Supplementary data for paper: A multiobjective decision-making approach for modelling robotic disassembly for sustainable remanufacturing

Tables

Table 1: PD matrix. Gear pump A.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	M
1	0.0	55.0	85.5	121.0	85.5	55.0	70.5	Inf	Inf	Inf	Inf	164.4	258.6	209.9	213.3	202.6
2	55.0	0.0	56.0	85.5	97.6	86.0	59.8	Inf	Inf	Inf	Inf	195.5	285.5	238.3	241.5	191.9
3	85.5	56.0	0.0	55.0	86.0	97.6	59.8	Inf	Inf	Inf	Inf	231.5	321.5	274.3	277.5	189.3
4	121.0	85.5	55.0	0.0	55.0	85.5	70.5	Inf	Inf	Inf	Inf	249.4	343.6	294.9	298.3	196.8
5	85.5	97.6	86.0	55.0	0.0	56.0	59.8	Inf	Inf	Inf	Inf	231.5	321.5	274.3	277.5	189.3
6	55.0	86.0	97.6	85.5	56.0	0.0	59.8	Inf	Inf	Inf	Inf	195.5	285.5	238.3	241.5	191.9
7	70.5	59.8	59.8	70.5	59.8	59.8	0.0	72.5	62.0	62.0	51.0	209.9	311.5	260.4	273.8	187.3
8	Inf	Inf	Inf	Inf	Inf	Inf	72.5	0.0	64.5	100.5	53.5	145.3	244.6	195.9	199.3	215.6
9	Inf	Inf	Inf	Inf	Inf	Inf	62.0	64.5	0.0	78.0	11.0	171.7	271.0	222.3	225.7	212.8
10	Inf	Inf	Inf	Inf	Inf	Inf	62.0	100.5	78.0	0.0	67.0	207.7	307.0	258.3	261.7	210.4
11	Inf	Inf	Inf	Inf	Inf	Inf	51.0	53.5	11.0	67.0	0.0	178.9	278.1	229.4	232.8	201.8
12	164.4	195.5	231.5	249.4	231.5	195.5	209.9	145.3	171.7	207.7	178.9	0.0	144.2	84.9	96.1	171.9
13	258.6	285.5	321.5	343.6	321.5	285.5	311.5	244.6	271.0	307.0	278.1	144.2	0.0	61.0	56.0	423.1
14	209.9	238.3	274.3	294.9	274.3	238.3	260.4	195.9	222.3	258.3	229.4	84.9	61.0	0.0	Inf	362.1
15	213.3	241.5	277.5	298.3	277.5	241.5	273.8	199.3	225.7	261.7	232.8	96.1	56.0	Inf	0.0	316.5
M	202.6	191.9	189.3	196.8	189.3	191.9	187.3	215.6	212.8	210.4	201.8	171.9	423.1	362.1	316.5	0.0

Table 2: PD matrix. Gear pump B.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	M
1	0.0	76.2	132.2	126.0	132.2	76.2	68.2	Inf	Inf	Inf	Inf	75.5	236.5	121.7	128.7	135.7	142.7	179.5	213.5	213.5	208.5	208.5	211.5	211.5	244.1
2	76.2	0.0	76.0	132.2	138.4	82.4	74.4	Inf	Inf	Inf	Inf	131.7	242.7	139.5	146.5	153.5	160.5	185.7	219.7	171.7	214.7	166.7	217.7	169.7	219.0
3	132.2	76.0	0.0	76.2	82.4	138.4	116.4	Inf	Inf	Inf	Inf	187.7	284.7	195.5	202.5	209.5	216.5	227.7	261.7	213.7	256.7	208.7	259.7	211.7	240.7
4	126.0	132.2	76.2	0.0	76.2	132.2	110.2	Inf	Inf	Inf	Inf	181.5	278.5	189.3	196.3	203.3	210.3	221.5	255.5	255.5	250.5	250.5	253.5	253.5	280.1
5	132.2	138.4	82.4	76.2	0.0	76.0	116.4	Inf	Inf	Inf	Inf	187.7	284.7	195.5	202.5	209.5	216.5	227.7	213.7	261.7	208.7	256.7	211.7	259.7	296.6
6	76.2	82.4	138.4	132.2	76.0	0.0	74.4	Inf	Inf	Inf	Inf	131.7	242.7	139.5	146.5	153.5	160.5	185.7	171.7	219.7	166.7	214.7	169.7	217.7	279.3
7	Inf	Inf	Inf	Inf	Inf	Inf	0.0	85.2	Inf	Inf	Inf	123.7	220.7	131.5	138.5	145.5	152.5	163.7	197.7	197.7	192.7	192.7	195.7	195.7	250.3
8	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.0	52.5	94.5	Inf	58.5	219.5	104.7	111.7	118.7	125.7	162.5	196.5	196.5	191.5	191.5	194.5	194.5	245.8
9	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.0	62.0	Inf	90.0	187.0	97.8	104.8	111.8	118.8	130.0	164.0	164.0	159.0	159.0	162	162	252.6
10	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	62.0	0.0	38.0	132.0	229.0	139.8	146.8	153.8	160.8	172.0	206.0	206.0	201.0	201.0	204	204	267.0
11	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	80.0	Inf	0.0	150.0	247.0	157.8	164.8	171.8	178.8	190.0	224.0	224.0	219.0	219.0	222	222	265.3
12	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.0	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	253.9
13	236.5	242.7	284.7	278.5	284.7	242.7	220.7	219.5	187.0	229.0	247.0	181.0	0.0	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	320.8
14	121.7	139.5	195.5	189.3	195.5	139.5	131.5	104.7	97.8	139.8	157.8	66.2	134.8	0.0	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	266.1
15	128.7	146.5	202.5	196.3	202.5	146.5	138.5	111.7	104.8	146.8	164.8	73.2	Inf	27.0	0.0	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	268.8
16	135.7	153.5	209.5	203.3	209.5	153.5	145.5	118.7	111.8	153.8	171.8	80.2	Inf	Inf	27.0	0.0	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	271.6
17	142.7	160.5	216.5	210.3	216.5	160.5	152.5	125.7	118.8	160.8	178.8	87.2	Inf	Inf	Inf	27.0	0.0	Inf	Inf	Inf	Inf	Inf	Inf	Inf	274.6
18	179.5	185.7	227.7	221.5	227.7	185.7	163.7	162.5	130.0	172.0	190.0	124.0	Inf	Inf	Inf	Inf	56.8	0.0	Inf	Inf	Inf	Inf	Inf	Inf	288.6
19	213.5	219.7	261.7	255.5	213.7	171.7	197.7	196.5	164.0	206.0	224.0	158.0	Inf	Inf	Inf	Inf	Inf	54.0	0.0	68.0	Inf	73.0	Inf	70	313.7
20	213.5	171.7	213.7	255.5	261.7	219.7	197.7	196.5	164.0	206.0	224.0	158.0	Inf	Inf	Inf	Inf	Inf	54.0	68.0	0.0	73.0	Inf	70	Inf	274.4
21	208.5	214.7	256.7	250.5	208.7	166.7	192.7	191.5	159.0	201.0	219.0	153.0	Inf	Inf	Inf	Inf	Inf	Inf	25.0	73.0	0.0	68.0	Inf	71	311.3
22	208.5	166.7	208.7	250.5	256.7	214.7	192.7	191.5	159.0	201.0	219.0	153.0	Inf	Inf	Inf	Inf	Inf	Inf	73.0	25.0	68.0	0.0	71	Inf	271.6
23	211.5	217.7	259.7	253.5	211.7	169.7	195.7	194.5	162.0	204.0	222.0	156.0	Inf	Inf	Inf	Inf	Inf	Inf	Inf	70.0	23.0	71.0	0	68	312.7
24	211.5	169.7	211.7	253.5	259.7	217.7	195.7	194.5	162.0	204.0	222.0	156.0	Inf	Inf	Inf	Inf	Inf	Inf	70.0	Inf	71.0	23.0	68	0	273.3
M	244.1	219.0	240.7	280.1	296.6	279.3	250.3	245.8	252.6	267.0	265.3	253.9	320.8	266.1	268.8	271.6	274.6	288.6	313.7	274.4	311.3	271.6	312.7	273.3	0

Table 3: Input data for f_1 objective. Gear pump A.

Item	RP_i	RC_i	CD_i	$rc_{i,1}$	$rc_{i,2}$	$oh_{i,1}$	$oh_{i,2}$	$oh_{i,3}$	$oh_{i,4}$	$dp_{i,1}$	$dp_{i,2}$	$dp_{i,3}$	$dp_{i,4}$
1	0.35	0.0024	0	0.1	0.3	0.0022	0.0056	0.0022	0.0011	0.09	0.13	0.10	0.07
2	0.35	0.0024	0	0.1	0.3	0.0022	0.0056	0.0022	0.0011	0.09	0.13	0.10	0.07
3	0.35	0.0024	0	0.1	0.3	0.0022	0.0056	0.0022	0.0011	0.09	0.13	0.10	0.07
4	0.35	0.0024	0	0.1	0.3	0.0022	0.0056	0.0022	0.0011	0.09	0.13	0.10	0.07
5	0.35	0.0024	0	0.1	0.3	0.0022	0.0056	0.0022	0.0011	0.09	0.13	0.10	0.07
6	0.35	0.0024	0	0.1	0.3	0.0022	0.0056	0.0022	0.0011	0.09	0.13	0.10	0.07
7	8.50	0.1614	0	1.2	4	0.1530	0.3826	0.1530	0.0765	0.12	0.17	0.14	0.09
8	0.00	0.0000	0.3	0	0	0.0012	0.0030	0.0012	0.0006	0.09	0.13	0.10	0.07
9	12.70	0.0358	0	1	7.5	0.0340	0.0849	0.0340	0.0170	0.17	0.26	0.21	0.14
10	12.70	0.0358	0	1	7.5	0.0340	0.0849	0.0340	0.0170	0.17	0.26	0.21	0.14
11	3.50	0.0123	0	0.3	2	0.0116	0.0291	0.0116	0.0058	0.12	0.17	0.14	0.09
12	37.00	0.4605	0	4.5	8.3	0.4366	1.0914	0.4366	0.2183	0.23	0.35	0.28	0.18
13	6.30	0.0430	0	0.7	3.2	0.0408	0.1020	0.0408	0.0204	0.12	0.17	0.14	0.09
14	2.50	0.0064	0	0.5	1.2	0.0060	0.0151	0.0060	0.0030	0.06	0.09	0.07	0.05
15	3.00	0.0284	0	0.7	1.6	0.0269	0.0672	0.0269	0.0134	0.09	0.13	0.10	0.07

Table 4: Input data for f_1 objective. Gear pump B.

Item	RP_i	RC_i	CD_i	$rc_{i,1}$	$rc_{i,2}$	$oh_{i,1}$	$oh_{i,2}$	$oh_{i,3}$	$oh_{i,4}$	$dp_{i,1}$	$dp_{i,2}$	$dp_{i,3}$	$dp_{i,4}$
1	0.43	0.0049	0	0.1	0.3	0.0024	0.0060	0.0024	0.0012	0.12	0.17	0.14	0.09
2	0.43	0.0049	0	0.1	0.3	0.0024	0.0060	0.0024	0.0012	0.12	0.17	0.14	0.09
3	0.43	0.0049	0	0.1	0.3	0.0024	0.0060	0.0024	0.0012	0.12	0.17	0.14	0.09
4	0.43	0.0049	0	0.1	0.3	0.0024	0.0060	0.0024	0.0012	0.12	0.17	0.14	0.09
5	0.43	0.0049	0	0.1	0.3	0.0024	0.0060	0.0024	0.0012	0.12	0.17	0.14	0.09
6	0.43	0.0049	0	0.1	0.3	0.0024	0.0060	0.0024	0.0012	0.12	0.17	0.14	0.09
7	11.90	0.3767	0	1.2	2.5	0.1854	0.4634	0.1854	0.0927	0.14	0.22	0.17	0.12
8	0.00	0.0026	0.2	0	0	0.0013	0.0032	0.0013	0.0006	0.12	0.17	0.14	0.09
9	15.78	0.0836	0	0.6	3	0.0411	0.1029	0.0411	0.0206	0.17	0.26	0.21	0.14
10	15.78	0.0836	0	0.6	3	0.0411	0.1029	0.0411	0.0206	0.17	0.26	0.21	0.14
11	4.32	0.0252	0	0.3	0.9	0.0124	0.0311	0.0124	0.0062	0.12	0.17	0.14	0.09
12	37.80	1.0745	0	1.5	3.5	0.5287	1.3218	0.5287	0.2644	0.12	0.17	0.14	0.09
13	7.78	0.0885	0	0.7	2	0.0436	0.1089	0.0436	0.0218	0.23	0.35	0.28	0.18
14	0.00	0.0036	0.15	0	0	0.0018	0.0044	0.0018	0.0009	0.09	0.13	0.10	0.07
15	0.00	0.0036	0.15	0	0	0.0018	0.0044	0.0018	0.0009	0.09	0.13	0.10	0.07
16	0.00	0.0036	0.15	0	0	0.0018	0.0044	0.0018	0.0009	0.09	0.13	0.10	0.07
17	0.00	0.0036	0.15	0	0	0.0018	0.0044	0.0018	0.0009	0.09	0.13	0.10	0.07
18	3.60	0.0567	0	0.2	0.7	0.0279	0.0698	0.0279	0.0140	0.09	0.13	0.10	0.07
19	0.35	0.0039	0	0.1	0.3	0.0019	0.0048	0.0019	0.0010	0.09	0.13	0.10	0.07
20	0.35	0.0039	0	0.1	0.3	0.0019	0.0048	0.0019	0.0010	0.09	0.13	0.10	0.07
21	0.20	0.0011	0	0.1	0.3	0.0006	0.0014	0.0006	0.0003	0.12	0.17	0.14	0.09
22	0.20	0.0011	0	0.1	0.3	0.0006	0.0014	0.0006	0.0003	0.12	0.17	0.14	0.09
23	0.20	0.0011	0	0.1	0.3	0.0006	0.0014	0.0006	0.0003	0.12	0.17	0.14	0.09
24	0.20	0.0011	0	0.1	0.3	0.0006	0.0014	0.0006	0.0003	0.12	0.17	0.14	0.09

Table 5: Input data for f_2 objective. Gear pump A.

