

# DESIGN FOR ASSEMBLY METHODS

## Boothroyd and Dewhurst Charts – Assembly Order

Assembly Order	#	Part	Size			Thickness		Alpha	Beta	Alpha+Beta
			0-6mm	6-15mm	>15mm	< 2mm	>2mm			
1	26	Top Housing			x		x	360	360	720
2		- Invert -	-	-	-	-	-	-	-	-
3	28	Bottom Housing			x		x	360	360	720
4	27	Screw		x			x	360	0	360
5	27	Screw		x			x	360	0	360
6	27	Screw		x			x	360	0	360
7	27	Screw		x			x	360	0	360
8	14	Heater Mount			x		x	360	360	720
9	15	Screw		x			x	360	0	360
10	15	Screw		x			x	360	0	360
11	13	Heating Element			x		x	360	360	720
12	17	Thermal Switch			x		x	360	180	540
13	18	Bracket			x		x	180	360	540
14	19	Hose			x		x	180	0	180
15	19	Hose			x		x	180	0	180
16	20	Hose Clamp			x	x		180	360	540
17	20	Hose Clamp			x	x		180	360	540
18	20	Hose Clamp			x	x		360	360	720
19	16	Wire Clip			x		x	180	360	540
20	21	Heat Shield			x	x		180	360	540
21	24	Bracket			x	x		180	360	540
22	22	Washer		x		x		180	0	180
23	22	Washer		x		x		180	0	180
24	23	Screw		x			x	360	0	360
25	34	On/Off Button			x		x	360	360	720
26	42	Circuit Board			x		x	360	360	720
27	44	Bracket		x			x	360	360	720
28	45	Screw		x			x	360	0	360
29	43	Cord			x		x	360	180	540
30	35	Cord Restraint			x		x	360	360	720
31	31	Bottom Plate			x		x	360	360	720
32	32	Screw		x			x	360	0	360
33	33	Foot		x			x	360	0	360
34	2	Final Drive Gear			x		x	360	0	360
35	3	Shaft			x		x	180	0	180
36	4	Compound Gear			x		x	360	0	360
37	7	Switch Spring			x		x	180	0	180
38	9	Bracket			x		x	360	360	720
39	8	Motor			x		x	360	360	720
40	5	Screw		x			x	360	0	360
41	5	Screw		x			x	360	0	360
42	6	Switch Contact			x	x		360	360	720
43	6	Switch Contact			x	x		360	360	720
44	29	Motor Chamber Cover			x		x	360	360	720
45	30	Screw		x			x	360	0	360
46	30	Screw		x			x	360	0	360
47	30	Screw		x			x	360	0	360
48	25	One way valve		x			x	360	0	360
49		- Invert -	-	-	-	-	-	-	-	-
50	1	Hexagonal Reamer Drive			x		x	360	0	360
51	40	Water tube			x		x	360	0	360
52	41	O-ring		x			x	180	0	180
53	39	Juice/ Sugar Container			x		x	360	360	720
54	36	Sugar Chamber Lid			x		x	360	360	720
55	38	Reamer			x		x	360	360	720
56	37	Reamer Cover			x		x	360	360	720
57	11	Pitcher			x		x	360	360	720
58	12	Pitcher Handle Insert			x		x	360	360	720
59	10	Pitcher Lid			x		x	360	360	720

