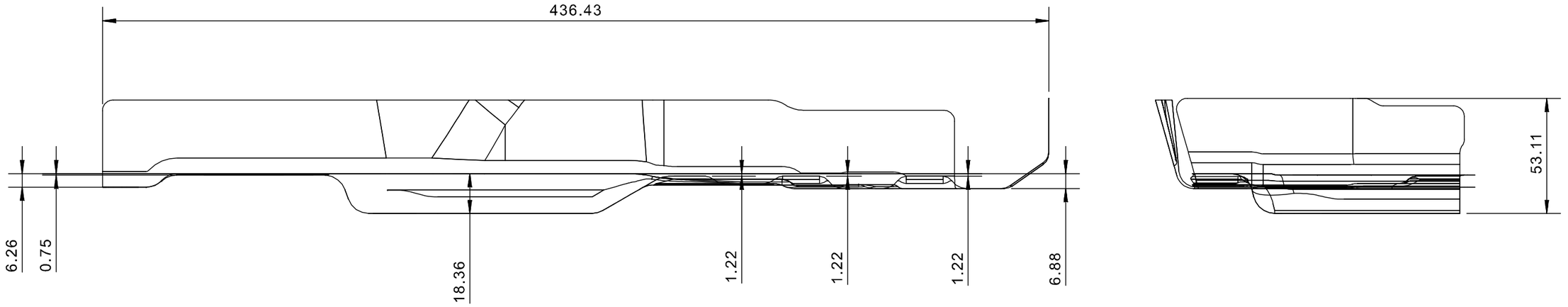
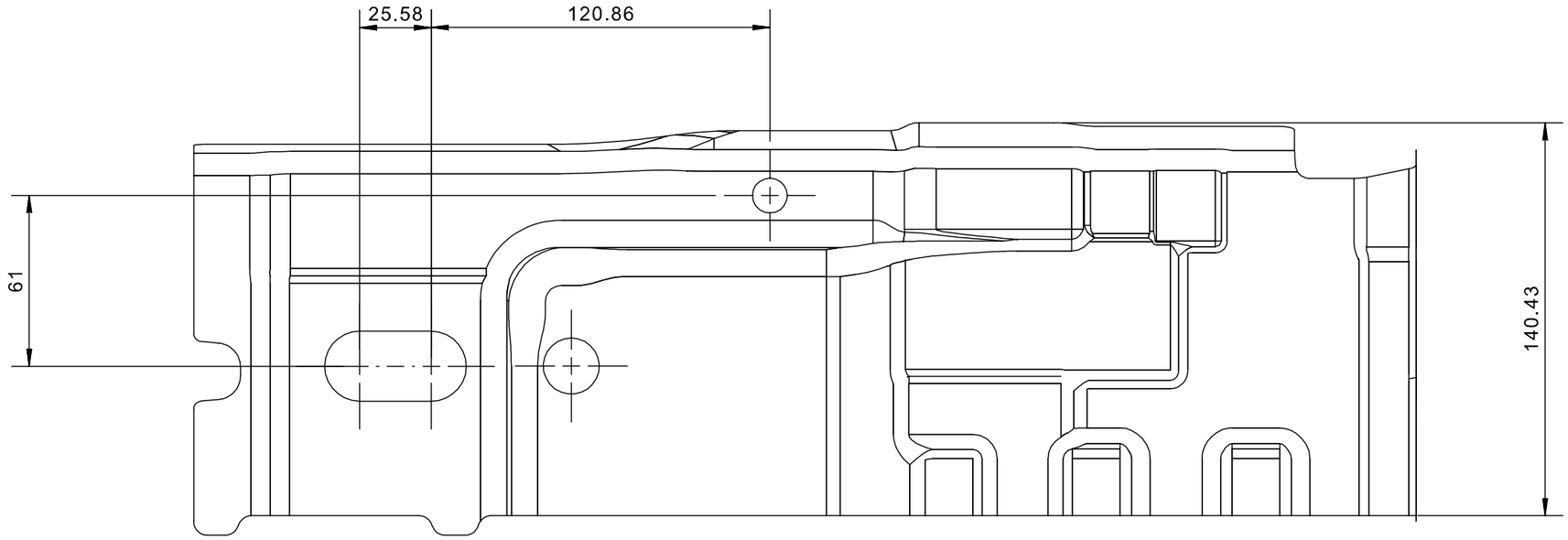
E.U. DE INGENIERIA TECNICA INDUSTRIAL DE BILBAO