Item	$gr_{i,1}$	$gr_{i,2}$	$gd_{1,i}$	$gd_{3,i}$	$gc_{i,1}$	$gc_{i,2}$	$gc_{i,3}$	$gc_{i,4}$
1	0.115	0.115	0.042	0.069	0.006	0.035	0.012	0.023
2	0.115	0.115	0.042	0.069	0.006	0.035	0.012	0.023
3	0.115	0.115	0.042	0.069	0.006	0.035	0.012	0.023
4	0.115	0.115	0.042	0.069	0.006	0.035	0.012	0.023
5	0.115	0.115	0.042	0.069	0.006	0.035	0.012	0.023
6	0.115	0.115	0.042	0.069	0.006	0.035	0.012	0.023
7	1.302	1.302	0.056	0.069	0.065	0.391	0.130	0.260
8	0.014	0.014	0.042	0.069	0.001	0.004	0.001	0.003
9	0.850	0.850	0.083	0.069	0.043	0.255	0.085	0.170
10	0.850	0.850	0.083	0.069	0.043	0.255	0.085	0.170
11	0.138	0.138	0.056	0.069	0.007	0.041	0.014	0.028
12	2.480	2.480	0.111	0.069	0.124	0.744	0.248	0.496
13	0.592	0.592	0.056	0.069	0.030	0.178	0.059	0.118
14	0.234	0.234	0.028	0.069	0.012	0.070	0.023	0.047
15	0.284	0.284	0.042	0.069	0.014	0.085	0.028	0.057

Note: $gd_{2,i}$, $gd_{4,i}$ and $gd_{5,i}$ values are obtained from the GD matrix

Table 6: GD matrix for f_2 objective. Gear pump A.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	M
1	0.000	0.032	0.050	0.071	0.050	0.032	0.263	Inf	Inf	Inf	Inf	0.254	0.401	0.366	0.339	0.017
2	0.032	0.000	0.033	0.050	0.057	0.050	0.257	Inf	Inf	Inf	Inf	0.248	0.395	0.359	0.333	0.016
3	0.050	0.033	0.000	0.032	0.050	0.057	0.256	Inf	Inf	Inf	Inf	0.247	0.394	0.358	0.331	0.016
4	0.071	0.050	0.032	0.000	0.032	0.050	0.260	Inf	Inf	Inf	Inf	0.251	0.398	0.362	0.336	0.016
5	0.050	0.057	0.050	0.032	0.000	0.033	0.256	Inf	Inf	Inf	Inf	0.247	0.394	0.358	0.331	0.016
6	0.032	0.050	0.057	0.050	0.033	0.000	0.257	Inf	Inf	Inf	Inf	0.248	0.395	0.359	0.333	0.016
7	Inf	Inf	Inf	Inf	Inf	Inf	0.000	0.271	Inf	Inf	Inf	0.123	0.392	0.357	0.330	0.016
8	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.000	0.038	0.059	Inf	0.262	0.143	0.115	0.347	0.018
9	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.000	0.046	0.006	0.260	0.159	0.130	0.345	0.018
10	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.046	0.000	0.039	0.259	0.180	0.151	0.343	0.017
11	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.039	0.000	0.254	0.163	0.134	0.338	0.017
12	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.000	Inf	Inf	Inf	0.014
13	0.401	0.395	0.394	0.398	0.394	0.395	0.392	0.143	0.159	0.180	0.163	0.383	0.000	Inf	Inf	0.035
14	0.366	0.359	0.358	0.362	0.358	0.359	0.357	0.115	0.130	0.151	0.134	0.348	0.036	0.000	Inf	0.030
15	0.339	0.333	0.331	0.336	0.331	0.333	0.330	0.347	0.345	0.343	0.338	0.321	Inf	0.432	0.000	0.026
M	0.017	0.016	0.016	0.016	0.016	0.016	0.016	0.018	0.018	0.017	0.017	0.014	0.035	0.030	0.026	0.000

Table 7: Input data for f_2 objective. Gear pump B.

Item	$gr_{i,1}$	$gr_{i,2}$	$gd_{1,i}$	$gd_{3,i}$	$gc_{i,1}$	$gc_{i,2}$	$gc_{i,3}$	$gc_{i,4}$
1	0.896	0.896	0.056	0.056	0.045	0.269	0.090	0.179
2	0.896	0.896	0.056	0.056	0.045	0.269	0.090	0.179
3	0.896	0.896	0.056	0.056	0.045	0.269	0.090	0.179
4	0.896	0.896	0.056	0.056	0.045	0.269	0.090	0.179
5	0.896	0.896	0.056	0.056	0.045	0.269	0.090	0.179
6	0.896	0.896	0.056	0.056	0.045	0.269	0.090	0.179
7	11.152	11.152	0.069	0.056	0.558	3.346	1.115	2.230
8	0.112	0.112	0.056	0.056	0.006	0.034	0.011	0.022
9	6.791	6.791	0.083	0.056	0.340	2.037	0.679	1.358
10	6.791	6.791	0.083	0.056	0.340	2.037	0.679	1.358
11	1.111	1.111	0.056	0.056	0.056	0.333	0.111	0.222
12	21.897	21.897	0.056	0.056	1.095	6.569	2.190	4.379
13	4.733	4.733	0.111	0.056	0.237	1.420	0.473	0.947
14	0.122	0.122	0.042	0.056	0.006	0.037	0.012	0.024
15	0.122	0.122	0.042	0.056	0.006	0.037	0.012	0.024
16	0.122	0.122	0.042	0.056	0.006	0.037	0.012	0.024
17	0.122	0.122	0.042	0.056	0.006	0.037	0.012	0.024
18	4.819	4.819	0.042	0.056	0.241	1.446	0.482	0.964
19	0.885	0.885	0.042	0.056	0.044	0.266	0.089	0.177
20	0.885	0.885	0.042	0.056	0.044	0.266	0.089	0.177
21	0.223	0.223	0.056	0.056	0.011	0.067	0.022	0.045
22	0.223	0.223	0.056	0.056	0.011	0.067	0.022	0.045
23	0.223	0.223	0.056	0.056	0.011	0.067	0.022	0.045
24	0.223	0.223	0.056	0.056	0.011	0.067	0.022	0.045

Note: $gd_{2,i}$, $gd_{4,i}$ and $gd_{5,i}$ values are obtained from the GD matrix

Table 8: GD matrix for f_2 objective. Gear pump B.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	M
1	0.000	0.044	0.077	0.073	0.077	0.044	0.039	Inf	Inf	Inf	Inf	0.044	0.137	0.070	0.074	0.079	0.083	0.104	0.124	0.124	0.121	0.121	0.122	0.122	0.141
2	0.044	0.000	0.044	0.077	0.080	0.048	0.043	Inf	Inf	Inf	Inf	0.076	0.140	0.081	0.085	0.089	0.093	0.107	0.127	0.099	0.124	0.096	0.126	0.098	0.127
3	0.077	0.044	0.000	0.044	0.048	0.080	0.067	Inf	Inf	Inf	Inf	0.109	0.165	0.113	0.117	0.121	0.125	0.132	0.151	0.124	0.149	0.121	0.150	0.123	0.139
4	0.073	0.077	0.044	0.000	0.044	0.077	0.064	Inf	Inf	Inf	Inf	0.105	0.161	0.110	0.114	0.118	0.122	0.128	0.148	0.148	0.145	0.145	0.147	0.147	0.162
5	0.077	0.080	0.048	0.044	0.000	0.044	0.067	Inf	Inf	Inf	Inf	0.109	0.165	0.113	0.117	0.121	0.125	0.132	0.124	0.151	0.121	0.149	0.123	0.150	0.172
6	0.044	0.048	0.080	0.077	0.044	0.000	0.043	Inf	Inf	Inf	Inf	0.076	0.140	0.081	0.085	0.089	0.093	0.107	0.099	0.127	0.096	0.124	0.098	0.126	0.162
7	Inf	Inf	Inf	Inf	Inf	Inf	0.000	0.049	Inf	Inf	Inf	0.072	0.128	0.076	0.080	0.084	0.088	0.095	0.114	0.114	0.112	0.112	0.113	0.113	0.145
8	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.000	0.030	0.055	Inf	0.034	0.127	0.061	0.065	0.069	0.073	0.094	0.114	0.114	0.111	0.111	0.113	0.113	0.142
9	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.000	0.036	Inf	0.052	0.108	0.057	0.061	0.065	0.069	0.075	0.095	0.095	0.092	0.092	0.094	0.094	0.146
10	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.036	0.000	0.022	0.076	0.133	0.081	0.085	0.089	0.093	0.100	0.119	0.119	0.116	0.116	0.118	0.118	0.154
11	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.046	Inf	0.000	0.087	0.143	0.091	0.095	0.099	0.103	0.110	0.130	0.130	0.127	0.127	0.128	0.128	0.154
12	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.000	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.147
13	0.137	0.140	0.165	0.161	0.165	0.140	0.128	0.127	0.108	0.133	0.143	0.105	0.000	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.186
14	0.070	0.081	0.113	0.110	0.113	0.081	0.076	0.061	0.057	0.081	0.091	0.038	0.078	0.000	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.154
15	0.074	0.085	0.117	0.114	0.117	0.085	0.080	0.065	0.061	0.085	0.095	0.042	Inf	0.016	0.000	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.156
16	0.079	0.089	0.121	0.118	0.121	0.089	0.084	0.069	0.065	0.089	0.099	0.046	Inf	Inf	0.016	0.000	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.157
17	0.083	0.093	0.125	0.122	0.125	0.093	0.088	0.073	0.069	0.093	0.103	0.050	Inf	Inf	Inf	0.016	0.000	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.159
18	0.104	0.107	0.132	0.128	0.132	0.107	0.095	0.094	0.075	0.100	0.110	0.072	Inf	Inf	Inf	Inf	0.033	0.000	Inf	Inf	Inf	Inf	Inf	Inf	0.167
19	0.124	0.127	0.151	0.148	0.124	0.099	0.114	0.114	0.095	0.119	0.130	0.091	Inf	Inf	Inf	Inf	Inf	0.031	0.000	0.039	Inf	0.042	Inf	0.041	0.182
20	0.124	0.099	0.124	0.148	0.151	0.127	0.114	0.114	0.095	0.119	0.130	0.091	Inf	Inf	Inf	Inf	Inf	0.031	0.039	0.000	0.042	Inf	0.041	Inf	0.159
21	0.121	0.124	0.149	0.145	0.121	0.096	0.112	0.111	0.092	0.116	0.127	0.089	Inf	Inf	Inf	Inf	Inf	Inf	0.014	0.042	0.000	0.039	Inf	0.041	0.180
22	0.121	0.096	0.121	0.145	0.149	0.124	0.112	0.111	0.092	0.116	0.127	0.089	Inf	Inf	Inf	Inf	Inf	Inf	0.042	0.014	0.039	0.000	0.041	Inf	0.157
23	0.122	0.126	0.150	0.147	0.123	0.098	0.113	0.113	0.094	0.118	0.128	0.090	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.041	0.013	0.041	0.000	0.039	0.181
24	0.122	0.098	0.123	0.147	0.150	0.126	0.113	0.113	0.094	0.118	0.128	0.090	Inf	Inf	Inf	Inf	Inf	Inf	0.041	Inf	0.041	0.013	0.039	0.000	0.158
M	0.141	0.127	0.139	0.162	0.172	0.162	0.145	0.142	0.146	0.154	0.154	0.147	0.186	0.154	0.156	0.157	0.159	0.167	0.182	0.159	0.180	0.157	0.181	0.158	0.000

Table 9: Input data for f_3 objective. Gear pump A.

