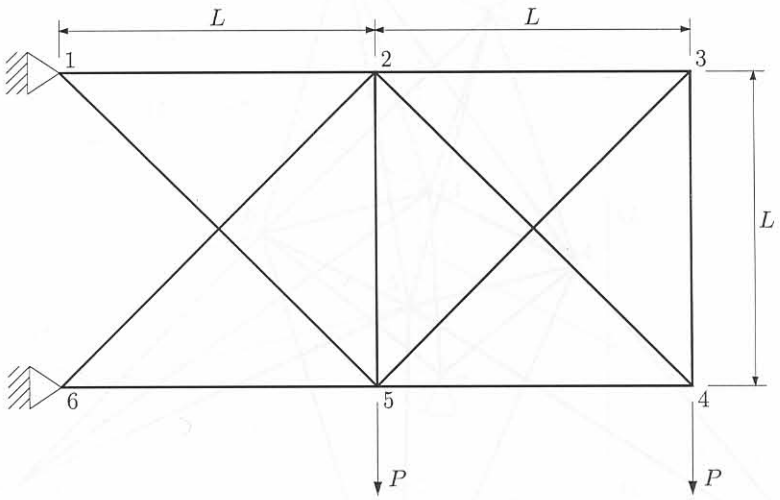
Appendix B

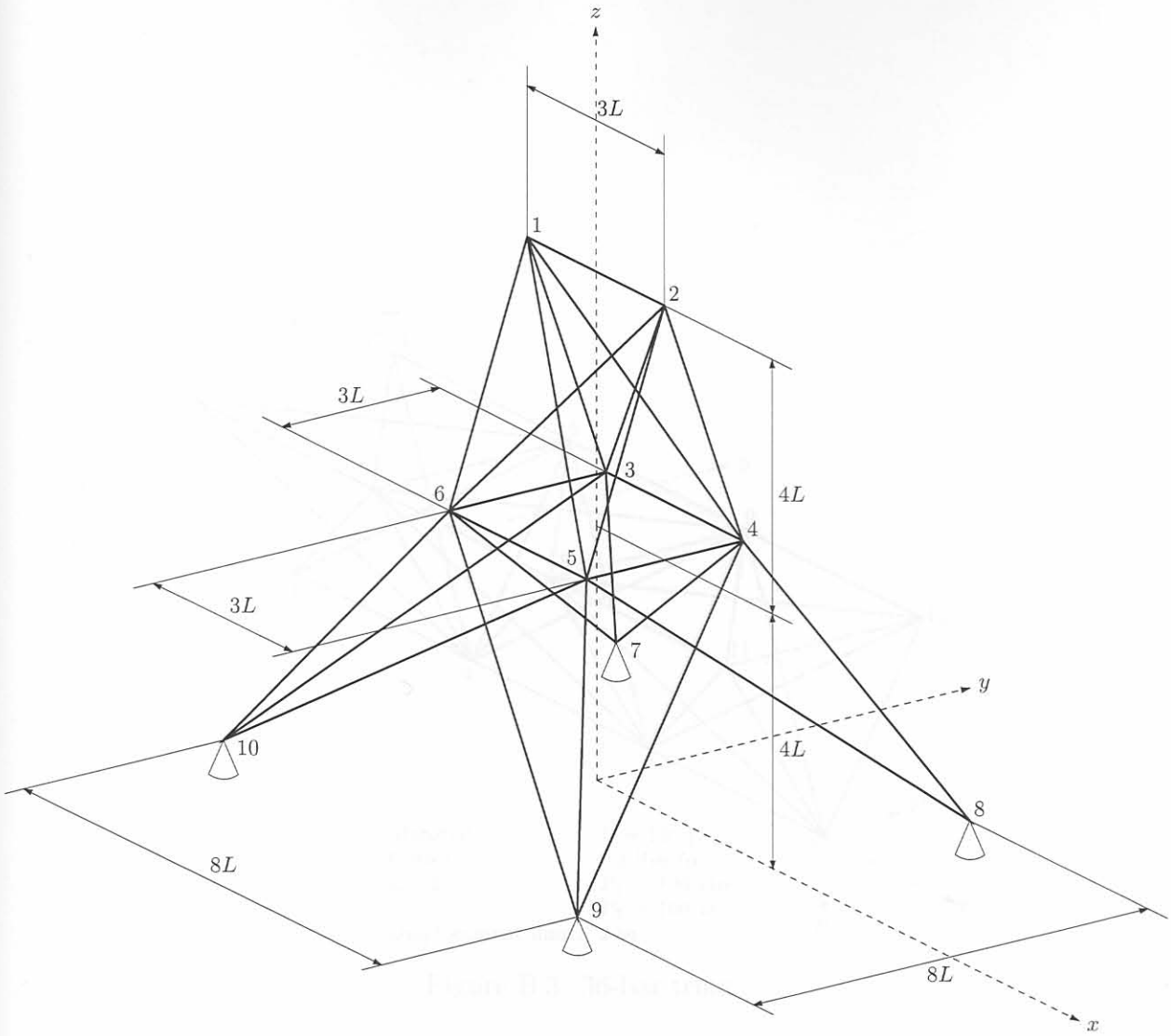
Structural test problems

B.1 Test problem geometries



Material:	$E = 10^7$ psi
Density:	0.1 lbm/in^3
Yield stress:	25000 psi
Displacement limit:	2 in
Length:	$L = 360$ in
Load:	$P = 100$ kip