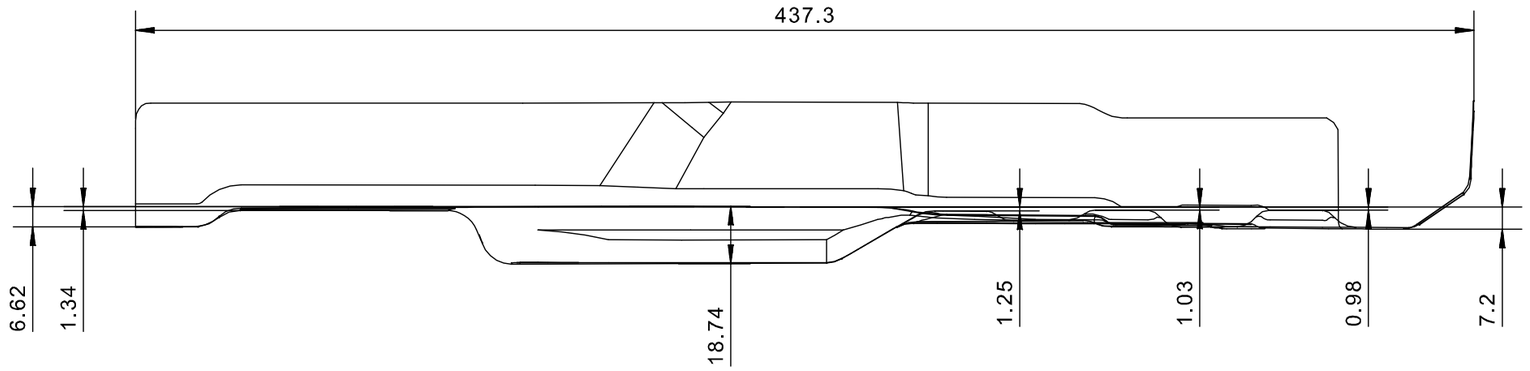
ESCALA		Hoja nº: 5
TOL. GEN m	1:1 (2:1)	Total hojas: 5
	ÚTIL DE MEDICIÓN	Calificación:

