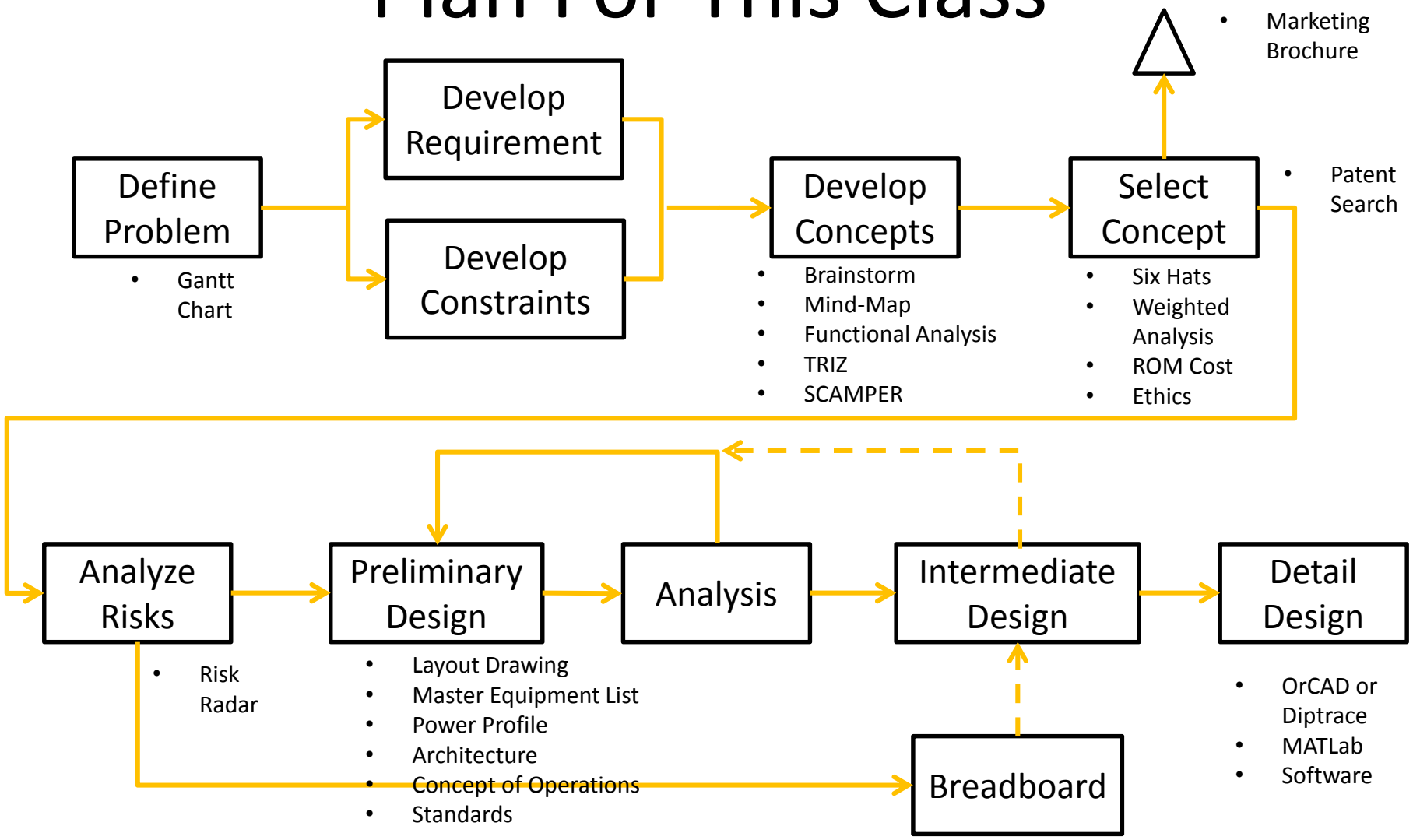
Elec 4309 Senior Design

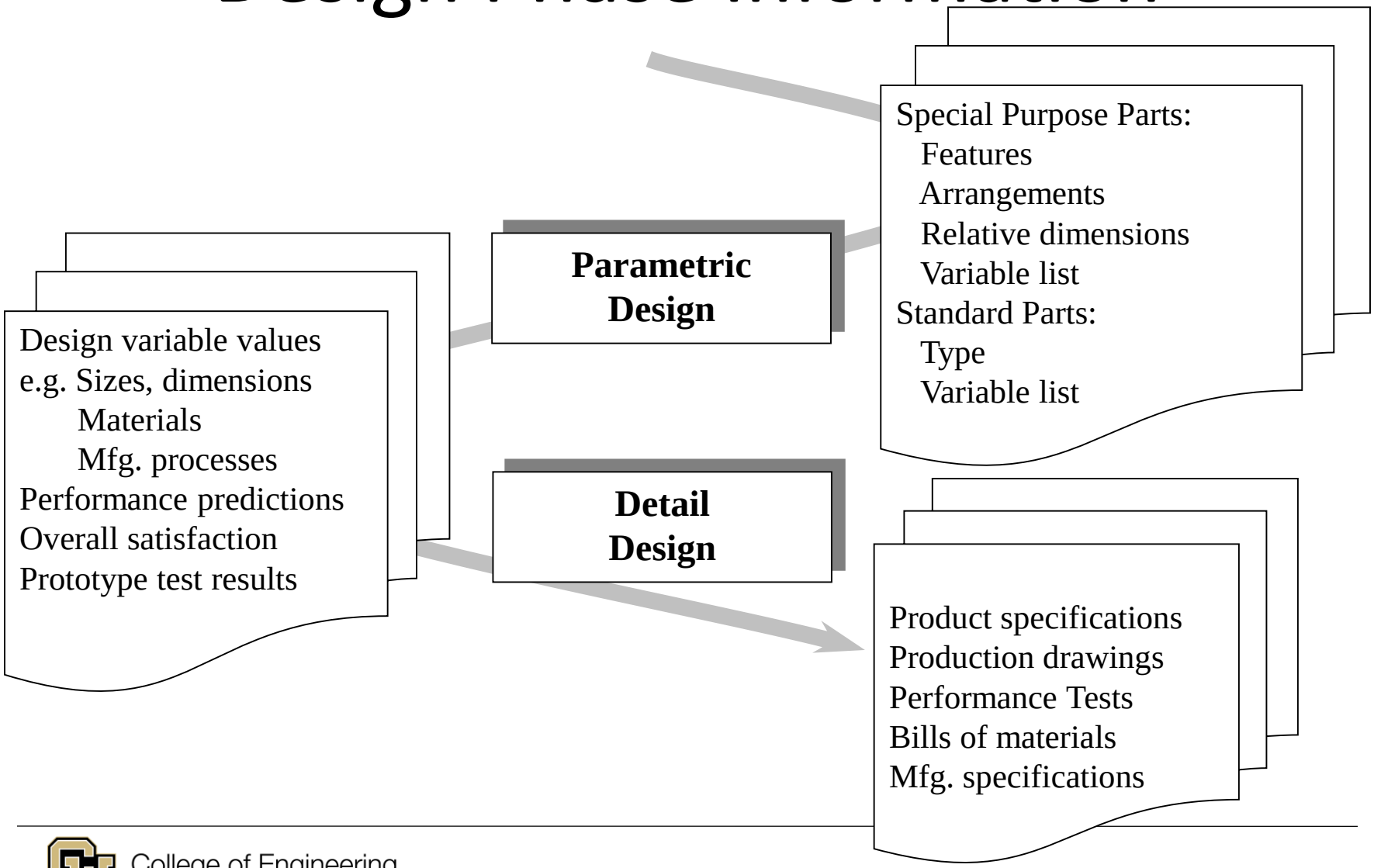
Wendell H Chun

Nov. 14, 2017

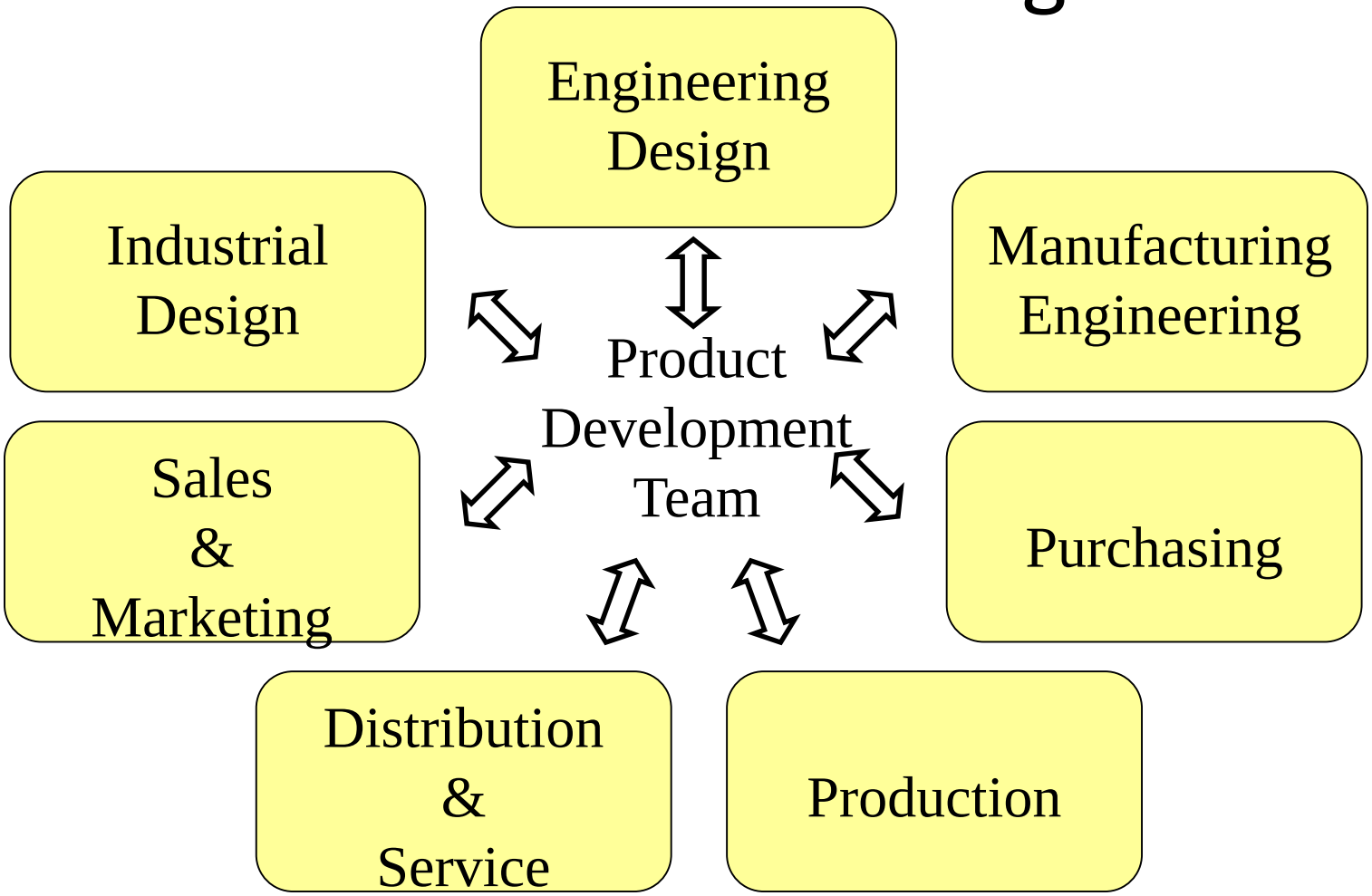
Plan For This Class



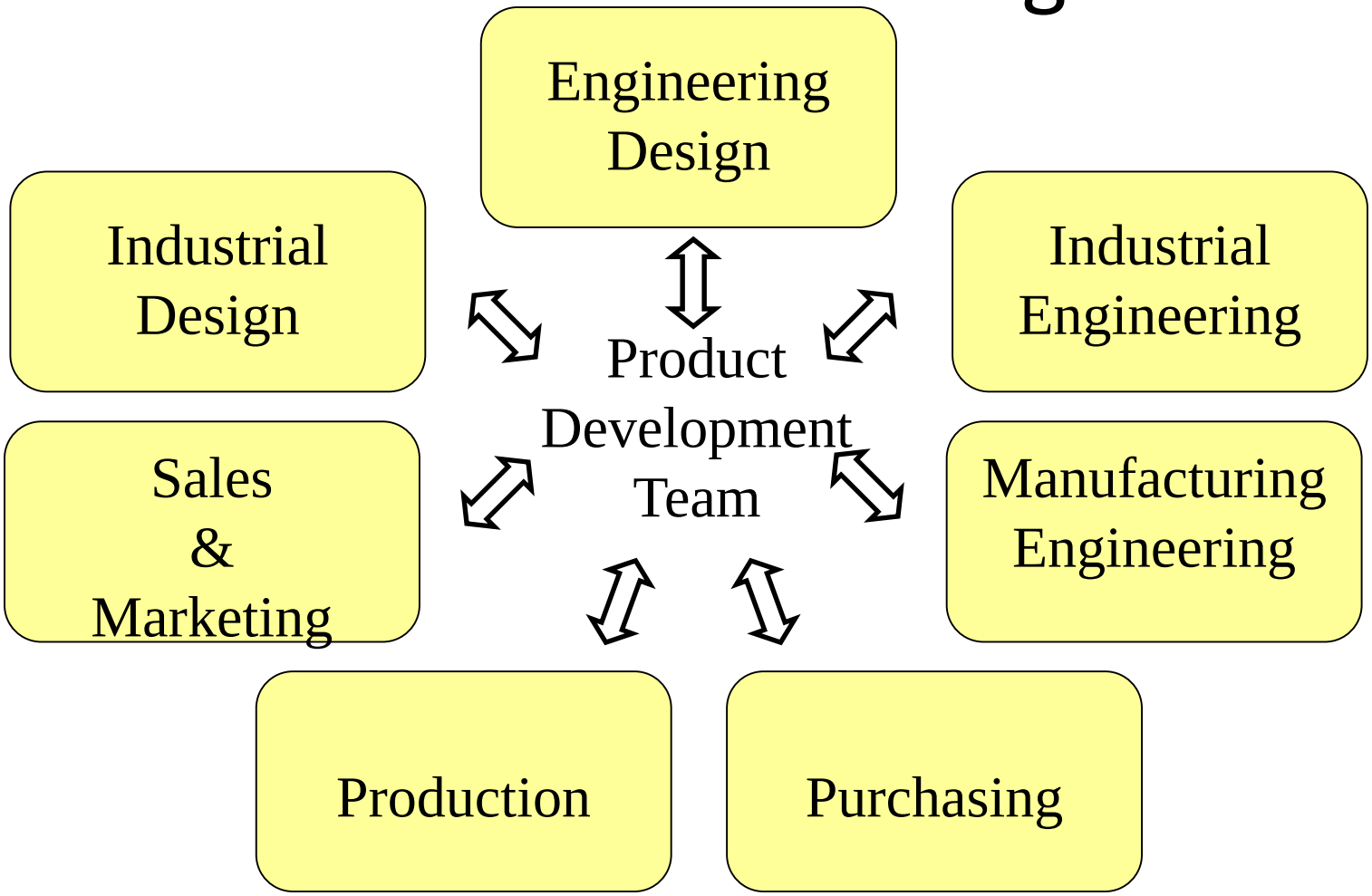
Design Phase Information



Design Information Flow & Decision-making



Design Information Flow & Decision-making



Sales & Marketing Responsibilities

- Product Warranty
- Shipping
- Warehousing
- Advertising campaign
- Product literature
- Owner's manual (layout, printing)
- Product launch

Industrial Design Responsibilities

- Product trim details
- Finish details
- Ergonomic refinements
- Product packaging

Design Engineering Responsibilities

- Detail design performance analyses
- Preproduction prototype performance tests
- Manufacturing process specifications
- Owner manual(s) (technical: operation/maintenance)
- Layout drawing
- Detail drawings
- Assembly drawings
- Bills of materials
- Engineering change notices
- Patents, trademarks, copyrights

Industrial Engineering Responsibilities

- Materials & Product flow
- Facility layout/remodeling
- Material handling equipment
- Inventory warehousing
- Assembly planning (machines & workers)

Manufacturing Engineering Responsibilities

- Fixture design / fabrication
- Tool design / fabrication
- Process equipment refurbishment / adaptation
- Process equipment acquisition / installation
- Process planning

Purchasing Responsibilities

- Vendor qualification, selection, negotiation
- Out-sourcing parts or subassemblies
- Raw materials
- Materials planning
- Quality control (raw materials, sourced parts)
- Make or buy (shared)

Production

- Tooling changeover (assist)
- Acceptance testing (QC, SPC)
- Worker training
- Workforce scheduling

Communicating Design Information

Written and Oral Communications:

- Email
- Memoranda / Letters
- Phone calls/voice mails
- Reports
- Meetings

Communicate to all the stakeholders:

1) often
2) thoroughly and
3) clearly.