Figure B.1: 10-bar truss



Material:	$E = 10^7$ psi
Density:	0.1 lbm/in^3
Stress limit:	40000 psi
Displacement limit:	0.35 in
Length:	$L = 25$ in

Figure B.2: 25-bar truss

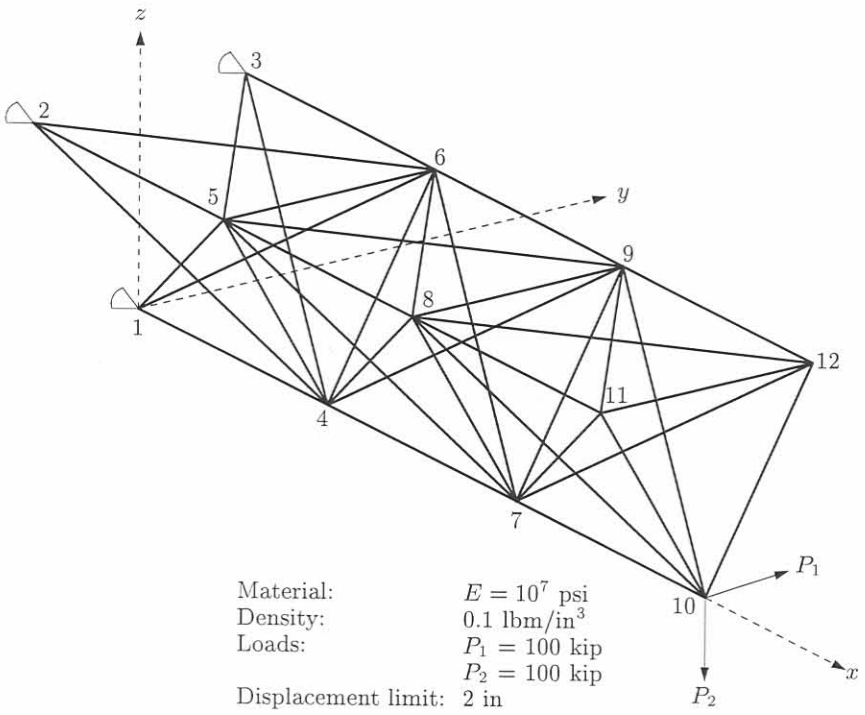


Figure B.3: 36-bar truss

B.2 Numerical results

B.2.1 Penalty constraint method without social pressure

	Optimum solution	PSO-DIV variant solution		
ϵ_s (%)		5	2	1
$\bar{f}^g_{best}$ (lbs)		4781.55	4682.07	4643.86
$\bar{\sigma}$		34.75	10.32	6.66
N_{fe} (ave.)		781	949	1185
Reliability		10/10	9/10	8/10
Best found f^g_{best} (lbs)	4607.1	4713.56	4665.98	4632.90
NI	0	0.1628	0.0426	0.0604
x_1	25.358	19.674	21.142	24.528
x_2	5.000	5.706	5.039	5.326
x_3	17.839	18.897	19.904	15.263
x_4	11.238	7.655	10.988	14.938
x_5	5.000	5.094	6.901	5.171
x_6	5.000	6.442	6.125	5.524
x_7	5.000	10.601	5.469	5.493
x_8	15.501	14.787	14.801	14.552
x_9	15.893	9.400	13.410	13.297
x_{10}	5.000	9.837	6.249	6.104
N_{fe}		492	1177	888

Table B.1: Convex 10-bar truss results with *a priori* stopping criterion

	Optimum solution	PSO-DIV variant solution		
ϵ_s (%)		5	2	1
$\bar{f}^g_{best}$ (lbs)		5292.40	5153.62	5105.78
$\bar{\sigma}$		15.120	5.776	4.818
N_{fe} (ave.)		1304	1609	2019
Reliability		10/10	10/10	10/10
Best found f^g_{best} (lbs)	5060.85	5260.94	5144.22	5094.34
NI	0	0.0784	0.129	0.0886
x_1	30.522	29.208	27.461	29.148
x_2	0.100	0.462	0.787	0.355
x_3	23.200	22.853	24.337	23.354
x_4	15.223	11.717	12.868	13.999
x_5	0.100	0.344	0.336	0.130
x_6	0.551	0.833	0.971	0.327
x_7	7.457	10.230	7.614	9.086
x_8	21.036	26.118	23.568	19.466
x_9	21.528	18.619	20.730	21.847
x_{10}	0.100	1.135	0.105	0.650
N_{fe}		1034	1002	1541

Table B.2: Non-convex 10-bar truss results with *a priori* stopping criterion

	Optimum solution	PSO-DIV variant solution		
ϵ_s (%)		5	2	1
$\bar{f}^g_{best}$ (lbs)		569.22	555.08	550.29
$\bar{\sigma}$		3.639	1.144	3.639
N_{fe} (ave.)		1324	1941	2528
Reliability		10/10	10/10	10/10
Best found f^g_{best} (lbs)	545.04	559.55	552.32	549.30
NI	0	0.000	0.000	0.00996
x_1	0.010	0.268	0.525	0.085
x_2	2.042	1.741	2.134	1.960
x_3	3.002	3.341	2.705	3.087
x_4	0.010	0.226	0.019	0.063
x_5	0.010	0.154	0.021	0.073
x_6	0.683	0.679	0.672	0.756
x_7	1.623	1.881	1.737	1.675
x_8	2.671	2.486	2.740	2.533
N_{fe}		1322	2787	2083