Item	$er_{i,1}$	$er_{i,2}$	$ec_{i,1}$	$ec_{i,2}$	$ec_{i,3}$	$ec_{i,4}$	$ed(x_i)$
1	0,00213	0,00213	0,00021	0,00064	0,00111	0,00221	0,00262
2	0,00213	0,00213	0,00021	0,00064	0,00111	0,00221	0,00262
3	0,00213	0,00213	0,00021	0,00064	0,00111	0,00221	0,00262
4	0,00213	0,00213	0,00021	0,00064	0,00111	0,00221	0,00262
5	0,00213	0,00213	0,00021	0,00064	0,00111	0,00221	0,00262
6	0,00213	0,00213	0,00021	0,00064	0,00111	0,00221	0,00262
7	0,11637	0,11637	0,01164	0,03491	0,07534	0,15068	0,00349
8	0,00030	0,00030	0,00003	0,00009	0,00001	0,00355	0,00262
9	0,02490	0,02490	0,00249	0,00747	0,01672	0,03344	0,00524
10	0,02490	0,02490	0,00249	0,00747	0,01672	0,03344	0,00524
11	0,00779	0,00779	0,00078	0,00234	0,00572	0,01145	0,00349
12	0,43960	0,43960	0,04396	0,13188	0,21490	0,42980	0,00000
13	0,02717	0,02717	0,00272	0,00815	0,02008	0,04015	0,00349
14	0,00508	0,00508	0,00051	0,00152	0,00298	0,00595	0,00175
15	0,02109	0,02109	0,00211	0,00633	0,01324	0,02648	0,00262

Note: $ed(x_i, x_{i+1})$ values are obtained from the ED matrix

Table 10: ED matrix for f_3 objective. Gear pump A.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	M
1	0.00000	0.00184	0.00286	0.00405	0.00286	0.00184	0.01505	Inf	Inf	Inf	Inf	0.01453	0.02294	0.02090	0.01937	0.00096
2	0.00184	0.00000	0.00187	0.00286	0.00326	0.00288	0.01469	Inf	Inf	Inf	Inf	0.01417	0.02258	0.02054	0.01901	0.00091
3	0.00286	0.00187	0.00000	0.00184	0.00288	0.00326	0.01460	Inf	Inf	Inf	Inf	0.01409	0.02249	0.02045	0.01892	0.00090
4	0.00405	0.00286	0.00184	0.00000	0.00184	0.00286	0.01485	Inf	Inf	Inf	Inf	0.01434	0.02274	0.02070	0.01918	0.00093
5	0.00286	0.00326	0.00288	0.00184	0.00000	0.00187	0.01460	Inf	Inf	Inf	Inf	0.01409	0.02249	0.02045	0.01892	0.00090
6	0.00184	0.00288	0.00326	0.00286	0.00187	0.00000	0.01469	Inf	Inf	Inf	Inf	0.01417	0.02258	0.02054	0.01901	0.00091
7	Inf	Inf	Inf	Inf	Inf	Inf	0.00000	0.01548	Inf	Inf	Inf	0.00702	0.02242	0.02038	0.01886	0.00089
8	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.00000	0.00216	0.00336	Inf	0.01497	0.00818	0.00655	0.01980	0.00102
9	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.00000	0.00261	0.00037	0.01487	0.00906	0.00744	0.01971	0.00101
10	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.00261	0.00000	0.00224	0.01479	0.01027	0.00864	0.01963	0.00100
11	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.00224	0.00000	0.01451	0.00930	0.00767	0.01934	0.00095
12	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.00000	Inf	Inf	Inf	0.00081
13	0.02294	0.02258	0.02249	0.02274	0.02249	0.02258	0.02242	0.00818	0.00906	0.01027	0.00930	0.02191	0.00000	Inf	Inf	0.00200
14	0.02090	0.02054	0.02045	0.02070	0.02045	0.02054	0.02038	0.00655	0.00744	0.00864	0.00767	0.01987	0.00204	0.00000	Inf	0.00171
15	0.01937	0.01901	0.01892	0.01918	0.01892	0.01901	0.01886	0.01980	0.01971	0.01963	0.01934	0.01834	Inf	0.02470	0.00000	0.00150
M	0.00096	0.00091	0.00090	0.00093	0.00090	0.00091	0.00089	0.00102	0.00101	0.00100	0.00095	0.00081	0.00200	0.00171	0.00150	0.00000

Table 11: Input data for f_3 objective. Gear pump B.

Item	$er_{i,1}$	$er_{i,2}$	$ec_{i,1}$	$ec_{i,2}$	$ec_{i,3}$	$ec_{i,4}$	$ed(x_i)$
1	0,00223	0,00223	0,00022	0,00067	0,00137	0,00273	0,00349
2	0,00223	0,00223	0,00022	0,00067	0,00137	0,00273	0,00349
3	0,00223	0,00223	0,00022	0,00067	0,00137	0,00273	0,00349
4	0,00223	0,00223	0,00022	0,00067	0,00137	0,00273	0,00349
5	0,00223	0,00223	0,00022	0,00067	0,00137	0,00273	0,00349
6	0,00223	0,00223	0,00022	0,00067	0,00137	0,00273	0,00349
7	0,16291	0,16291	0,01629	0,04887	0,10547	0,21095	0,00437
8	0,00183	0,00183	0,00018	0,00055	0,00001	0,00439	0,00349
9	0,03483	0,03483	0,00348	0,01045	0,02341	0,04682	0,00524
10	0,03483	0,03483	0,00348	0,01045	0,02341	0,04682	0,00524
11	0,00962	0,00962	0,00096	0,00289	0,00707	0,01413	0,00349
12	0,54442	0,54442	0,05444	0,16332	0,30086	0,60171	0,00349
13	0,03375	0,03375	0,00337	0,01012	0,02479	0,04959	0,00699
14	0,00155	0,00155	0,00016	0,00047	0,00002	0,00599	0,00262
15	0,00155	0,00155	0,00016	0,00047	0,00002	0,00599	0,00262
16	0,00155	0,00155	0,00016	0,00047	0,00002	0,00599	0,00262
17	0,00155	0,00155	0,00016	0,00047	0,00002	0,00599	0,00262
18	0,02528	0,02528	0,00253	0,00758	0,01589	0,03177	0,00262
19	0,00162	0,00162	0,00016	0,00049	0,00110	0,00219	0,00262
20	0,00162	0,00162	0,00016	0,00049	0,00110	0,00219	0,00262
21	0,00047	0,00047	0,00005	0,00014	0,00032	0,00064	0,00349
22	0,00047	0,00047	0,00005	0,00014	0,00032	0,00064	0,00349
23	0,00047	0,00047	0,00005	0,00014	0,00032	0,00064	0,00349
24	0,00047	0,00047	0,00005	0,00014	0,00032	0,00064	0,00349

Note: $ed(x_i, x_{i+1})$ values are obtained from the ED matrix

Table 12: ED matrix for f_3 objective. Gear pump B.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	M
1	0.0000	0.0025	0.0044	0.0042	0.0044	0.0025	0.0206	Inf	Inf	Inf	Inf	0.0207	0.0229	0.0211	0.0212	0.0213	0.0214	0.0218	0.0227	0.0214	0.0226	0.0213	0.0226	0.0213	0.0082
2	0.0025	0.0000	0.0025	0.0044	0.0046	0.0028	0.0197	Inf	Inf	Inf	Inf	0.0198	0.0221	0.0202	0.0203	0.0204	0.0205	0.0210	0.0218	0.0205	0.0218	0.0204	0.0218	0.0205	0.0073
3	0.0044	0.0025	0.0000	0.0025	0.0028	0.0046	0.0204	Inf	Inf	Inf	Inf	0.0206	0.0228	0.0210	0.0211	0.0211	0.0212	0.0217	0.0226	0.0212	0.0225	0.0211	0.0225	0.0212	0.0081
4	0.0042	0.0044	0.0025	0.0000	0.0025	0.0044	0.0218	Inf	Inf	Inf	Inf	0.0219	0.0241	0.0223	0.0224	0.0225	0.0226	0.0230	0.0239	0.0226	0.0238	0.0225	0.0238	0.0225	0.0094
5	0.0044	0.0046	0.0028	0.0025	0.0000	0.0025	0.0223	Inf	Inf	Inf	Inf	0.0224	0.0247	0.0228	0.0229	0.0230	0.0231	0.0236	0.0244	0.0231	0.0243	0.0230	0.0244	0.0231	0.0099
6	0.0025	0.0028	0.0046	0.0044	0.0025	0.0000	0.0217	Inf	Inf	Inf	Inf	0.0219	0.0241	0.0223	0.0223	0.0224	0.0225	0.0230	0.0239	0.0225	0.0238	0.0224	0.0238	0.0225	0.0093
7	Inf	Inf	Inf	Inf	Inf	Inf	0.0000	0.0206	Inf	Inf	Inf	0.0041	0.0231	0.0213	0.0214	0.0215	0.0216	0.0220	0.0229	0.0216	0.0228	0.0215	0.0228	0.0215	0.0084
8	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.0000	0.0018	0.0032	Inf	0.0207	0.0073	0.0035	0.0037	0.0040	0.0042	0.0054	0.0066	0.0214	0.0226	0.0213	0.0227	0.0214	0.0082
9	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.0000	0.0021	Inf	0.0210	0.0063	0.0033	0.0035	0.0037	0.0040	0.0043	0.0055	0.0216	0.0229	0.0215	0.0229	0.0216	0.0084
10	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.0021	0.0000	0.0013	0.0214	0.0077	0.0047	0.0049	0.0051	0.0054	0.0058	0.0069	0.0221	0.0234	0.0220	0.0234	0.0221	0.0089
11	0.0211	0.0202	0.0209	0.0223	0.0228	0.0222	0.0213	0.0037	0.0027	0.0013	0.0000	0.0214	0.0083	0.0053	0.0055	0.0057	0.0060	0.0064	0.0075	0.0221	0.0233	0.0220	0.0233	0.0220	0.0089
12	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.0000	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.0085
13	0.0229	0.0221	0.0228	0.0241	0.0247	0.0241	0.0231	0.0073	0.0063	0.0077	0.0083	0.0232	0.0000	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.0107
14	0.0211	0.0202	0.0210	0.0223	0.0228	0.0223	0.0213	0.0035	0.0033	0.0047	0.0053	0.0214	0.0045	0.0000	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.0089
15	0.0212	0.0203	0.0211	0.0224	0.0229	0.0223	0.0214	0.0037	0.0035	0.0049	0.0055	0.0215	Inf	0.0009	0.0000	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.0090
16	0.0213	0.0204	0.0211	0.0225	0.0230	0.0224	0.0215	0.0040	0.0037	0.0051	0.0057	0.0216	Inf	Inf	0.0009	0.0000	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.0091
17	0.0214	0.0205	0.0212	0.0226	0.0231	0.0225	0.0216	0.0042	0.0040	0.0054	0.0060	0.0217	Inf	Inf	Inf	0.0009	0.0000	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.0092
18	0.0218	0.0210	0.0217	0.0230	0.0236	0.0230	0.0220	0.0054	0.0043	0.0058	0.0064	0.0222	Inf	Inf	Inf	Inf	0.0019	0.0000	Inf	Inf	Inf	Inf	Inf	Inf	0.0097
19	0.0227	0.0218	0.0226	0.0239	0.0244	0.0239	0.0229	0.0227	0.0230	0.0234	0.0234	0.0230	Inf	Inf	Inf	Inf	Inf	0.0242	0.0000	0.0023	Inf	0.0236	Inf	0.0236	0.0105
20	0.0214	0.0205	0.0212	0.0226	0.0231	0.0225	0.0216	0.0214	0.0216	0.0221	0.0221	0.0217	Inf	Inf	Inf	Inf	Inf	0.0228	0.0023	0.0000	0.0236	Inf	0.0237	Inf	0.0092
21	0.0226	0.0218	0.0225	0.0238	0.0243	0.0238	0.0228	0.0226	0.0229	0.0234	0.0233	0.0229	Inf	Inf	Inf	Inf	Inf	Inf	0.0249	0.0236	0.0000	0.0023	Inf	0.0024	0.0104
22	0.0213	0.0204	0.0211	0.0225	0.0230	0.0224	0.0215	0.0213	0.0215	0.0220	0.0220	0.0216	Inf	Inf	Inf	Inf	Inf	Inf	0.0236	0.0223	0.0023	0.0000	0.0024	Inf	0.0091
23	0.0226	0.0218	0.0225	0.0238	0.0244	0.0238	0.0228	0.0227	0.0229	0.0234	0.0233	0.0230	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.0237	0.0008	0.0024	0.0000	0.0023	0.0105
24	0.0213	0.0205	0.0212	0.0225	0.0231	0.0225	0.0215	0.0214	0.0216	0.0221	0.0220	0.0216	Inf	Inf	Inf	Inf	Inf	Inf	0.0236	Inf	0.0024	0.0008	0.0023	0.0000	0.0091
M	0.0082	0.0073	0.0081	0.0094	0.0099	0.0093	0.0084	0.0082	0.0084	0.0089	0.0089	0.0085	0.0107	0.0089	0.0090	0.0091	0.0092	0.0097	0.0105	0.0092	0.0104	0.0091	0.0105	0.0091	0.0000

