Concordia University
Engineering and Computer Science

MECH 211 – Mechanical Engineering Drawing

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Credits: 3.5

Lecture 11

Working Drawings

Contents of the Presentation

Production and Assembly Documentation

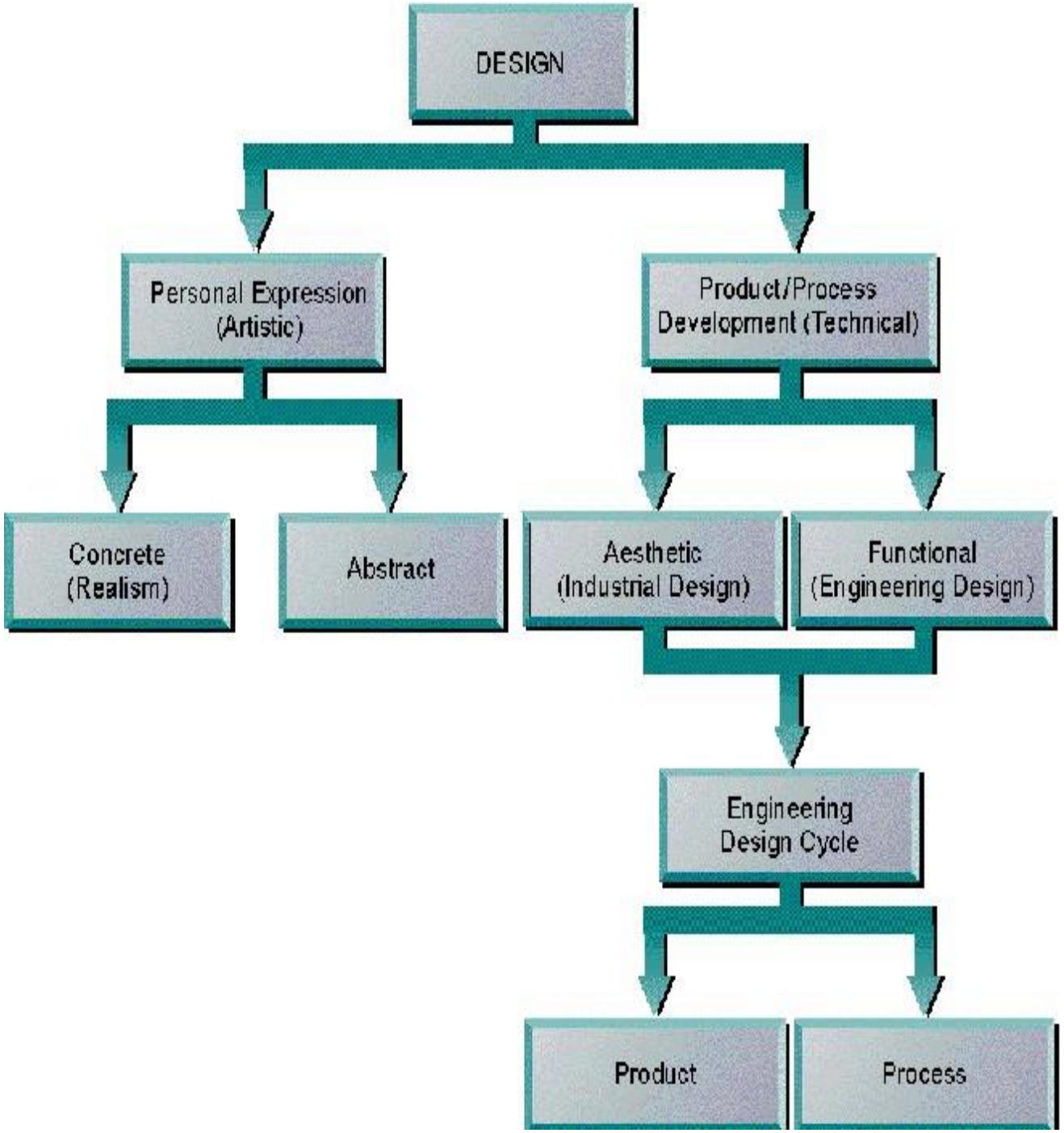
- Design process
- Technical documentation
- Working drawings
- Assembly working drawings
- Component working drawing
- Title block

Technical Data Presentation

- Modifications and revisions
- How to simplify the design process
- Checklist of a good design
- Technical data presentation

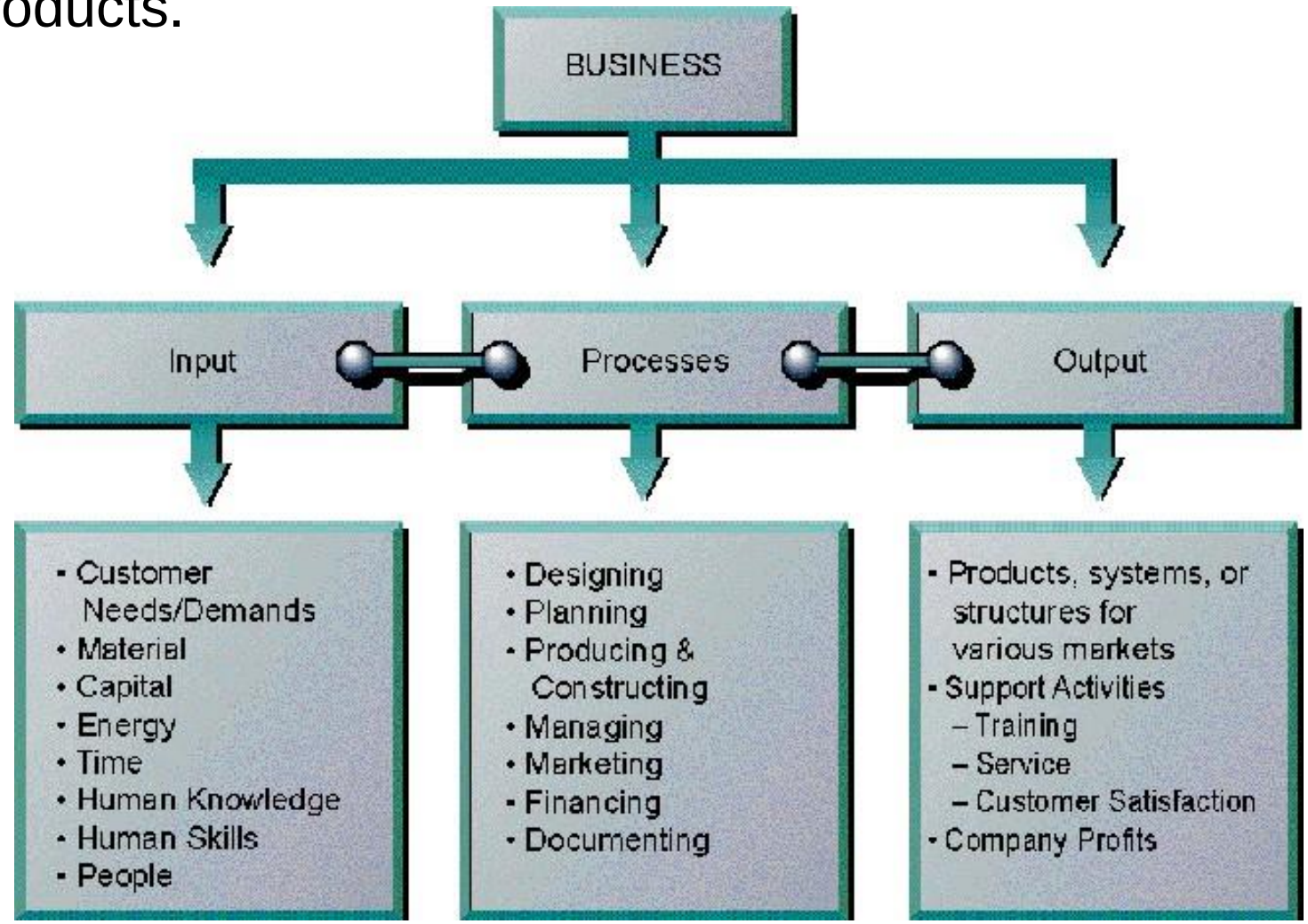
Design

The design process is a constrained creative process.

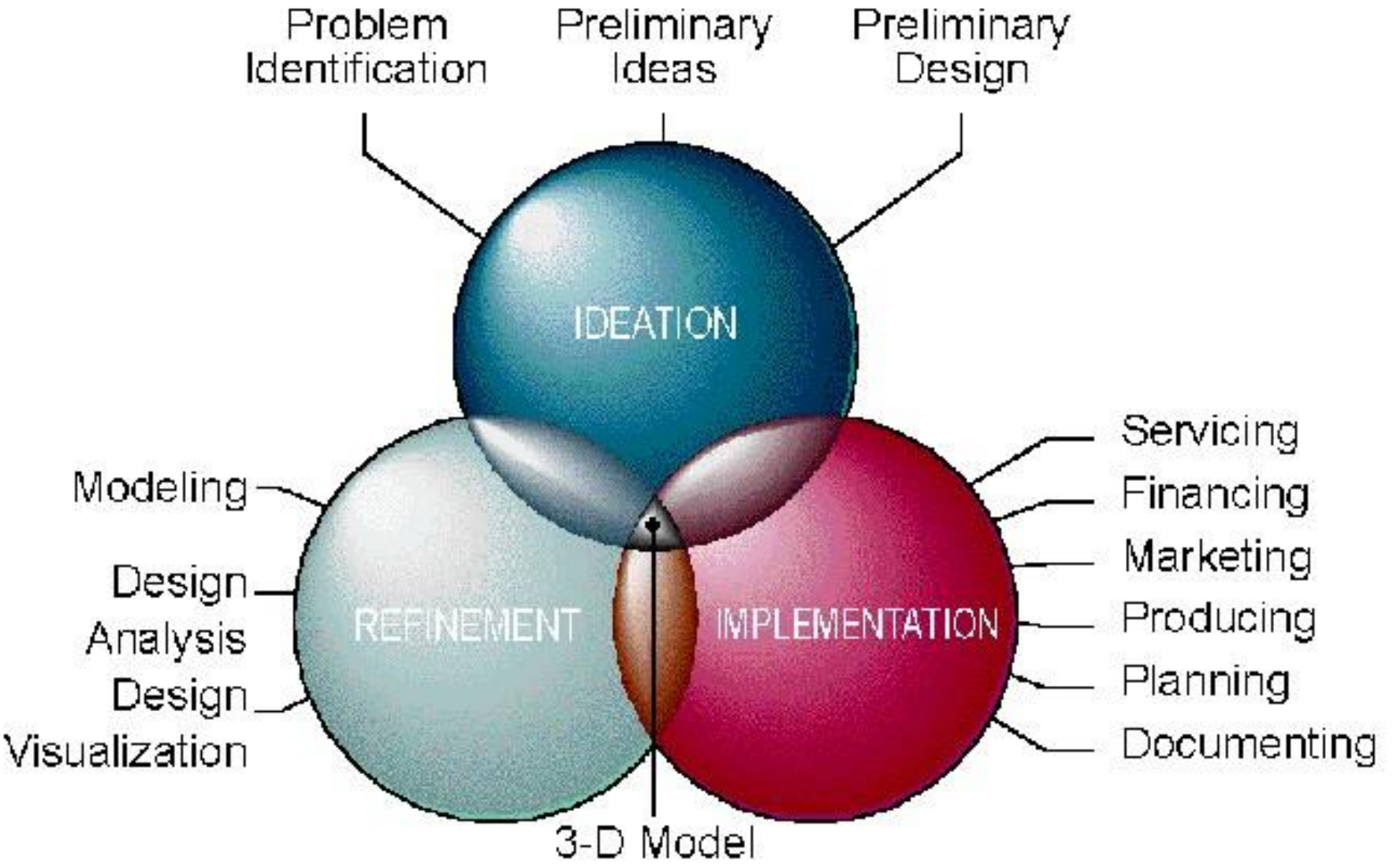


Design

Design is part of the business driven process of creating products.



Concurrent Design



Problem Identification

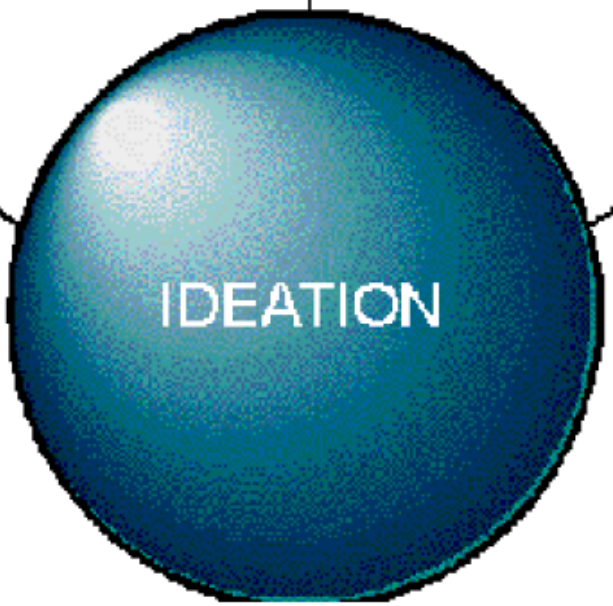
- Problem Statement
- Research
- Data Gathering
- Objectives
- Limitations
- Scheduling

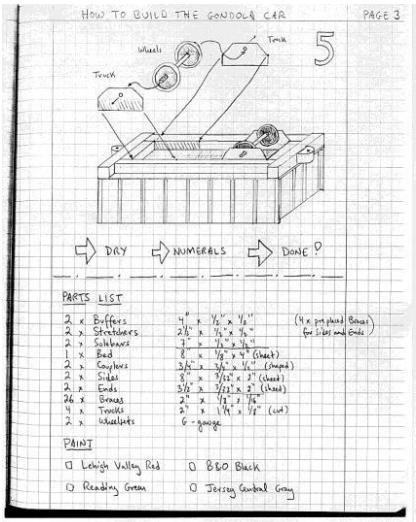
Preliminary Ideas

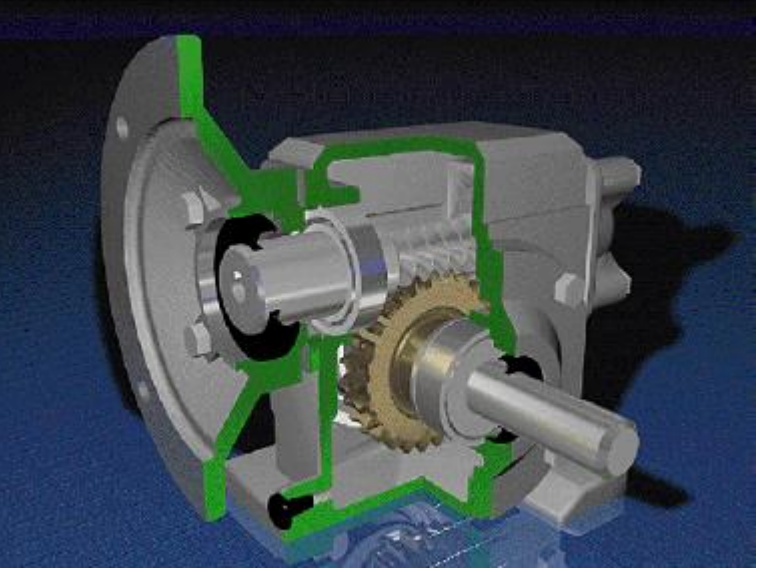
- Notes
- Sketches/Models
- Brainstorm
- Synthesis