## Boothroyd and Dewhurst Chart – Original Design

Assembly Order	#	Part	Number of times the operation is carried out consecutively	Two Digit Manual Handling Code	Manual Handling Time per Part (sec)	Two Digit Manual Insertion Code	Manual Insertion Time per Part (sec)	Operation Time (sec)	Operation Costs (cents)	Figures for Estimation of Theoretical Minimum Parts
1	26	Top Housing	1	03	1.95	00	1.50	3.45	1.38	1
2		- Invert -	-	-	-	-	-	-	-	-
3	28	Bottom Housing	1	03	1.95	00	1.50	3.45	1.38	0
4	27	Screw	1	11	1.80	83	6.00	7.80	3.12	0
5	27	Screw	1	11	1.80	83	6.00	7.80	3.12	0
6	27	Screw	1	11	1.80	83	6.00	7.80	3.12	0
7	27	Screw	1	11	1.80	83	6.00	7.80	3.12	0
8	14	Heater Mount	1	03	1.95	83	6.00	7.95	3.18	0
9	15	Screw	1	11	1.80	83	6.00	7.80	3.12	0
10	15	Screw	1	11	1.80	83	6.00	7.80	3.12	0
11	13	Heating Element	1	13	2.25	60	5.50	7.75	3.1	1
12	17	Thermal Switch	1	02	1.80	00	1.50	3.30	1.32	1
13	18	Bracket	1	02	1.80	00	1.50	3.30	1.32	0
14	19	Hose	1	00	1.13	10	2.50	3.63	1.452	1
15	19	Hose	1	00	1.13	10	2.50	3.63	1.452	1
16	20	Hose Clamp	1	32	2.36	13	5.00	7.36	2.944	1
17	20	Hose Clamp	1	32	2.36	13	5.00	7.36	2.944	1
18	20	Hose Clamp	1	32	2.36	13	5.00	7.36	2.944	1
19	16	Wire Clip	1	08	4.10	10	2.50	6.60	2.64	0
20	21	Heat Shield	1	32	2.36	00	1.50	3.86	1.544	1
21	24	Bracket	1	32	2.36	83	6.00	8.36	3.344	1
22	22	Washer	1	30	1.69	83	6.00	7.69	3.076	1
23	22	Washer	1	30	1.69	83	6.00	7.69	3.076	0
24	23	Screw	1	11	1.80	84	8.50	10.30	4.12	1
25	34	On/Off Button	1	03	1.95	10	2.50	4.45	1.78	1
26	42	Circuit Board	1	03	1.95	60	5.50	7.45	2.98	1
27	44	Bracket	1	13	2.25	71	9.00	11.25	4.5	0
28	45	Screw	1	11	1.80	83	6.00	7.80	3.12	0
29	43	Cord	1	02	1.80	00	1.50	3.30	1.32	1
30	35	Cord Restraint	1	03	1.95	03	2.00	3.95	1.58	0
31	31	Bottom Plate	1	03	1.95	10	2.50	4.45	1.78	1
32	32	Screw	1	11	1.80	83	6.00	7.80	3.12	0
33	33	Foot	1	11	1.80	10	2.50	4.30	1.72	0
34	2	Final Drive Gear	1	01	1.50	60	5.50	7.00	2.8	1
35	3	Shaft	1	00	1.13	80	6.50	7.63	3.052	0
36	4	Compound Gear	1	01	1.50	60	5.50	7.00	2.8	1
37	7	Switch Spring	1	00	1.13	70	6.50	7.63	3.052	0
38	9	Bracket	1	03	1.95	60	5.50	7.45	2.98	1
39	8	Motor	1	03	1.95	60	5.50	7.45	2.98	1
40	5	Screw	1	11	1.80	83	6.00	7.80	3.12	1
41	5	Screw	1	11	1.80	83	6.00	7.80	3.12	1
42	6	Switch Contact	1	33	2.51	60	5.50	8.01	3.204	1
43	6	Switch Contact	1	33	2.51	60	5.50	8.01	3.204	1
44	29	Motor Chamber Cover	1	03	1.95	00	1.50	3.45	1.38	1
45	30	Screw	1	11	1.80	83	6.00	7.80	3.12	0
46	30	Screw	1	11	1.80	83	6.00	7.80	3.12	0
47	30	Screw	1	11	1.80	83	6.00	7.80	3.12	0
48	25	One way valve	1	61	2.57	10	2.50	5.07	2.028	1
49		- Invert -	-	-	-	-	-	-	-	-
50	1	Hexagonal Reamer Drive	1	01	1.50	00	1.50	3.00	1.2	1
51	40	Water tube	1	01	1.50	10	2.50	4.00	1.6	0
52	41	O-ring	1	10	1.43	10	2.50	3.93	1.572	1
53	39	Juice/ Sugar Container	1	03	1.95	00	1.50	3.45	1.38	1
54	36	Sugar Chamber Lid	1	03	1.95	10	2.50	4.45	1.78	1
55	38	Reamer	1	03	1.95	00	1.50	3.45	1.38	1
56	37	Reamer Cover	1	03	1.95	00	1.50	3.45	1.38	1
57	11	Pitcher	1	03	1.95	00	1.50	3.45	1.38	1
58	12	Pitcher Handle Insert	1	03	1.95	10	2.50	4.45	1.78	0
59	10	Pitcher Lid	1	03	1.95	10	2.50	4.45	1.78	1