Table 13: Goal 1+2+3 Gear pump A (Multi-objective Aggregate Method) using EDBA

Iteration	Population size	Disassembly Sequence	Disassembly Direction	Disassembly mode	Disasembly Tool	Best Found Value
100	50	5-4-2-1-6-3-15-14-13-12-7-9-11-10-8	2-2-2-2-2-2-1-1-1-1-2-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	65.18
100	60	3-1-6-5-4-2-15-14-13-12-7-11-9-10-8	2-2-2-2-2-2-1-1-1-1-2-2-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	65.20
100	70	2-1-6-5-4-3-15-14-13-12-7-10-11-9-8	2-2-2-2-2-2-1-1-1-1-2-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	65.26
100	80	15-14-13-1-6-5-4-3-2-12-7-9-11-10-8	1-1-1-2-2-2-2-2-2-1-2-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	2-3-3-1-1-1-1-1-1-4-4-3-3-3-3	65.23
200	50	2-1-6-5-4-3-15-14-13-12-7-9-11-10-8	2-2-2-2-2-2-1-1-1-1-2-1-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	65.19
200	60	3-4-5-6-1-2-15-14-13-12-7-10-11-9-8	2-2-2-2-2-2-1-1-1-1-2-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	65.26
200	70	4-3-2-1-6-5-15-14-13-12-7-11-9-10-8	2-2-2-2-2-2-1-1-1-1-2-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	65.27
200	80	15-14-13-1-6-5-4-3-2-12-7-9-11-10-8	1-1-1-2-2-2-2-2-2-1-2-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	2-3-3-1-1-1-1-1-1-4-4-3-3-3-3	65.23
300	50	5-4-3-1-2-6-15-14-13-12-7-11-9-10-8	2-2-2-2-2-2-1-1-1-1-2-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	65.20
300	60	6-1-2-3-4-5-15-14-13-12-7-9-11-10-8	2-2-2-2-2-2-1-1-1-1-2-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	65.25
300	70	6-1-2-3-4-5-15-14-13-12-7-11-9-10-8	2-2-2-2-2-2-1-1-1-1-2-1-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	65.22
300	80	2-1-6-5-4-3-15-14-13-12-7-9-11-10-8	2-2-2-2-2-2-1-1-1-1-2-2-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	65.25
400	50	3-2-4-5-6-1-15-14-13-12-7-11-9-10-8	2-2-2-2-2-2-1-1-1-1-2-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	65.17
400	60	5-6-1-2-3-4-15-14-13-12-7-10-11-9-8	2-2-2-2-2-2-1-1-1-1-2-2-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	65.24
400	70	5-6-1-2-3-4-15-14-13-12-7-9-11-10-8	2-2-2-2-2-2-1-1-1-1-2-2-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	65.24
400	80	3-2-1-6-5-4-15-14-13-12-7-10-9-11-8	2-2-2-2-2-2-1-1-1-1-2-2-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	65.21
500	50	3-4-6-1-2-5-15-14-13-12-7-11-9-10-8	2-2-2-2-2-2-1-1-1-1-2-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	65.21
500	60	1-2-3-4-6-5-15-14-13-12-7-11-9-10-8	2-2-2-2-2-2-1-1-1-1-2-2-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	65.17
500	**70**	**15-14-13-1-2-3-4-5-6-7-12-9-11-10-8**	**1-1-1-2-2-2-2-2-2-2-1-1-1-1-1**	**1-1-1-1-1-1-1-1-1-1-1-1-1-1-4**	**2-3-3-1-1-1-1-1-1-4-4-3-3-3-3**	**65.30**
500	80	15-14-13-6-1-2-4-3-5-7-12-11-9-10-8	1-1-1-2-2-2-2-2-2-2-1-2-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	2-3-3-1-1-1-1-1-1-4-4-3-3-3-3	65.16

Notes:

Disassembly direction: 1 = Y+ direction and 2 = Y- direction.

Disassembly mode: 1 = reuse, 2 = remanufacturing, 3 = recycle, 4 = disposal.

Disassembly tool: 1 = Spanner-I, 2 = Spanner-II,3 = Gripper-I, 4 = Gripper-II

Table 14: Goal 1+2+3 Gear pump B (Multi-objective aggregate method) using EDBA

Iteration	Population size	Disassembly Sequence	Disassembly Direction	Disassembly mode	Disasembly Tool	Best Found Value
100	50	24-22-23-21-6-1-5-3-4-2-7-20-19-18-11-9-10-13-17-16-8-15-14-12	1-1-1-1-2-2-2-2-2-2-2-1-1-1-2-2-2-1-1-1-2-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-1-4-1-4-4-4-1	3-3-3-3-1-1-1-1-1-1-5-2-2-4-4-4-4-4-4-4-4-4-4-4-5	87.088189
100	60	2-4-5-6-1-3-7-24-23-21-22-19-20-18-17-9-10-8-16-15-11-13-14-12	2-2-2-2-2-2-2-1-1-1-1-1-1-1-1-2-2-2-1-1-2-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-4-4-4-1-1-4-1	1-1-1-1-1-1-5-3-3-3-3-2-2-4-4-4-4-4-4-4-4-4-4-4-5	87.38462024
100	**70**	**6-5-4-3-2-1-7-23-24-21-22-20-19-18-17-9-8-10-11-13-16-15-14-12**	**2-2-2-2-2-2-2-1-1-1-1-1-1-1-1-2-2-2-2-1-1-1-1-1**	**1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-4-1-1-1-4-4-4-1**	**1-1-1-1-1-1-5-3-3-3-3-2-2-4-4-4-4-4-4-4-4-4-4-4-5**	**87.62500312**
100	80	1-4-5-3-6-2-7-24-22-23-21-20-19-18-17-9-10-11-16-8-13-15-14-12	2-2-2-2-2-2-2-1-1-1-1-1-1-1-1-2-2-2-1-2-1-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-4-4-1-4-4-1	1-1-1-1-1-1-5-3-3-3-3-2-2-4-4-4-4-4-4-4-4-4-4-4-5	87.61987446
200	50	6-2-4-3-5-1-7-24-23-21-22-20-19-18-10-11-8-9-13-17-16-15-14-12	2-2-2-2-2-2-2-1-1-1-1-1-1-1-2-2-2-2-1-1-1-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-4-4-4-1	1-1-1-1-1-1-5-3-3-3-3-2-2-4-4-4-4-4-4-4-4-4-4-4-5	86.39803831
200	60	24-22-23-21-19-20-2-3-4-5-6-1-18-17-16-7-13-15-9-10-11-8-14-12	1-1-1-1-1-1-2-2-2-2-2-2-2-1-1-1-2-1-1-2-2-2-2-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-4-4-1-1-4-1-1-1-4-4-1	3-3-3-3-2-2-1-1-1-1-1-1-4-4-4-5-4-4-4-4-4-4-4-5	86.36057678
200	70	1-6-3-5-4-2-24-23-22-21-19-20-7-18-8-9-10-11-13-17-16-15-14-12	2-2-2-2-2-2-1-1-1-1-1-2-1-2-2-2-2-2-1-1-1-1-1-2	1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-1-1-1-1-1-4-4-4-1	1-1-1-1-1-1-3-3-3-3-3-2-2-5-4-4-4-4-4-4-4-4-4-4-5	87.59250141
200	80	24-22-23-21-19-20-2-3-4-5-6-1-7-18-9-10-11-8-13-17-16-15-14-12	1-1-1-1-1-1-2-2-2-2-2-2-1-2-2-2-2-2-1-1-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-4-4-4-4-1	3-3-3-3-2-2-1-1-1-1-1-5-4-4-4-4-4-4-4-4-4-4-4-5	86.46575605
300	50	2-3-5-4-6-1-7-24-23-21-22-19-20-18-8-9-10-11-13-17-16-15-14-12	2-2-2-2-2-2-2-1-1-1-1-1-1-2-2-2-2-2-1-1-1-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-1-4-4-4-1	1-1-1-1-1-1-5-3-3-3-3-2-2-4-4-4-4-4-4-4-4-4-4-4-5	87.48688807
300	60	24-23-21-22-2-4-5-1-6-3-7-19-20-18-17-10-11-9-13-16-15-14-8-12	1-1-1-1-2-2-2-2-2-2-2-1-1-1-1-2-2-2-1-1-1-1-2-1	1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-1-4-4-4-1	3-3-3-3-1-1-1-1-1-1-5-2-2-4-4-4-4-4-4-4-4-4-4-4-5	87.33490632
300	70	2-6-5-4-3-1-7-24-23-21-22-20-19-18-9-8-17-11-13-16-15-10-14-12	2-2-2-2-2-2-2-1-1-1-1-1-1-2-2-1-2-1-1-1-2-1-1-1	1-1-1-1-1-1-1-1-1-4-1-1-1-1-4-1-1-1-4-4-1-4-4-1	1-1-1-1-1-1-5-3-3-3-3-2-2-4-4-4-4-4-4-4-4-4-4-4-5	87.264519
300	80	1-6-5-3-4-2-7-24-23-21-22-19-20-18-9-10-11-17-16-15-14-13-8-12	2-2-2-2-2-2-2-1-1-1-1-1-1-1-2-2-2-1-1-1-1-1-2-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-4-4-4-1-4-1	1-1-1-1-1-1-5-3-3-3-3-2-2-4-4-4-4-4-4-4-4-4-4-4-5	86.79701869
400	50	1-6-5-3-4-2-7-24-23-22-21-19-20-18-17-10-9-13-8-16-11-15-14-12	2-2-2-2-2-2-2-1-1-1-1-1-1-1-1-2-2-1-2-1-2-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-4-4-1-4-4-1	1-1-1-1-1-1-5-3-3-3-3-2-2-4-4-4-4-4-4-4-4-4-4-4-5	86.06367477
400	60	1-2-6-4-5-3-7-24-22-23-21-19-20-18-17-11-9-8-10-13-16-15-14-12	2-2-2-2-2-2-2-1-1-1-1-1-1-1-1-2-2-2-2-1-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-4-1-1-4-4-4-1	1-1-1-1-1-1-5-3-3-3-3-2-2-4-4-4-4-4-4-4-4-4-4-4-5	87.3404985
400	70	3-4-5-1-6-2-24-23-21-22-20-19-18-17-7-16-10-11-15-14-9-13-8-12	2-2-2-2-2-2-2-1-1-1-1-1-1-1-1-2-1-2-2-1-1-2-1-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-4-4-1-4-4-1	1-1-1-1-1-1-3-3-3-3-3-2-2-4-4-5-4-4-4-4-4-4-4-4-5	86.50319112
400	80	2-6-1-5-4-3-7-24-23-21-22-20-19-10-11-18-17-8-9-13-16-15-14-12	2-2-2-2-2-2-2-1-1-1-1-1-1-2-2-1-1-2-2-1-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-4-1-1-4-4-4-1	1-1-1-1-1-1-5-3-3-3-3-2-2-4-4-4-4-4-4-4-4-4-4-4-5	87.4675654
500	50	2-1-6-5-4-3-7-23-24-22-21-20-19-18-11-9-10-13-17-8-16-15-14-12	2-2-2-2-2-2-2-1-1-1-1-1-1-1-2-2-2-2-1-1-2-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-4-4-4-1-4-1	1-1-1-1-1-1-5-3-3-3-3-2-2-4-4-4-4-4-4-4-4-4-4-4-5	87.60000501
500	60	1-2-4-5-3-6-7-23-21-24-22-19-20-9-10-18-17-11-13-8-16-15-14-12	2-2-2-2-2-2-2-1-1-1-1-1-2-2-1-1-2-1-2-1-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-1-1-4-4-4-1	1-1-1-1-1-1-5-3-3-3-3-2-2-4-4-4-4-4-4-4-4-4-4-4-5	86.90396292
500	70	3-2-1-5-4-6-24-22-23-21-20-19-7-8-9-10-18-17-16-11-13-15-14-12	2-2-2-2-2-2-1-1-1-1-1-1-2-2-2-2-1-1-1-2-1-1-1-2	1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-4-4-1-1-4-4-1	1-1-1-1-1-1-3-3-3-3-3-2-2-5-4-4-4-4-4-4-4-4-4-4-5	86.80268856
500	80	23-21-24-22-2-3-5-4-6-1-7-19-20-18-17-8-10-16-9-15-11-13-14-12	1-1-1-1-2-2-2-2-2-2-2-1-1-1-1-2-2-1-2-1-2-1-1-2	1-1-1-1-1-1-1-1-1-1-1-4-1-1-4-1-4-1-4-1-1-1-4-1	3-3-3-3-1-1-1-1-1-1-5-2-2-4-4-4-4-4-4-4-4-4-4-4-5	86.77013039