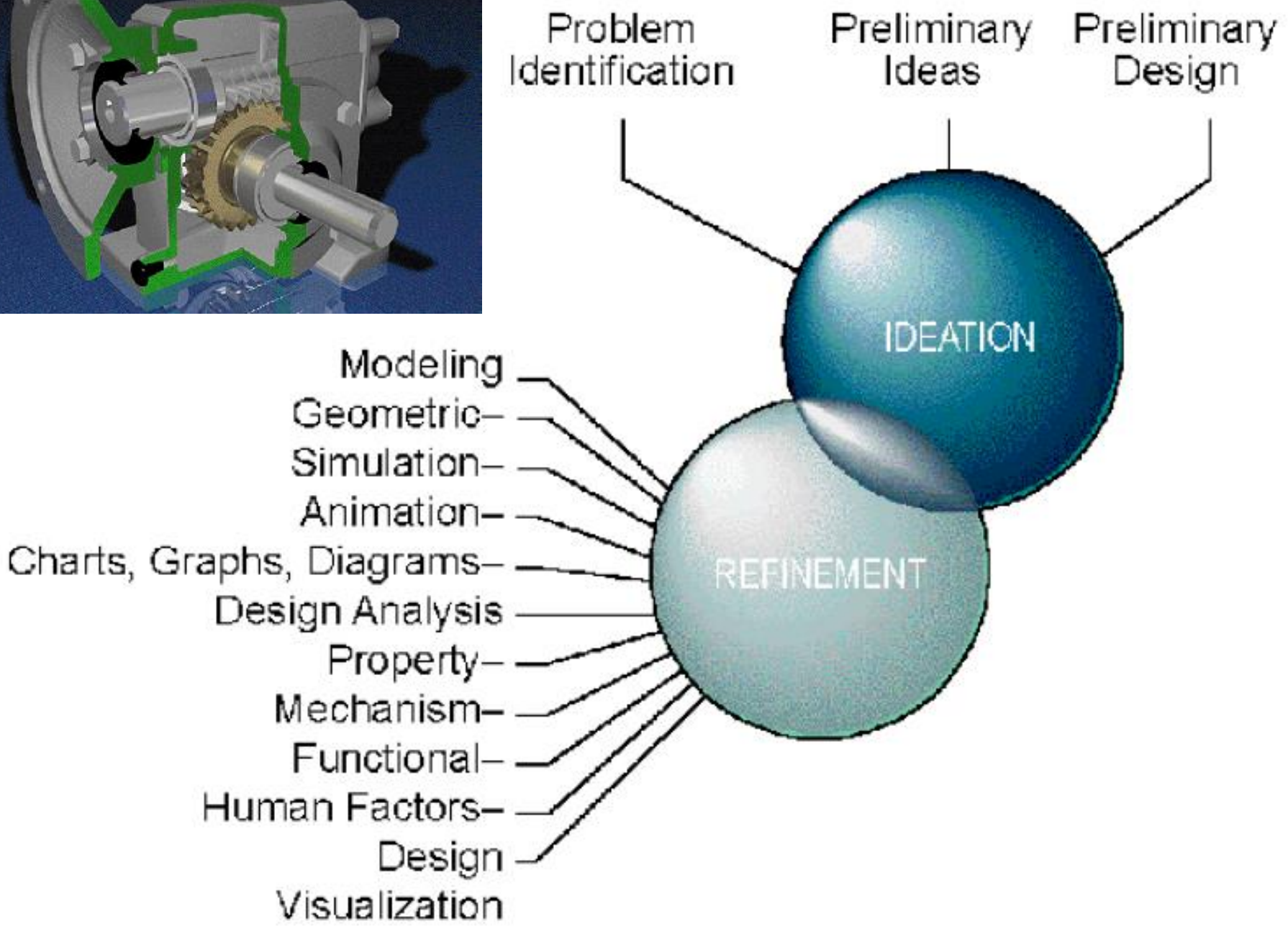
Preliminary Design

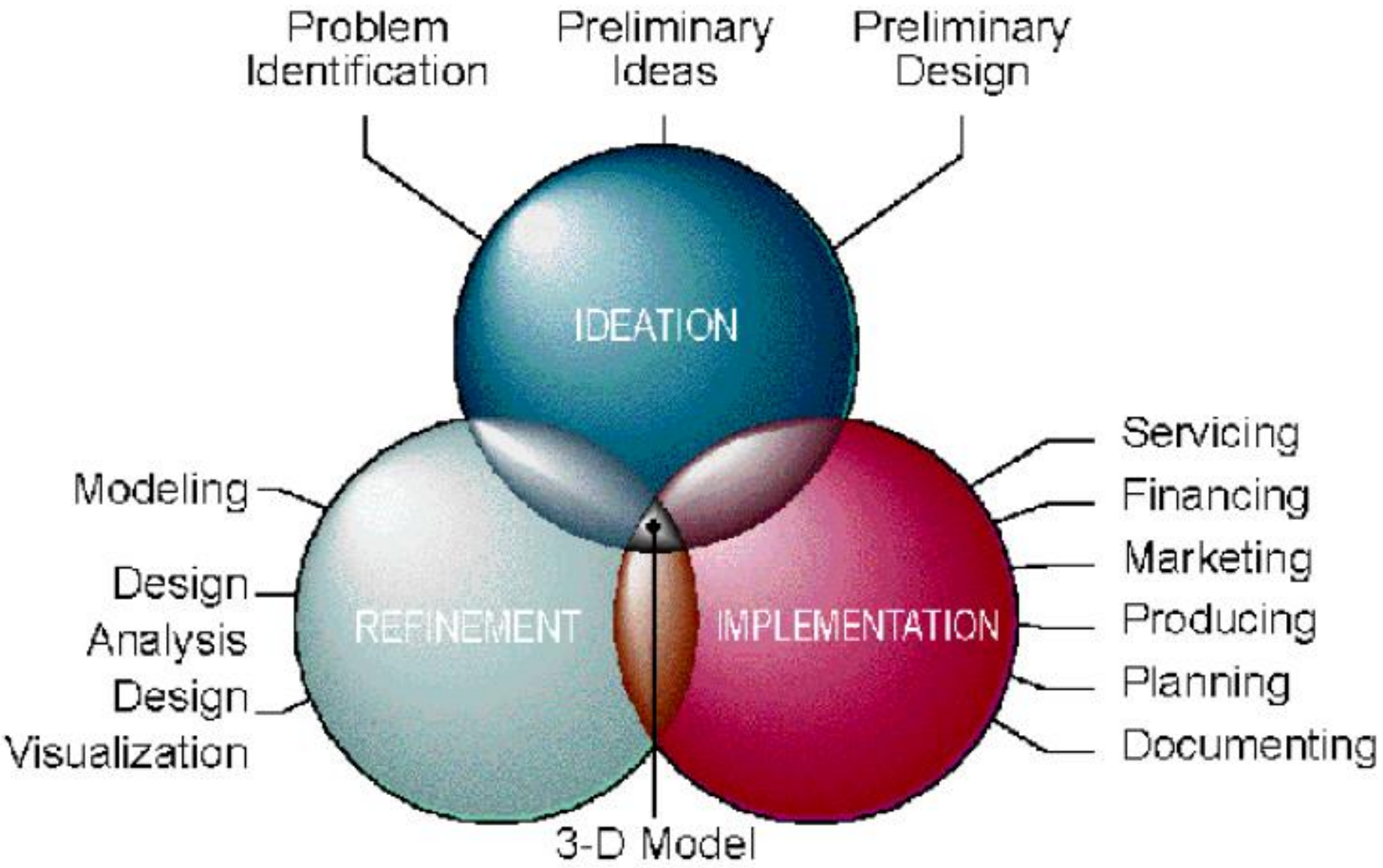
- Evaluation
- Selection





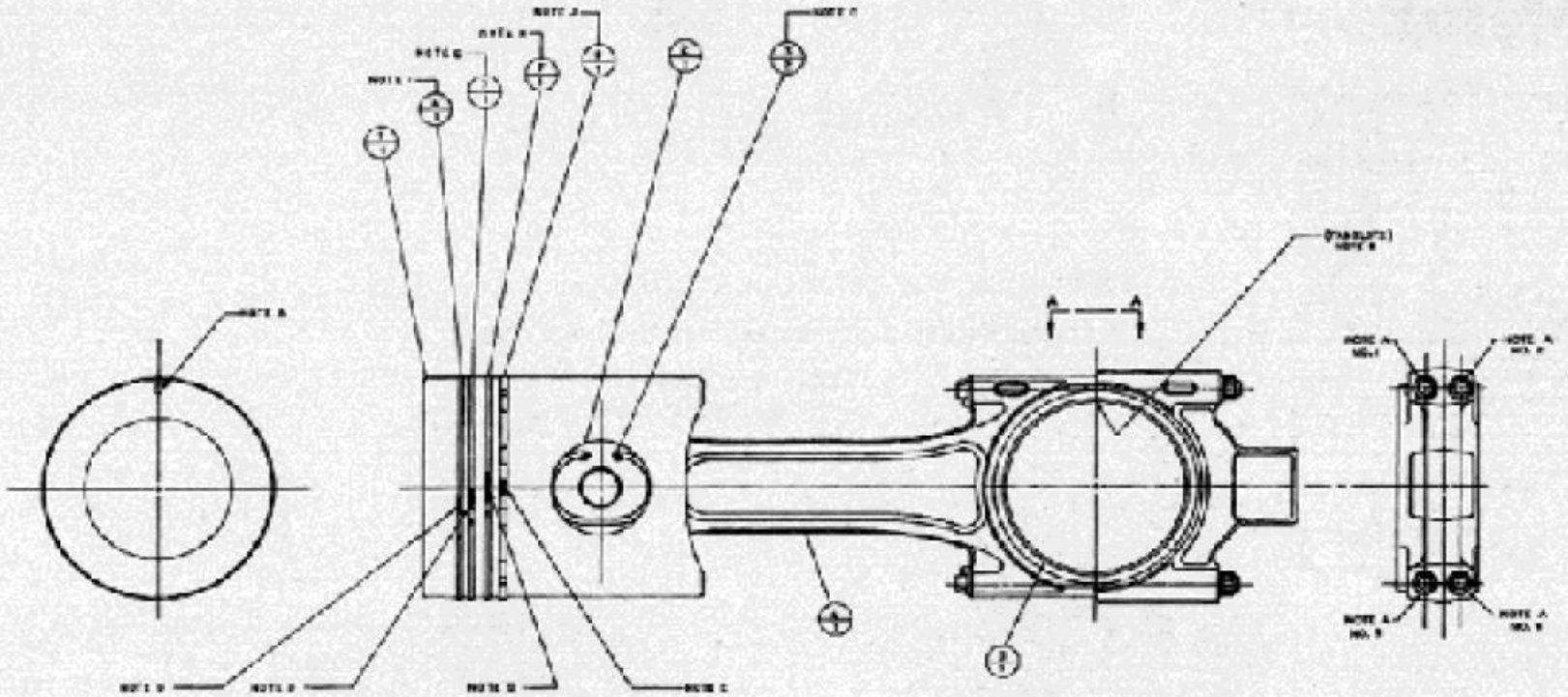



Problem Identification
Preliminary Ideas
Preliminary Design
IDEATION
REFINEMENT
Modeling
Geometric–
Simulation–
Animation–
Charts, Graphs, Diagrams–
Design Analysis
Property–
Mechanism–
Functional–
Human Factors–
Design Visualization


Problem Identification
Preliminary Ideas
Preliminary Design
IDEATION
Modeling
Design Analysis
Design Visualization
REFINEMENT
IMPLEMENTATION
Servicing
Financing
Marketing
Producing
Planning
Documenting
3-D Model

Technical Documentation

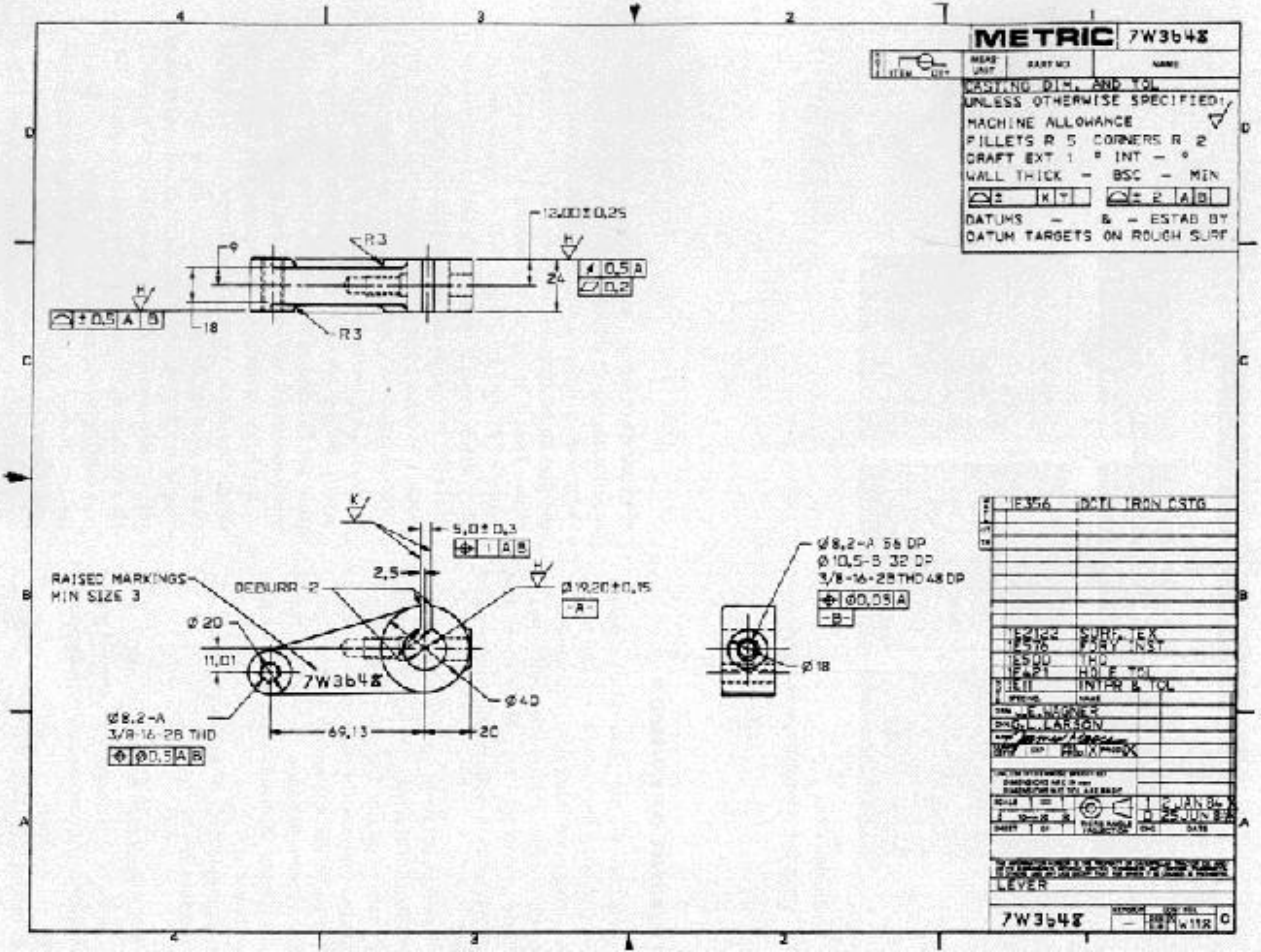
- Developed for a new product.
- Includes working drawings apart from calculations, technology details, assembly scheme, etc.
- Working drawings include:
  - Assembly working drawings
  - Component working drawings
- Component working drawings for the same part may look different for different processes.



VIEW A-A

CONNECTING ROD AND CAPS TO BE MARKED (BY STAMPING ONLY) WITH THE NUMBER OF THE CYLINDER IN WHICH THEY ARE USED. NUMBERS ARE TO BE ON THE SAME SIDE OF ROD AND CAPS AS BEARING TAB SLOTS.

CERTIFICATION


METRIC 7W3648
CASTING DIM. AND TOL
UNLESS OTHERWISE SPECIFIED:
MACHINE ALLOWANCE
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DRAFT EXT 1 ° INT — °
WALL THICK — BSC — MIN
DATUMS — & — ESTAB BY
DATUM TARGETS ON ROUGH SURF
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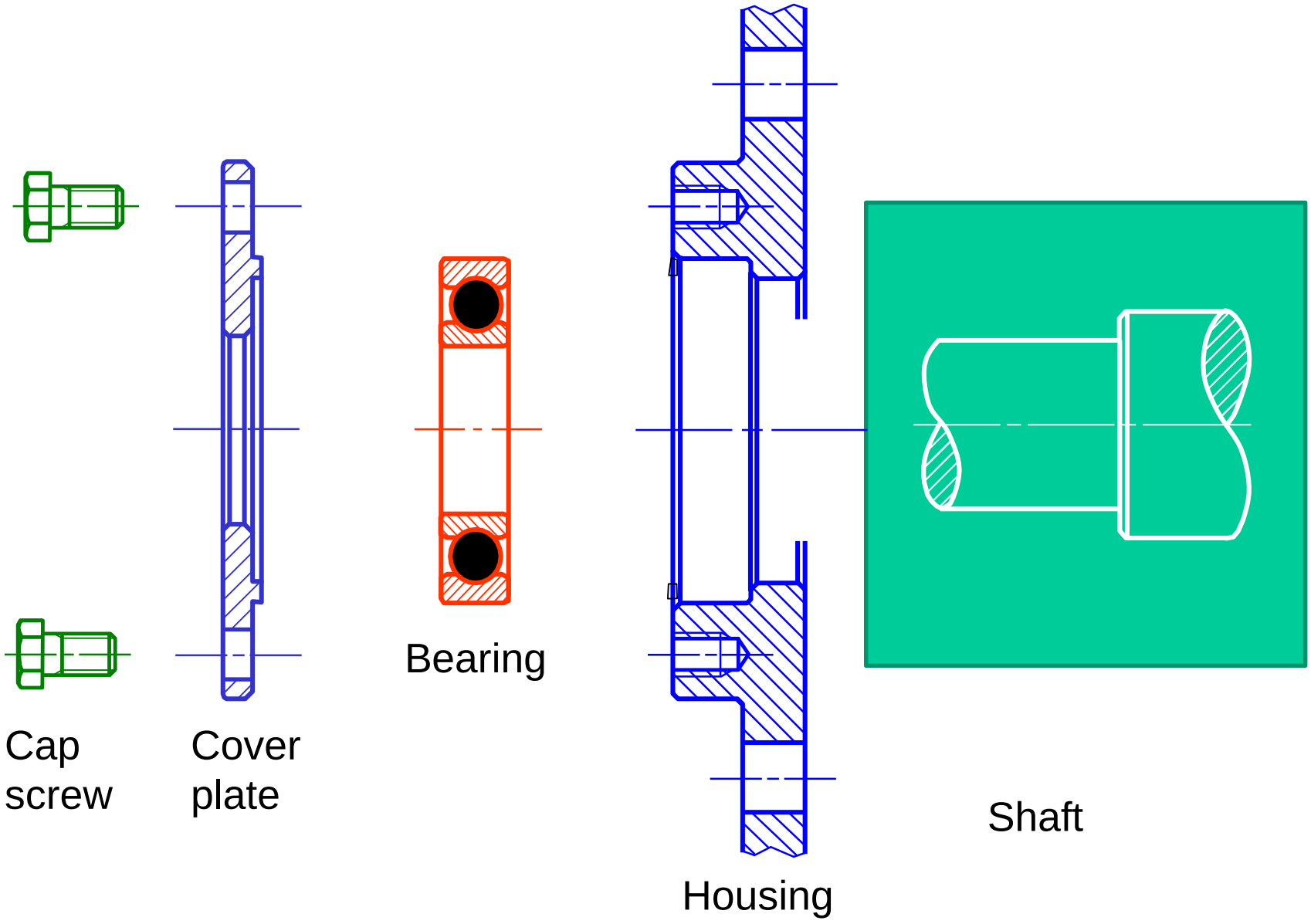
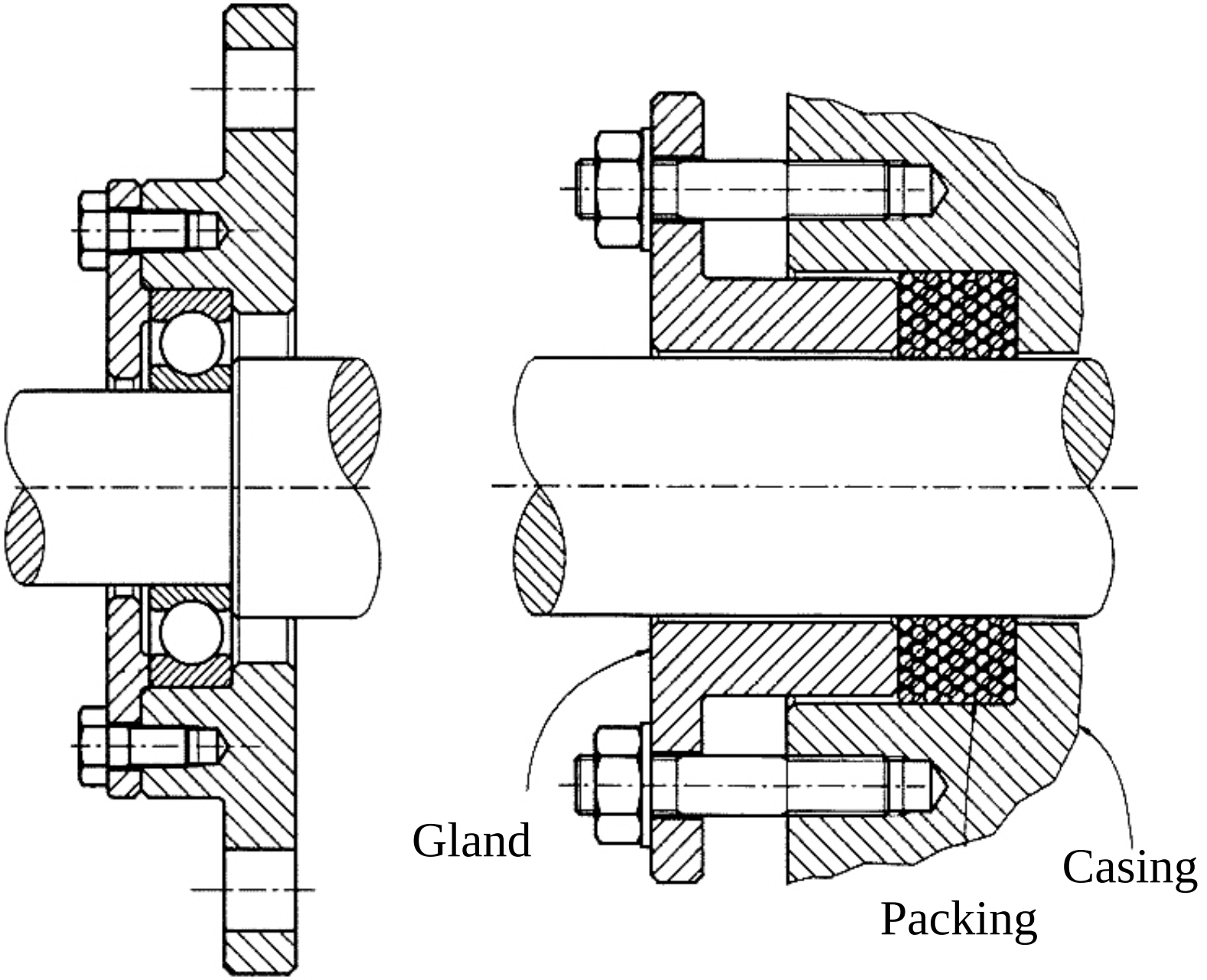
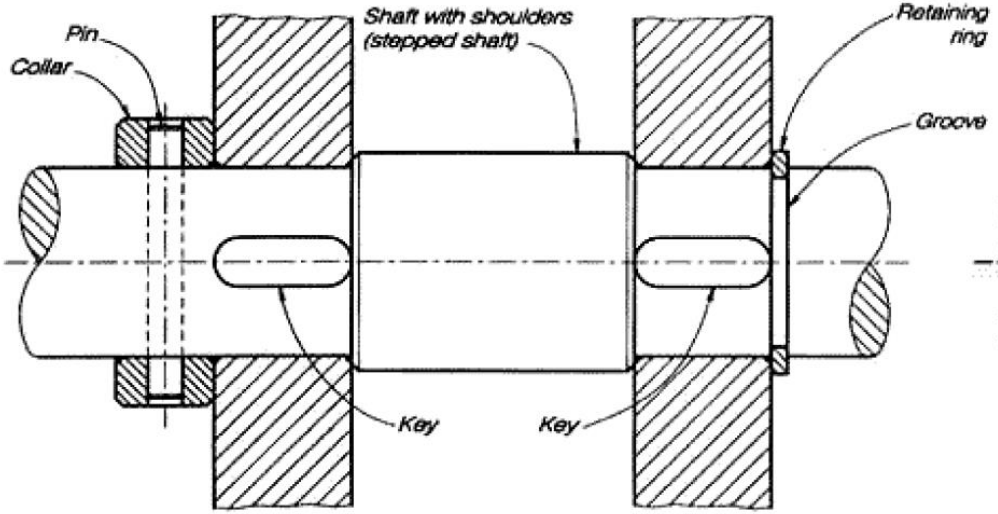
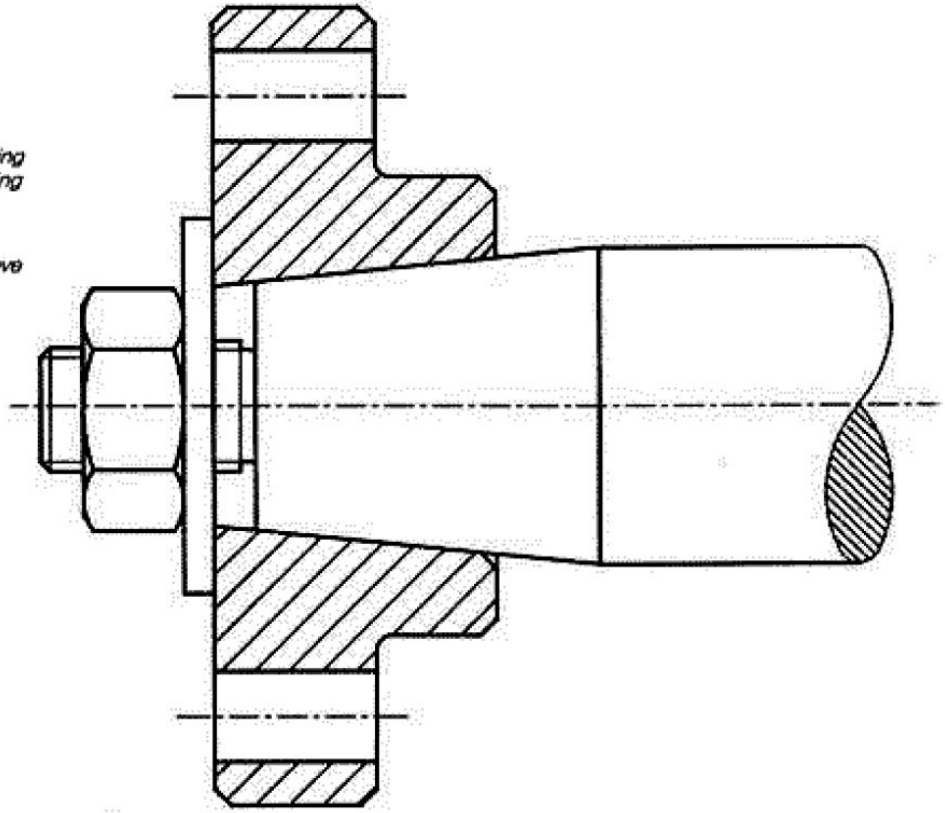
R3
24
18
0,5 A
0,2
± 0,5 A B
5,0 ± 0,3
1 A B
2,5
RAISED MARKINGS
MIN SIZE 3
DEBURR .2
Ø 19,20 ± 0,15
-A-
Ø 20
11,01
7W3648
Ø 40
Ø 8,2 -A
3/8-16-2B THD
Ø0,5 A B
69,13
20
Ø 8,2-A 56 DP
Ø 10,5-B 32 DP
3/8-16-2B THD 48 DP
Ø0,05 A
-B-
Ø 18
1E356 DCTL IRON CSTG
1E2122 SURF TEX
1E576 FDRY INST
1E500 THD
1E421 HOLE TOL
1E11 INTPR & TOL
E.WAGNER
G.L.LARSON
LEVER
7W3648

