DFA Example

- Time estimation
- Design Rules
- Redesign

Time Estimation for Assembly

- Handling
 - pick up
 - orient
- Insertion
 - location (obstructed view? Self locating?)
 - hold down and resistance
 - securing method

Handling Issues





Size



Fragile/Sharp



Nest/Tangle

Jerse fiexible

Slippery/Flexible

B-D Manual handling chart

			parts	are easy	to grasp	and manij	oulate	parts present handling difficulties (1)					
			thic	kness > 7	mm	thickness	s≤2mm	thickness ≥ Z mm			tbickness ≤ 2 mm		
Key	ONE HAN	size >16 mm	6 mm.s size s15 mm	life Chann	ssre >6 mm	Mže ≤6 mm	sice >15 mm	5 mm.s. 1/24 1/5 mm	aide Karron	etzre ≫\$e finns	tire 56 mm		
-			0	1	2	3	4	5	6	7	8	9	
ols	$(\alpha + \beta) < 360^{\circ}$	0	1.13	1.43	1.88	1.59	2.18	1.84	2.17	2.65	2.45	2.98	
d ing to		1	1.5	1.8	2.25	2.06	2.55	2.25	2.57	3.06	3	3.38	
ned an ar har grasp	$360^{\circ} \le (\alpha + \beta)$ < 540°	12	1.8	2.1	2.55	2:36	2.85	2.57	2.9	3.38	3.18	3.7	
grasp by or bid of	$540^{\circ} \leq (\alpha + \beta)$	13	1.95	2.25	2.7	2.51	3	2.73	3.06	3.55	3.34	4	
n bo ated	< 720°	1											
parts ca manipul without	$\langle \alpha + \beta \rangle = 720^{\circ}$	/											

MANUAL HANDLING - ESTIMATED TIMES (seconds)

Insertion Issues



		1	afte to n loca	t assembly taintain ori tion (3)	holding down required during subsequent processes to maintain orientation or location (3)									
Key: PART ADDED			easy to align and position during assembly (4)			not easy to align or position during assembly		easy to align and position during assembly (4)			not easy to align or position during assembly			
			no resistance to insertion		oce. 19 10 15) ir	o sistance settion	resistance to insertion (5)	no rexistance to insertion	resistance to insertion (5)		no resistance to insertion		resistance to insertion (5)	
	NOT SEC	URED		0	1		2	3	6	7		Ŵ	8	9
part i togi (ind associated		0	1.5	2.	5	2.5	3.5	5.5	6.5	5	1	6.5	7.5
hand reach locat	handst can early reach the desired		1	4 5		10	5	6	8	9		9		10
diate)	due to ob-		2	5.5	6.	5	6.5	7.5	9.5	10.5	5	1	0.5	11.5
div secured and associa uning bands v reach the	due to ob- structed ac- cess and re-	1	1	no screw tion or deforma mediatel	ing opera- plastic tion im- r after in-	1	plastic defe plastic ben	irmation imm ding	ediately aft rivett	ter insertso ing or simil	n Iar	_	screw t	ightening iately
finally secured perfunding bands fincluding bands based weach the	vision (2) due to ob- structed at- cess and re- stricted, vision (2)	/		no screw tion or deforma mediately sertion () fills, circl nuts, etc. Pug 2	ing opera- plastic tion im- r after in- nap/press ips, spire	n and Uning	plastic defo plastic ben or torsion not eas positio assemb	irmation imm ding to align or n during sly	ediately af rivett opera	ter insertso ing or simi tion not easy to position d assembly	in Iar o aligi Iuring	v or	screw I immed after in P o 5	lightening lately isertion (6) 한 요즘
In ally secured associated associ	due to ob structed ac- cess and re- stricted vision (2) PART SE IMMEDI d associated loof rg bands) can			no n	ng opera- plastic in a point of the point of	easy to align and position during	blastic defe plastic ben or torsion not eas positio assemt oursissu ou	trmation intro ding tailign or n during sly Uzerriou (2) Uzerriou	equately to any and the state of the state o	ter insertso ing or simi tion not easy ti position d assembly Output Se of Output Se of Output Se of Output Se of	in lar lar luring luring luring luring	di let metradui	single of the second se	ret easy to align or position and/or logitic align (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)
adiately finally secured associated and associated associated associated associated associated associated associated and associated and associated associated as a security as a securit	due to ob structed ac- cess and re- stricted vision (2) PART SE IMMEDI d associated loof in bands) can each the desired operated samly			no screw tion or deformation or serior or on up we used to up we use or or or or serior or or or or serior or or or or serior or or or or serior o	ng opera- plastic in- tion er in- sessembly and on the instance to the set of the set of the instance to the set of the set of the instance to the set of the set of the instance to the instance to the set of the set of the set of the instance to the set of the set of the set of the set of the instance to the set of the set of the set of the set of the instance to the set of the set of the set of the set of the instance to the set of the instance to the set of t	C position dign and C	Plastic defe plastic ben or torsion not eas positio assemt oursissu ou 3	ding ding to align or n during sly (2) upplies during sly (2) upplies 4	content during the state of the	ter insertso ing or simi ition not easy ti position d assembly Outside Si Si Si Si Si Si Si	in lar luring luring type type type type type type type type	o di	structure and account of the structure o	C por easy to alligo not easy to alligo or position and/or toryional resistance (5)
d immediately in a graph in	due to ob structed ac- cess and re- stricted vision (2) PART SE IMMEDI d associated fool operated same		3	no screw tion or deformation of sertion of nubs, etc. (b) units of 0 2	ng opera- plastic in after in applying of action of the second during the second during the second during the second seco	pur utility unitied of 4	blastic defe plastic ben or torsion not eas positio assemt ourstissa ou 3 5	ding ding vy to align or n during sly (2) unertion 4 6	A Seembly (4) A	ter insertso ing or simi tion not easy ti position d assembly outpass	in lar luring luring 0 align 10 align 1	o or	science a consistent for the second s	B C
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MANUAL INSERTION -- ESTIMATED TIMES (seconds)



