

## ME450:ASPECTS OF *DESIGN FOR MANUFACTURE* WORKSHEET

The attached information demonstrates one of many aspects of *DFM* (here related to assembly operations). It emphasizes the relationships between a "good design" and manufacturing.

The following should assist you in your attempt to achieve a "good design".

\*Consider some components in your product design which require assembly.
\*List the assembly sequence.
\*Calculate the Information Content for those parts assembly.
\*Calculate the assembly time (for manual assembly).
\*Redesign for ease of assembly.
\*Repeat calculations and compare.
\* Have you improved your design in this respect?

## **BASIC PRINCIPLES OF "GOOD DESIGN"**

**AXIOM 1**: In good design, undesirable interactions are avoided **AXIOM 2**: Among designs that avoid undesirable interactions, the best design is the one with

minimum information content

#### information content I = log 2 {di/ti }

di =particular dimension
 ti =the tolerance of that dimension
 n=total number of dimensions to specify the part

\*\*In assemblies, "dimensions and tolerances" refer to the placement of each part in the assembly

			Γ	parts .	Ne easy to	o graspia	nd manip	ulate	parts	lificultie	ficulties (1)			
			Γ	thick	ness > 2	mm	thickness	\$ 2 mm	thickness > 2 mm			thickness ≤ 2 mm		
Key					sur >15 mm	6 mini S size \$15 mni	51/1 < 5 mm	1175 >6 mm	sizi ≰6 mm	size >15 mm	6 mm ≴ size ≲15 mm	size <6 mm	size >6 mm	512+ 5.6 mm
UNE HAND				F	0		2	3	4	5	6	7	8	9
<u>.</u>				0	1.13	1.43	1.88	1.69	2.18	1.84	2.17	2.65	2.45	2.98
ر او دور	(α+)	s) < 360°	1	1	1.5	1.8	2.25	2.06	2.55	2.25	2.57	3.06	3	3.38
ed and e hanc graspir	360°	$360^\circ \leq (\alpha + \beta)$ < $540^\circ$		2	1.8	2.1	2.55	2.36	2.85	2.57	2.9	3.38	3.18	3.7
graspe by on id of 1	540*	≤ (α+β)	ĺ	3	1.95	2.25	2.7	2.51	3	2.73	3.06	3.55	3.34	4
222		< 720°	۲ /											
	<b> </b>			ſ		parts n	eed twee	zers for g	rasping a	nd manipu	alation		œ ا	
tring	(a+	β) = 720*	/	⊦	parts ca	n be man	ipulated	without	parts rec	uire opti	cal magn	ification	тари. При	scia Sing tion
Å Ë Š				L	optical magnification for man				ipulation	parts n	resent	l i i i	o E F	
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on tv		0 ≤ β		ł	0	1	2	3	4	5	6	7	8	9
l but	180°	≤ 180°		4	3.6	6.85	4.35	7.6	5.6	8.35	6.35	8.6	7	7
id and e hanc sping	8	β = 360°		5	4	7.25	4.75	8	6	8.75	6.75	9	8	8
by on	-	0 ≤ β		6	4.8	8.05	5.55	8.8	6.8	9.55	7.55	9.8	8	9
a be Lated	360	≤ 180°	7	5.1	8.35	5.85	9.1	7.1	9.55	7.85	10.1	9	10	
l Ω g ₹	н 8	A = 3600												
1 a a t					parts present no additional parts pre bandling difficulties (e.g. s					esent add sticky, di	litional hi elicate, sl	ippery, et	c)(1)	
<b>J</b>					α ≤ 180°			a	= 360°	$\alpha \le 180^{\circ}$ $\alpha = 36$			= 360°	
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1		fo		.	> 15 mm			1 2	-	5	6	7	8	9
parts se	everel	y nest or		R	4.1	4.5	5.1	5.6	6.75	5	5.25	5.85	6.35	7
tangle	or are	flexible		ت	L	<u> </u>	<u></u>	1	4		<u></u>			ويستعرب والمراجع
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(with th	(with the use of					parts can be handled by one person without mechanical assistance								Ξ.
grasping tools if					parts do not severely nest or tangle and are not flexible								4 - E	
necessary) (2)				part weight < 10 lb				arts are heavy (> 10 lb)			Ž	l E iš iš		
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					grasp and other			handling	grasp a	and other handlin ulate difficulties (1		nandling Ilties (1)	202	1 2 2 L
required for				manip	- 2400		• (a - 360)	• α ≤ 180	a = 360	a ≤ 180	a = 360	- Star	wo pe usista	
two hat	two hands two persons					u = 300"	2 2 100			5	6	7	8	9
or mec	hanic	al assistance eraspine	·   `		0	+	$+\frac{2}{2}$						7	9
and tra	nspor	ting parts		9	2	3		3	<u> </u>	<u> </u>		<u> </u>		

# MANUAL HANDLING-ESTIMATED TIMES (seconds)

Classification, coding and data base for part features affecting manual handling time





Classification, coding, and data base for part features affecting insertion and fastening

	0	$\mathcal{O}$				
	0	0	$\Diamond$	$\Diamond$	0	
α	0	180	180	90	360	
ß	0	0	90	180	0	360

Alpha and beta rotational symmetries for various parts.



Alternative designs for securing a cover to an enclosure using threaded fasteners.

					Information Content of Design B					
Inform Feature	Quantity	Dimension	n A Tolerance	Information	Feature	Quantity	Dimension	Tolerance	Information (bits)	
					a Diserver	1	3 mm	0.063 mm	5.573	
Screw Diameter	4	3 mm	0.063 mm	12.294	Position screw in	· · ·	17.5 mm	0.5 mm	5.129	
X-direction	4	30 mm	0.5 mm	23.628	X-direction Position screw in	· · ·	17.5 mm	0.5 mm	5.129	
Y-direction	4	30 mm	0.5 mm	23.628	Y-direction Install screw	<u> </u>	17.5 (181	600	5 170	
Install screw (6 turns)	4	2160*	<u>60°</u>	20.680	(6 turns)	1	2160 .		6130	
Locate cover in X-direction	1	35 mm	0.5 mm	6.129	X-direction	1	<u>35 mm</u>	0.5 mm	0.129	
Locate cover in Vedirection	1	35 mm	0.5 mm	6.129	Y-direction	1	35 mm	0.5 mm	6.129	
Total			<u> </u>	102.488	Total				33.259	

### ssembly Time for Design A.

Part	Quantity	Handling Time (sec)	Insertion Time (sec)	Assembly Time (sec)	Comments
D	1	1.95	1.50	3.45	· · · · · · · · · · · · · · · · · · ·
8186		2.16	6.50	10.68	Not easy to align
Cover		2.30	8.00	39.20	
Screws	4	1.80	8.00	\$1.13	
Tetal		1			

### Assembly Time for Design B

Part	Quantity	Handling Time (sec)	Insertion Time (sec)	Assembly Time (sec)	Comments
	1	1.95	1.50	3.45	
53.96		2.36	2.00	4.36	Easy to align
Cover		1.80	8.00	9.80	
Screws				17.61	



total estimated assembly time vs. dimensional

information content for three alternative cover attachement designs.