Example



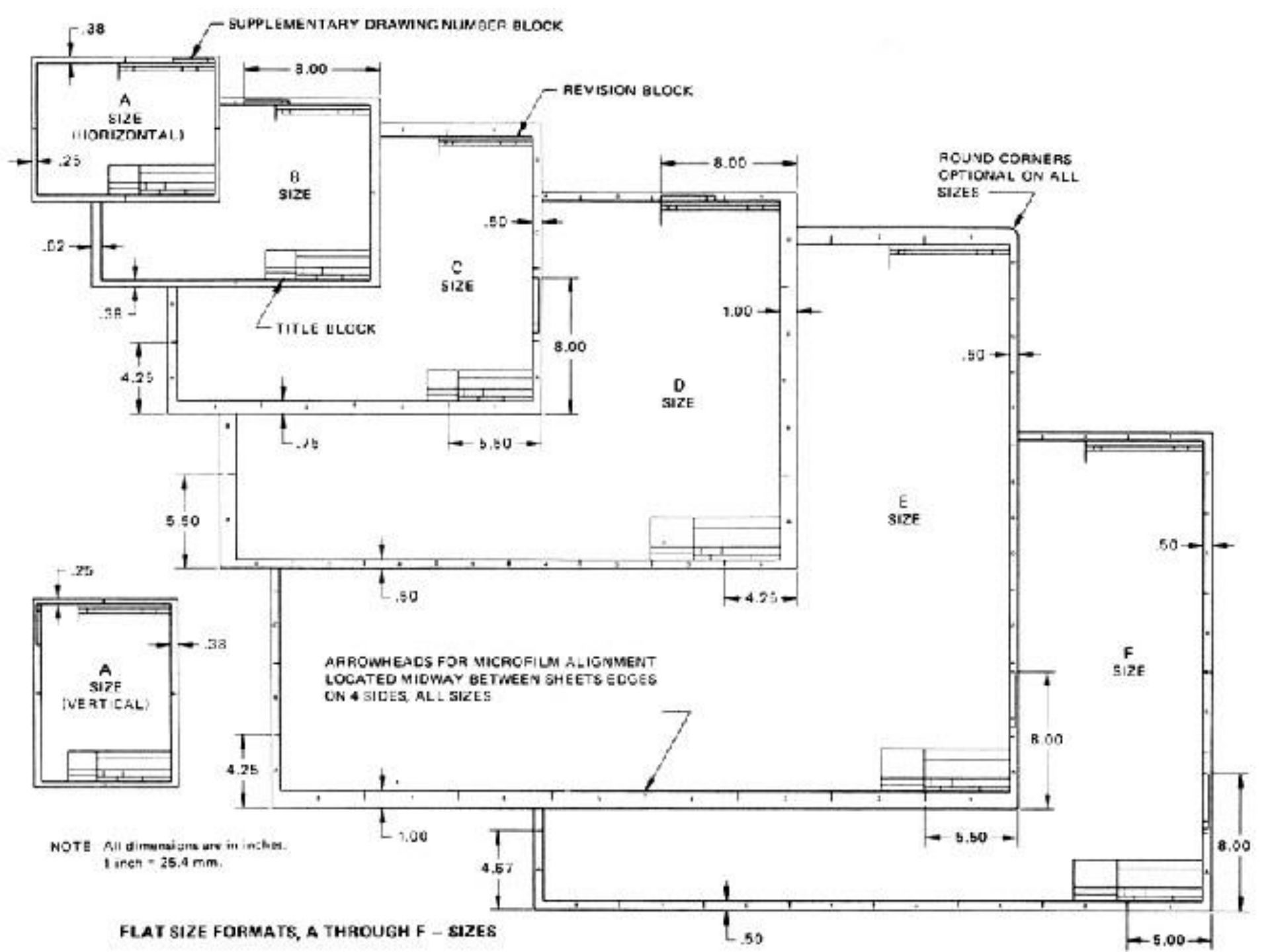

Gland
Casing
Packing


Pin
Collar
Shaft with shoulders
(stepped shaft)
Retaining
ring
Groove
Key
Key



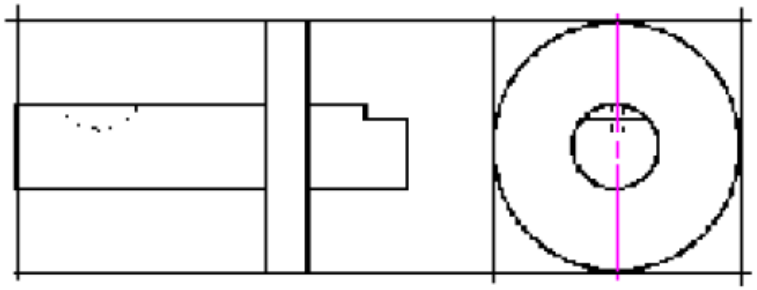
Drawing Form

- A drawing must follow a certain format.
- The scale should be selected to make sure that the component would fit the format.
- A preliminary evaluation should be performed before the drawing is completed.
- Take into consideration the space for dimensions.

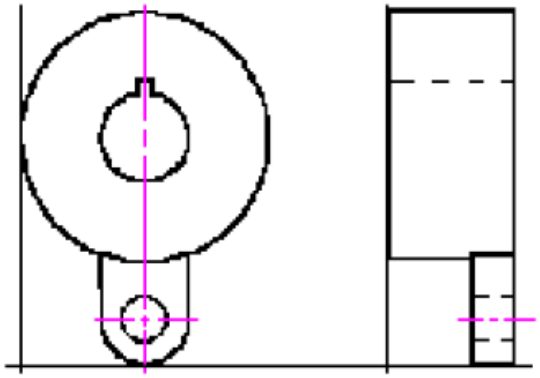


FLAT SIZE FORMATS, A THROUGH F – SIZES

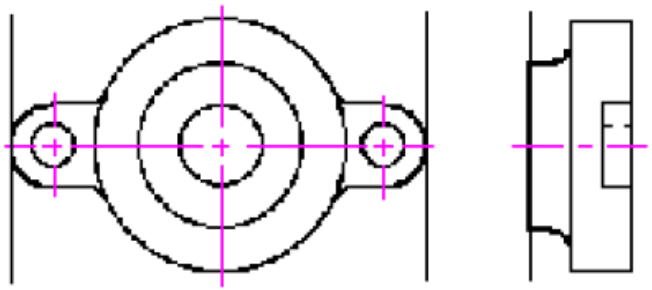
BILL OF MATERIALS			
ITEM	QUAN.	DRAWING NO OR PART NAME	DESCRIPTION



1. PIN DOWEL



2. SLINGER

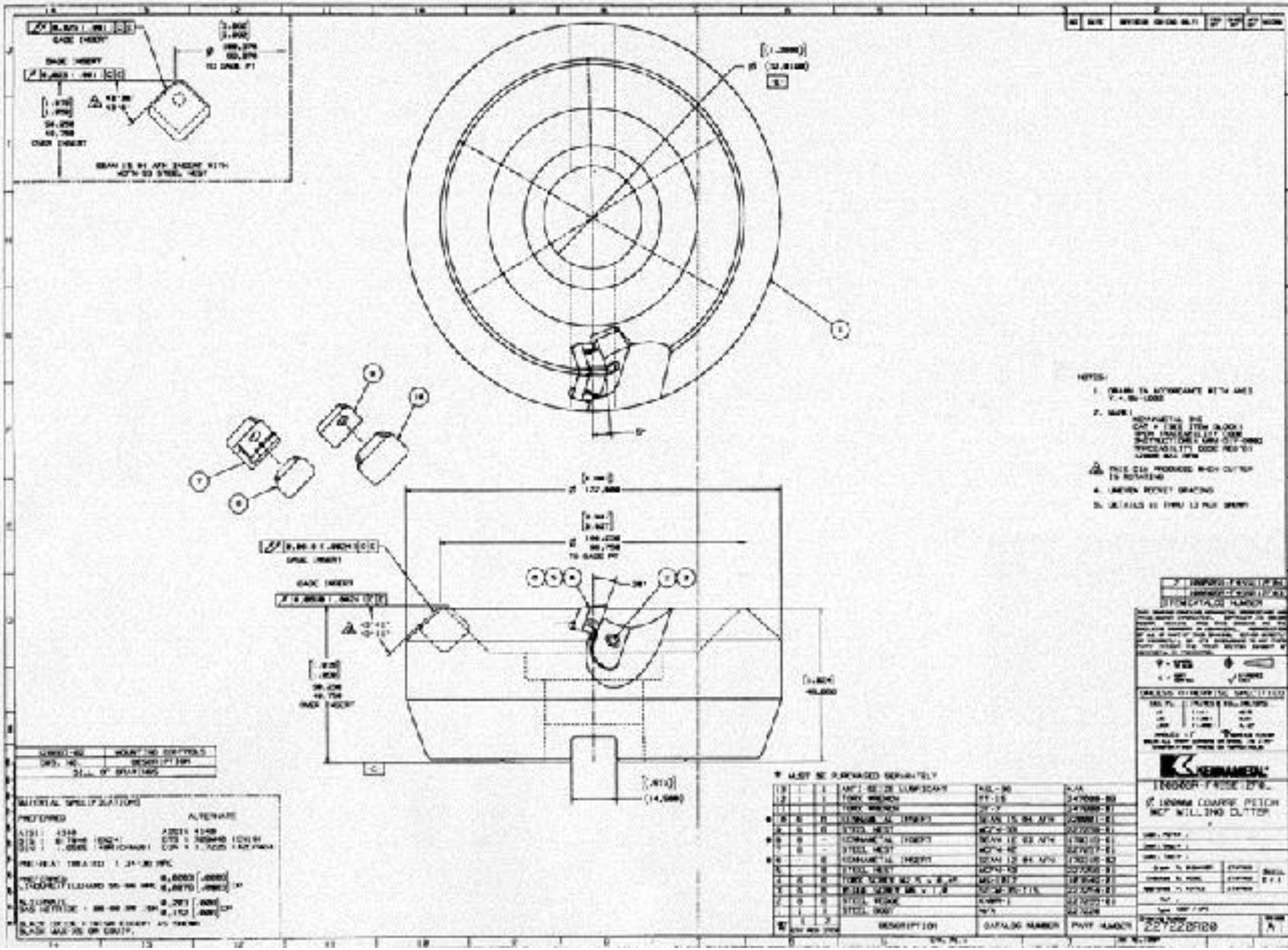


3. BRACKET

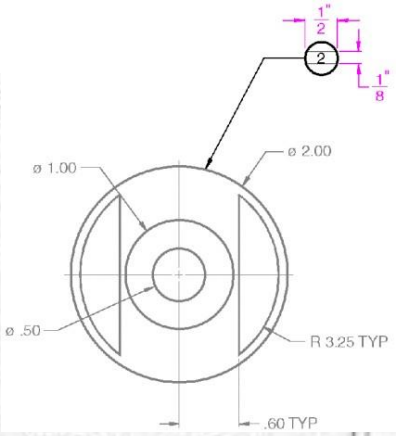
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: FRACTIONS = ± .XX DECIMALS = .X .XXX DECIMALS = .X ANGLES: = .XX METRIC = ± .XXX METRIC = ±	MATERIAL	FINISH	Ion Stiharu
WEIGHT	NAME	DATE	TITLE
DRAWN BY	Kevin		SLINGER ASSEMBLY
CHECKED BY	Bryan		
APPROVED BY	Carolyn		REFERENCE DRAWING
SCALE		C	DRAWING NUMBER

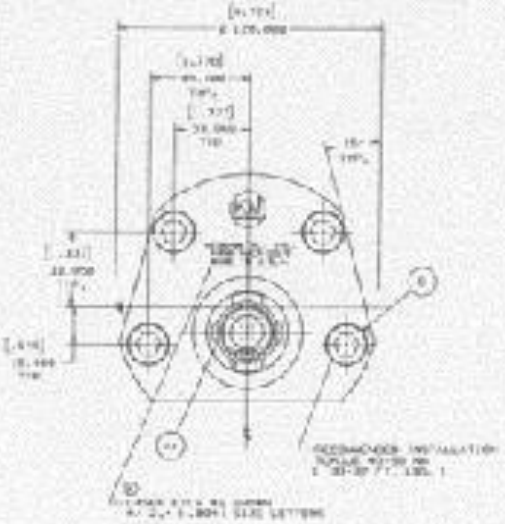
Assembly Drawings

- Assembly drawings shows how each component is positioned with respect to other components.
- Each component should be identified and listed in a parts list.
- **Outline assembly** – gives the general graphic description of the shape.
- **Sectioned assembly** – shows the hidden features and their interdependence.
- **Pictorial assembly** – usually isometric, indicates how the parts, shown separated, are assembled.

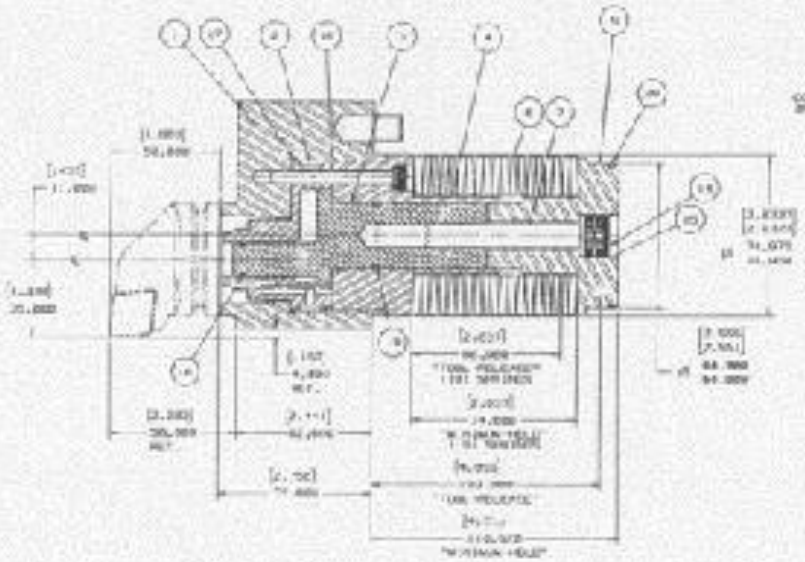


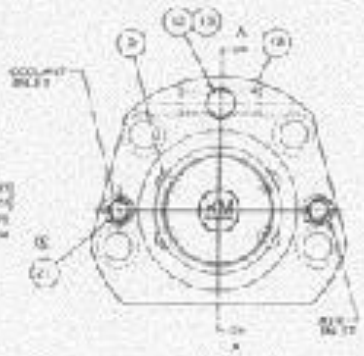
MUST BE PURCHASED SEPARATELY
DESCRIPTION
CATALOG NUMBER
PART NUMBER
KENNAMETAL
COARSE PITCH
MILLING CUTTER
MATERIAL SPECIFICATIONS
PREFERRED
ALTERNATE
NOTES:





SECTION A - A





MAX WORK RELEASE FORCE
= 130,000N (29.4 4,000 LBS.)

TOTAL STROKE = 7.62 (.300)