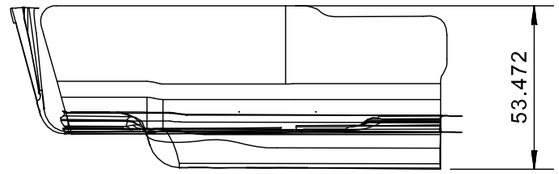


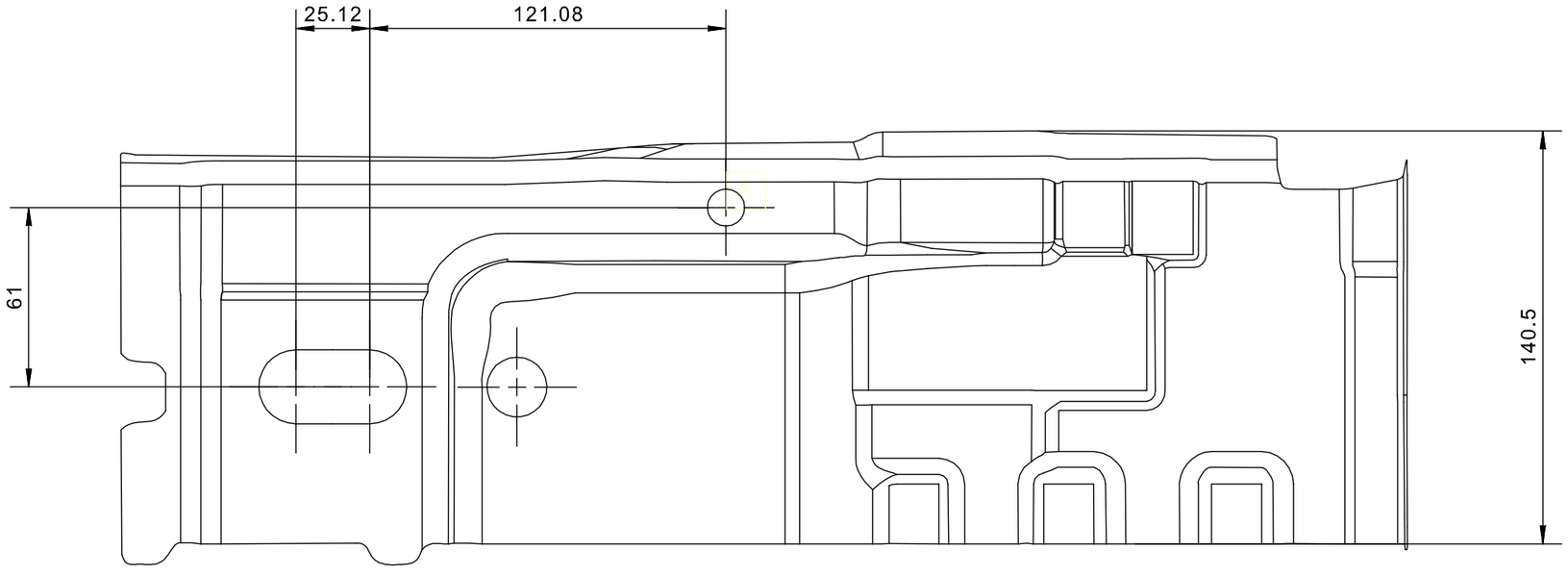


e = 0.7 mm

Apellidos: Ormazabal Villamor		U.P.V / E.H.U	
Nombre: Maitane		EU. DE INGENIERIA TECNICA INDUSTRIAL DE BILBAO	
Especialidad: Grado en Ingeniería Mecánica			
Fecha: 5 de Enero de 2017			
	ESCALA	PLANO PIEZA ORIGINAL	Nº Hojas: 1
TOL. GEN m	1:2		Nº Total Hojas: 1
			Calificación:







e = 0.7 mm

Apellidos: Ormazabal Villamor		U.P.V / E.H.U	
Nombre: Maitane		E.U. DE INGENIERIA TECNICA INDUSTRIAL DE BILBAO	
Especialidad: Grado en Ingeniería Mecánica			
Fecha: 5 de Enero de 2017			
ESCALA	PIEZA INGENIERIA INVERSA	Nº Hojas: 1	
TOL. GEN m	1:2	Nº Total planos: 1	
		Calificación:	

5.6.- Presupuesto

5.6.1.1.- Cuadro de Precios

5.6.1.1.1.- Presupuesto de Amortización de Equipos

Código	Descripción	Tiempo (horas)	Precio Unitario (euros)	Precio Total (euros)
A	Máquina de Medición por Coordenadas TRIMEK SPARK 06.05.05 y sus componentes (Cabezal PH10T,extensión, palpador de esfera de rubí) Software CAPPS 6.0	40	10	400

TOTAL PARCIAL.....400 €

5.6.1.1.2.- Presupuesto de Ejecución del Proyecto

5.6.1.1.2.1.- Diseño y Fabricación del útil de medición

Código	Descripción	Tiempo (horas)	Precio Unitario (euros)	Precio Total (euros)
A	Ingeniería de Diseño	30	45	1350
B	Mano de obra	20	30	600

TOTAL PARCIAL.....1950 €

5.6.1.1.2.2.- Ejecución de las Mediciones

Código	Descripción	Tiempo (horas)	Precio Unitario (euros)	Precio Total (euros)
A	Mediciones realizadas con la Máquina de Medición por Coordenadas TRIMEK SPARK 06.05.05	40	45	1800
B	Medicion con Escáner Láser HANDYSCANNER 700	16	60	960

TOTAL PARCIAL.....2760 €

5.6.1.1.2.3.- Elaboración de los informes

Código	Descripción	Tiempo (horas)	Precio Unitario (euros)	Precio Total (euros)
A	Cálculos	10	45	450
B	Evaluación de los resultados	15	45	675
C	Propuesta técnica	10	45	450

TOTAL PARCIAL.....1575 €

5.6.1.1.3.- Materiales

Cantidad	Descripción	Precio Unitario (euros)	Precio Total (euros)
1	Placa de aluminio AW-5083 (600x400 mm)	100	100
2	Bloque de aluminio AW-5083 (15x6 mm)	20	40
1	Tubo de acero F-1140 (30mm)	30	30
3	Conjunto de amarre bajo	40	120
1	Conjunto de amarre alto	50	50
1	Conjunto amarre largo	50	50
16	Tornillo cilíndrico con hexágono interior M8x25 DIN 912	0,45	7,2
8	Tornillo cilíndrico con hexágono interior M4x16 DIN 912	0,21	1,68
6	Tornillo avellanado M4x12 DIN 7991	0,15	0,9
10	Pasador cilíndrico ∅6x24 DIN 1469	0,27	2,7
8	Tuerca hexagonal M4 DIN 934	0,23	1,84

TOTAL PARCIAL.....404,32 €

5.6.1.2.- Presupuesto Total

- **Presupuesto de Amortización de Equipos**

SUBTOTAL.....400€

- **Presupuesto de Ejecución del Proyecto**
  - Diseño y Fabricación del útil de medición.....1950 €
  - Ejecución de las Mediciones.....2760 €
  - Elaboración de los informes.....1575 €

SUBTOTAL.....6285 €

- **Presupuesto Materiales**

SUBTOTAL.....404,32 €

- **Beneficio Industrial (5%).....334,46€**

- **I.V.A (21 %).....1404,75€**

TOTAL PRESUPUESTO.....8094,07€

Asciende el Presupuesto Total del Proyecto a la expresa cantidad de:

OCHOMIL NOVENTA Y CUATRO EUROS CON SIESTE CENTIMOS

Bilbao, a 20 de Abril de 2017

Maitane Ormazabal Villamor