Notes:

Disassembly direction: 1 = Y+ direction and 2 = Y- direction.

Disassembly mode: 1 = reuse, 2 = remanufacturing, 3 = recycle, 4 = disposal.

Disassembly tool: 1 = Spanner-I, 2 = Spanner-II,3 = Spanner-III, 4 = Gripper-I, 5 = Gripper-II

Table 15: Pareto Optimal Solutions of Gear pump A (NSGA-II - Iteration 500, Population Size 80

No.	Disassembly Sequence	Disassembly Direction	Disassembly mode	Disasembly Tool	f1	f2	f3
1	1-6-5-2-3-4-15-7-10-9-13-8-11-12-14	2-2-2-2-2-2-1-2-2-2-2-2-2-2-2	1-1-1-1-1-1-1-1-1-1-4-1-1-1	1-1-1-1-1-1-2-4-3-3-3-3-3-4-3	63.119	0.853	-0.195
2	1-5-6-2-4-3-15-14-13-12-8-11-10-9-7	2-2-2-2-2-2-1-1-1-1-1-1-1-1-1	1-1-1-1-1-1-1-1-1-1-4-1-1-1-1	1-1-1-1-1-1-2-3-3-4-3-3-3-3-4	63.161	0.850	-0.195
3	1-2-3-4-5-6-15-7-8-9-10-13-11-12-14	2-2-2-2-2-2-1-2-2-2-2-2-2-2-2	1-1-1-1-1-1-1-1-4-1-1-1-1-1-1	1-1-1-1-1-1-2-4-3-3-3-3-3-4-3	63.132	0.853	-0.195
4	1-4-2-3-5-6-15-7-8-14-13-10-11-9-12	2-2-2-2-2-2-1-2-2-1-1-2-2-2-1	1-1-1-1-1-1-1-1-4-1-1-1-1-1-1	1-1-1-1-1-1-2-4-3-3-3-3-3-3-4	63.647	0.841	-0.195
5	3-2-4-5-1-6-7-9-11-8-15-10-14-13-12	2-2-2-2-2-2-2-2-2-2-1-2-1-2-2	1-1-1-1-1-1-1-1-1-4-1-1-1-1-1	1-1-1-1-1-1-4-3-3-3-2-3-3-3-4	63.702	0.840	-0.195
6	3-5-2-1-4-15-14-13-6-12-10-9-11-8-7	2-2-2-2-2-1-1-1-2-1-1-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-4-1	1-1-1-1-1-2-3-3-1-4-3-3-3-3-4	62.928	0.848	-0.195
7	3-5-1-2-4-6-15-14-13-12-7-10-11-9-8	2-2-2-2-2-2-1-1-1-1-2-2-1-2-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-2-3-3-4-4-3-3-3-3-3	63.953	0.857	-0.21
8	4-2-3-6-1-5-15-14-13-12-7-10-11-9-8	2-2-2-2-2-2-1-1-1-1-2-1-2-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-2-3-3-4-4-3-3-3-3-3	63.989	0.857	-0.21
9	4-2-3-5-1-6-15-7-8-9-14-13-10-12-11	2-2-2-2-2-2-1-2-2-2-1-1-2-1-1	1-1-1-1-1-1-1-1-4-1-1-1-1-1-1	1-1-1-1-1-1-2-4-3-3-3-3-3-4-3	63.202	0.848	-0.195
10	4-5-2-6-1-15-3-7-8-9-10-11-12-13-14	2-2-2-2-2-1-2-2-2-2-2-2-2-2-1	1-1-1-1-1-1-1-1-4-1-1-1-1-1-1	1-1-1-1-1-2-1-4-3-3-3-3-4-3-3	62.077	0.850	-0.195
11	4-1-6-5-2-3-15-14-13-12-10-11-9-8-7	2-2-2-2-2-2-1-1-1-1-1-1-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-4-1	1-1-1-1-1-1-2-3-3-4-3-3-3-3-4	63.994	0.854	-0.195
12	4-3-6-5-2-15-14-13-1-12-9-11-10-8-7	2-2-2-2-2-1-1-1-2-1-1-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-4-1	1-1-1-1-1-2-3-3-1-4-3-3-3-3-4	63.066	0.849	-0.195
13	5-6-2-1-4-3-7-11-9-10-8-15-12-14-13	2-2-2-2-2-2-2-2-2-2-2-1-2-1-2	1-1-1-1-1-1-1-1-1-4-1-1-1-1-1	1-1-1-1-1-1-4-3-3-3-3-2-4-3-3	65.220	0.862	-0.195
14	5-2-1-3-4-6-7-10-8-11-9-13-15-12-14	2-2-2-2-2-2-2-2-2-2-2-2-1-2-2	1-1-1-1-1-1-1-1-4-1-1-1-1-1-1	1-1-1-1-1-1-4-3-3-3-3-3-2-4-3	63.264	0.854	-0.195
15	5-2-4-6-1-3-15-14-13-7-12-8-10-9-11	2-2-2-2-2-2-1-1-1-2-1-1-1-2-1	1-1-1-1-1-1-1-1-1-1-4-1-1-1-1	1-1-1-1-1-1-2-3-3-4-4-3-3-3-3	63.384	0.850	-0.195
16	5-4-1-3-2-6-15-14-12-7-8-10-11-9-13	2-2-2-2-2-2-1-1-1-2-2-2-2-1-1	1-1-1-1-1-1-1-1-1-4-1-1-1-1-1	1-1-1-1-1-1-2-3-4-4-3-3-3-3-3	63.549	0.851	-0.195
17	5-2-3-6-4-1-7-9-11-10-8-15-14-12-13	2-2-2-2-2-2-2-2-2-2-2-1-1-1-1	1-1-1-1-1-1-1-1-1-4-1-1-1-1-1	1-1-1-1-1-1-4-3-3-3-3-2-3-4-3	62.783	0.849	-0.195
18	5-6-1-4-2-3-7-11-13-9-10-15-14-8-12	2-2-2-2-2-2-2-2-2-2-2-1-1-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-4-1	1-1-1-1-1-1-4-3-3-3-3-2-3-3-4	63.441	0.844	-0.195
19	5-3-4-6-1-2-15-14-12-7-9-13-10-8-11	2-2-2-2-2-2-1-1-1-2-1-1-2-2-1	1-1-1-1-1-1-1-1-1-1-1-1-1-4-1	1-1-1-1-1-1-2-3-4-4-3-3-3-3-3	62.985	0.845	-0.195
20	5-1-3-4-6-2-15-7-11-9-8-13-14-10-12	2-2-2-2-2-2-1-2-2-2-2-2-1-2-1	1-1-1-1-1-1-1-1-1-4-1-1-1-1-1	1-1-1-1-1-1-2-4-3-3-3-3-3-3-4	64.389	0.849	-0.195
21	6-3-1-4-5-2-15-7-8-10-11-13-14-9-12	2-2-2-2-2-2-1-2-2-2-2-2-1-2-2	1-1-1-1-1-1-1-1-4-1-1-1-1-1-1	1-1-1-1-1-1-2-4-3-3-3-3-3-3-4	63.923	0.845	-0.195
22	6-3-4-1-5-2-7-10-11-9-13-8-15-14-12	2-2-2-2-2-2-2-2-2-2-2-2-1-1-2	1-1-1-1-1-1-1-1-1-1-1-4-1-1-1	1-1-1-1-1-1-4-3-3-3-3-3-2-3-4	64.035	0.846	-0.195
23	6-5-1-2-4-15-14-13-3-7-12-8-10-9-11	2-2-2-2-2-1-1-1-2-2-1-2-2-2-2	1-1-1-1-1-1-1-1-1-1-1-4-1-1-1	1-1-1-1-1-2-3-3-1-4-4-3-3-3-3	63.258	0.852	-0.195
24	6-4-5-2-3-1-7-11-9-13-8-15-14-10-12	2-2-2-2-2-2-2-2-2-2-2-1-1-2-1	1-1-1-1-1-1-1-1-1-1-4-1-1-1-1	1-1-1-1-1-1-4-3-3-3-3-2-3-3-4	64.422	0.850	-0.195
25	6-15-14-13-1-3-4-2-5-7-12-8-9-10-11	2-1-1-1-2-2-2-2-2-2-1-1-1-2-1	1-1-1-1-1-1-1-1-1-1-1-4-1-1-1	1-2-3-3-1-1-1-1-1-4-4-3-3-3-3	62.783	0.849	-0.195
26	6-1-3-5-4-2-7-15-11-8-10-9-12-14-13	2-2-2-2-2-2-2-1-2-2-2-2-2-1-2	1-1-1-1-1-1-1-1-1-4-1-1-1-1-1	1-1-1-1-1-1-4-2-3-3-3-3-4-3-3	63.089	0.850	-0.195
27	6-5-4-3-2-1-15-7-10-13-11-9-14-8-12	2-2-2-2-2-2-1-2-2-2-2-2-1-2-1	1-1-1-1-1-1-1-1-1-1-1-1-1-4-1	1-1-1-1-1-1-2-4-3-3-3-3-3-3-4	64.618	0.849	-0.195
28	15-5-3-4-1-2-6-7-9-11-8-10-12-14-13	1-2-2-2-2-2-2-2-2-2-2-2-2-1-1	1-1-1-1-1-1-1-1-1-4-1-1-1-1-1	2-1-1-1-1-1-1-4-3-3-3-3-4-3-3	63.863	0.853	-0.195
29	15-1-6-4-3-5-2-7-10-9-11-14-13-8-12	1-2-2-2-2-2-2-2-2-2-2-2-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-4-1	2-1-1-1-1-1-1-4-3-3-3-3-3-3-4	65.946	0.858	-0.195
30	15-3-5-6-2-4-1-7-8-11-9-13-10-14-12	1-2-2-2-2-2-2-2-2-2-2-2-2-1-2	1-1-1-1-1-1-1-1-4-1-1-1-1-1-1	2-1-1-1-1-1-1-4-3-3-3-3-3-3-4	63.654	0.838	-0.195
31	15-14-3-1-2-5-4-6-7-12-11-10-13-8-9	1-1-2-2-2-2-2-2-2-1-2-2-1-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-4-1	2-3-1-1-1-1-1-1-4-4-3-3-3-3-3	63.312	0.843	-0.195
32	15-2-4-1-5-6-3-14-13-12-7-10-8-11-9	1-2-2-2-2-2-2-2-1-1-1-2-2-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1	2-1-1-1-1-1-1-3-3-4-4-3-3-3-3	63.555	0.844	-0.195
33	15-3-4-1-2-6-5-14-13-12-11-10-9-8-7	1-2-2-2-2-2-2-2-1-1-1-1-1-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-4-1	2-1-1-1-1-1-1-3-3-4-3-3-3-3-4	63.335	0.844	-0.195
34	15-14-1-6-3-4-2-5-7-11-9-10-8-12-13	1-1-2-2-2-2-2-2-2-2-2-2-2-2-1	1-1-1-1-1-1-1-1-1-1-1-1-4-1-1	2-3-1-1-1-1-1-1-4-3-3-3-3-4-3	62.828	0.850	-0.195

Notes:

Disassembly direction: 1 = Y+ direction and 2 = Y- direction.