Final Design

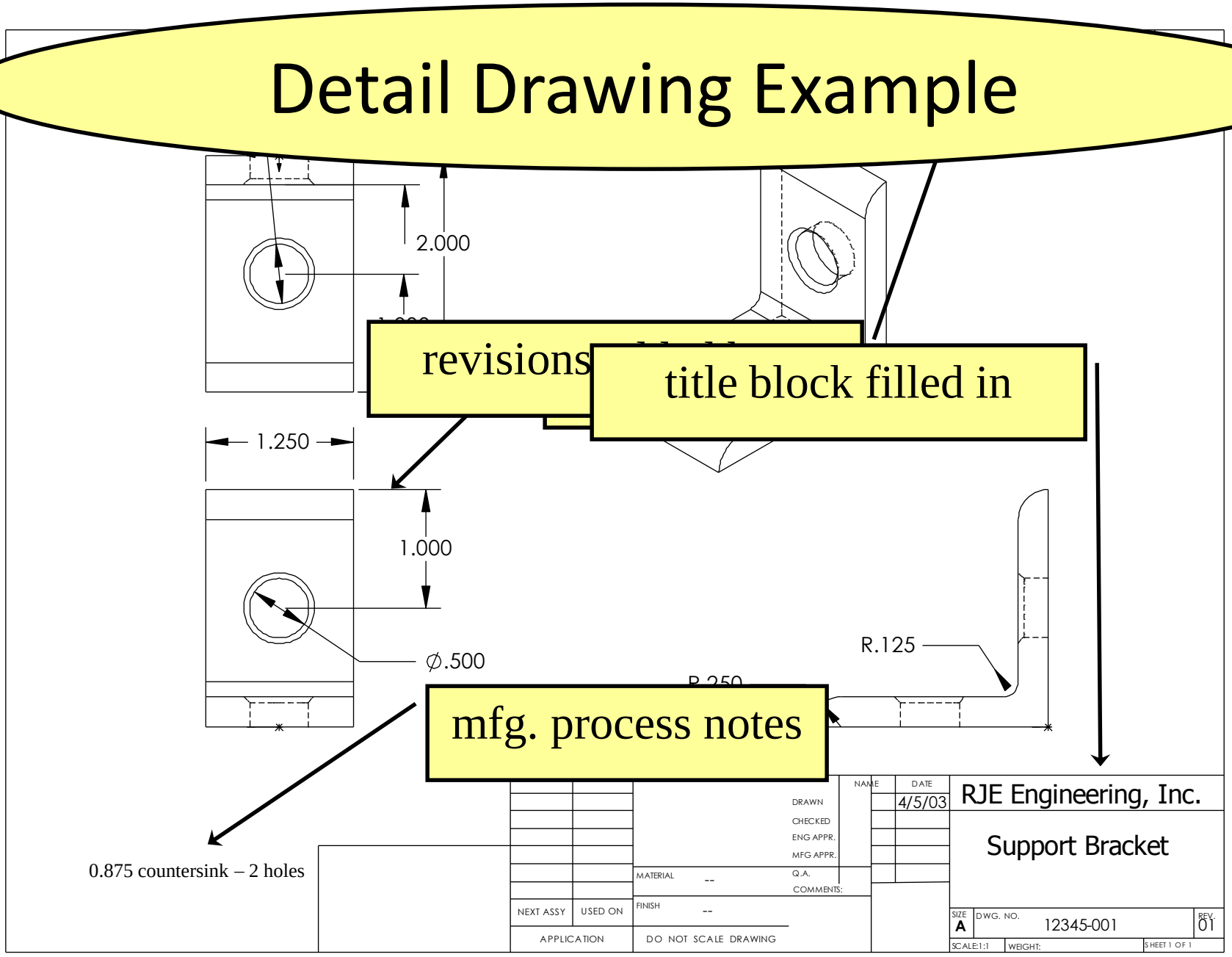
- **Communication book**: letters, emails, minutes, reports.
- **Technical info book**: catalogs, articles, surveys.
- **Design book**: sketches, diagrams, math models, optimization problems.
- **Production drawing book**: assembly drawings, detail drawings, list of standard and special-purpose parts or bill of materials.

Graphic Communications – Drawings

Production / Working drawings

- Detail drawing
- Assembly Drawing
- Bill of Materials (sometimes on Assembly)