ITEM	QTY	DESCRIPTION	CATALOG NUMBER	PART NUMBER
1	2	O-RING		
2	1	O-RING		
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4	1	O-RING		
5	1	O-RING		
6	1	O-RING		
7	1	O-RING		
8	1	RETAINING RING		
9	1	HOUSING		
10	1	LINEAR BALL BUSHING		
11	1	LINEAR BALL BUSHING		
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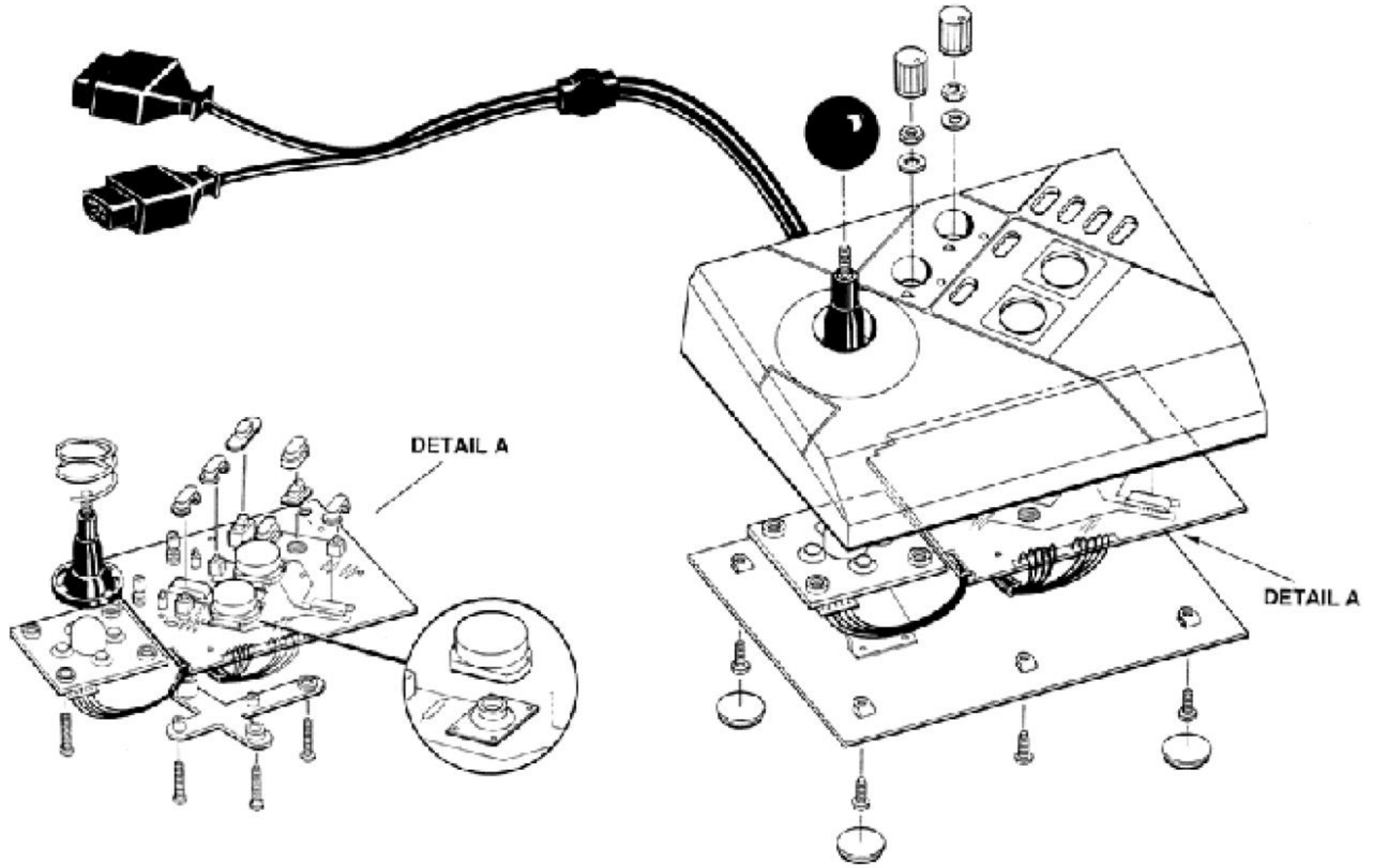
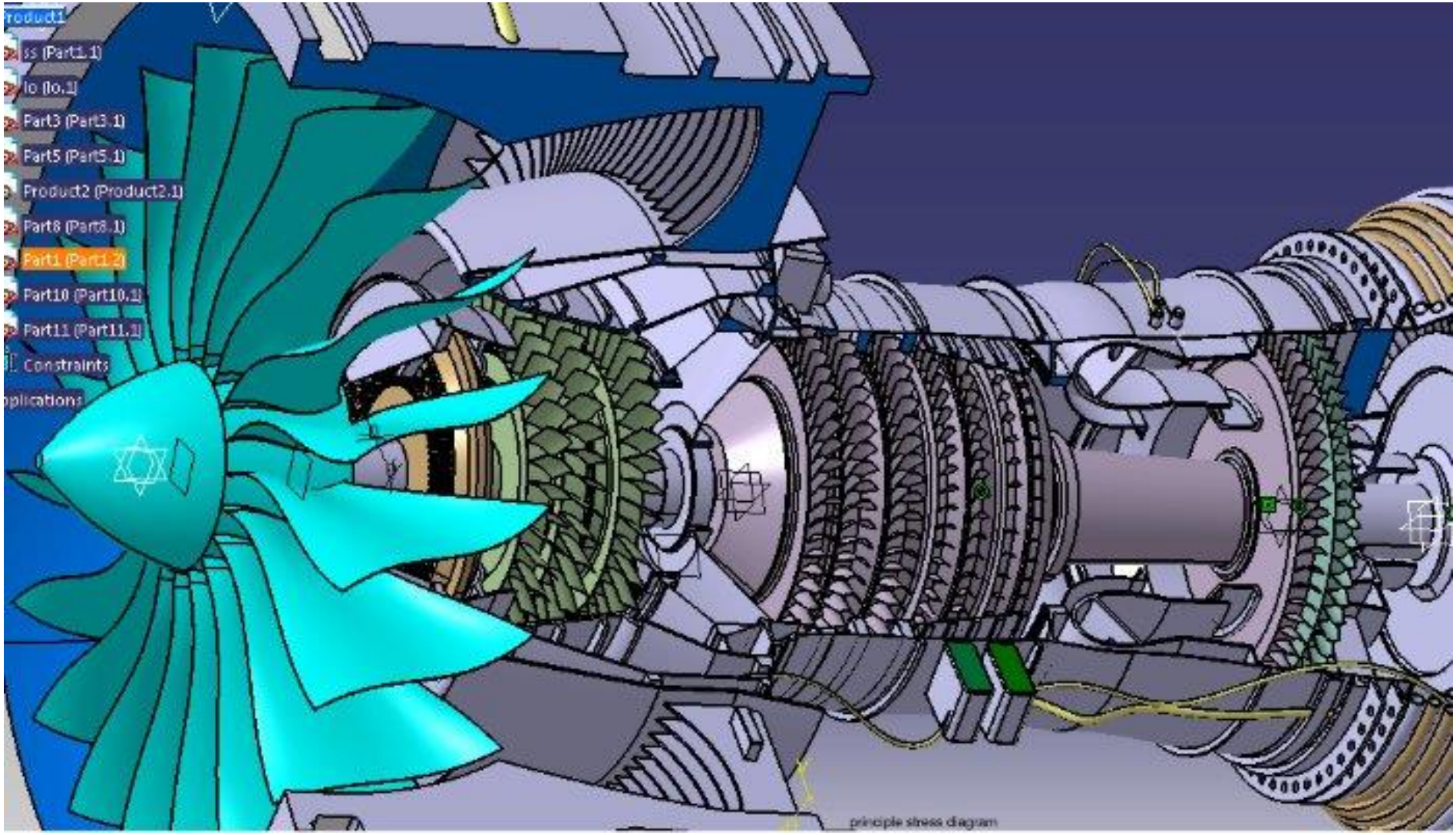
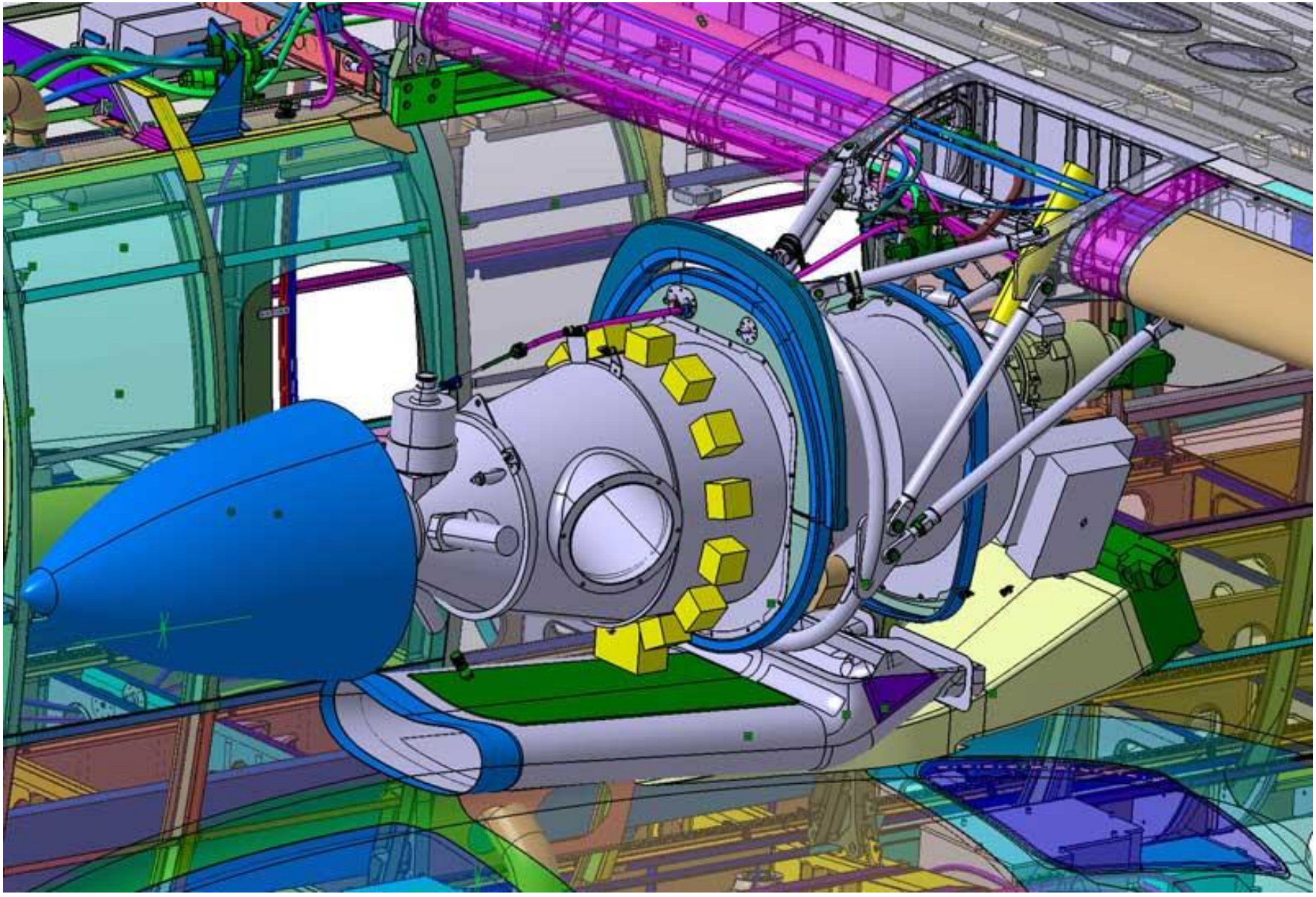

DETAIL A
DETAIL A

3D Models


Product1
ss (Part1.1)
lo (lo.1)
Part3 (Part3.1)
Part5 (Part5.1)
Product2 (Product2.1)
Part8 (Part8.1)
Part1 (Part1.2)
Part10 (Part10.1)
Part11 (Part11.1)
Constraints
principle stress diagram

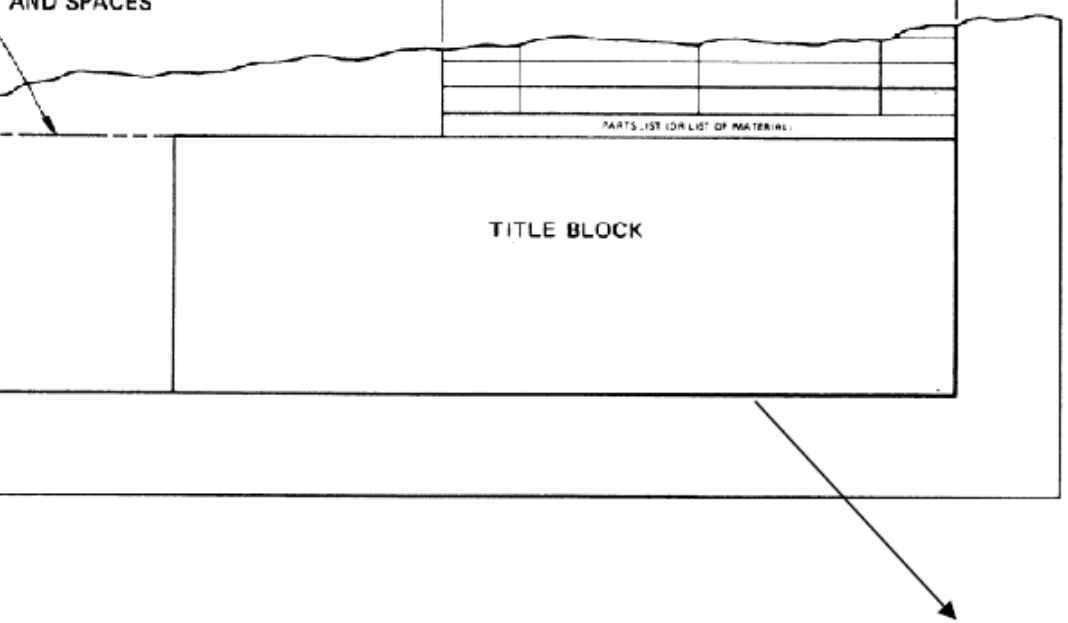
3D Models

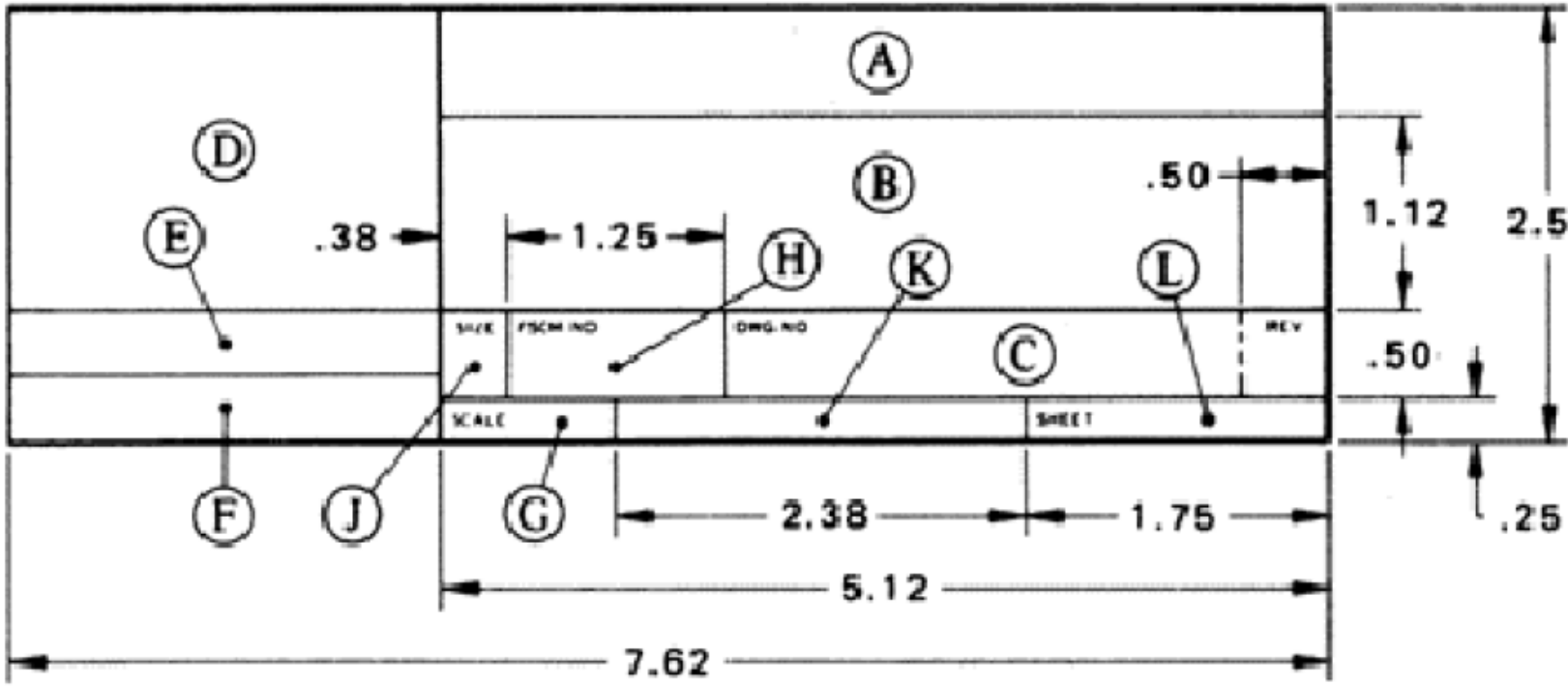


Title Blocks and Drawing Numbers

Are used to record important information and keep track of parts:

a) Name and address of the company
b) Title of the drawing
c) Drawing number
d) Dated names of the designers
e) Design approval
f) Additional approval
g) Predominant drawing scale
h) Supply code for manufacturers
i) Drawing sheet side letter designation
j) Actual or estimated item weight



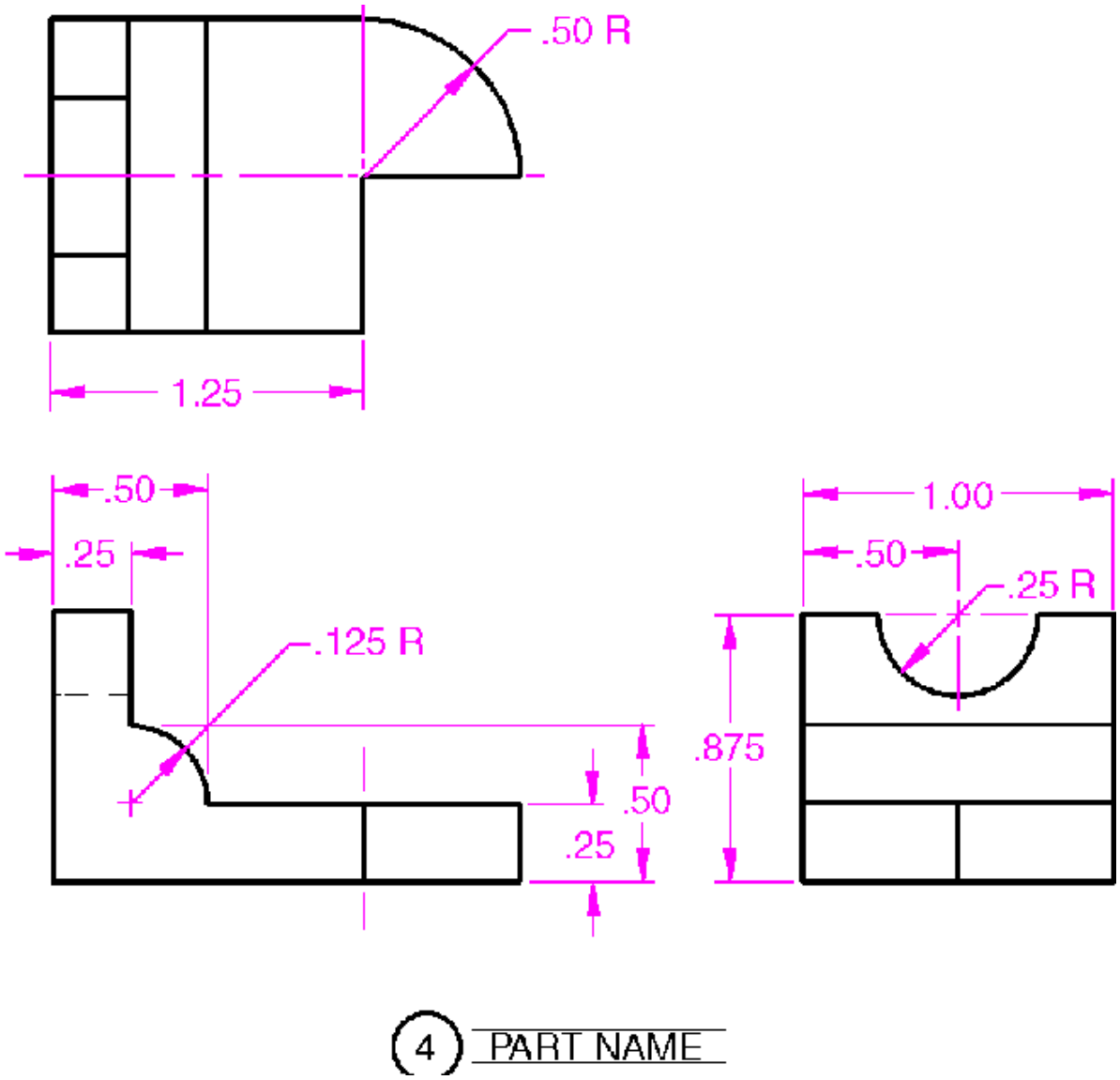


NOTE: All dimensions are in inches. 1 inch = 25.4 mm.

TITLE BLOCK FOR D, E, F, H, J AND K – SIZES

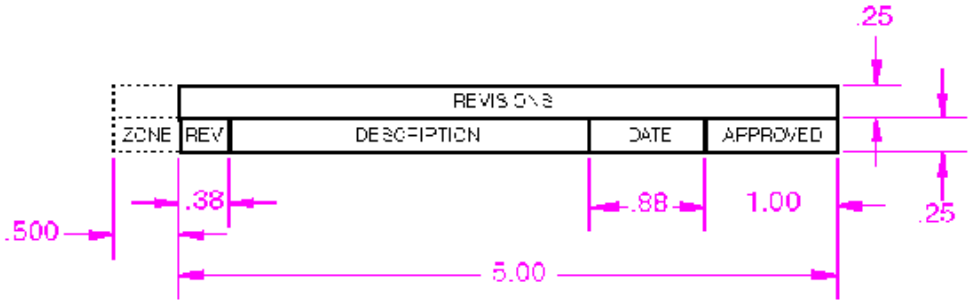
Detail Drawings

In a detailed drawing of an assembly, the part name and the detail number are located within the drawing area.