Table B.3: 25-bar truss results with *a priori* stopping criterion

	Optimum solution	PSO-DIV variant solution		
ϵ_s (%)		5	2	1
$\bar{f}^g_{best}$ (lbs)		37457.34	36415.98	36078.53
$\bar{\sigma}$		44.012	37.836	4.740
N_{fe} (ave.)		2970	5833	7438
Reliability		10/10	10/10	10/10
Best found f^g_{best} (lbs)	35726	37375.39	36325.53	35602.03
NI	0	0.00836	0.000	0.0192
x_1	38.715	29.886	34.809	48.914
x_2	24.111	39.694	25.539	16.455
x_3	7.138	6.318	10.703	8.539
x_4	95.047	93.355	94.658	97.451
x_5	59.794	47.074	54.997	64.444
x_6	14.435	13.139	15.291	14.104
x_7	5.000	7.213	5.240	5.056
x_8	5.000	7.962	6.816	5.380
x_9	14.564	17.831	16.800	15.543
x_{10}	5.000	5.263	6.162	5.075
x_{11}	5.000	5.492	5.966	5.058
x_{12}	5.000	7.800	5.264	5.043
x_{13}	28.042	38.046	36.440	23.952
x_{14}	28.042	27.796	27.225	28.301
x_{15}	27.684	36.206	25.934	27.852
x_{16}	27.684	18.230	29.674	28.017
x_{17}	28.653	31.476	29.977	30.275
x_{18}	28.653	33.133	23.198	24.458
x_{19}	5.000	5.940	5.159	5.072
x_{20}	5.000	5.154	5.183	5.033
x_{21}	5.000	5.409	5.653	5.012
N_{fe}		2421	6546	10374

Table B.4: Convex 36-bar truss results with *a priori* stopping criterion

	Optimum solution	PSO-DIV variant solution		
Stopping N_{fe}		2000	1000	500
ϵ_a		0.01	0.01	0.01
$\bar{f}^g_{best}$ (lbs)		4606.26	4611.13	4606.56
$\bar{\sigma}$		0.2540	5.590	0.794
N_{fe} (ave.)		26193	16298	7048
Reliability		10/10	10/10	10/10
Best found f^g_{best} (lbs)	4607.1	4606.06	4607.19	4606.04
NI	0	0.001040	0.00433	0.00102
x_1	25.358	25.269	24.956	25.311
x_2	5.000	5.000	5.001	5.000
x_3	17.839	17.898	18.256	17.919
x_4	11.238	11.312	11.204	11.200
x_5	5.000	5.000	5.000	5.000
x_6	5.000	5.000	5.000	5.000
x_7	5.000	5.000	5.209	5.000
x_8	15.501	15.478	15.132	15.495
x_9	15.893	15.842	16.046	15.859
x_{10}	5.000	5.000	5.000	5.000
N_{fe}		18984	19131	8167

Table B.5: Convex 10-bar truss results with logical stopping criterion

	Optimum solution	PSO-DIV variant solution		
Stopping N_{fe}		2000	1000	500
ϵ_a		0.01	0.01	0.01
$\bar{f}^g_{best}$ (lbs)		5064.05	5064.36	5064.70
$\bar{\sigma}$		7.306	5.119	7.986
N_{fe} (ave.)		23242	13219	6688
Reliability		10/10	10/10	10/10
Best found f^g_{best} (lbs)	5060.85	5059.89	5060.10	5060.06
NI	0	0.0175	0.000	0.00131
x_1	30.522	29.992	29.880	29.997
x_2	0.100	0.100	0.100	0.100
x_3	23.200	23.088	23.505	23.629
x_4	15.223	15.329	15.281	15.232
x_5	0.100	0.100	0.100	0.100
x_6	0.551	0.570	0.564	0.552
x_7	7.457	7.459	7.426	7.419
x_8	21.036	21.169	21.193	21.166
x_9	21.528	21.708	21.546	21.450
x_{10}	0.100	0.100	0.100	0.100
N_{fe}		21824	16991	8537

Table B.6: Non-convex 10-bar truss results with logical stopping criterion

	Optimum solution	PSO-DIV variant solution		
Stopping N_{fe}		2000	1000	500
ϵ_a		0.01	0.01	0.01
$\bar{f}^g_{best}$ (lbs)		546.56	547.67	547.11
$\bar{\sigma}$		1.092	1.501	1.402
N_{fe} (ave.)		9914	6520	3003
Reliability		10/10	10/10	10/10
Best found f^g_{best} (lbs)	545.04	545.33	545.77	545.89
NI	0	0.000136	0.00007	0.0100
x_1	0.010	0.010	0.010	0.010
x_2	2.042	2.025	2.093	2.143
x_3	3.002	2.995	3.140	2.962
x_4	0.010	0.010	0.010	0.010
x_5	0.010	0.010	0.010	0.010
x_6	0.683	0.641	0.672	0.614
x_7	1.623	1.645	1.525	1.564
x_8	2.671	2.729	2.675	2.793
N_{fe}		6436	5659	4122