- Layout (sketch)

Detail Drawing Example



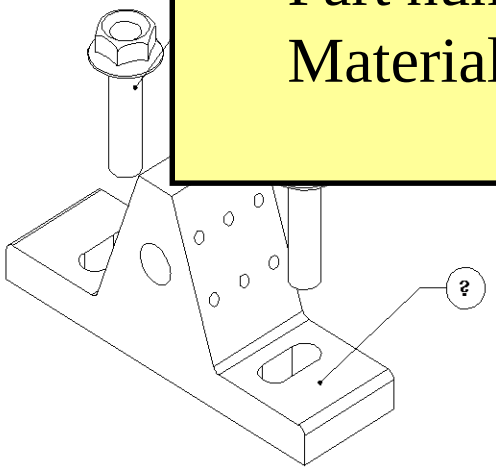
Assembly Drawing Example

ITEM NO.	QTY.	PART NO.	
1	1	guide	SS 303
2	1	rod	SS 303
3	1	PLATE	SS 303
4	2	M8-1.25 x 30	ALUMINUM
5	2	4mmcapscrew	ALUMINUM

balloon annotations

Bill of Materials
- Item number
- Quantity
- Part number
- Material type or Source

Exploded view



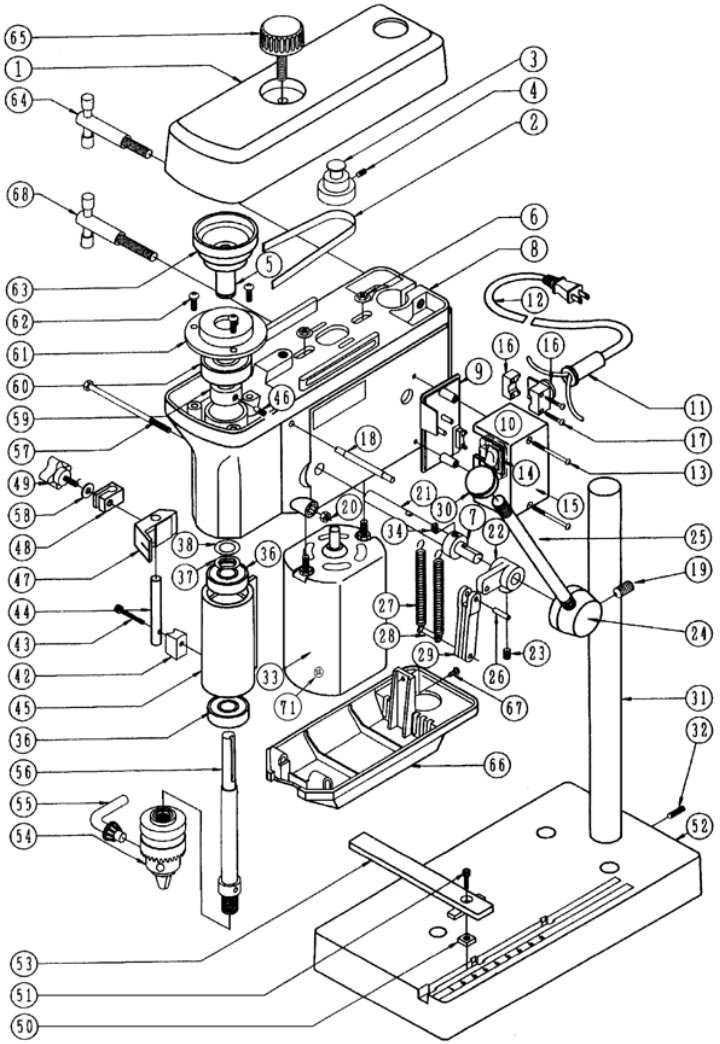
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL —
FINISH —
NEXT ASSY | USED ON
APPLICATION