Disassembly mode: 1 = reuse, 2 = remanufacturing, 3 = recycle, 4 = disposal.

Disassembly tool: 1 = Spanner-I, 2 = Spanner-II,3 = Gripper-I, 4 = Gripper-II

Table 16: Pareto Optimal Solutions of Gear pump A (PESA-II - Iteration 300, Population Size 80)

No.	Disassembly Sequence	Disassembly Direction	Disassembly mode	Disasembly Tool	f1	f2	f3
1	1-2-5-4-3-6-7-15-14-13-11-12-8-10-9	2-2-2-2-2-2-2-1-1-2-2-1-1-2-1	1-1-1-1-1-1-1-1-1-1-1-4-1-1	1-1-1-1-1-1-4-2-3-3-3-4-3-3-3	63.683	0.853	-0.195
2	1-2-3-4-6-5-7-8-15-13-14-11-12-10-9	2-2-2-2-2-2-2-2-1-2-1-2-1-1-1	1-1-1-1-1-1-1-4-1-1-1-1-1-1-1	1-1-1-1-1-1-4-3-2-3-3-3-4-3-3	63.409	0.849	-0.195
3	1-4-6-2-5-3-7-10-8-11-9-13-15-12-14	2-2-2-2-2-2-2-2-2-2-2-2-2-1-2-1	1-1-1-1-1-1-1-1-4-1-1-1-1-1-1-1	1-1-1-1-1-1-4-3-3-3-3-3-2-4-3	62.968	0.851	-0.195
4	1-5-2-6-4-3-15-7-11-9-10-8-12-14-13	2-2-2-2-2-2-1-2-2-2-2-2-2-1-2	1-1-1-1-1-1-1-1-1-1-1-4-1-1-1	1-1-1-1-1-1-2-4-3-3-3-3-4-3-3	64.686	0.861	-0.195
5	2-3-6-1-4-15-14-13-5-7-12-11-10-9-8	2-2-2-2-2-2-1-1-1-2-2-1-2-2-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-2-3-3-1-4-4-3-3-3-3	62.827	0.850	-0.21
6	2-1-4-6-5-3-7-11-10-9-15-14-8-12-13	2-2-2-2-2-2-2-2-2-2-2-1-1-2-1-1	1-1-1-1-1-1-1-1-1-1-1-1-4-1-1	1-1-1-1-1-1-4-3-3-3-2-3-3-4-3	62.889	0.854	-0.195
7	2-3-4-6-5-1-15-7-10-11-9-13-14-8-12	2-2-2-2-2-2-2-1-2-2-2-2-2-1-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-4-1	1-1-1-1-1-1-2-4-3-3-3-3-3-3-4	65.658	0.858	-0.195
8	3-2-5-6-1-4-15-7-10-9-14-12-8-11-13	2-2-2-2-2-2-2-1-2-2-2-1-1-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-4-1-1	1-1-1-1-1-1-2-4-3-3-3-4-3-3-3	63.118	0.846	-0.195
9	3-2-6-1-4-5-15-7-8-11-10-13-14-9-12	2-2-2-2-2-2-2-1-2-2-2-2-2-1-2-2	1-1-1-1-1-1-1-1-4-1-1-1-1-1-1	1-1-1-1-1-1-2-4-3-3-3-3-3-3-4	64.100	0.846	-0.195
10	3-2-5-1-4-15-14-13-6-12-7-10-8-9-11	2-2-2-2-2-2-1-1-1-2-1-2-1-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-4-1-1	1-1-1-1-1-2-3-3-1-4-4-3-3-3-3	62.851	0.848	-0.195
11	3-4-1-6-5-2-15-7-9-11-8-10-13-14-12	2-2-2-2-2-2-2-1-2-2-2-2-2-2-1-1	1-1-1-1-1-1-1-1-1-4-1-1-1-1-1	1-1-1-1-1-1-2-4-3-3-3-3-3-3-4	64.102	0.846	-0.195
12	4-5-6-1-2-3-15-14-13-12-11-7-9-10-8	2-2-2-2-2-2-2-1-1-1-1-1-2-2-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-3-4-3-4-3-3-3	62.152	0.848	-0.21
13	4-6-5-1-3-2-15-7-10-9-8-11-14-12-13	2-2-2-2-2-2-2-1-2-2-2-2-2-2-1-1	1-1-1-1-1-1-1-1-1-1-4-1-1-1-1	1-1-1-1-1-1-2-4-3-3-3-3-3-4-3	62.777	0.848	-0.195
14	4-6-3-2-5-1-15-7-8-14-9-11-13-10-12	2-2-2-2-2-2-2-1-2-2-1-2-2-2-2-1	1-1-1-1-1-1-1-1-4-1-1-1-1-1-1	1-1-1-1-1-1-2-4-3-3-3-3-3-3-4	63.363	0.839	-0.195
15	5-2-4-3-1-6-15-7-10-9-8-11-13-12-14	2-2-2-2-2-2-2-1-2-2-2-2-2-2-2-1	1-1-1-1-1-1-1-1-1-1-4-1-1-1-1	1-1-1-1-1-1-2-4-3-3-3-3-3-4-3	62.996	0.851	-0.195
16	5-2-3-4-1-15-14-13-6-12-7-10-8-11-9	2-2-2-2-2-1-1-1-2-1-2-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-4-1-1	1-1-1-1-1-2-3-3-1-4-4-3-3-3-3	63.015	0.846	-0.195
17	5-6-3-2-1-15-4-7-9-11-10-14-13-8-12	2-2-2-2-2-1-2-2-2-2-2-1-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-4-1	1-1-1-1-1-2-1-4-3-3-3-3-3-3-4	64.497	0.851	-0.195
18	5-6-3-4-2-1-7-10-8-15-13-9-11-14-12	2-2-2-2-2-2-2-2-2-1-2-2-2-1-1	1-1-1-1-1-1-1-1-4-1-1-1-1-1-1	1-1-1-1-1-1-4-3-3-2-3-3-3-3-4	63.988	0.847	-0.195
19	5-6-2-4-3-1-15-7-11-8-14-13-9-10-12	2-2-2-2-2-2-1-2-2-2-1-2-2-2-1	1-1-1-1-1-1-1-1-1-4-1-1-1-1-1	1-1-1-1-1-1-2-4-3-3-3-3-3-3-4	63.924	0.844	-0.195
20	5-6-4-3-2-1-15-7-11-8-9-14-10-13-12	2-2-2-2-2-2-1-2-2-2-2-1-2-2-1	1-1-1-1-1-1-1-1-1-4-1-1-1-1-1	1-1-1-1-1-1-2-4-3-3-3-3-3-3-4	63.483	0.840	-0.195
21	6-5-3-4-2-1-15-14-12-7-9-11-10-13-8	2-2-2-2-2-2-1-1-1-2-1-1-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-4	1-1-1-1-1-1-2-3-4-4-3-3-3-3-3	63.623	0.853	-0.21
22	15-14-13-6-5-1-4-2-3-7-12-8-9-11-10	1-1-1-2-2-2-2-2-2-2-1-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-4-1-1-1	2-3-3-1-1-1-1-1-1-4-4-3-3-3-3	64.348	0.852	-0.195
23	15-6-1-3-2-4-5-7-10-11-14-13-8-9-12	1-2-2-2-2-2-2-2-2-2-1-1-2-2-2	1-1-1-1-1-1-1-1-1-1-1-4-1-1-1	2-1-1-1-1-1-1-4-3-3-3-3-3-3-4	64.603	0.848	-0.195
24	15-5-1-2-3-4-6-7-9-8-11-10-13-12-14	1-2-2-2-2-2-2-2-2-2-2-2-2-2-1	1-1-1-1-1-1-1-1-4-1-1-1-1-1-1	2-1-1-1-1-1-1-4-3-3-3-3-3-4-3	63.325	0.851	-0.195

Notes:

Disassembly direction: 1 = Y+ direction and 2 = Y- direction.

Disassembly mode: 1 = reuse, 2 = remanufacturing, 3 = recycle, 4 = disposal.

Disassembly tool: 1 = Spanner-I, 2 = Spanner-II,3 = Gripper-I, 4 = Gripper-II

Table 17: Pareto Optimal Solutions of Gear pump B (NSGA-II - Iteration 500 population size 60)