Table B.7: 25-bar truss results with logical stopping criterion

	Optimum solution	PSO-DIV variant solution		
Stopping N_{fe}		2000	1000	500
ϵ_a		0.01	0.01	0.01
$\bar{f}^g_{best}$ (lbs)		35743.58	35726.16	35673.95
$\bar{\sigma}$		65.370	116.551	0.445
N_{fe} (ave.)		39886	23577	14666
Reliability		9/10	10/10	10/10
Best found f^g_{best} (lbs)	35726	35672.98	35673.23	35673.12
NI	0	0.167	0.028	0.008
x_1	38.715	38.577	38.691	39.184
x_2	24.111	24.273	24.310	23.735
x_3	7.138	7.226	7.048	7.154
x_4	95.047	94.594	94.604	94.536
x_5	59.794	59.825	59.597	59.624
x_6	14.435	14.318	14.478	14.410
x_7	5.000	5.000	5.000	5.000
x_8	5.000	5.000	5.000	5.000
x_9	14.564	14.453	14.559	14.501
x_{10}	5.000	5.000	5.000	5.000
x_{11}	5.000	5.000	5.000	5.000
x_{12}	5.000	5.000	5.001	5.000
x_{13}	28.042	28.039	28.118	27.880
x_{14}	28.042	27.969	27.691	28.055
x_{15}	27.684	27.525	27.460	27.667
x_{16}	27.684	27.550	27.790	27.497
x_{17}	28.653	28.533	28.515	28.501
x_{18}	28.653	28.522	28.555	28.618
x_{19}	5.000	5.000	5.000	5.000
x_{20}	5.000	5.000	5.000	5.000
x_{21}	5.000	5.000	5.001	5.000
N_{fe}		37506	22427	12329

Table B.8: Convex 36-bar truss results with logical stopping criterion

B.2.2 Social pressure modification method

	Optimum solution	PSO-DIV variant solution		
ϵ_s (%)		5	2	1
$\bar{f}^g_{best}$ (lbs)		4819.40	4694.14	4650.74
$\bar{\sigma}$		14.042	5.206	1.882
N_{fe} (ave.)		425	936	1302
Reliability		10/10	10/10	10/10
Best found f^g_{best} (lbs)	4607.1	4790.98	4682.30	4647.62
NI	0	0.0000	0.0000	0.0000
x_1	25.358	24.761	25.665	24.181
x_2	5.000	5.701	5.122	5.032
x_3	17.839	19.879	21.799	21.096
x_4	11.238	11.817	8.908	11.449
x_5	5.000	6.231	5.286	5.071
x_6	5.000	6.904	5.242	5.063
x_7	5.000	7.290	7.832	6.155
x_8	15.501	10.476	13.130	12.456
x_9	15.893	16.221	13.696	15.765
x_{10}	5.000	6.876	6.365	5.913
N_{fe}		610	954	1180

Table B.9: Social pressure modified PSOA: Convex 10-bar truss results with *a priori* stopping criterion

	Optimum solution	PSO-DIV variant solution		
ϵ_s (%)		5	2	1
$\bar{f}^g_{best}$ (lbs)		5293.93	5153.06	5108.54
$\bar{\sigma}$		11.401	8.142	3.451
N_{fe} (ave.)		803	1083	1366
Reliability		10/10	10/10	10/10
Best found f^g_{best} (lbs)	5060.85	5277.19	5134.86	5100.52
NI	0	0.0066	0.0000	0.0032
x_1	30.522	26.401	28.174	29.812
x_2	0.100	0.184	0.480	0.186
x_3	23.200	22.034	23.646	25.610
x_4	15.223	17.376	14.359	16.452
x_5	0.100	0.497	0.139	0.128
x_6	0.551	1.355	0.245	0.496
x_7	7.457	6.992	8.497	7.422
x_8	21.036	25.164	23.827	20.411
x_9	21.528	22.834	21.015	20.741
x_{10}	0.100	0.491	0.113	0.153
N_{fe}		897	969	1206

Table B.10: Social pressure modified PSOA: Non-convex 10-bar truss results with *a priori* stopping criterion

	Optimum solution	PSO-DIV variant solution		
ϵ_s (%)		5	2	1
$\bar{f}^g_{best}$ (lbs)		569.24	554.56	550.26
$\bar{\sigma}$		3.034	1.893	0.204
N_{fe} (ave.)		1029	1329	2616
Reliability		10/10	10/10	10/10
Best found f^g_{best} (lbs)	545.04	561.42	550.38	549.82
NI	0	0.000	0.000	0.000
x_1	0.010	0.292	0.092	0.055
x_2	2.042	1.964	2.208	2.012
x_3	3.002	3.014	3.165	2.744
x_4	0.010	0.142	0.051	0.025
x_5	0.010	0.433	0.068	0.039
x_6	0.683	0.621	0.726	0.735
x_7	1.623	1.809	1.452	1.823
x_8	2.671	2.683	2.616	2.638
N_{fe}		1062	765	3069

Table B.11: Social pressure modified PSOA: 25-bar truss results with *a priori* stopping criterion