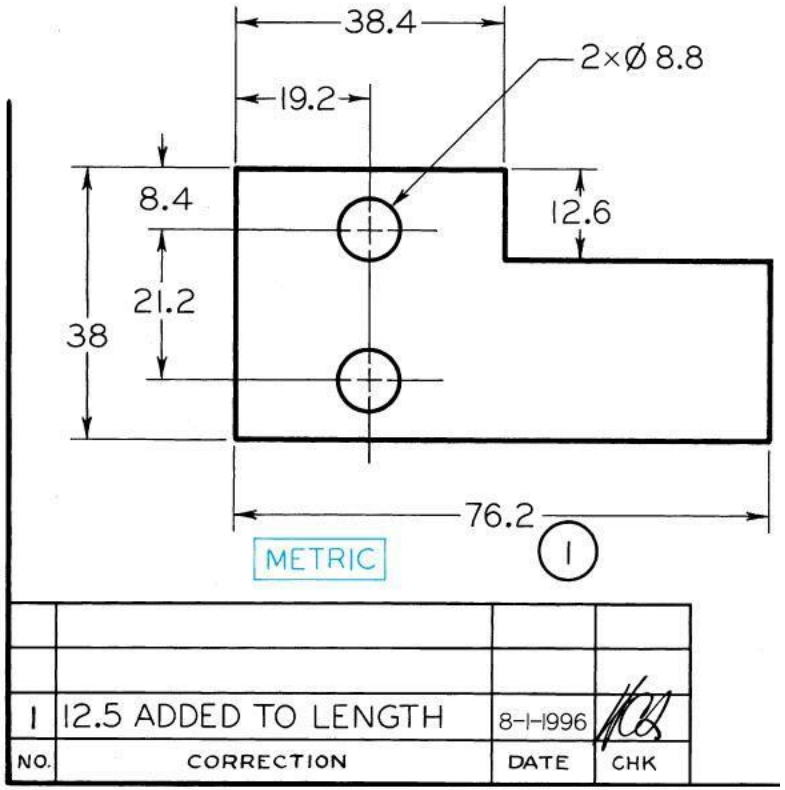


Modifications and Revisions

- Revisions are required due to changes in design. So to keep track of all the modification, revisions need to be numbered and maintained
- The track of modifications is kept on the drawing (some new approaches are applied on CAD).
- If changes are considerable, new drawing is made with OBSOLETE stamped on old

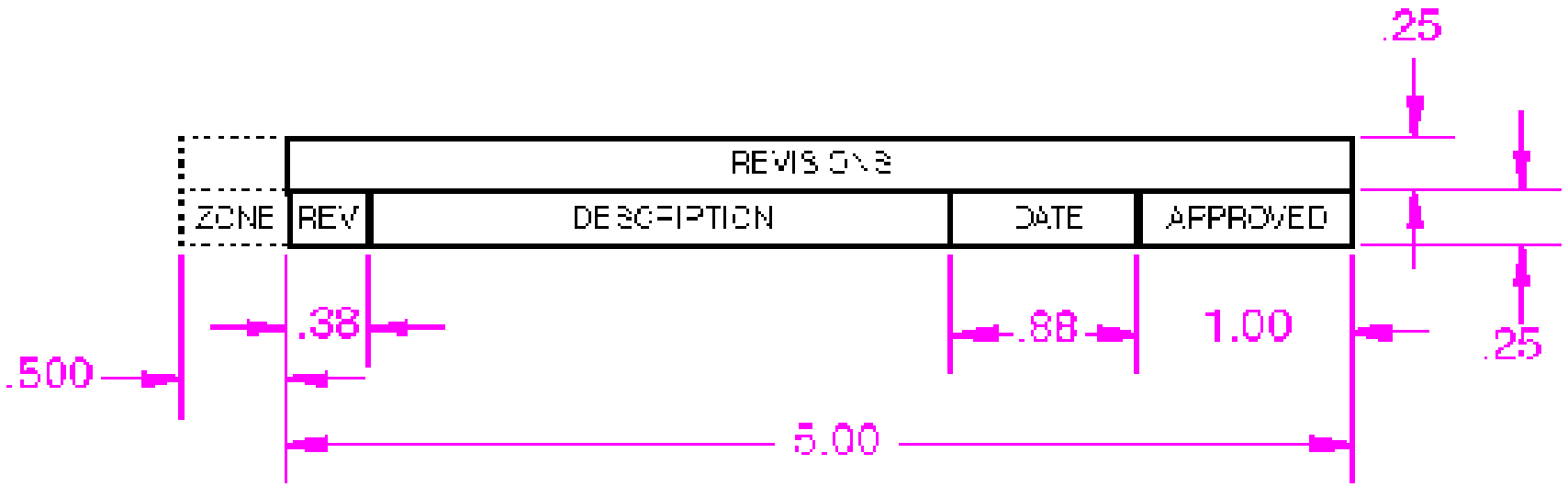


Revision block for A, B, C, and G - sizes



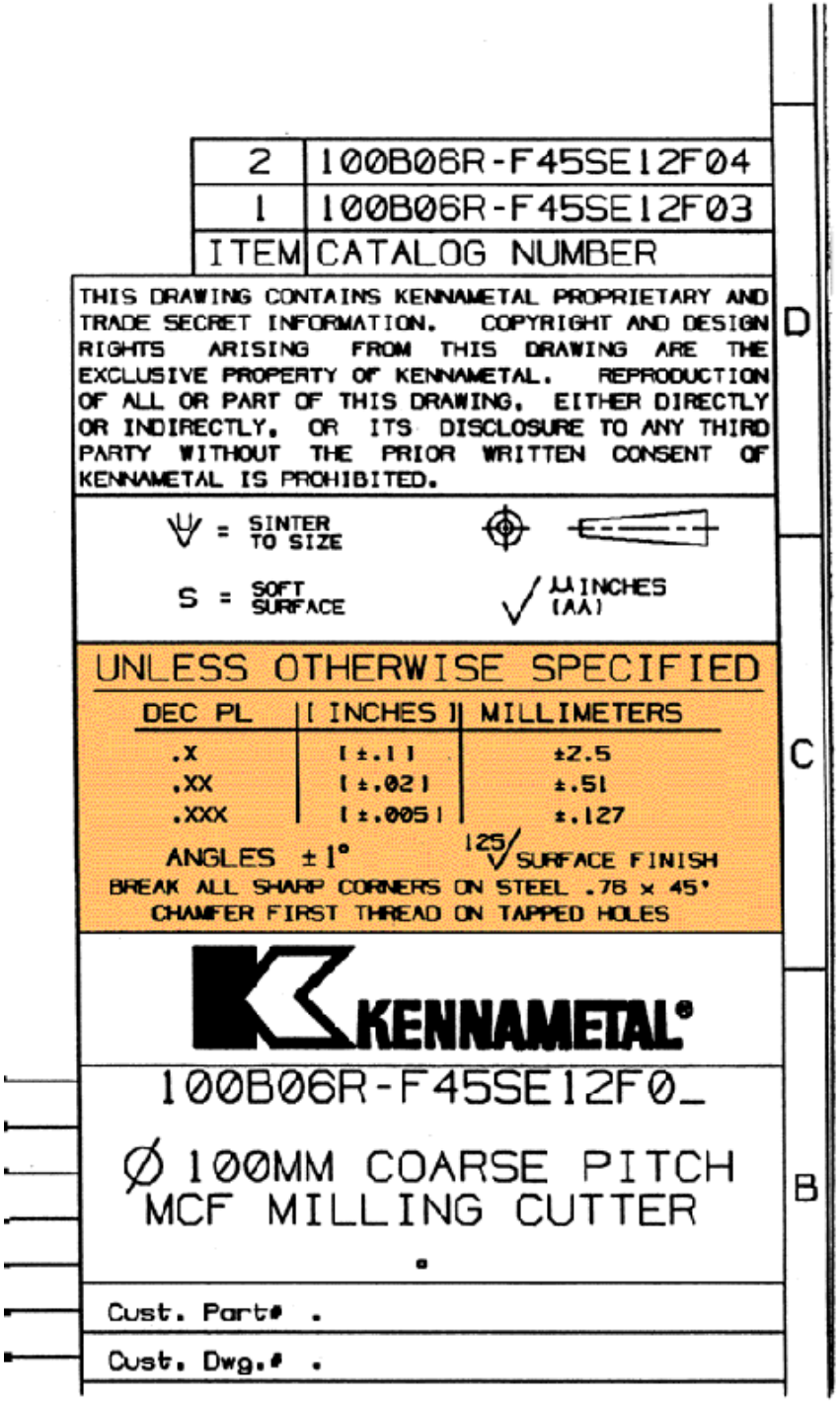
Modifications and Revisions

The revision number, a serial number for modifications, is kept on the drawing (some new approaches are applied on CAD).

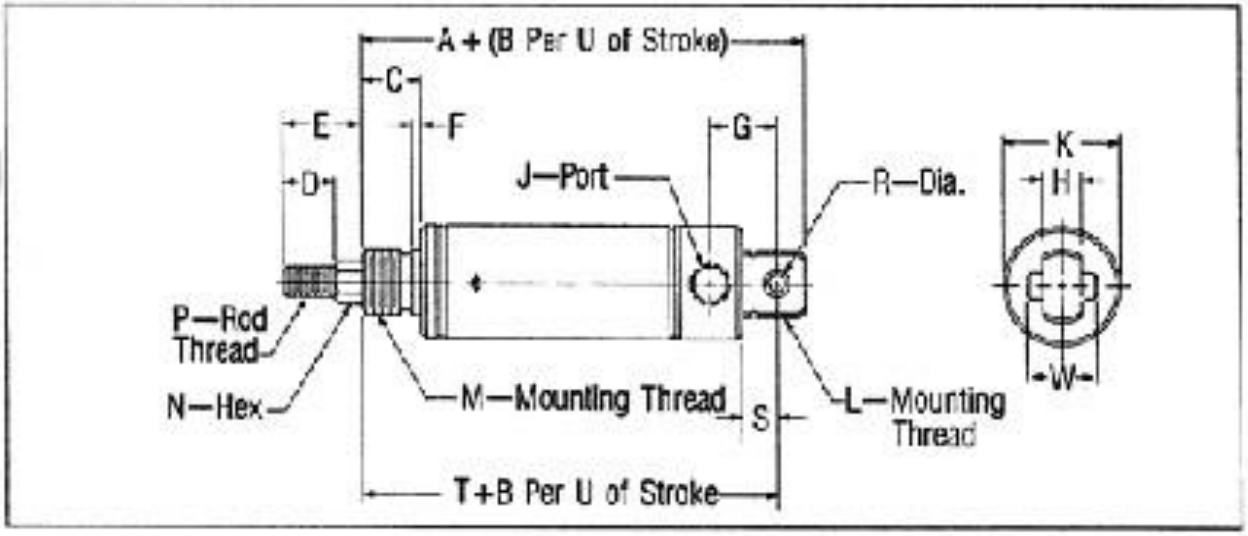


Revision block for A, B, C, and G - sizes

General Tolerance Notes

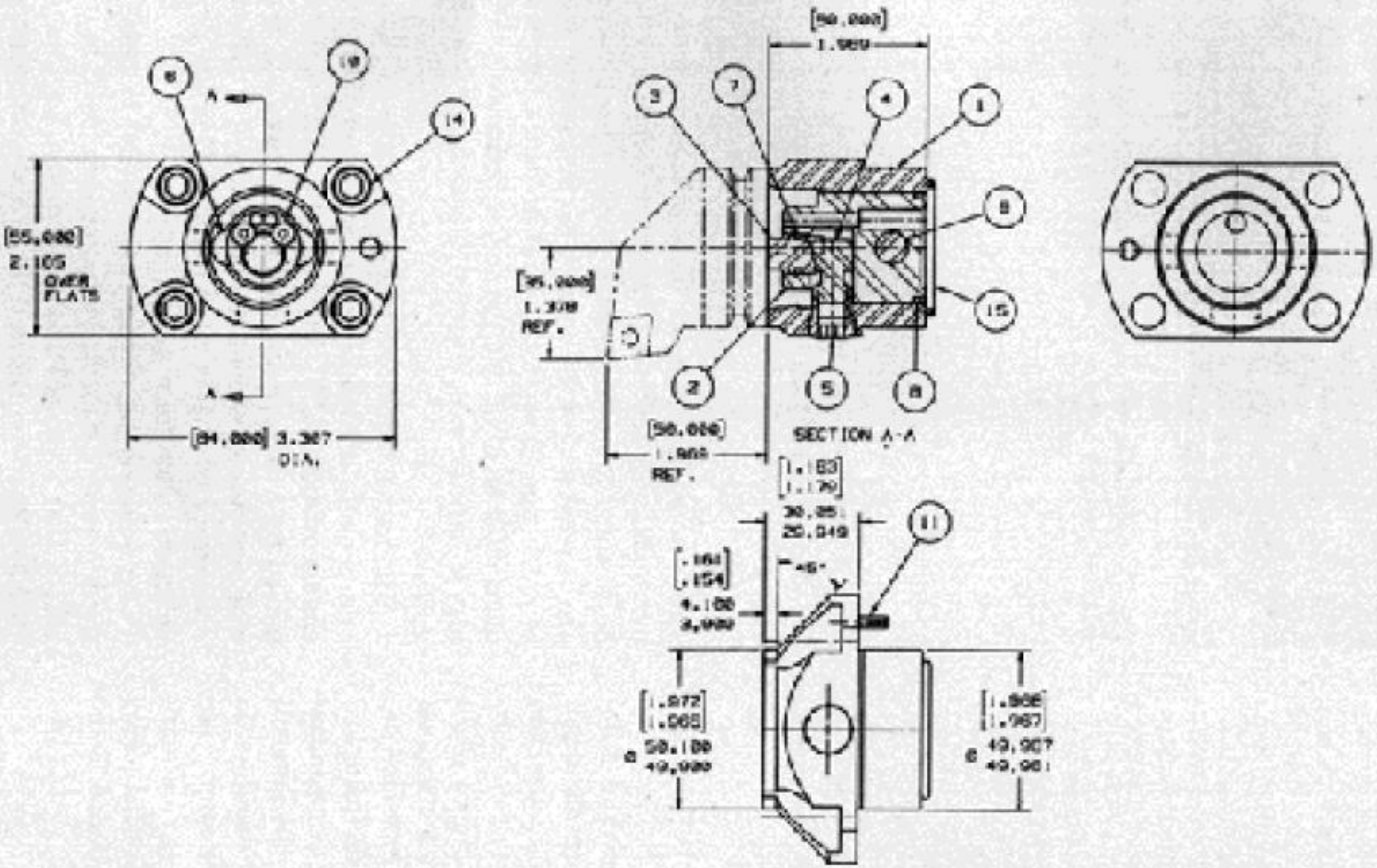


Tabular Drawing (Catalog)



	Dimension																		Mounting Accessories		
Bore	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	W	Pivot Bkt.	Rod Clevis	Foot Bkt.
7/16"	2.00	.93	.31	.50	.75	.05	.43	.31	10-32	.74	7/16-20	3/8-24	3/16	10-32	.15	.25	1.75	0.50	.50	M13S	M14S	M11SS
9/16"	2.00	1.62	.37	.50	.75	.05	.43	.31	10-32	.62	7/16-20	7/16-20	3/16	10-32	.15	.25	1.81	1.00	.50	M13S	M14S	M11SD
3/4"	2.56	1.68	.43	.50	.75	.05	.62	.37	1/8NPT	.86	5/8-18	1/2-20	1/4	1/4-28	.25	.34	2.25	1.00	.75	M23S	M24S	M21SS
1 1/16"	2.81	1.55	.50	.50	.75	.06	.62	.37	1/8NPT	1.12	5/8-18	5/8-18	3/8	5/16-24	.25	.34	2.53	1.00	.75	M23S	M24	M21
1 1/4"	3.53	1.81	.62	.87	1.12	.09	.71	.50	1/8NPT	1.34	3/4-16	3/4-16	7/16	7/16-20	.25	.40	3.12	1.00	.87	M23S	M64S	M61S
1 1/2"	3.25	1.66	.62	.87	1.25	.09	.81	.62	1/8NPT	1.56	(—*)	3/4-16	7/16	7/16-20	.37	.50	2.87	1.00	1.00	M63S	M64S	M61S

*Unthreaded; see Standard Option Section for threaded rear stud mounting.
Note: Spring Forces same as for Model SNHS.



16	1	PROTECTIVE PLUG	KM50PP	253017-01
15	1	O-RING	OR0140710370Y75	262245-27
14	4	LOW HD.SOC.HD. CAP SCREW	MS-1301	249745-10
13	1	OPERATING INSTRUCTIONS	PUB.NO. A88-35	N/A
12	1	WRENCH (WALD PRODUCTS)	KM75210	N/A
11	1	DIAMOND PIN (CARR LANE)	CL-2-DPY MOD.	221123-01
12	2	SOCKET HEAD CAP SCREW	MS-1302	277014-03
9	1	DOWEL PIN	MS-1348	220424-01
8	1	O-RING	OR0130810370Y75	202245-27
7	1	O RING	OR0023640370Y75	202245-12
6	2	CHROME ALLOY STEEL BALL	LSB120025	252049-23
5	1	KM50 TORQUE SCREW	KM50TS3L	249105-01
4	1	KM50 LOCKROD	KM50LR2	248715-01
3	1	KM50 BUMP-OFF PIN	KM50BOP2	248183-01
2	1	KM50 BALL CANISTER	N/A	288752-01
1	1	KM50 STEEL SLEEVE	N/A	221000-01
DET NO	QTY	DESCRIPTION	CATALOG NUMBER	PART NUMBER

U.S. PATENT NOS.: 4,723,0
4,736,698; 4,747,735 4
FOREIGN PATENTS PENDING

UNLESS OTHERWISE SPECIFIED

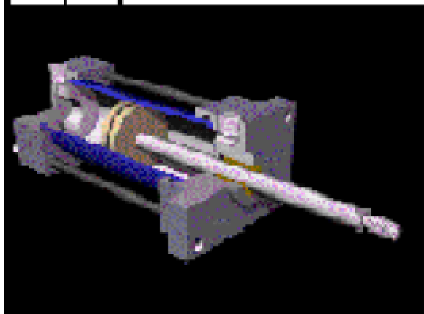
KENNAMETAL

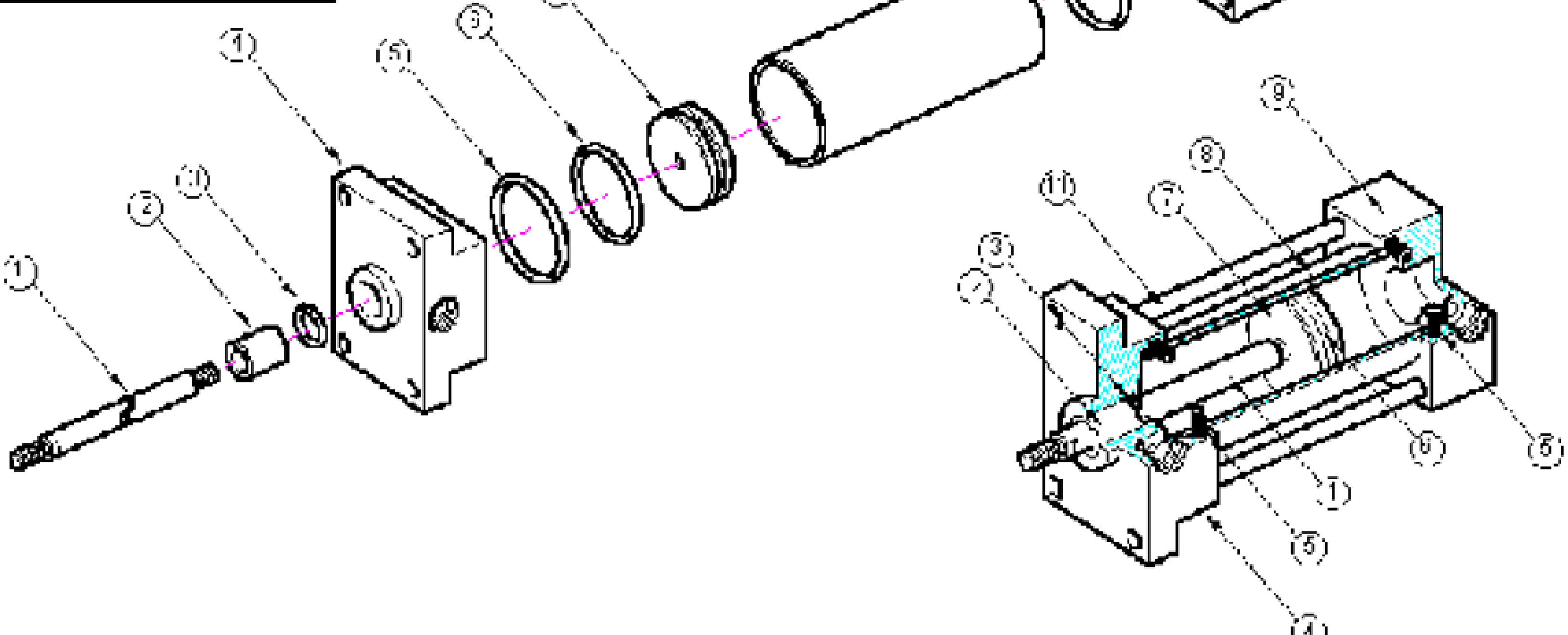
KM50-NCM-TF
CLAMPING UNIT

ASSEMBLY

221807H06

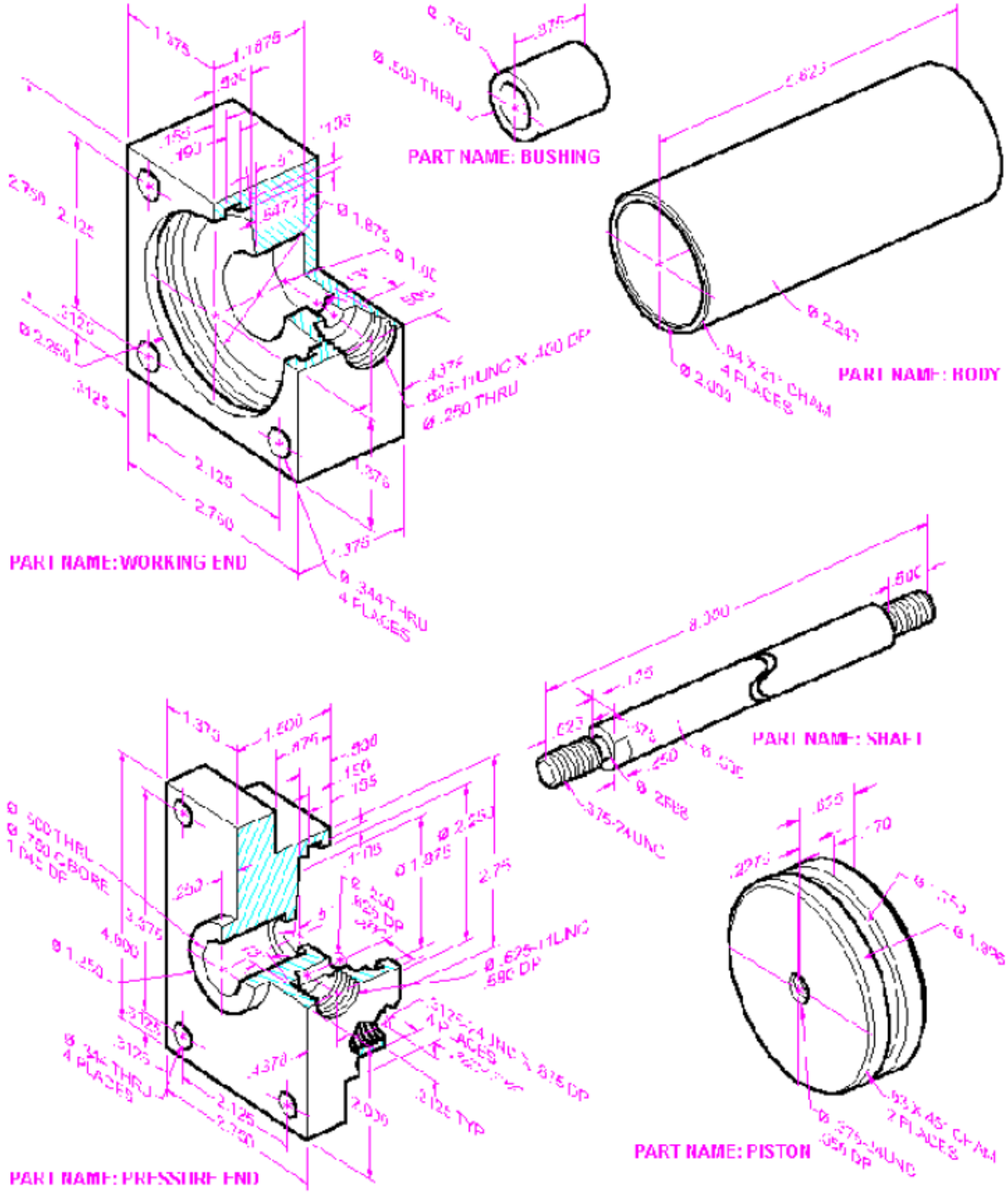
ITEM	QTY	NAME	DESCRIPTION
1	1	SHAFT	STEEL
2	2	BUSHING	BRONZE
3	2	O-RING	RUBBER
4	1	PRESSURE END	STEEL
5	1	O-RING (LARGE)	RUBBER
6	1	O-RING (PISTON)	RUBBER
7	1	PISTON	RUBBER
8	4	BODY	STEEL
9	8	WORKING END	STEEL
10	2	FLAT WASHER	.375 X .875 [illegible]
11	1	HEX HEAD BOLT	.3125-24UNC X [illegible]