<b>Total</b>	350.37	140.148	34
--------------	--------	---------	----

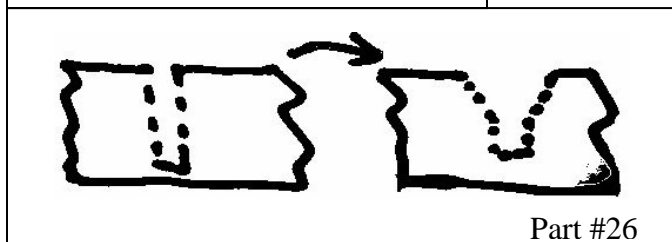
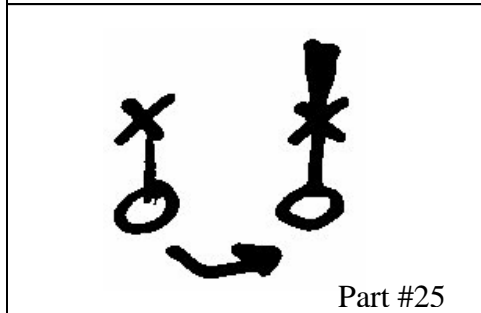
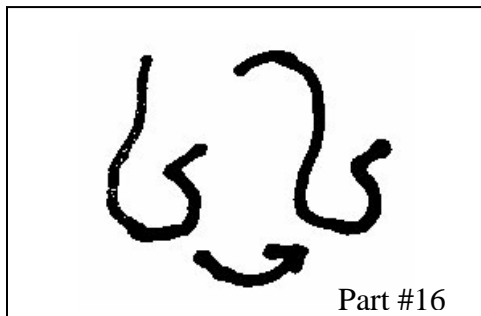
# Using DFA to Minimize and Redesign Parts

## Eliminated Parts

Step #	Part #	Name	Reason
4 -7	27	Screw	Top and bottom snap-fit eliminate the need for screws
23	22	Washer	Two washers are redundant, only one needed
30	35	Cord Restraint	Cord restraint can be molded onto cord instead of using a separate piece
32	32	Screw	Snap-fit used to secure bottom plate, screw not needed
33	33	Foot	This part provides no necessary function
45-47	30	Screw	Motor cover secured using snap-fits, no screws needed
58	12	Pitcher Handle Insert	Handle insert is decorative; the function is to provide additional colors. This could be accomplished using multiple shot molding.

## Redesigned Parts

Part #	Name	Reason
16	Wire Clip	Added wings to prevent from tangling (nesting)
25	One way Valve	Make it easier to handle [include a handle]
26	Housing	Shaft insertion (funnel shaped)



## Design for No-Assembly

We have determined three moving parts that could benefit from a compliant design

#	Part	Redesign	Pros	Cons
10-11	Pitcher lid hinge	Combine pitcher and lid into one part using a living hinge	No assembly required, fewer parts	Added manufacturing complexity, cleaning may be difficult
36-26	Sugar chamber lid	Combine sugar chamber and lid using a living hinge	No assembly required, fewer parts	Added manufacturing complexity, cleaning may be difficult
7	Switch spring	Create leaf spring molded into upper housing to replace spring	Fewer parts, easier assembly	Added manufacturing complexity, possible fatigue failure