	Optimum solution	PSO-DIV variant solution		
ϵ_s (%)		5	2	1
$\bar{f}^g_{best}$ (lbs)		37450.93	36489.65	36074.39
$\bar{\sigma}$		59.918	67.874	11.952
N_{fe} (ave.)		1232	1973	2431
Reliability		10/10	9/10	10/10
Best found f^g_{best} (lbs)	35726	37340.09	36385.04	36044.45
NI	0	0.0144	0.012	0.011
x_1	38.715	31.449	41.804	35.538
x_2	24.111	27.103	21.082	22.024
x_3	7.138	16.533	6.752	18.632
x_4	95.047	86.386	97.298	90.770
x_5	59.794	51.480	64.502	60.527
x_6	14.435	18.869	15.385	14.742
x_7	5.000	5.674	5.510	5.214
x_8	5.000	6.386	7.810	5.518
x_9	14.564	19.458	15.522	17.323
x_{10}	5.000	16.851	5.298	5.191
x_{11}	5.000	16.223	5.944	5.450
x_{12}	5.000	5.160	5.316	5.646
x_{13}	28.042	33.090	35.448	27.734
x_{14}	28.042	25.307	15.944	30.645
x_{15}	27.684	27.160	26.140	27.238
x_{16}	27.684	30.415	29.242	27.214
x_{17}	28.653	29.223	29.592	30.169
x_{18}	28.653	31.422	27.427	25.223
x_{19}	5.000	5.342	5.249	5.147
x_{20}	5.000	5.778	5.803	5.065
x_{21}	5.000	5.505	5.110	5.136
N_{fe}		1091	1778	1490

Table B.12: Social pressure modified PSOA: Convex 36-bar truss results with *a priori* stopping criterion

	Optimum solution	PSO-DIV variant solution		
Stopping N_{fe}		2000	1000	500
ϵ_a		0.01	0.01	0.01
$\bar{f}^g_{best}$ (lbs)		4606.11	4606.12	4612.72
$\bar{\sigma}$		0.163	0.077	15.733
N_{fe} (ave.)		9505	8552	6269
Reliability		10/10	10/10	10/10
Best found f^g_{best} (lbs)	4607.1	4606.03	4606.04	4606.03
NI	0	0.000	0.000	0.000
x_1	25.358	25.342	25.337	25.313
x_2	5.000	5.000	5.000	5.000
x_3	17.839	17.843	17.817	17.854
x_4	11.238	11.244	11.234	11.245
x_5	5.000	5.000	5.000	5.000
x_6	5.000	5.000	5.000	5.000
x_7	5.000	5.000	5.000	5.000
x_8	15.501	15.467	15.541	15.470
x_9	15.893	15.886	15.842	15.893
x_{10}	5.000	5.000	5.000	5.000
N_{fe}		7392	6379	5866

Table B.13: Social pressure modified PSOA: Convex 10-bar truss results with logical stopping criterion

	Optimum solution	PSO-DIV variant solution		
Stopping N_{fe}		2000	1000	500
ϵ_a		0.01	0.01	0.01
$\bar{f}^g_{best}$ (lbs)		5067.51	5062.33	5066.69
$\bar{\sigma}$		17.509	5.121	7.309
N_{fe} (ave.)		10194	8011	4885
Reliability		10/10	10/10	10/10
Best found f^g_{best} (lbs)	5060.85	5059.85	5059.89	5060.16
NI	0	0.00128	0.001	0.001
x_1	30.522	29.999	29.998	29.901
x_2	0.100	0.100	0.100	0.100
x_3	23.200	23.268	23.323	23.484
x_4	15.223	15.129	15.320	15.171
x_5	0.100	0.100	0.100	0.100
x_6	0.551	0.554	0.553	0.545
x_7	7.457	7.454	7.456	7.445
x_8	21.036	21.232	21.280	21.320
x_9	21.528	21.670	21.448	21.494
x_{10}	0.100	0.100	0.100	0.100
N_{fe}		10260	8212	6569

Table B.14: Social pressure modified PSOA: Non-convex 10-bar truss results with logical stopping criterion

	Optimum solution	PSO-DIV variant solution		
Stopping N_{fe}		2000	1000	500
ϵ_a		0.01	0.01	0.01
$\bar{f}^g_{best}$ (lbs)		546.84	547.95	550.34
$\bar{\sigma}$		1.478	2.371	3.223
N_{fe} (ave.)		9596	6301	3277
Reliability		10/10	10/10	10/10
Best found f^g_{best} (lbs)	545.04	545.21	545.55	545.58
NI	0	0.000	0.000	0.000
x_1	0.010	0.010	0.010	0.018
x_2	2.042	2.121	2.138	2.139
x_3	3.002	2.893	3.052	2.878
x_4	0.010	0.010	0.010	0.018
x_5	0.010	0.010	0.010	0.014
x_6	0.683	0.671	0.663	0.667
x_7	1.623	1.611	1.527	1.604
x_8	2.671	2.717	2.704	2.727
N_{fe}		7126	6774	3492

Table B.15: Social pressure modified PSOA: 25-bar truss results with logical stopping criterion