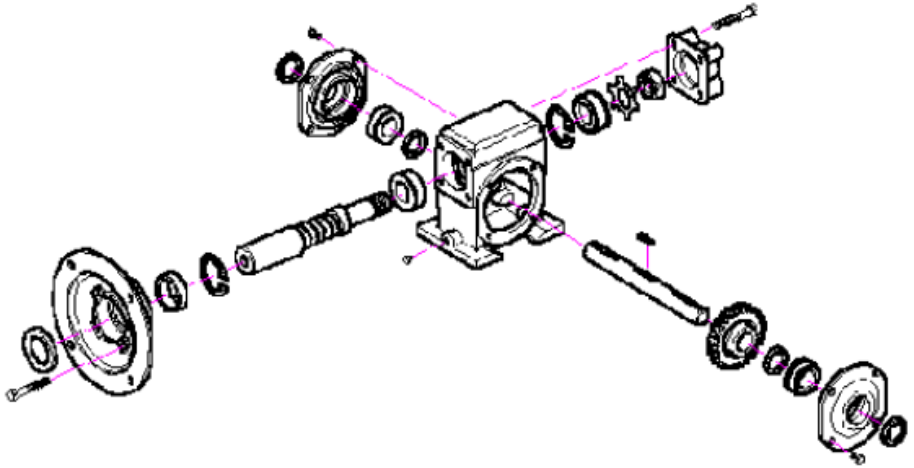




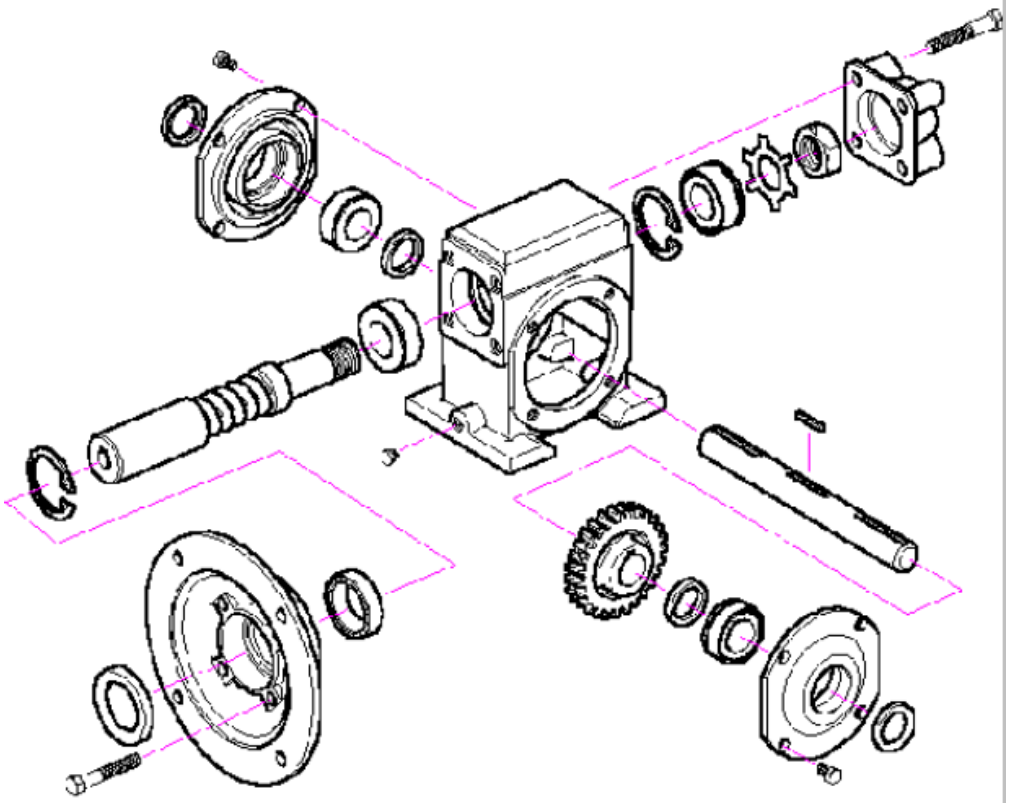
ASSEMBLED SECTION

DUAL-ACTING AIR CYLINDERS

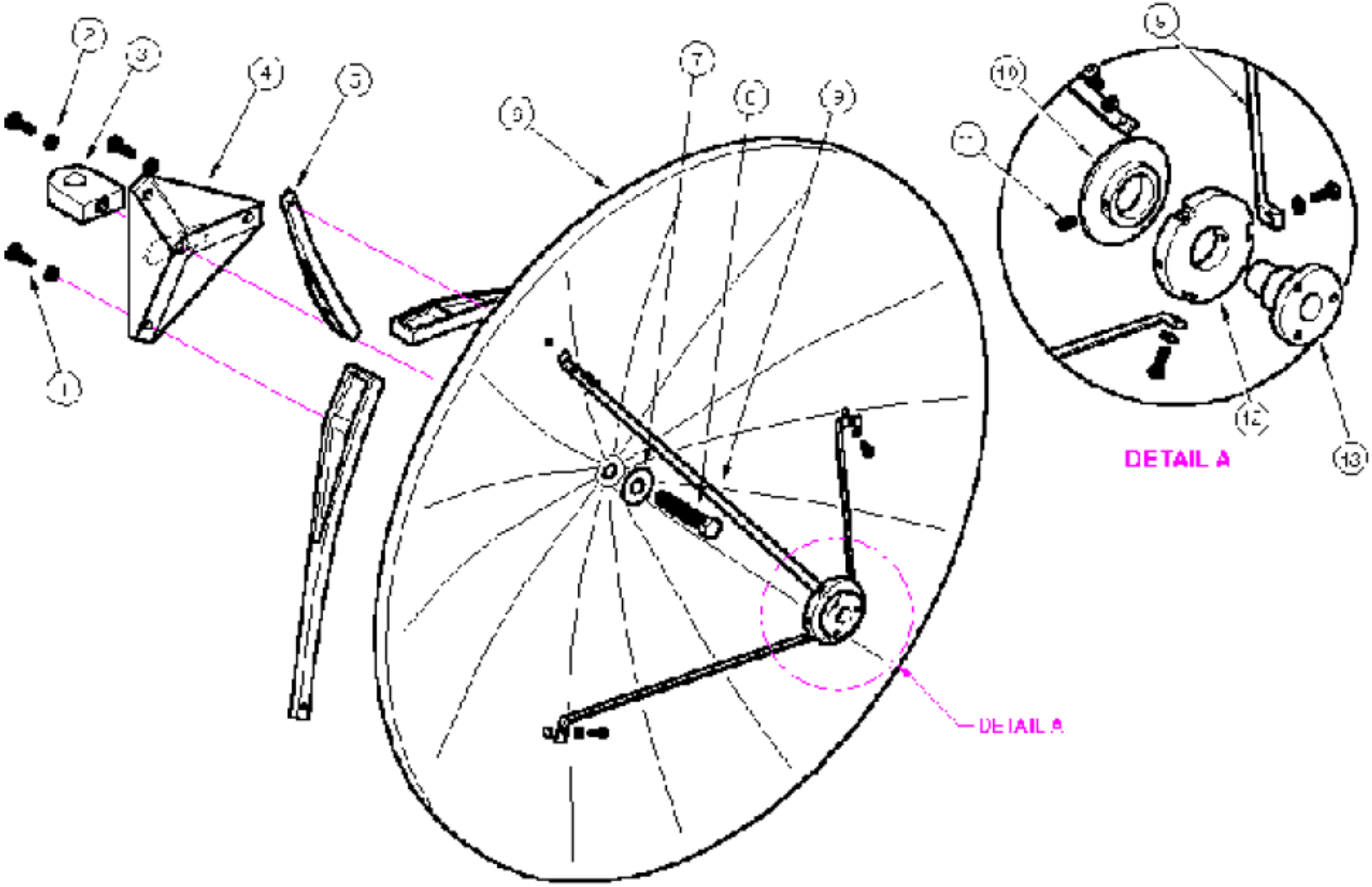

PART NAME: BUSHING
PART NAME: BODY
PART NAME: WORKING END
PART NAME: SHAFT
PART NAME: PRESSURE END
PART NAME: PISTON



(A) 'In-line' pump orientation



(B) Case of flow lines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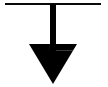
DETAIL A
DETAIL A

How to Simplify the Design Process

1. Use text descriptions whenever possible to eliminate drawing entirely.
2. Use text descriptions whenever practical to eliminate projected views.
3. Eliminate views where the shape can be given by description e.g. HEX, SQ, DIA, 
4. Show partial views of symmetrical objects.
5. Avoid elaborate, pictorial or repetitive detail.

How to Simplify the Design Process

6. When it is necessary to show thread detail, do not show them over the entire length of the bolt.
7. Eliminate detail for nuts, bolt heads, and other standard parts. Show outlines to show position only.
8. Reduce part detailing on assembly drawing.
9. Avoid unnecessary hidden lines that add no clarification.
10. Use sectioning only when it is necessary for the clarity of the drawing.

How to Simplify the Design Process

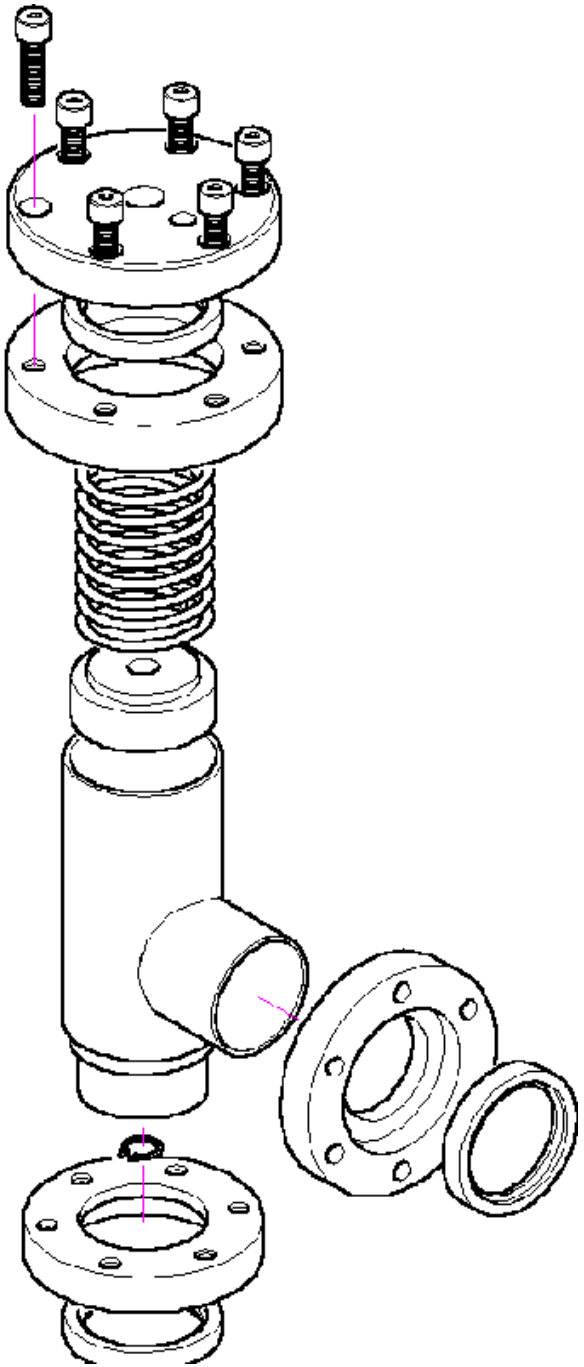
11. Simplify graphics for holes and tapped holes with the use of symbols.
12. Omit views with no dimensional or written instructions.
13. Kept within limits: a small drawing is usually easier and quicker to make than a large one.
14. When two parts are slightly different, a complete graphical representation of both parts is not required. The note: SAME AS EXCEPT …….. Or OTHERWISE SAME AS …. may be written.

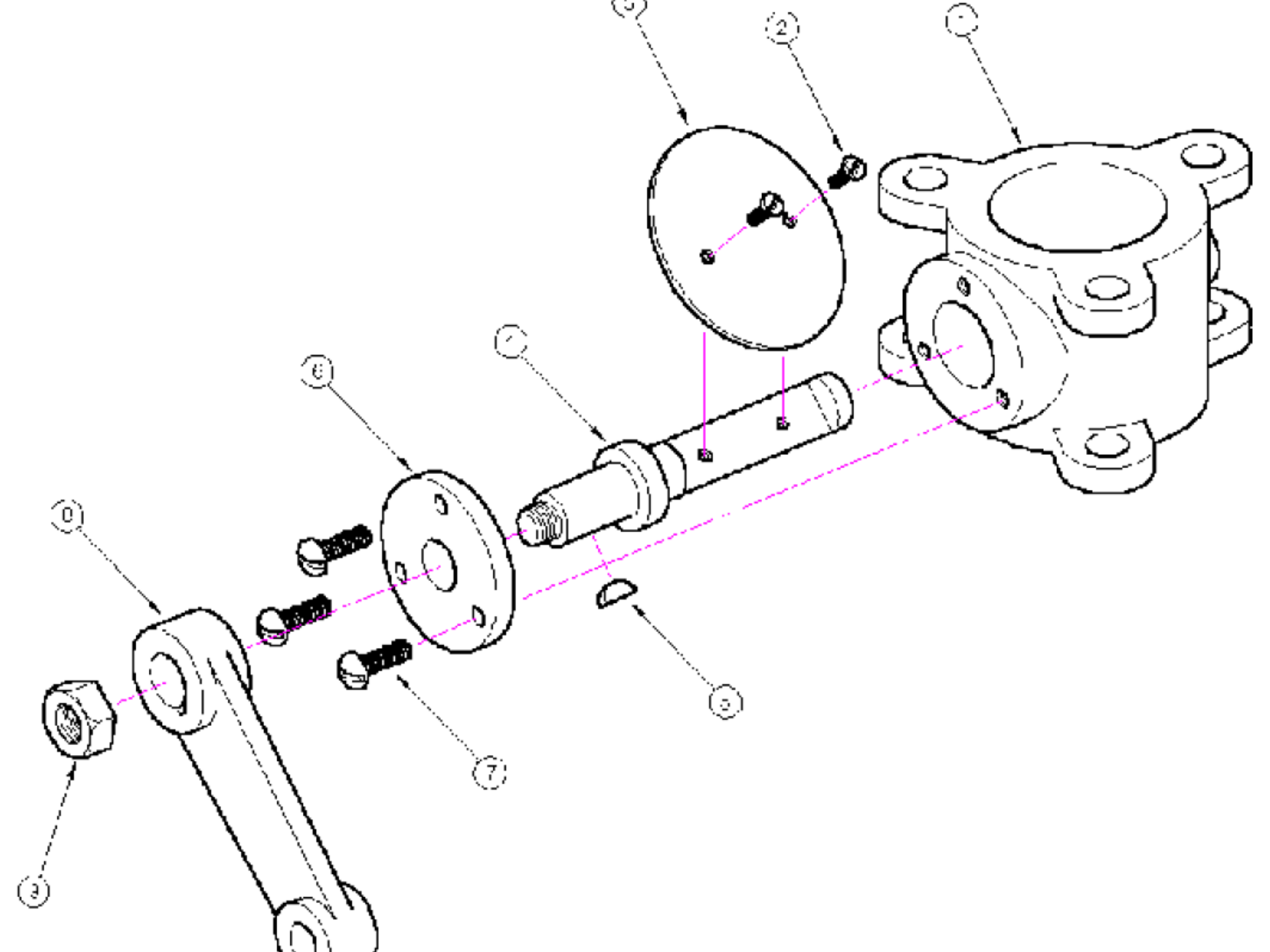
How to Simplify the Design Process

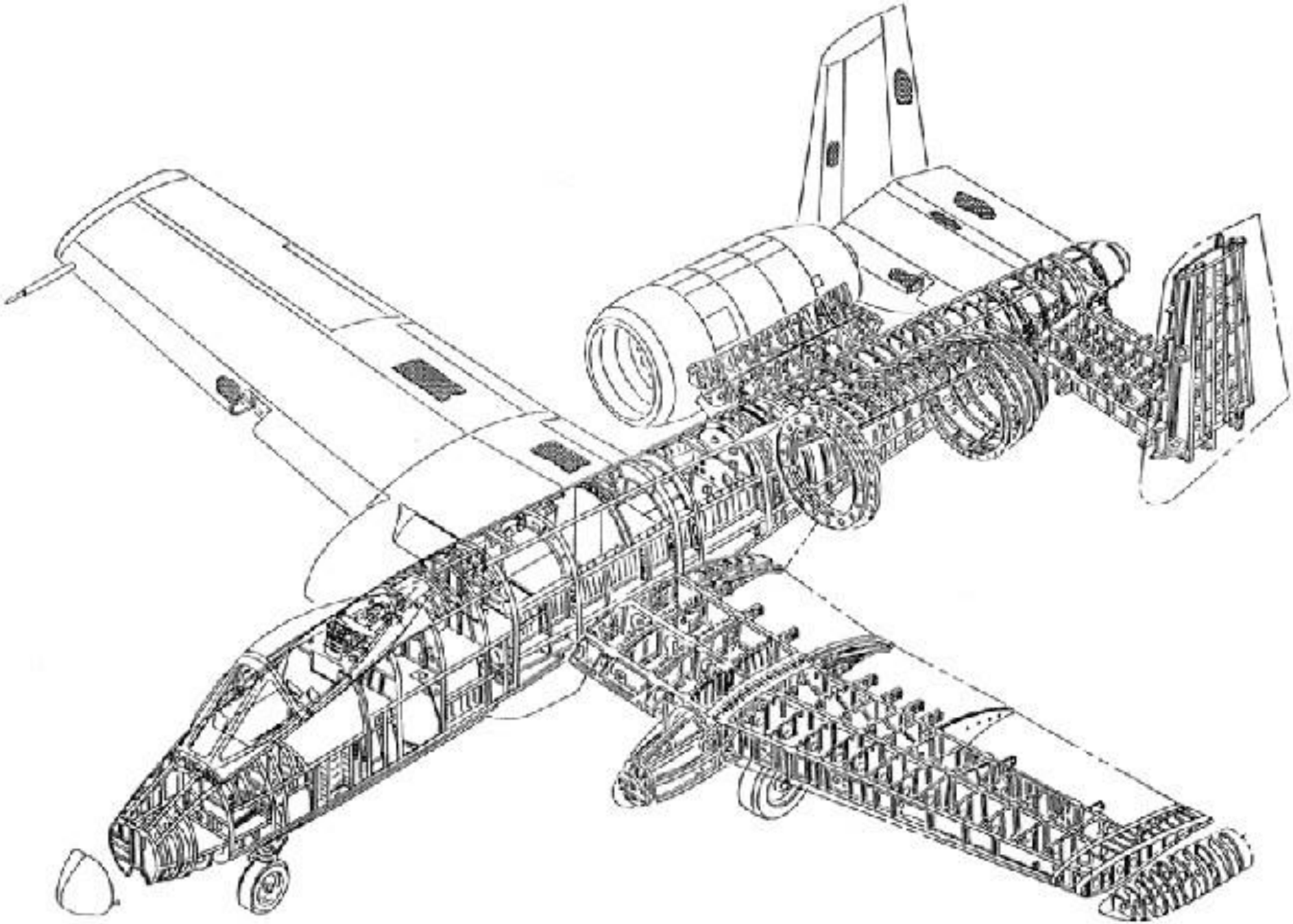
15. Drawings made to modify stock or commercial parts should be made as plainly as possible. Avoid detail.
16. Use std abbr whenever possible.
17. Whenever necessary, zoom in on small details on larger parts for clarity.
18. Draw small parts large enough to avoid crowding so that they are easy to read, but not so large that they take unnecessary space on the drawing.
19. Do not duplicate dimensions.