No.	Disassembly Sequence	Disassembly Direction	Disassembly mode	Disasembly Tool	f1	f2	f3
1	1-6-4-2-5-3-24-22-23-21-7-10-20-19-18-9-13-8-17-16-11-15-14-12	2-2-2-2-2-2-1-1-1-1-2-2-1-1-1-2-1-2-1-1-2-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-4-4-1-4-4-1	1-1-1-1-1-1-3-3-3-3-5-4-2-2-4-4-4-4-4-4-4-4-4-5	74.69	7.9624	0.7775
2	2-3-4-6-5-1-24-22-23-21-20-19-7-18-10-9-13-17-11-8-16-12-14-15	2-2-2-2-2-2-1-1-1-1-1-1-2-1-2-2-1-1-2-2-1-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-4-4-1-4-4	1-1-1-1-1-1-3-3-3-3-2-2-5-4-4-4-4-4-4-4-4-5-4-4	75.187	7.9674	0.7775
3	2-3-4-24-22-23-21-6-1-5-7-8-9-11-19-20-18-17-16-10-13-15-12-14	2-2-2-1-1-1-1-2-2-2-2-2-2-2-1-1-1-1-1-2-1-1-2-2	1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-4-4-1-1-4-1-4-4	1-1-1-3-3-3-3-3-1-1-1-5-4-4-4-2-2-4-4-4-4-4-4-5-4	71.71	7.9479	0.7775
4	2-5-4-24-23-22-21-20-6-1-3-19-18-17-7-8-10-11-13-9-12-16-15-14	2-2-2-1-1-1-1-1-2-2-2-1-1-1-2-2-2-2-1-2-2-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-4-1-4-1-1-1-1-1-4-4-4-4	1-1-1-3-3-3-3-3-2-1-1-1-2-4-4-5-4-4-4-4-4-5-4-4-4	70.123	7.9406	0.7775
5	2-6-3-1-4-5-7-10-24-11-22-20-8-23-21-19-18-17-16-15-9-14-13-12	2-2-2-2-2-2-2-2-1-2-1-1-2-1-1-1-1-1-1-1-2-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-4-4-4-1-4-1-1	1-1-1-1-1-1-5-4-3-4-3-2-4-3-3-2-4-4-4-4-4-4-4-5	66.857	7.9184	0.7775
6	2-23-4-3-1-5-21-19-24-22-6-7-8-9-10-20-18-13-12-17-14-16-15-11	2-1-2-2-2-2-1-1-1-1-2-2-2-2-2-1-1-1-2-1-2-1-2-2	1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-1-4-4-4-4-1	1-3-1-1-1-1-3-2-3-3-1-5-4-4-4-2-4-4-5-4-4-4-4-4	64.064	7.9072	0.7775
7	3-1-6-4-5-2-23-21-24-19-22-20-7-18-11-9-8-13-17-16-10-15-14-12	2-2-2-2-2-2-1-1-1-1-1-1-2-1-2-2-2-1-1-1-2-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-4-4-1-4-1	1-1-1-1-1-1-3-3-3-2-3-2-5-4-4-4-4-4-4-4-4-4-4-5	73.038	7.9542	0.7775
8	3-1-4-6-5-2-24-23-21-7-22-20-10-11-9-19-18-17-8-13-16-15-12-14	2-2-2-2-2-2-1-1-1-2-1-1-2-2-2-1-1-1-2-1-1-1-2-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-4-1-4-4-1-4	1-1-1-1-1-1-3-3-3-5-3-2-4-4-4-2-4-4-4-4-4-4-4-5-4	70.373	7.9418	0.7775
9	3-6-23-24-21-22-19-4-5-1-2-7-20-10-9-8-18-11-17-13-12-14-16-15	2-2-1-1-1-1-1-2-2-2-2-2-1-2-2-2-1-2-1-1-2-2-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-4-1-4-4	1-1-3-3-3-3-3-2-1-1-1-1-5-2-4-4-4-4-4-4-4-5-4-4-4	69.633	7.9364	0.7775
10	3-4-5-2-23-6-24-21-22-19-20-18-17-1-7-13-16-9-15-8-10-11-12-14	2-2-2-2-1-2-1-1-1-1-1-1-1-2-2-1-1-2-1-2-2-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-4-1-4-4-1-1-1-4	1-1-1-1-3-1-3-3-3-2-2-4-4-1-5-4-4-4-4-4-4-5-4-4	68.945	7.9379	0.7775
11	3-4-23-21-2-24-6-19-1-22-20-5-18-7-8-10-9-13-17-12-14-11-15-16	2-2-1-1-2-1-2-1-2-1-1-2-1-2-2-2-2-1-1-2-2-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-4-1-4-1-4-4-1-4	1-1-3-3-1-3-1-2-1-3-2-1-4-5-4-4-4-4-4-5-4-4-4-4	62.075	7.897	0.7775
12	4-3-6-24-2-22-20-23-21-19-18-17-1-5-7-8-16-11-13-10-9-15-14-12	2-2-2-1-2-1-1-1-1-1-1-1-2-2-2-2-1-2-1-2-2-1-1-2	1-1-1-1-1-1-1-1-1-1-1-4-1-1-4-4-1-1-1-1-4-4-1-1	1-1-1-3-1-3-2-3-3-2-4-4-1-1-5-4-4-4-4-4-4-4-4-5	68.338	7.9277	0.7775
13	4-3-6-1-2-24-22-23-20-5-21-7-19-18-10-13-17-8-9-12-14-11-15-16	2-2-2-2-2-1-1-1-1-2-1-2-1-1-2-1-1-2-2-2-2-2-2-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-4-1-1-4-1-4	1-1-1-1-1-3-3-3-2-1-3-5-2-4-4-4-4-4-4-5-4-4-4-4	68.263	7.9312	0.7775
14	4-24-3-5-23-22-6-1-2-21-7-20-19-11-18-17-10-13-9-8-16-12-15-14	2-1-2-2-1-1-2-2-2-1-2-1-1-2-1-1-2-1-2-2-1-2-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-4-4-1-4	1-3-1-1-3-3-1-1-1-3-5-2-2-4-4-4-4-4-4-4-5-4-4	66.934	7.9179	0.7775
15	4-5-3-1-2-24-22-23-6-20-7-21-9-19-8-18-11-13-10-12-17-16-15-14	2-2-2-2-2-1-1-1-2-1-2-1-2-1-2-1-2-1-2-2-1-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-4-4-4-4-4-4	1-1-1-1-1-3-3-3-1-2-5-3-4-2-4-4-4-4-4-5-4-4-4-4	66.599	7.921	0.7775
16	4-5-6-1-23-24-2-3-21-19-7-9-22-20-18-11-13-8-10-17-16-12-14-15	2-2-2-2-1-1-2-2-1-1-2-2-1-1-1-2-1-2-2-1-1-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-4-4-1-4-4	1-1-1-1-3-3-3-1-1-3-2-5-4-3-2-4-4-4-4-4-4-4-5-4-4	66.481	7.9214	0.7775
17	5-4-6-24-23-22-1-21-20-3-2-19-18-17-7-16-10-8-13-9-12-15-14-11	2-2-2-1-1-1-2-1-1-2-2-1-1-1-2-1-2-2-1-2-2-1-2-1	1-1-1-1-1-1-1-1-1-1-1-1-4-1-4-1-4-1-1-1-4-4-1-1	1-1-1-3-3-3-1-3-2-1-1-2-4-4-5-4-4-4-4-4-5-4-4-4	66.617	7.9171	0.7775
18	5-24-22-4-6-2-23-3-21-19-20-18-1-7-17-8-9-13-10-16-15-11-14-12	2-1-1-2-2-2-1-2-1-1-1-1-2-2-1-2-2-1-2-1-1-2-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-4-1-1-1-4-4-1-4	1-3-3-1-1-1-3-1-3-2-2-4-1-5-4-4-4-4-4-4-4-4-4-5	66.425	7.9185	0.7775
19	5-24-22-23-20-3-2-6-21-4-19-18-1-13-7-17-9-8-16-10-12-14-11-15	2-1-1-1-1-2-2-2-1-2-1-1-2-1-2-1-2-2-1-2-2-2-2-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-4-4-1-1-4-1-4	1-3-3-3-2-1-1-1-3-1-2-4-1-4-5-4-4-4-4-4-5-4-4-4	61.947	7.8973	0.7775
20	6-23-21-24-22-1-20-2-3-4-5-7-9-19-8-10-11-18-13-12-17-16-15-14	2-1-1-1-1-2-1-2-2-2-2-2-2-1-2-2-2-1-1-2-1-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-4-4-4-4	1-3-3-3-3-1-2-1-1-1-1-5-4-2-4-4-4-4-4-5-4-4-4-4	68.155	7.9322	0.7775
21	6-23-2-3-4-5-21-1-24-22-19-7-20-10-11-18-9-13-8-12-14-15-16-17	2-1-2-2-2-2-1-2-1-1-1-2-1-2-2-1-2-1-2-2-2-2-2-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-4-4-4-4-4	1-3-1-1-1-1-3-1-3-3-2-5-2-4-4-4-4-4-4-5-4-4-4-4	66.407	7.9199	0.7775
22	23-24-22-21-20-4-5-2-19-18-17-6-13-16-15-1-3-7-14-8-10-9-11-12	1-1-1-1-1-2-2-2-1-1-1-2-1-1-1-2-2-2-1-2-2-2-2-1	1-1-1-1-1-1-1-1-1-1-4-1-1-4-4-1-1-1-4-4-1-1-1-1	3-3-3-3-2-1-1-1-2-4-4-1-4-4-4-1-1-5-4-4-4-4-4-5	70.221	7.939	0.7775
23	23-21-3-6-5-4-1-2-7-24-10-11-8-19-22-20-18-9-13-17-16-15-12-14	1-1-2-2-2-2-2-2-2-1-2-2-2-1-1-1-1-2-1-1-1-1-2-1	1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-1-4-4-4-1-4-4	3-3-1-1-1-1-1-1-5-3-4-4-4-2-3-2-4-4-4-4-4-4-5-4	70.009	7.9377	0.7775
24	23-21-4-19-24-22-3-5-6-2-1-7-20-8-10-18-17-11-13-9-16-15-12-14	1-1-2-1-1-1-2-2-2-2-2-2-1-2-2-1-1-2-1-1-2-1-1-2	1-1-1-1-1-1-1-1-1-1-1-4-1-1-4-1-1-1-4-4-1-1-4-4	3-3-1-2-3-3-1-1-1-1-1-5-2-4-4-4-4-4-4-4-4-4-4-5	69.445	7.934	0.7775
25	23-21-1-6-3-2-24-22-20-19-5-4-18-7-13-9-8-10-17-12-14-15-16-11	1-1-2-2-2-2-1-1-1-1-2-2-1-1-2-1-2-2-2-1-2-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-4-1-4-4-4-4-1	3-3-1-1-1-1-3-3-2-2-1-1-4-5-4-4-4-4-4-5-4-4-4-4	69.122	7.929	0.7775
26	23-1-24-6-2-4-22-20-5-21-19-18-13-3-7-17-8-9-10-12-14-11-15-16	1-2-1-2-2-2-1-1-2-1-1-1-1-2-2-1-2-2-2-2-2-2-2-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-4-1-1-1-4-1-4-4	3-1-3-1-1-1-3-2-1-3-2-4-4-1-5-4-4-4-4-5-4-4-4-4	61.123	7.895	0.7775
27	23-24-22-5-20-21-2-1-19-18-3-13-6-17-4-7-8-16-9-15-10-12-14-11	1-1-1-2-1-1-2-2-1-1-2-1-2-1-2-2-2-1-2-1-2-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-4-4-1-4-1-4-1-4-1	3-3-3-1-2-3-1-1-2-4-1-4-1-4-1-5-4-4-4-4-4-5-4-4	60.289	7.8833	0.7775
28	24-6-23-5-1-2-3-21-22-20-19-18-17-16-4-15-7-8-10-9-13-11-14-12	1-2-1-2-2-2-2-1-1-1-1-1-1-1-2-1-2-2-2-2-1-2-1-2	1-1-1-1-1-1-1-1-1-1-1-4-4-1-4-1-4-1-1-1-1-4-1-1	3-1-3-1-1-1-1-3-3-2-2-4-4-4-1-4-5-4-4-4-4-4-4-5	69.906	7.9387	0.7775
29	24-4-23-21-22-20-19-18-13-3-17-16-2-1-6-5-15-7-14-10-11-12-8-9	1-2-1-1-1-1-1-1-1-2-1-1-2-2-2-2-1-2-1-2-2-1-1-2	1-1-1-1-1-1-1-1-1-1-4-4-1-1-1-4-1-4-1-1-1-4-1-1	3-1-3-3-3-2-2-4-4-1-4-4-1-1-1-1-4-5-4-4-4-5-4-4	68.173	7.9241	0.7775
30	24-2-5-4-1-6-23-22-3-20-7-8-21-11-19-10-18-9-13-17-16-15-12-14	1-2-2-2-2-2-1-1-2-1-2-2-1-2-1-2-1-2-1-1-1-1-2-2	1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-1-1-4-4-4-1-4-4	3-1-1-1-1-1-3-3-1-2-5-4-3-4-2-4-4-4-4-4-4-5-4-4	66.771	7.9207	0.7775
31	24-1-5-4-2-3-23-22-20-6-21-19-7-8-10-18-9-13-12-14-11-15-17-16	1-2-2-2-2-2-1-1-1-2-1-1-2-2-2-1-2-1-2-2-2-2-1-1	1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-1-4-1-4-4-4-4	3-1-1-1-1-1-3-3-2-1-3-2-5-4-4-4-4-4-5-4-4-4-4-4	66.377	7.9195	0.7775
32	24-23-3-2-1-21-5-4-22-19-20-6-18-13-7-17-9-10-8-12-14-15-16-11	1-1-2-2-2-1-2-2-1-1-1-2-1-1-2-1-1-2-1-2-2-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-4-1-4-4-4-1	3-3-1-1-1-3-1-1-3-2-2-1-4-4-5-4-4-4-4-5-4-4-4-4	66.263	7.9145	0.7775

Notes:

Disassembly direction: 1 = Y+ direction and 2 = Y- direction.

Disassembly mode: 1 = reuse, 2 = remanufacturing, 3 = recycle, 4 = disposal.

Disassembly tool: 1 = Spanner-I, 2 = Spanner-II,3 = Spanner-III, 4 = Gripper-I, 5 = Gripper-II

Table 18: Pareto Optimal Solutions of Gear pump B (PESA-II - Iteration 500, population size 70)