	Optimum solution	PSO-DIV variant solution		
Stopping N_{fe}		2000	1000	500
ϵ_a		0.01	0.01	0.01
$\bar{f}^g_{best}$ (lbs)		38983.18	35742.00	35762.24
$\bar{\sigma}$		70.389	60.567	56.896
N_{fe} (ave.)		9287	7844	5102
Reliability		10/10	10/10	10/10
Best found f^g_{best} (lbs)	35726	35673.91	35673.90	35674.71
NI	0	0.00829	0.00826	0.00837
x_1	38.715	38.607	38.109	38.178
x_2	24.111	24.665	24.890	25.031
x_3	7.138	6.811	7.077	6.885
x_4	95.047	94.767	94.926	94.320
x_5	59.794	59.637	59.424	59.633
x_6	14.435	14.391	14.432	14.520
x_7	5.000	5.000	5.000	5.000
x_8	5.000	5.000	5.000	5.000
x_9	14.564	14.514	14.549	14.539
x_{10}	5.000	5.000	5.000	5.000
x_{11}	5.000	5.000	5.000	5.000
x_{12}	5.000	5.000	5.000	5.000
x_{13}	28.042	28.087	27.902	27.588
x_{14}	28.042	27.806	28.011	28.233
x_{15}	27.684	27.220	27.611	27.737
x_{16}	27.684	27.721	27.413	27.571
x_{17}	28.653	28.756	28.612	28.563
x_{18}	28.653	28.455	28.496	28.571
x_{19}	5.000	5.000	5.000	5.000
x_{20}	5.000	5.000	5.000	5.000
x_{21}	5.000	5.000	5.000	5.000
N_{fe}		18846	12802	10250

Table B.16: Social pressure modified PSOA: Convex 36-bar truss results with logical stopping criterion

	Optimum solution	Constriction factor	Dynamic inertia and velocity red.
ϵ_s (%)		1	1
$\bar{f}^g_{best}$		36054.13	36074.39
$\bar{\sigma}$		29.991	11.952
N_{fe} (Ave.)		4442	2431
Reliability		10/10	10/10
f_{best}	35726	35975.82	36044.45
NI	0	0.00291	0.011
x_1	38.715	34.040	35.538
x_2	24.111	32.391	22.024
x_3	7.138	6.479	18.632
x_4	95.047	100.794	90.770
x_5	59.794	61.501	60.527
x_6	14.435	13.427	14.742
x_7	5.000	5.227	5.214
x_8	5.000	5.119	5.518
x_9	14.564	12.137	17.323
x_{10}	5.000	5.291	5.191
x_{11}	5.000	5.571	5.450
x_{12}	5.000	5.070	5.646
x_{13}	28.042	27.526	27.734
x_{14}	28.042	27.858	30.645
x_{15}	27.684	29.411	27.238
x_{16}	27.684	24.788	27.214
x_{17}	28.653	26.359	30.169
x_{18}	28.653	30.316	25.223
x_{19}	5.000	5.119	5.147
x_{20}	5.000	5.265	5.065
x_{21}	5.000	5.020	5.136
N_{fe}		4436	1490

Table B.17: 36-bar truss: Comparison between constriction factor and dynamic inertia / velocity reduction variants

B.2.3 Summary of standard penalty method vs. penalty method with social pressure

	Standard penalty method	Penalty with social pressure
	$\epsilon_s = 5\%$	
$\bar{f}^g_{best}$ (lbs)	4781.55	4819.40
$\bar{\sigma}$	34.746	14.04
N_{fe} (ave.)	780	425
Convergence ratio	10/10	10/10
Best found f^g_{best} (lbs)	4713.56	4790.98
Normalized infeasability	0.1628	0.0000
N_{fe}	492	610
	$\epsilon_s = 2\%$	
$\bar{f}^g_{best}$ (lbs)	4682.07	4694.14
$\bar{\sigma}$	10.322	5.206
N_{fe} (ave.)	949	936
Convergence ratio	9/10	10/10
Best found f^g_{best} (lbs)	4665.98	4682.30
Normalized infeasability	0.0426	0.0000
N_{fe}	1177	954
	$\epsilon_s = 1\%$	
$\bar{f}^g_{best}$ (lbs)	4643.86	4650.74
$\bar{\sigma}$	6.659	1.882
N_{fe} (ave.)	1185	1302
Convergence ratio	8/10	10/10
Best found f^g_{best} (lbs)	4632.90	4647.62
Normalized infeasability	0.0604	0.0000
N_{fe}	888	1180

Table B.18: Convex 10-bar problem: Comparison between constraint implementations

	Standard penalty method	Penalty with social pressure
	$\epsilon_s = 5\%$	
$\bar{f}^g_{best}$ (lbs)	5292.40	5293.94
$\bar{\sigma}$	15.120	11.401
N_{fe} (ave.)	1304	803
Convergence ratio	10/10	10/10
Best found f^g_{best} (lbs)	5260.94	5277.12
Normalized infeasability	0.0784	0.0066
N_{fe}	1034	897
	$\epsilon_s = 2\%$	
$\bar{f}^g_{best}$ (lbs)	5153.62	5153.06
$\bar{\sigma}$	5.776	8.142
N_{fe} (ave.)	1609	1083
Convergence ratio	10/10	10/10
Best found f^g_{best} (lbs)	5144.22	5134.86
Normalized infeasability	0.129	0.000
N_{fe}	1002	969
	$\epsilon_s = 1\%$	
$\bar{f}^g_{best}$ (lbs)	5105.78	5108.54
$\bar{\sigma}$	4.818	3.451
N_{fe} (ave.)	2019	1366
Convergence ratio	10/10	10/10
Best found f^g_{best} (lbs)	5094.34	5100.52
Normalized infeasability	0.0886	0.0032
N_{fe}	1541	1206