How to Simplify the Design Process

20. Use recognized standard symbols to greatly simplify drawings for common objects.
21. Eliminate repetitive data with the use of general notes.
22. When drafting, keep free-hand drawing only to where it is required, preferring to use instruments.
23. Wherever practical, use geometric symbols instead of notes.
24. Wherever it is acceptable, provide rectangular coordinates or tabular dimensioning instead of dimension lines.

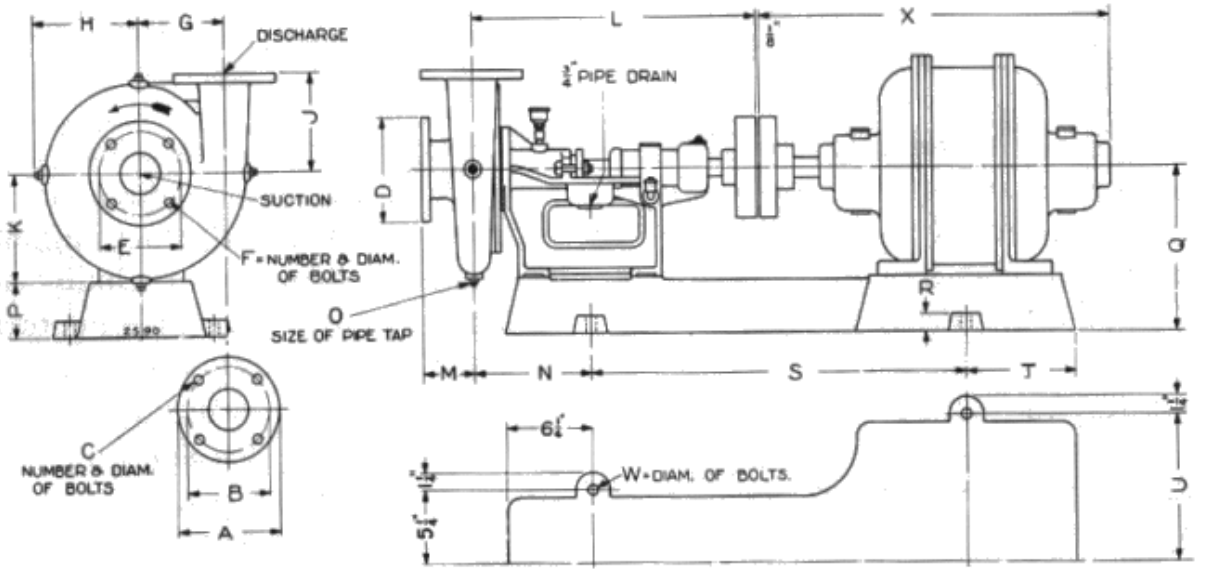






Tabular drawing (catalog)

- Is one on which the dimension are replaced by letters, and accompanying table lists the corresponding dimensions for a series of sizes.
- Thus one drawing serves for a range of sizes covered.
- But there is a serious risk of misreading the table.

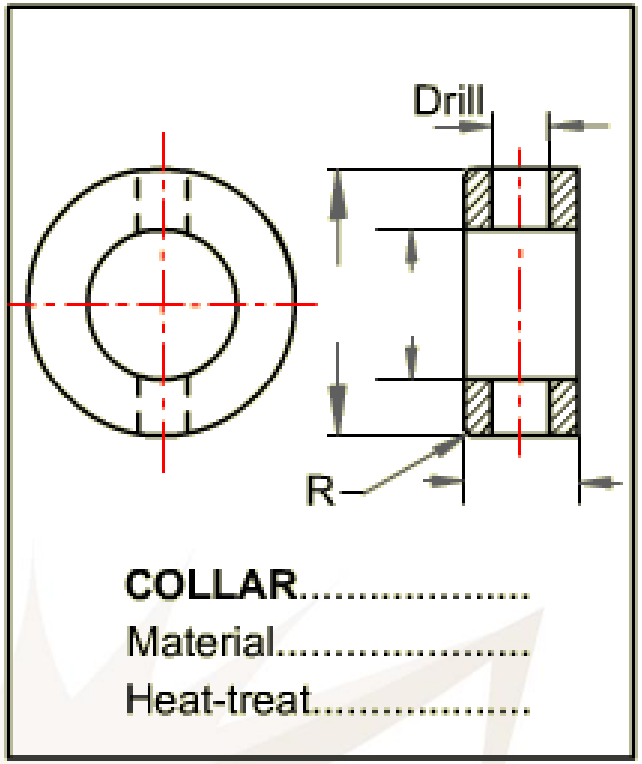


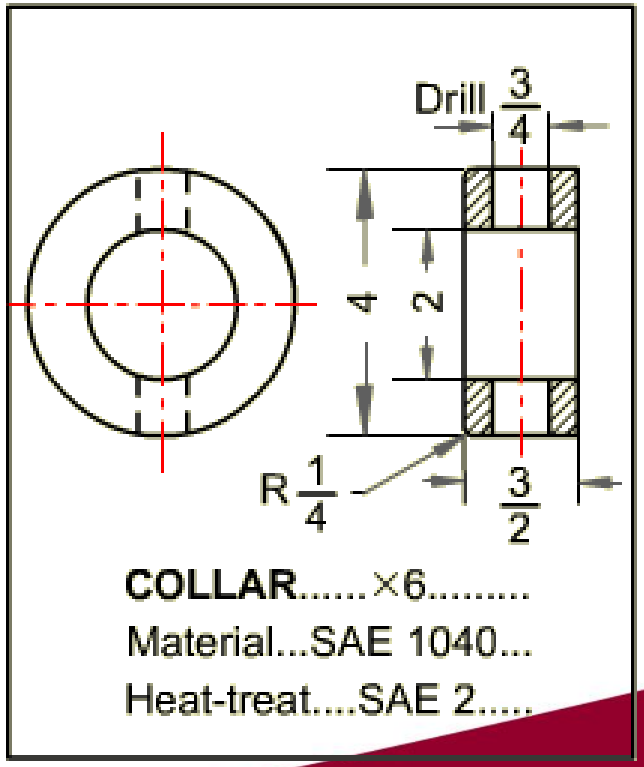
CODE WORD	PIPE SIZES DISCH.	PIPE SIZES SUCT'N.	DIMENSIONS IN INCHES A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	T	U	W	X
JAY	1½"	2"	TAPPED OPENINGS						5 1/4	6 7/8	6 1/2	7 3/8	20 3/8	3 1/4	8 3/4	3/8	ABOVE DIMENSIONS DETERMINED BY SIZE OF MOTOR AND BASE USED							
JABBER	2"	2½"	6	4 3/4	4-3/8	7	5 1/2	4-3/8	5 29/32	7 1/4	6 1/2	7 3/8	20 7/16	3	8 1/4	3/8								
JACKET	3"	3"	7 1/2	6	4-3/8	7 1/2	6	4-3/8	6 1/4	7 15/16	7	7 3/4	20 15/16	3 1/2	8 1/2	3/8								
JACK	4"	4"	9	7 1/2	8-3/8	9	7 1/2	8-3/8	7 15/16	8 3/4	7 3/4	8 15/16	22 11/16	4 1/2	10	1/2								
JACOBUS	5"	5"	10	8 1/2	8-3/4	10	8 1/2	8-3/4	8 1/8	9 1/8	8 1/4	8 13/16	22 15/16	5	10 1/4	1/2								

Standardized drawing

To avoid misreading of tables as in tabular drawing, yet simplify drawing process

- Drawing is made without dimensioned.
- Copied by any methods.
- Dimensions filled accordingly.





Checklist for a Good Design

1. Is the drawing easy to read?
2. Are solid outlines distinct from dimension lines?
3. Is the lettering neat and clear?
4. Is all of the information on the drawing?
5. Will the drawing print well?
6. Have all the rules of standard drafting practice been followed?

Checklist for a Good Design

7. Is the nomenclature correct? Will everyone understand it the same way?
8. Is the drawing title truly descriptive?
9. Are all the necessary views given?
10. Are all the dimensions shown?
11. Are there dimensions which are given twice?
12. Are all the notes properly located?
13. Could any of the notes be misunderstood?
14. Do the parts agree with the list?

Checklist for a Good Design

15. Are all standard parts specified correctly?
16. Is the scale mentioned?
17. Are finishes specified in the drawing?
18. Are there any heat treatments?
19. Have standard manufacturing processes been followed?
20. Can the part be produced more simply and/or more economically?

Checklist for a Good Design

21. Are the materials specified?
22. Are standard parts used to a maximum?
23. Are standard part suppliers indicated?
24. This is your design. Are you ready to approve it?

Technical Data Presentation

Technical communication require enhanced ways to convey data and numerical information

MAG(TREN)	PHASE(TREN)	IMAG	REAL	MAG	PHASE	MAG(TREN)	PHASE(TREN)	IMAG	REAL	MAG	PHASE	MAG(TREN)
26.1287	-180.0000005	2.15324E-07	-26.0287	26.0287	-180.0000005	26.0287	-180.0000005	2.15324E-07	-25.3287	25.3287	-180.0000005	25.3287
26.1288	-180.0000317	-0.000809	-26.0289	26.02890001	-179.9982192	26.02880001	-179.9991098	-0.002295	-25.3289	25.3289001	-179.9948085	25.32880005
25.64784981	-131.6957183	2.04	-8.3	8.547022873	-193.8086224	20.20154096	-184.6022807	-10.33	44.3	45.48844798	-13.12584485	32.0486827
28.95132643	-97.96415498	-4.533	29.1	29.45094377	-8.853989418	22.51389166	-140.6652079	0.71	32.5	32.50775446	1.251493346	32.16345064
31.40878786	-77.13796096	-17.98	37.1	41.22730163	-25.85650422	26.25657366	-117.7034671	-15.48	31.5	35.0981538	-26.17082038	32.75039127
33.53802407	-62.16180586	-10.672	31	32.78553925	-18.99643745	27.34473459	-101.2522955	-4.442	31.9	32.20778421	-7.927328138	32.65995676
36.62170197	-31.43062462	0.213	35.2	35.20064444	0.346700343	28.873392	-71.19451205	2.424	43.4	43.46764056	3.196793128	35.68311352
39.44612293	-0.86542368	0.514	41.6	41.60317531	0.707897407	31.46910455	-41.07682595	1.688	41.4	41.43439808	2.334824517	38.36736318
42.34289628	5.519800663	1.966	40.2	40.24804537	2.799846426	36.7526083	-8.308747817	1.526	41	41.02838866	2.131537061	37.62401996
43.22825258	5.533797457	2.664	40	40.08861305	3.810272	38.52555318	-6.198037581	2.164	44.1	44.15306214	2.809267431	39.56490457
43.42345535	4.711813463	2.894	40.8	40.90250892	4.057272989	38.47142106	-1.212408047	0.455	46.2	46.20224048	0.564258374	41.41558569
43.13192018	2.204145796	0.57	42.9	42.90378655	0.761227802	40.15779561	2.080536161	2.38	43.6	43.6649104	3.124512684	43.32510672
42.58493131	1.937115398	2.099	41	41.05369412	2.930705805	41.13330389	2.511203738	4.429	42.7	42.92908153	5.921751583	43.23534688
42.48909705	1.329458943	1.006	43.7	43.71157783	1.31875001	41.4847043	2.613012505	1.196	40.8	40.81752584	1.679071923	43.13253484
42.39515945	0.906209117	1.407	42.7	42.72317461	1.887260061	41.89722595	2.480914778	1.107	42.5	42.5144146	1.492049174	43.38020583
42.01642917	0.434922695	-0.16	42	42.00030476	-0.21826858	42.21584113	1.789491348	0.388	42.6	42.60176691	0.521834454	43.12165663
41.93178682	0.322315106	1.66	41	41.03359112	2.31851401	42.23768916	1.496698185	0.96	43.6	43.61056753	1.261354636	42.68971114
42.17634917	0.610967193	-0.853	45.9	45.90792534	-1.064655224	42.93837796	1.195384847	-1.023	42.3	42.31236851	-1.385393831	42.46428749
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42.21847736	0.136864276	-1.826	42.1	42.13958087	-2.483528788	42.88837651	-0.264839101	0.634	40.5	40.50496212	0.896853268	41.9662661
41.88493263	-0.0657412	2.141	41.7	41.75492643	2.939152132	42.72700101	-0.079523756	0.391	41.5	41.5018419	0.539806914	41.79750398
42.1187724	-0.285318156	0.054	43.7	43.70003336	0.070800241	43.01028991	-0.051346619	-0.7496	44.2	44.20635588	-0.971601797	42.06493548
42.21872329	-0.463976165	-1.432	43	43.02383786	-1.90737779	43.3419977	-0.0[illegible]0919	-0.744	44.1	44.10627547	-0.966530983	42.14755347
42.0851383	-0.304524959	-1.662	42.5	42.53248457	-2.239460898	42.77942424	[illegible]	1.408	43.6	43.62272875	1.84964292	42.36594684
42.1385488	0.089452888	0.4739	41.4	41.40271224	0.655828118	42.4255952	[illegible]	-0.3641	42.5	42.5015596	-0.490844305	42.74062062
42.49211165	-0.245667084	-1.258	42.8	42.81848391	-1.683582822	42.538[illegible]	[illegible]	0.21	43.1	43.1005116	0.279165162	43.1732122
43.29182953	-0.160636482	-0.415	44.4	44.40193943	-0.535519281	42.9799[illegible]	[illegible]	-0.052	43.8	43.80003087	-0.068022355	43.5562437
43.27557789	0.150206713	0.689	44	44.00539423	0.897126498	43.030[illegible]	[illegible]	-0.2	43	43.00046511	-0.266490076	43.3552619
43.40966443	0.073794376	-0.466	43.8	43.80247888	-0.609562235	43.160[illegible]	[illegible]	-0.1582	42.7	42.70029306	-0.212275195	43.1209315
43.27713138	-0.142675763	0.075	42.9	42.90006556	0.100167345	43.221[illegible]	[illegible]	-0.775	42.5	42.50706559	-1.044689606	42.93498764
43.39393482	-0.760324385	1.5824	43.8	43.82857504	2.069073663	43.626[illegible]	[illegible]	-0.7336	43.4	43.40619966	-0.968391277	43.08576098
43.44211693	-0.248308477	-0.845	43.5	43.50820641	-1.112847021	43.741[illegible]	[illegible]	0.1445	43.9	43.90023782	0.188592488	43.21904868
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45.83508362	-1.423295629	-1.168	46.1	46.11479398	-1.451348297	45.9695578	-1.309341183	-1.552	45.8	45.82628835	-1.940808661	45.77817231
45.98406846	-1.314399808	-0.605	44.1	44.10414975	-0.785981229	45.87012915	-1.385076417	-0.355	46.6	46.60135218	-0.43647228	46.07589943
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46.68523761	-1.225693349	-0.418	46.3	46.30188683	-0.5172567	46.03920637	-0.554504459	-0.79	46.5	46.50671027	-0.973318531	46.36945804
46.85216417	-1.237761519	-0.763	46.5	46.50625946	-0.940059289	46.30687563	-0.742657417	-0.517	47.8	47.80279583	-0.619681234	46.61829639
46.93505102	-1.217024477	-1.2466	46.4	46.41674279	-1.538959942	45.92429252	-0.785062758	-2.0666	48.1	48.14437491	-2.460180457	46.76595636
46.57108109	-1.289876158	-2.827	45.7	45.78735556	-3.53980381	45.86971945	-1.133138677	-0.77	46.2	46.20641622	-0.954841254	46.829311
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46.3615153	-1.656238333	-2.635	47	47.07380615	-3.208861662	46.40351742	-1.995628859	-2.185	47.4	47.4503343	-2.639297818	47.0544782
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45.88860612	-2.275704328	-3.677	48.6	48.73889955	-4.326666078	46.83679296	-2.992815899	-1.159	48.9	48.91373305	-1.357737791	47.91747574
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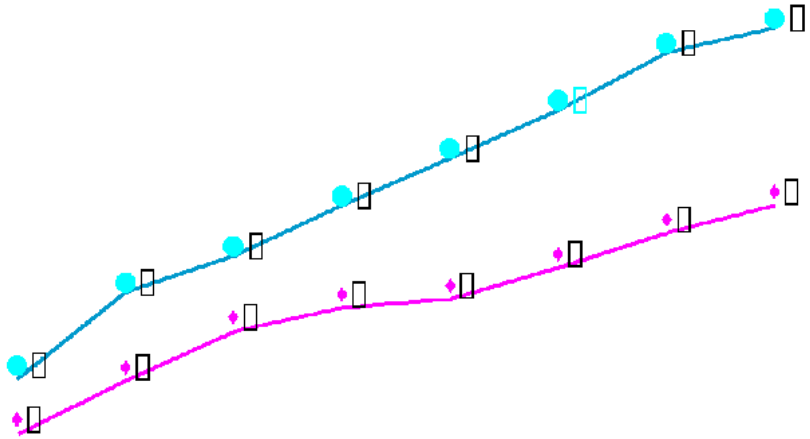
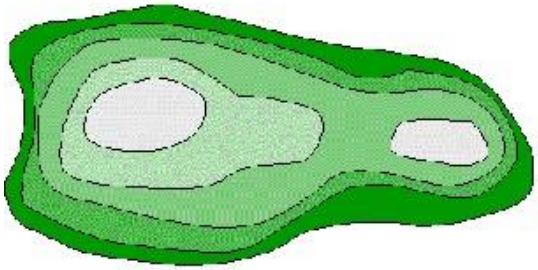
47.025252	-2.216683154	-1.705	46.8	46.83104766	-2.086455527	47.65275254	-3.319802303	-1.365	48	48.01940467	-1.628909729	48.87252763