## Boothroyd and Dewhurst Charts – Redesign

Assembly Order	#	Part	Number of times the operation is carried out consecutively	Two Digit Manual Handling Code	Manual Handling Time per Part (sec)	Two Digit Manual Insertion Code	Manual Insertion Time per Part (sec)	Operation Time (sec)	Operation Costs (cents)	Figures for Estimation of Theoretical Minimum Parts
1	26	Top Housing	1	03	1.95	00	1.50	3.45	1.38	1
2		- Invert -	-	-	-	-	-	-	-	-
3	28	Bottom Housing	1	03	1.95	00	1.50	3.45	1.38	0
4	14	Heater Mount	1	03	1.95	83	6.00	7.95	3.18	0
5	15	Screw	1	11	1.80	83	6.00	7.80	3.12	0
6	15	Screw	1	11	1.80	83	6.00	7.80	3.12	0
7	13	Heating Element	1	13	2.25	60	5.50	7.75	3.1	1
8	17	Thermal Switch	1	02	1.80	00	1.50	3.30	1.32	1
9	18	Bracket	1	02	1.80	00	1.50	3.30	1.32	0
10	19	Hose	1	00	1.13	10	2.50	3.63	1.452	1
11	19	Hose	1	00	1.13	10	2.50	3.63	1.452	1
12	20	Hose Clamp	1	32	2.36	13	5.00	7.36	2.944	1
13	20	Hose Clamp	1	32	2.36	13	5.00	7.36	2.944	1
14	20	Hose Clamp	1	32	2.36	13	5.00	7.36	2.944	1
15	16	Wire Clip	1	02	1.80	10	2.50	4.30	1.72	0
16	21	Heat Shield	1	32	2.36	00	1.50	3.86	1.544	1
17	24	Bracket	1	32	2.36	83	6.00	8.36	3.344	1
18	22	Washer	1	30	1.69	83	6.00	7.69	3.076	1
19	23	Screw	1	11	1.80	84	8.50	10.30	4.12	1
20	34	On/Off Button	1	03	1.95	10	2.50	4.45	1.78	1
21	42	Circuit Board	1	03	1.95	60	5.50	7.45	2.98	1
22	44	Bracket	1	13	2.25	71	9.00	11.25	4.5	0
23	45	Screw	1	11	1.80	83	6.00	7.80	3.12	0
24	43	Cord	1	02	1.80	00	1.50	3.30	1.32	1
25	31	Bottom Plate	1	03	1.95	10	2.50	4.45	1.78	1
26	2	Final Drive Gear	1	01	1.50	60	5.50	7.00	2.8	1
27	3	Shaft	1	00	1.13	60	5.50	6.63	2.652	0
28	4	Compound Gear	1	01	1.50	60	5.50	7.00	2.8	1
29	7	Switch Spring	1	00	1.13	70	6.50	7.63	3.052	0
30	9	Bracket	1	03	1.95	60	5.50	7.45	2.98	1
31	8	Motor	1	03	1.95	60	5.50	7.45	2.98	1
32	5	Screw	1	11	1.80	83	6.00	7.80	3.12	1
33	5	Screw	1	11	1.80	83	6.00	7.80	3.12	1
34	6	Switch Contact	1	33	2.51	60	5.50	8.01	3.204	1
35	6	Switch Contact	1	33	2.51	60	5.50	8.01	3.204	1
36	29	Motor Chamber Cover	1	03	1.95	00	1.50	3.45	1.38	1
37	25	One way valve	1	11	1.80	10	2.50	4.30	1.72	1
38		- Invert -	-	-	-	-	-	-	-	-
39	1	Hexagonal Reamer Drive	1	01	1.50	00	1.50	3.00	1.2	1
40	40	Water tube	1	01	1.50	10	2.50	4.00	1.6	0
41	41	O-ring	1	10	1.43	10	2.50	3.93	1.572	1
42	39	Juice/ Sugar Container	1	03	1.95	00	1.50	3.45	1.38	1
43	36	Sugar Chamber Lid	1	03	1.95	10	2.50	4.45	1.78	1
44	38	Reamer	1	03	1.95	00	1.50	3.45	1.38	1
45	37	Reamer Cover	1	03	1.95	00	1.50	3.45	1.38	1
46	11	Pitcher	1	03	1.95	00	1.50	3.45	1.38	1
47	10	Pitcher Lid	1	03	1.95	10	2.50	4.45	1.78	1

<b>Total</b>	263.51	105.404	34
--------------	--------	---------	----

**Design Eff**    38.71%