DRAWN | CHECKED | ENG APPR. | MFG APPR. | Q.A. | COMMENTS: | DATE | NAME

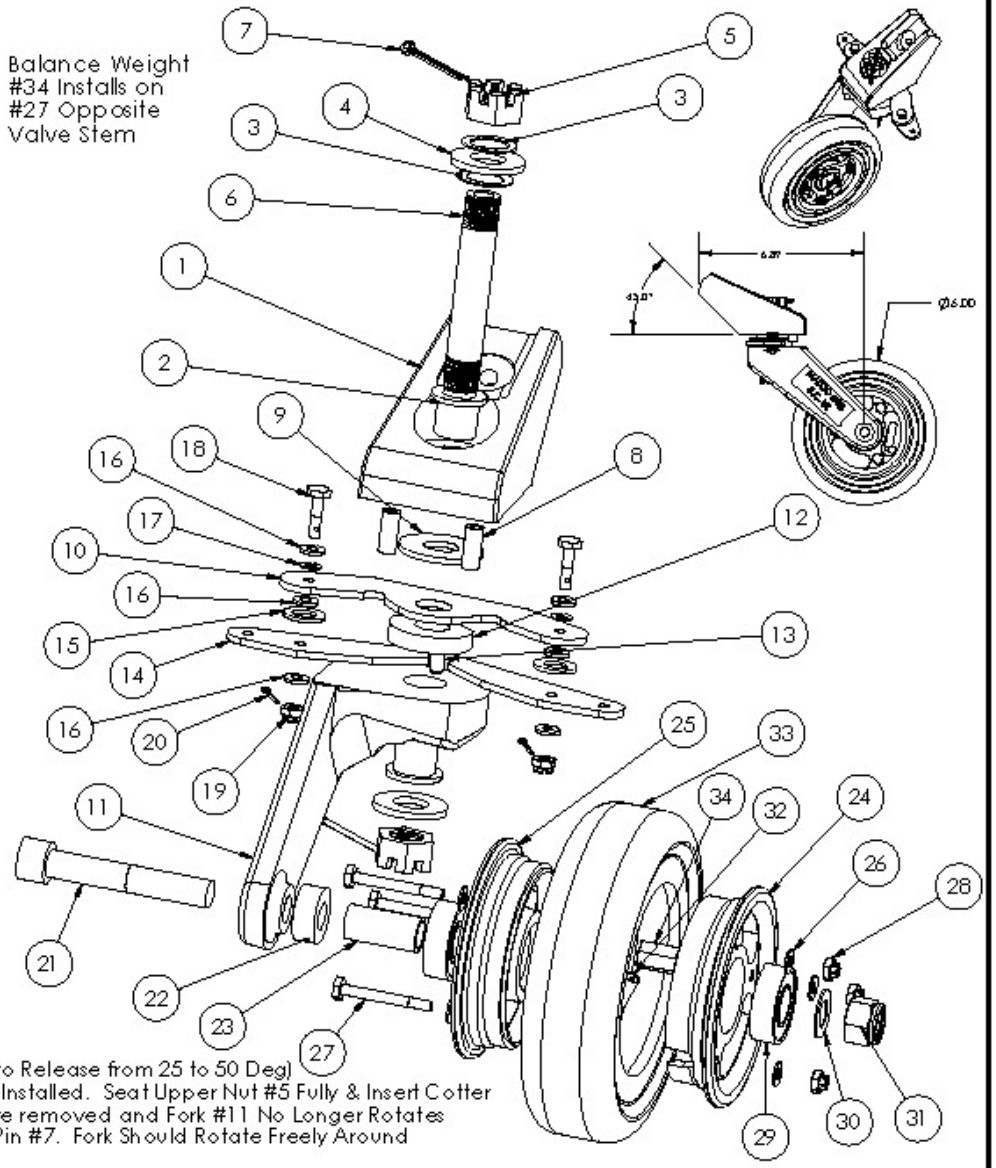
<COMPANY NAME>
TITLE: 1GR_ex ASSEMBLY
SIZE B | DWG. NO. | REV
SCALE: 1:1 | WEIGHT: | SHEET 1 OF 1