Table B.19: Non-convex 10-bar problem: Comparison between constraint implementations

	Standard penalty method	Penalty with social pressure
	$\epsilon_s = 5\%$	
$\bar{f}^g_{best}$ (lbs)	569.22	569.24
$\bar{\sigma}$	3.639	3.034
N_{fe} (ave.)	1324	1029
Convergence ratio	10/10	10/10
Best found f^g_{best} (lbs)	559.55	561.42
Normalized infeasability	0.000	0.000
N_{fe}	1322	1062
	$\epsilon_s = 2\%$	
$\bar{f}^g_{best}$ (lbs)	555.08	554.56
$\bar{\sigma}$	1.144	1.893
N_{fe} (ave.)	1941	1329
Convergence ratio	10/10	10/10
Best found f^g_{best} (lbs)	552.32	550.38
Normalized infeasability	0.000	0.000
N_{fe}	2787	765
	$\epsilon_s = 1\%$	
$\bar{f}^g_{best}$ (lbs)	550.29	550.26
$\bar{\sigma}$	3.639	0.204
N_{fe} (ave.)	2528	2616
Convergence ratio	10/10	10/10
Best found f^g_{best} (lbs)	549.30	549.82
Normalized infeasability	0.0099	0.000
N_{fe}	2083	3069

Table B.20: Non-convex 25-bar problem: Comparison between constraint implementations

	Standard penalty method	Penalty with social pressure
	$\epsilon_s = 5\%$	
$\bar{f}^g_{best}$ (lbs)	37457.34	37450.93
$\bar{\sigma}$	44.012	59.918
N_{fe} (ave.)	2970	1232
Convergence ratio	10/10	10/10
Best found f^g_{best} (lbs)	37375.39	37340.09
Normalized infeasability	0.0083	0.0144
N_{fe}	2421	1091
	$\epsilon_s = 2\%$	
$\bar{f}^g_{best}$ (lbs)	36415.98	36489.65
$\bar{\sigma}$	37.836	67.874
N_{fe} (ave.)	5833	1973
Convergence ratio	10/10	9/10
Best found f^g_{best} (lbs)	36325.53	36385.04
Normalized infeasability	0.000	0.0120
N_{fe}	6546	1778
	$\epsilon_s = 1\%$	
$\bar{f}^g_{best}$ (lbs)	36078.53	36074.39
$\bar{\sigma}$	4.740	11.952
N_{fe} (ave.)	7438	2431
Convergence ratio	10/10	10/10
Best found f^g_{best} (lbs)	35602.03	36044.45
Normalized infeasability	0.0192	0.0114
N_{fe}	10374	1490

Table B.21: Convex 36-bar problem: Comparison between constraint implementations

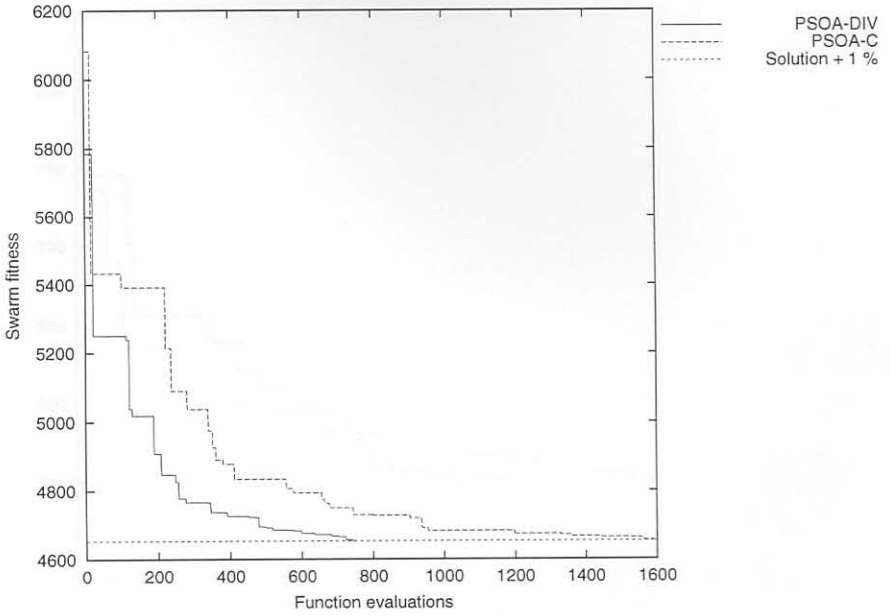


Figure B.4: Convex 10-bar truss: Typical history plot for contriction and dynamic inetia and maximum velocity variants