Encoding Data and Markers

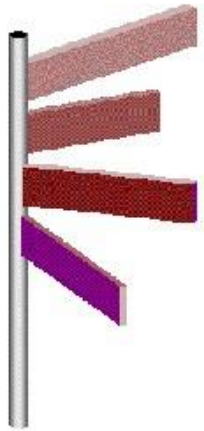


Arrow

Mesh



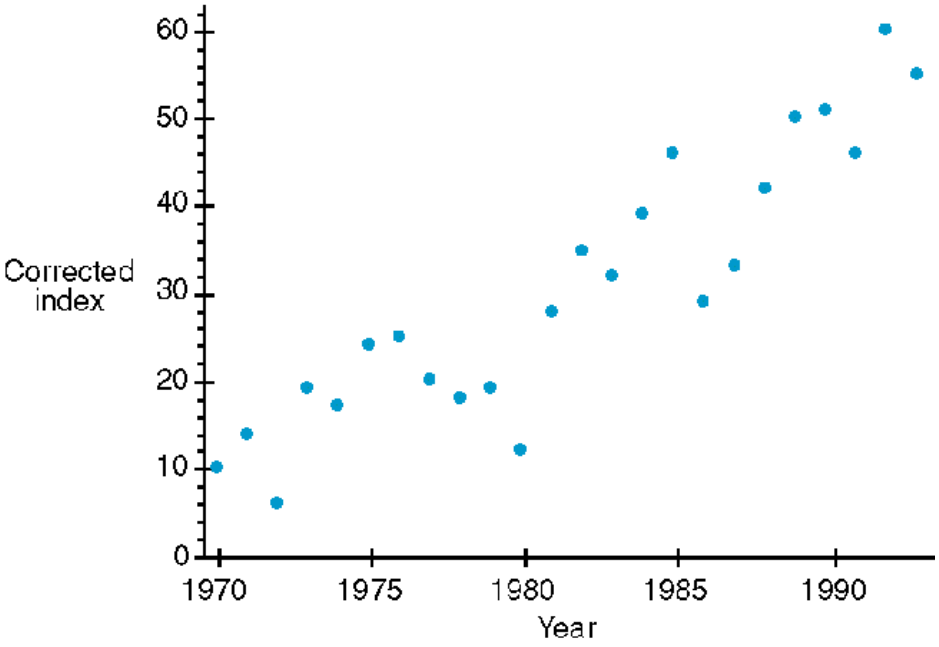
Contour lines



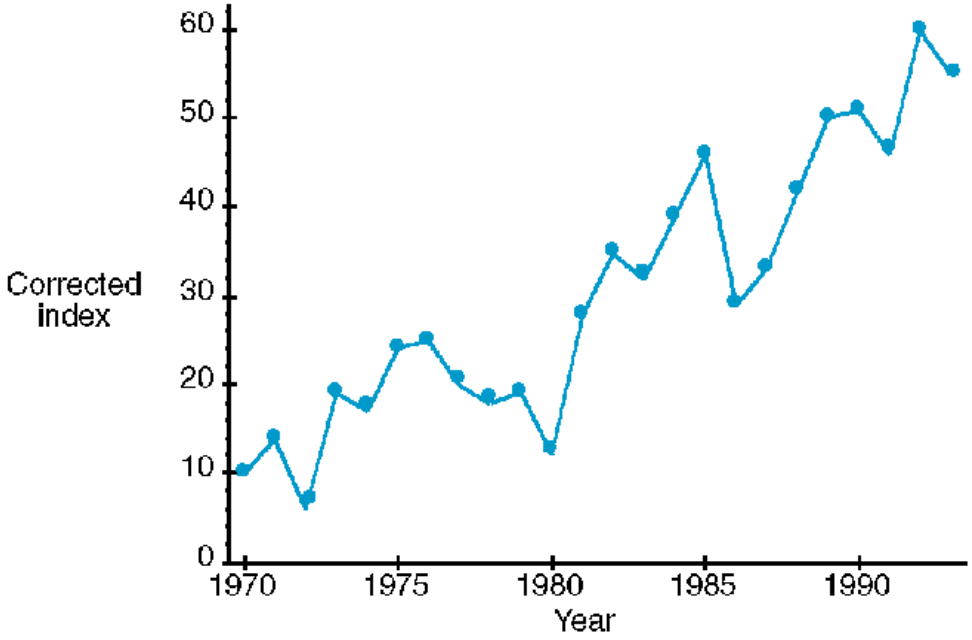
Glyph

Plots

2D scatter plot

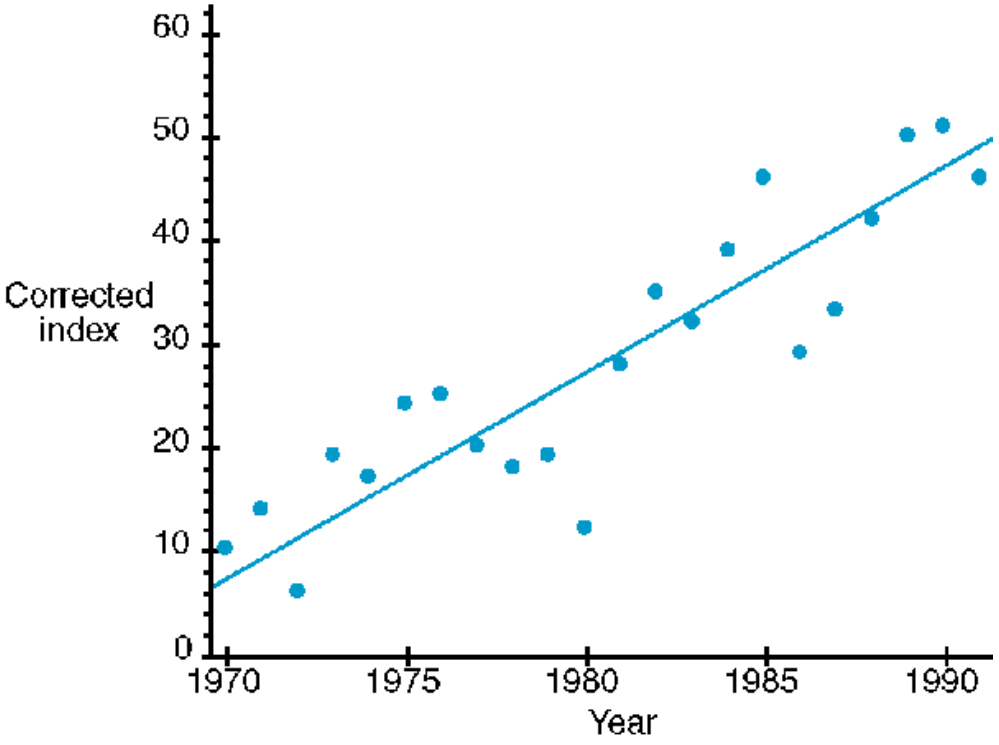


2D connected line plot

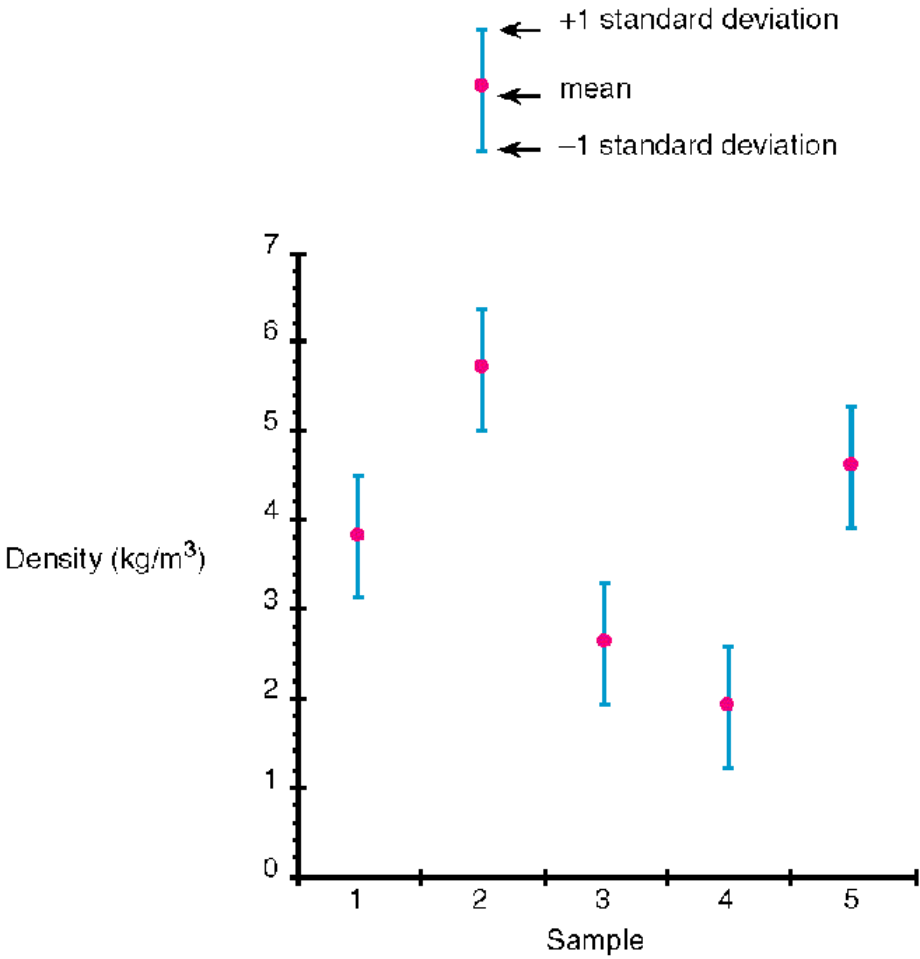


Plots

Regression line graph

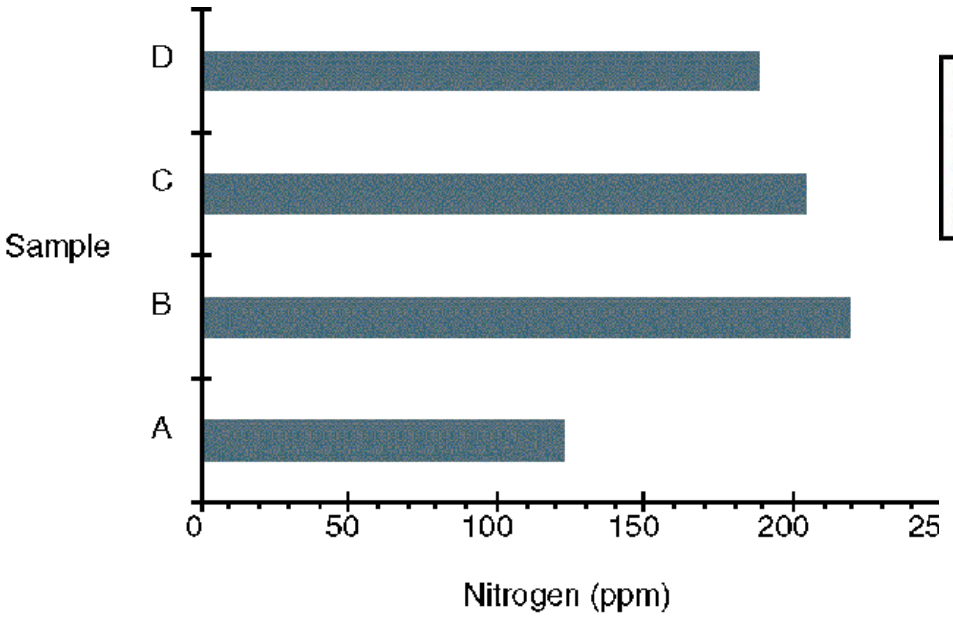


Mean and standard deviation

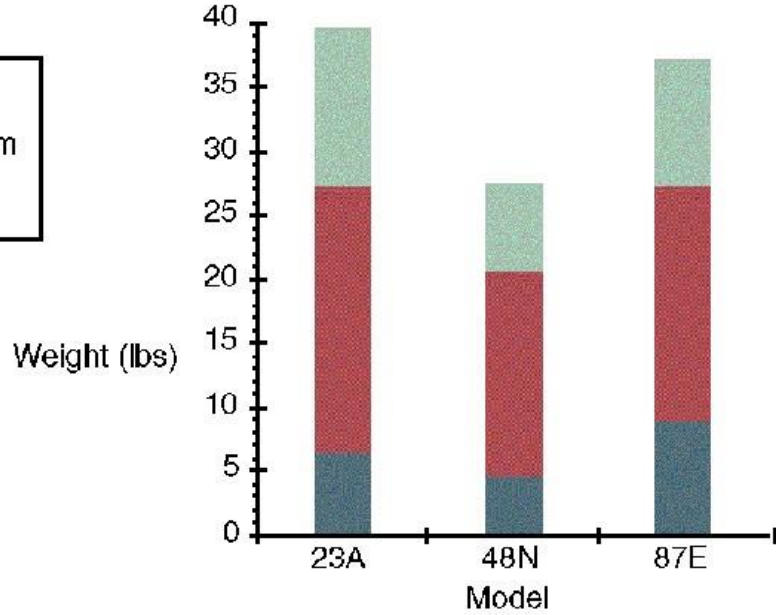


Plots

Bar graph (horizontal)

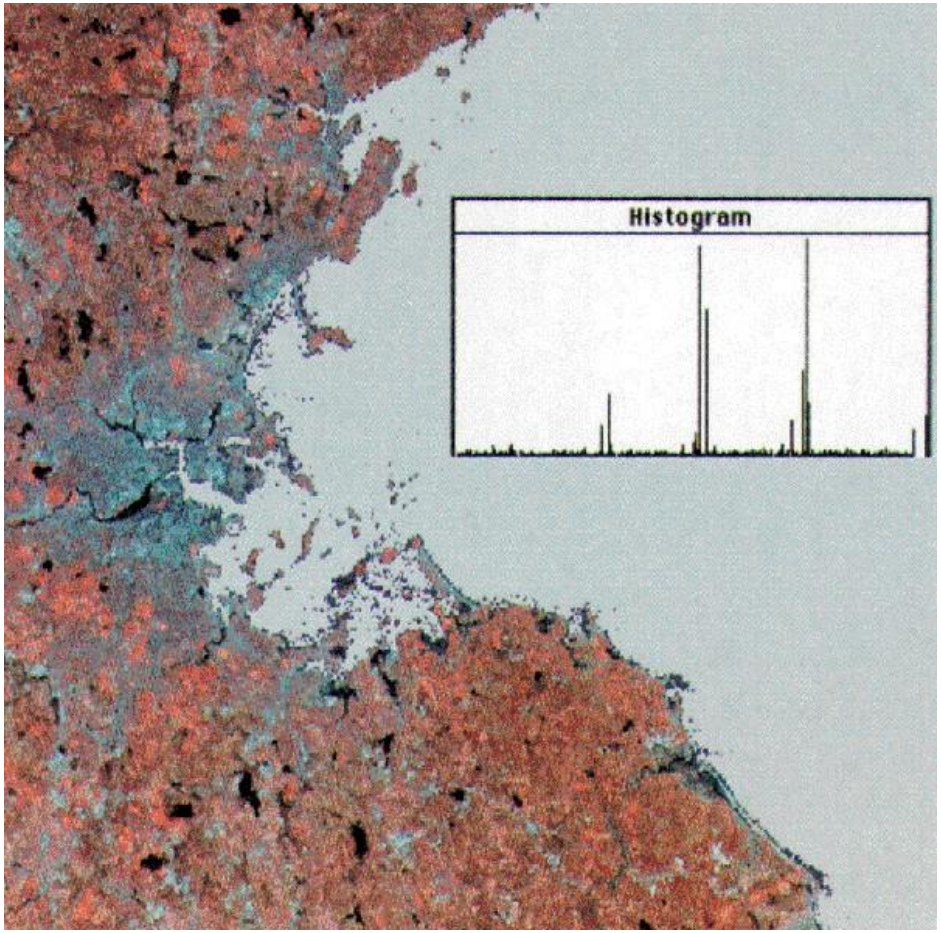


Composite bar graph

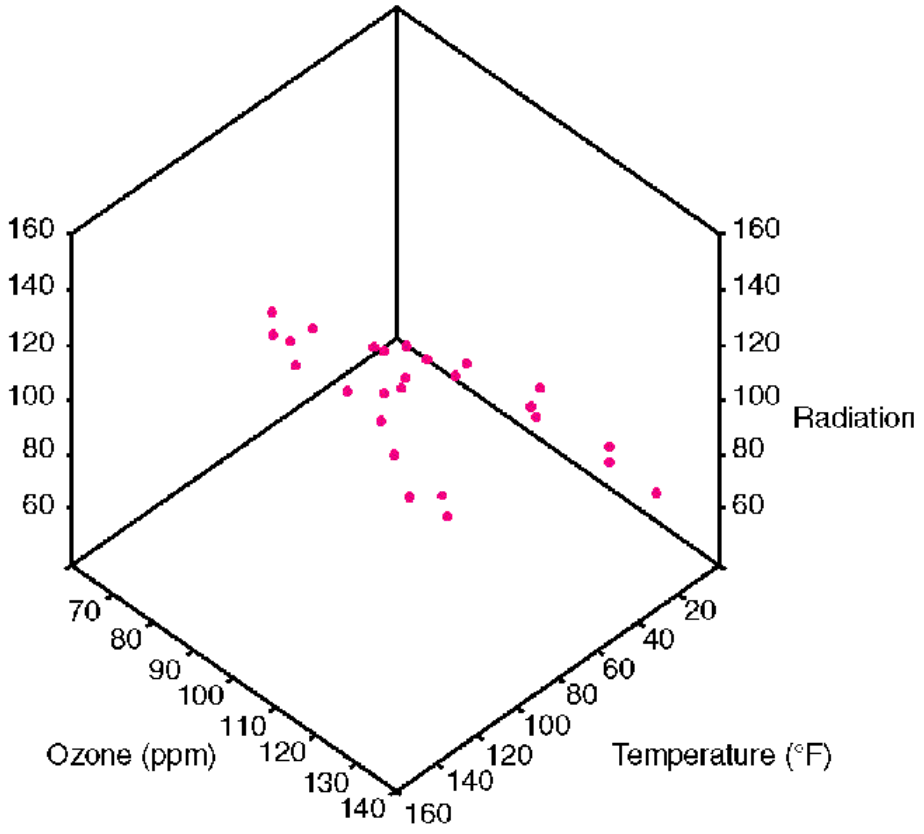


Plots

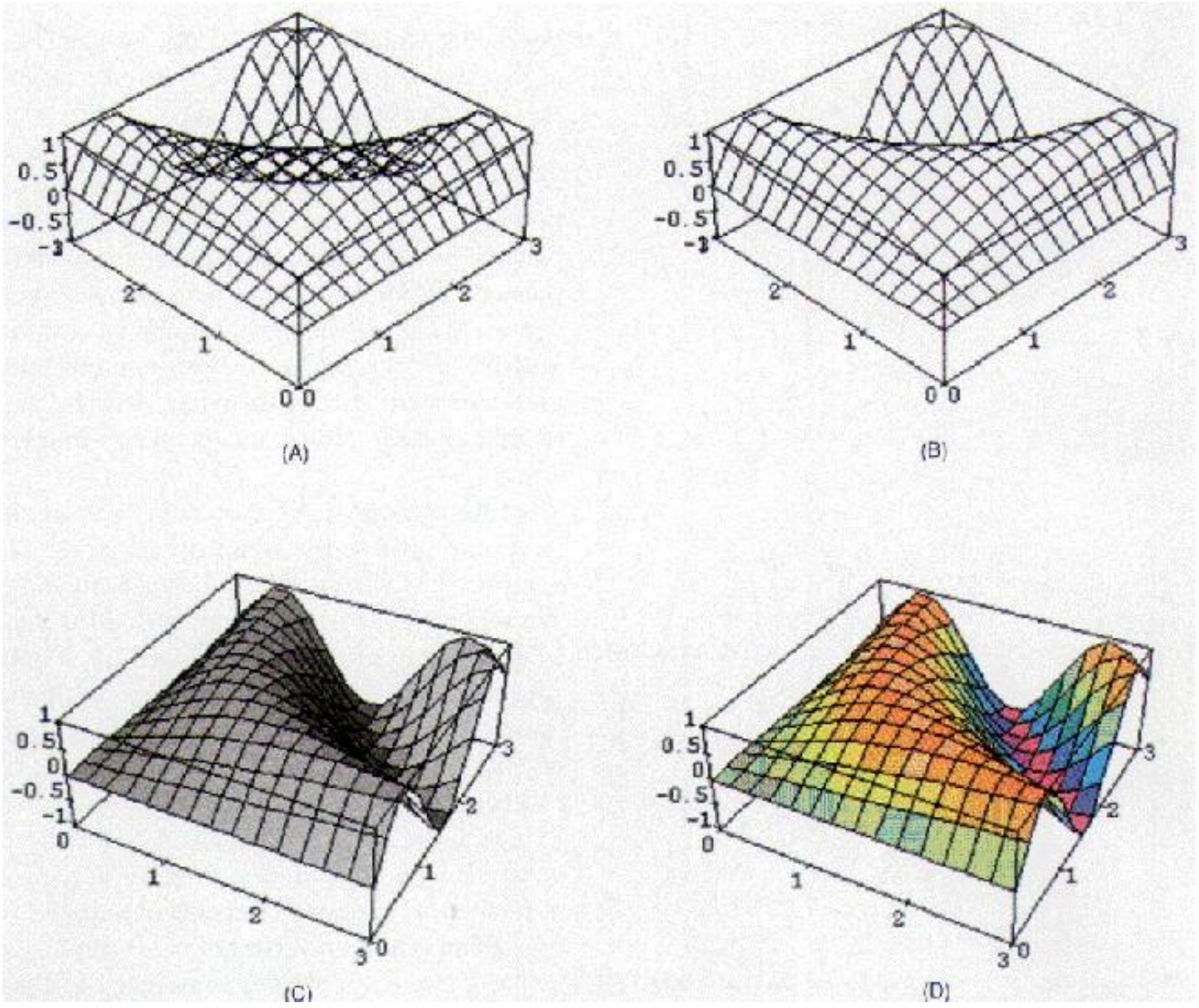
Histogram (distribution of image)



3D scatter plot



Plots



Exercise

Please pick up a pen and a sheet of paper.

- Please draw a bolt and a nut to the best of your ability.
- Is not necessary to provide your name on the paper.
- Please leave the sheet on my desk.
- The paper will be used in a study that is directed towards creativity versus knowledge.
- Make-up class – next week, Tuesday, December 6, same time as usual. If you wish to do so, you may bring problems which you would like have solved.

MECH 211 – Mechanical Engineering Drawing

NEXT LECTURE

Design a Catapult

- You are an engineer (start imagining yourself as one).
- Your kid sibling is asking you to make a catapult for play during the winter season.
- What are the things that you should know before you design and manufacture this catapult?

Needs or Functionality

- What you are going to launch with it?
- How fast do you want projectile to go?
- How far will your catapult launch the projectile?
- Which mechanism will be used in the catapult?
- How will you to design it?
- Once it is designed, how will you produce it?

Preliminary Design Constraints

- The projectile: “assume an eraser, used in the drawing class”.
- The eraser must be launched to a minimum distance of 10 meters.
- Since you are designing this for your kid sibling, you cannot use unsafe elements, such as:
  - Mechanisms which produce a lot of energy or sound, such as explosive materials, etc.
  - Gasoline or heat to power the device.

Design Requirement

Since the catapult should be easily built, you must consider the following:

- Using a minimum number of parts in the assembly (<=15).
- Using power sources like springs, air cylinders, rubber bands or other similar objects.
- The geometric parameters of the components in the catapult will have an effect on its performance.
- Using mostly standard parts in your design.

What do you have to do?

Come to the next class with a piece of paper outlining the design, including the following:

- Components, their sizes and specs.
- Your considerations in choosing those particular dimensions and sizes.
- 2 or 3 written lines describing the operating mechanism.