More Examples

MicroLux Drill Press



ITEM #	Part Number	Description	QTY.
1	WHLTWB	BASE, TAIL WHEEL	1
2	WHLTW-19	BUSHING, HAT	2
3	MSCU625-0210	WASHER, CURVED	2
4	MSC.625SAE	WASHER, 5/8	2
5	MSC.62-18HEXNUT/SLOTTED	NUT, HEX SLOTTED	2
6	MSC.625-18X4BOLT(A)	AXLE, VERTICAL	1
7	MSC.11x1.5COTTERPIN	PIN, COTTER ZINC	2
8	WHLBSP4	SPACER, 4"/UL BRAKE	2
9	WHLTW-2	WASHER, BRONZE	1
10	WHLT-02	ARM, TAIL WHEEL	1
11	WHLTW-6F	FORK, 6" TAIL WHEEL	1
12	WHLTW-21	BUSHING	1
13	MSC.25-20x.50	BOLT, SHCS .25-20X.50	1
14	WHLT-03	Wing, Tail Wheel	2
15	MSC.750X.443X.062WASHER	Washer, Nylon	2
16	MSCAN960-10	WASHER, THICK	6
17	MSCB0375-020	WASHER, BELLEVILLE	2
18	MSCAN3-6	BOLT,HEX DRILLED	2
19	MSCAN310-3	NUT, CASTLE	2
20	MSC.062X.50COTTERPIN	PIN, COTTER ZINC	2
21	MSC.50-13X3.0SHCS(A)	BOLT, SHCS .50-13x3.0 PLATED	1
22	WHLTW-3	SPACER, TAIL WHEEL	1
23	WHLT6SL	SLEEVE, TAIL T-6P	1
24	WHLW35/.625	WHEL HALF, TAIL VALVE	1
25	WHLTW35/.625	WHEEL HALF, TAIL BACK	1
26	MSCAN960-10L	WASHER, THIN	6
27	MSCAN3-15A	BOLT, HEX	3
28	MSCMS21045-3	NUT, FLEX LOCK	3
29	MSC1623DCTN	Bearing, Ball 0.625	2
30	MSCAN960-816L	WASHER	1
31	MSC.50-13NYLOCK	NUT, NYLOCK	1
32	TIRTU6X2	TUBE, 6X2	1
33	TIRT6X2	TIRE, 6X2	1
34	TWB5WGT	WEIGHT, BALANCE	2