Pneumatic Piston Sub-Assembly

2 – cover(steel) not easy to align – assembly worker's fingers must be used to align edges

4 – piston stop(plastic) edge is chamfered for ease of alignment

6 – main block(plastic) depth of bore is 28mm with small through hole for piston spindle

B-D Manual handling chart



B-D Manual insertion chart A

MANUAL INSERTION - ESTIMATED TIMES (seconds)



B-D Manual insertion chart B



Pneumatic Piston Sub-Assembly

1	2	3	4	5	6	7	8	9	Name of Assembly
Part I.D. No.	number of times the operation is carried out consecutively	two-digit manual handling code	manual handling time per part	two-digit manual insertion code	manual insertion time per part	operation time, seconds (2)*[(4)+(6)]	operation cost, cents 0.4*(7)	figures for estimation of theoretical minimum parts	PNEUMATIC PISTON
6	1	30	1.95	00	1.50	3.45	1.38	1	MAIN BLOCK
5	1	10	1.50	10	4.00	5.50	2.20	1	PISTON
4	1	10	1.50	00	1.50	3.00	1.20	1	PISTON STOP
3	1	05	1.84	00	1.50	3.34	1.34	1	SPRING
2	1	23	2.36	08	6.50	8.86	3.54	0	COVER
1	2	11	1.80	39	8.00	19.60	7.84	0	SCREW
						43.75	17.50	4	design efficiency 0.27
						ТМ	CM	NM	= (3*NM)/TM

Boothroyd/Dewhurst Design Rules

- Reduce part count and part types
- Strive to eliminate adjustments
- Design parts to be self-aligning and self-locating
- Ensure adequate access and unrestricted vision
- Ensure the ease of handling of parts from bulk
- Minimize the need for reorientations during assembly
- Design parts that cannot be installed incorrectly
- Maximize part symmetry if possible or make parts obviously asymmetrical

Rules to reduce part count

- During operation of the product, does the part move relative to all other parts already assembled?
 - Only gross motion should be considered small motions that can be accommodated by elastic hinges, for example, are not sufficient for a positive answer
- Must the part be of a different material than or be isolated from all other parts already assembled?
 - Only fundamental reasons concerned with material properties are acceptable
- Must the part be separate from all other parts already assembled because otherwise necessary assembly or disassembly of other separate parts would be impossible?



Re-design

1	2	3	4	5	6	7	8	9	Name of Assembly
Part I.D. No.	number of times the operation is carried out consecutively	two-digit manual handling code	manual handling time per part	two-digit manual insertion code	manual insertion time per part	operation time, seconds (2)*[(4)+(6)]	operation cost, cents 0.4*(7)	figures for estimation of theoretical minimum parts	PNEUMATIC PISTON (re-design)
4	1	30	1.95	00	1.50	3.45	1.38	1	MAIN BLOCK
3	1	10	1.50	00	1.50	3.00	1.20	1	PISTON
1	1	05	1.84	00	1.50	3.34	1.34	1	SPRING
2	1	10	1.50	30	2.00	3.50	1.40	1	COVER & STOP
						13.29	5.32	4	design efficiency 0.90
						ΤM	CM	NM	= (3*NM)/TM