No.	Disassembly Sequence	Disassembly Direction	Disassembly mode	Disasembly Tool	f1	f2	f3
1	1-5-3-6-24-23-2-22-21-20-19-4-18-17-16-7-13-11-9-8-10-12-14-15	2-2-2-2-1-1-2-1-1-1-1-2-1-1-1-2-1-2-2-2-2-2-2-1	1-1-1-1-1-1-1-1-1-1-1-1-1-4-4-1-1-1-1-4-1-1-4-4	1-1-1-1-3-3-1-3-3-2-2-1-4-4-4-5-4-4-4-4-4-5-4-4	67.693	7.923	0.7415
2	1-6-2-3-4-24-5-7-22-11-9-10-8-23-21-19-20-18-13-12-17-16-14-15	2-2-2-2-2-1-2-2-1-2-2-2-2-1-1-1-1-1-1-2-1-1-2-1	1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-1-1-4-4-4-4	1-1-1-1-1-3-1-5-3-4-4-4-4-3-3-2-2-4-4-5-4-4-4-4	69.098	7.937	0.7415
3	1-2-5-6-23-21-24-22-19-4-20-3-7-18-17-8-9-10-11-13-16-12-14-15	2-2-2-2-1-1-1-1-1-2-1-2-2-1-1-2-2-2-2-1-1-2-2-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-4-1-1-1-1-4-1-4-4	1-1-1-1-3-3-3-3-2-1-2-1-5-4-4-4-4-4-4-4-4-5-4-4	70.686	7.946	0.7415
4	2-1-3-6-5-24-22-23-21-19-4-20-18-17-7-13-11-9-16-8-10-15-14-12	2-2-2-2-2-1-1-1-1-1-2-1-1-1-2-1-2-2-1-2-2-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-4-4-1-4-4-1	1-1-1-1-1-3-3-3-3-2-1-2-4-4-5-4-4-4-4-4-4-4-4-5	72.768	7.953	0.7415
5	2-1-3-6-5-4-24-22-23-21-19-20-18-13-7-17-11-9-16-8-10-15-14-12	2-2-2-2-2-2-1-1-1-1-1-1-1-1-2-1-2-2-1-2-2-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-4-4-1-4-4-1	1-1-1-1-1-1-3-3-3-3-2-2-4-4-5-4-4-4-4-4-4-4-4-5	75.523	7.970	0.7415
6	3-24-22-23-2-6-1-20-21-4-19-18-13-5-17-7-16-15-10-8-9-12-14-11	2-1-1-1-2-2-2-1-1-2-1-1-1-2-1-2-1-1-2-2-2-2-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-4-4-1-4-1-1-4-1	1-3-3-3-1-1-1-2-3-1-2-4-4-1-4-5-4-4-4-4-4-5-4-4	63.966	7.905	0.7415
7	3-1-2-4-5-24-23-21-19-6-7-10-22-11-9-8-20-18-13-12-14-17-16-15	2-2-2-2-2-1-1-1-1-2-2-2-1-2-2-2-1-1-1-2-2-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-4-4-4-4	1-1-1-1-1-3-3-3-2-1-5-4-3-4-4-4-2-4-4-5-4-4-4-4	66.787	7.921	0.7415
8	3-24-22-23-2-6-1-4-21-20-19-18-13-5-17-7-16-15-10-8-9-11-12-14	2-1-1-1-2-2-2-2-1-1-1-1-1-2-1-2-1-1-2-2-2-2-2-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-4-4-1-4-1-1-1-4	1-3-3-3-1-1-1-1-3-2-2-4-4-1-4-5-4-4-4-4-4-4-5-4	67.661	7.929	0.7415
9	3-5-1-4-6-24-2-7-23-21-11-8-22-20-19-9-10-18-17-13-12-14-15-16	2-2-2-2-2-1-2-2-1-1-2-2-1-1-2-2-1-1-1-2-2-2-2-2	1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-1-4-1-1-4-4-4-4	1-1-1-1-1-3-1-5-3-3-4-4-3-2-2-4-4-4-4-4-5-4-4-4	68.630	7.930	0.7415
10	3-5-4-1-6-2-24-22-23-21-20-7-11-19-18-10-8-17-16-9-13-12-15-14	2-2-2-2-2-2-1-1-1-1-1-2-2-1-1-2-2-1-1-2-1-2-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-4-4-1-1-1-4-4-4	1-1-1-1-1-1-3-3-3-3-2-5-4-2-4-4-4-4-4-4-4-5-4-4	70.830	7.947	0.7415
11	4-2-5-3-1-24-6-7-23-9-10-11-8-21-22-20-19-18-17-16-13-12-14-15	2-2-2-2-2-1-2-2-1-2-2-2-2-1-1-1-1-1-1-1-1-2-2-2	1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-4-4-1-1-1-4-4-4	1-1-1-1-1-3-1-5-3-4-4-4-4-3-3-2-2-4-4-4-4-5-4-4	69.090	7.936	0.7415
12	4-6-5-3-1-2-7-10-23-21-11-9-8-24-22-20-19-18-17-16-13-12-14-15	2-2-2-2-2-2-2-2-1-1-2-2-2-1-1-1-1-1-1-1-1-2-2-2	1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-4-4-1-1-1-4-4-4	1-1-1-1-1-1-5-4-3-3-4-4-4-3-3-2-2-4-4-4-4-5-4-4	70.232	7.940	0.7415
13	5-6-1-2-23-3-4-21-19-24-7-22-20-18-9-10-8-13-17-11-16-15-14-12	2-2-2-2-1-2-2-1-1-1-2-1-1-2-2-2-1-1-2-1-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-4-1-4-4-4-4-1	1-1-1-1-3-1-1-3-2-3-5-3-2-4-4-4-4-4-4-4-4-4-4-5	68.063	7.927	0.7415
14	6-3-23-4-24-21-1-2-5-22-7-19-20-9-10-11-18-17-8-13-16-15-14-12	2-2-1-2-1-1-2-2-2-1-2-1-1-2-2-2-2-1-1-2-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-4-1-4-4-4-4-1	1-1-3-1-3-3-1-1-1-3-5-2-2-4-4-4-4-4-4-4-4-4-4-5	69.270	7.929	0.7415
15	6-2-5-1-3-4-23-21-24-22-7-20-8-10-11-19-18-9-13-17-16-12-14-15	2-2-2-2-2-2-1-1-1-1-2-1-2-2-2-2-1-1-2-1-1-1-2-2	1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-1-1-1-4-4-1-1-4-4-4	1-1-1-1-1-1-3-3-3-3-5-2-4-4-4-2-4-4-4-4-4-5-4-4	71.669	7.949	0.7415
16	23-21-24-19-5-6-2-3-22-20-1-4-18-17-7-16-11-8-9-13-15-10-12-14	1-1-1-1-2-2-2-2-1-1-2-2-1-1-2-1-2-2-2-2-1-1-2-2	1-1-1-1-1-1-1-1-1-1-1-1-4-1-4-1-4-1-1-4-1-1-4	3-3-3-2-1-1-1-1-3-2-1-1-4-4-5-4-4-4-4-4-4-5-4-4	68.135	7.928	0.7415
17	24-4-2-1-3-23-22-5-21-20-19-18-17-6-13-7-16-10-15-11-9-14-8-12	1-2-2-2-2-1-1-2-1-1-1-1-1-2-1-2-1-2-1-2-2-1-2-2	1-1-1-1-1-1-1-1-1-1-1-1-4-1-1-1-4-1-4-1-1-4-4-1	3-1-1-1-1-3-3-1-3-2-2-4-4-1-4-5-4-4-4-4-4-4-4-5	68.041	7.928	0.7415
18	24-4-6-1-3-2-23-22-21-19-20-18-5-7-17-11-8-9-13-16-15-14-10-12	1-2-2-2-2-2-1-1-1-1-1-1-2-2-1-2-2-2-2-1-1-1-1-2	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-4-1-4-1-1-4-4-4-1-1	3-1-1-1-1-1-3-3-3-2-2-4-1-5-4-4-4-4-4-4-4-4-4-5	70.045	7.939	0.7415

Notes:

Disassembly direction: 1 = Y+ direction and 2 = Y- direction.

Disassembly mode: 1 = reuse, 2 = remanufacturing, 3 = recycle, 4 = disposal.

Disassembly tool: 1 = Spanner-I, 2 = Spanner-II,3 = Spanner-III, 4 = Gripper-I, 5 = Gripper-II

Figures

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Iter_pop	Statistic	df	Sig.	Statistic	df	Sig.
GearA_goal123	100_50	.232	50	<.001	.669	50	<.001
	100_60	.323	50	<.001	.536	50	<.001
	100_70	.188	50	<.001	.809	50	<.001
	100_80	.233	50	<.001	.650	50	<.001
	200_50	.277	50	<.001	.638	50	<.001
	200_60	.237	50	<.001	.483	50	<.001
	200_70	.337	50	<.001	.435	50	<.001
	200_80	.354	50	<.001	.494	50	<.001
	300_50	.360	50	<.001	.504	50	<.001
	300_60	.325	50	<.001	.454	50	<.001
	300_70	.296	50	<.001	.589	50	<.001
	300_80	.152	50	.005	.916	50	.002
	400_50	.290	50	<.001	.509	50	<.001
	400_60	.264	50	<.001	.621	50	<.001
	400_70	.181	50	<.001	.832	50	<.001
	400_80	.281	50	<.001	.586	50	<.001
	500_50	.292	50	<.001	.447	50	<.001
	500_60	.320	50	<.001	.451	50	<.001
	500_70	.138	50	.018	.940	50	.014
	500_80	.279	50	<.001	.512	50	<.001
GearB_goal123	100_50	.122	50	.062	.942	50	.016
	100_60	.162	50	.002	.941	50	.015
	100_70	.170	50	<.001	.942	50	.016
	100_80	.106	50	.200*	.973	50	.295
	200_50	.100	50	.200*	.952	50	.043
	200_60	.090	50	.200*	.953	50	.045
	200_70	.139	50	.017	.955	50	.056
	200_80	.124	50	.053	.947	50	.025
	300_50	.181	50	<.001	.936	50	.010
	300_60	.122	50	.059	.972	50	.287
	300_70	.082	50	.200*	.983	50	.688
	300_80	.135	50	.023	.947	50	.026
	400_50	.102	50	.200*	.965	50	.150
	400_60	.143	50	.012	.965	50	.147
	400_70	.126	50	.046	.948	50	.028
	400_80	.121	50	.065	.980	50	.536
	500_50	.145	50	.010	.955	50	.057
	500_60	.077	50	.200*	.972	50	.285
	500_70	.089	50	.200*	.970	50	.235
	500_80	.169	50	.001	.949	50	.032

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure 1: Normality Test Results for Gear pump A and B - Goal 1+2+3 (Multiobjective aggregate method

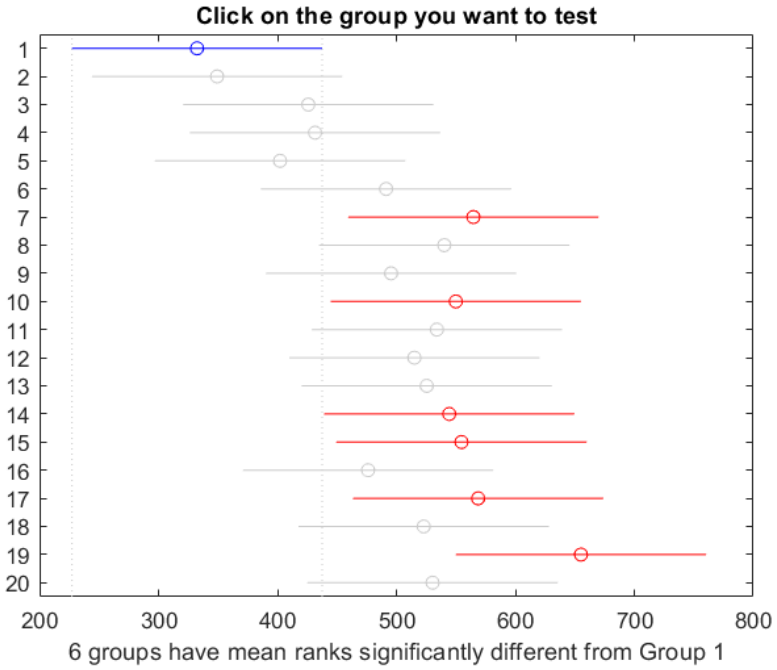

Figure 2: Post-hoc (Dunn-Sidak) test Results for Gear pump A

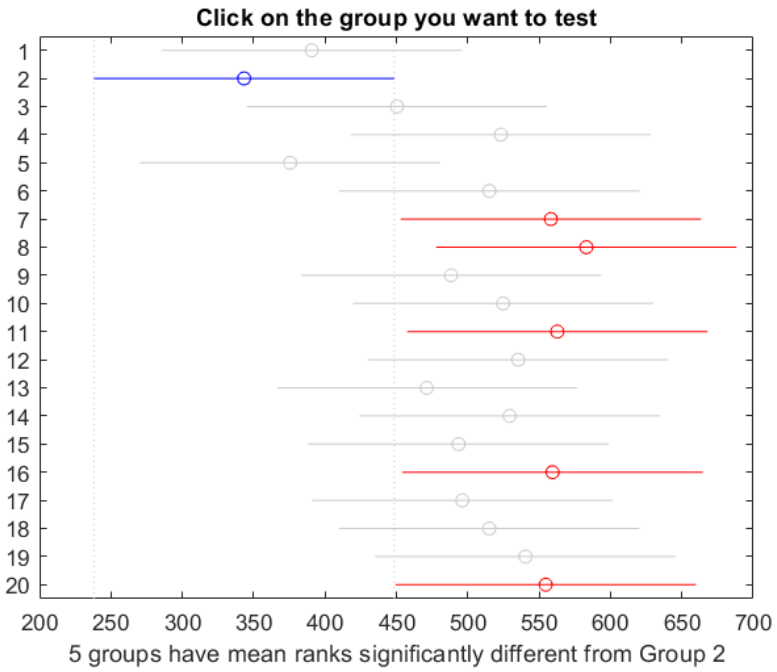

Figure 3: Post-hoc (Dunn-Sidak) test Results for Gear pump B