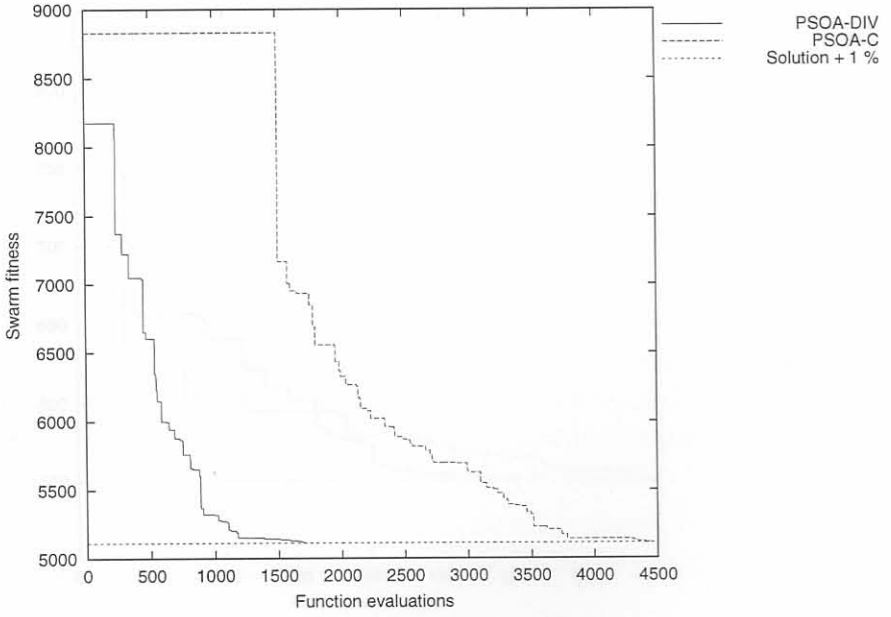


Figure B.5: Non-convex 10-bar truss: Typical history plot for contriction and dynamic inetia and maximum velocity variants

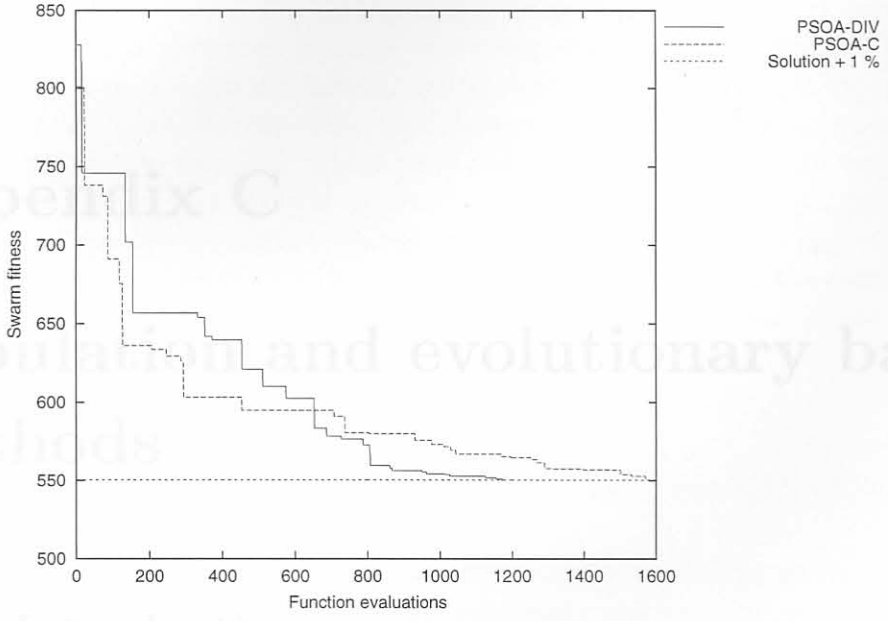


Figure B.6: Non-convex 25-bar truss: Typical history plot for contriction and dynamic inetia and maximum velocity variants

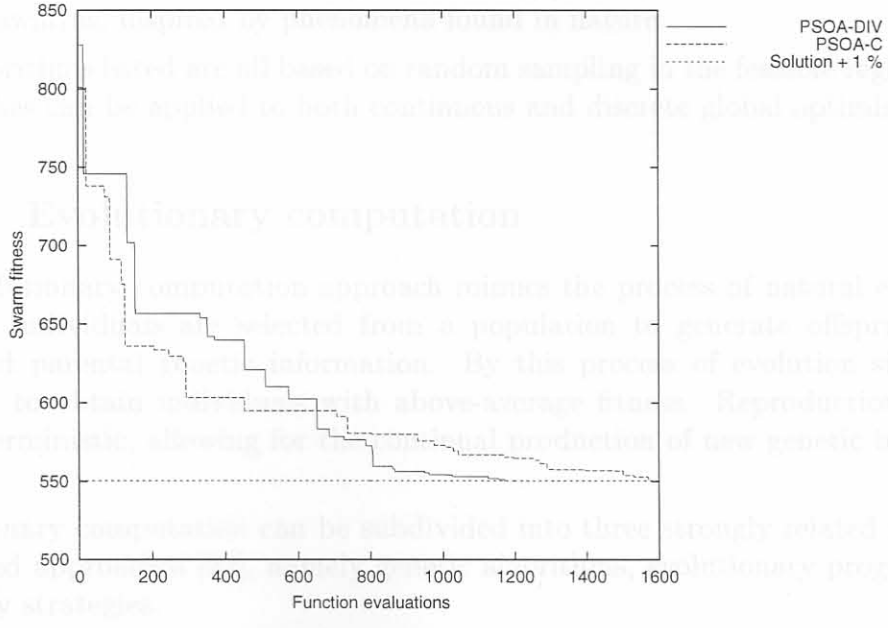


Figure B.7: Non-convex 36-bar truss: Typical history plot for contriction and dynamic inetia and maximum velocity variants