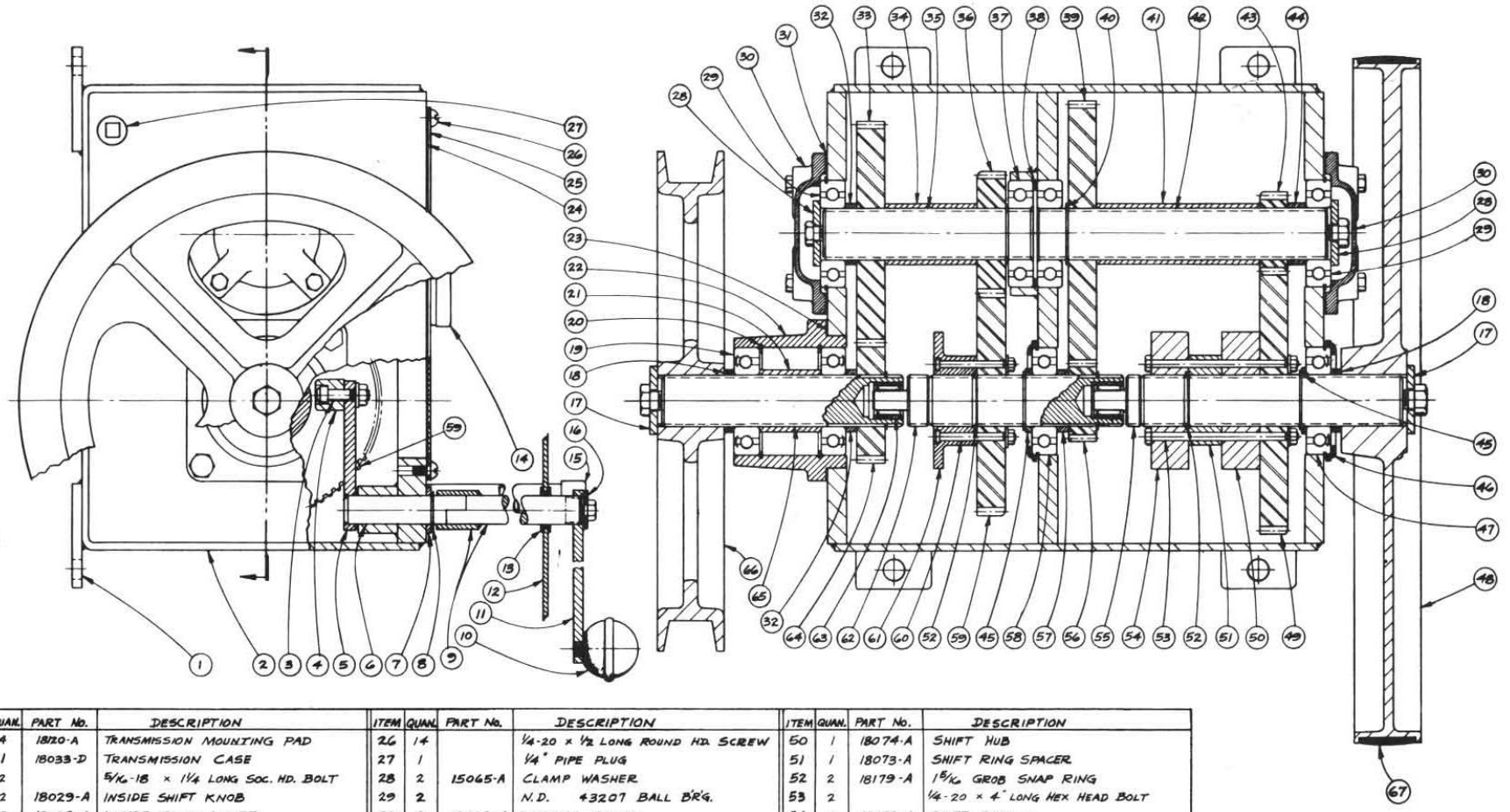


Note: Alternate Wing Available to Provide Earlier Steering Release.
Release with Standard WHLT-03 = +- 45 Deg
Release with Optional WHLT-03A = +-25 Deg (May be Hand Ground to Release from 25 to 50 Deg)
TO SET PRELOAD IN VERTICAL AXLE #6: Be certain #3 Springs Are Installed. Seat Upper Nut #5 Fully & Insert Cotter Pin #7. Tighten Lower Nut #5 Slowly Until All Freeplay of Springs #3 are removed and Fork #11 No Longer Rotates Freely. Loosen Lower Nut #5 2-3 Locking Features and Install Cotter Pin #7. Fork Should Rotate Freely Around Complete Rotation.

MATCO mfg
550W 3615 South
Salt Lake City, Utah 84115 USA

NOMENCLATURE: TAIL WHEEL, 6" PNEUMATIC		PART NUMBER: WHLT-6P	SCALE: 1:4	TOLERANCES (EXCEPT AS NOTED) DO NOT SCALE DRAWING LINEAR .XX = ± .03, .XXX = ± .01, ANGULAR ± 1/2, CONCENTRIC ± .01
MATERIAL: VARIOUS	DRAWING NO.: TAIL/3D-T6P	REVISION: NC	Est Wt. (lb): 4.83	
DRAWN BY: George R. Happ	FINISH: VARIES	DATE: 3/20/2006	CHECKED BY	SHEET 1 OF 1, SHEET SIZE A

18180



ITEM	QUAN.	PART No.	DESCRIPTION
1	4	18120-A	TRANSMISSION MOUNTING PAD
2	1	18033-D	TRANSMISSION CASE
3	2		5/16-18 × 1¼ LONG SOC. HD. BOLT
4	2	18029-A	INSIDE SHIFT KNOB
5	2	18028-A	INSIDE SHIFT LEVER
6	2	18068-A	SHIFTING PIVOT PIN
7	2	15243-A	RETAINING WASHER
8	2		TRU. # 5100-75 SNAP RING
9	2	18075-A	SHIFTING SHAFT
10	2	GS-2218-A	SHIFT KNOB
11	2	18061-A	SHIFT LEVER
12	1		FRAME
13	1	F-319-A	BUSHING
14	1	S-1226-A	AIR FILTER
15	1	18172-A	OIL DIP STICK
16	2	18124-A	SHIFTING SHAFT CLAMP WASHER
17	2	18123-A	PULLEY CLAMP WASHER
18	2	18171-A	PULLEY SPACER
19	2		N.D. Z9507 BALL BR'G.
20	2		TRU. # 5000-281 SNAP RING
21	1	18003-A	BEARING SPACER
22	1	18178-B	BEARING HOUSING
23	1	18088-A	BEARING HOUSING GASKET
24	1	18091-A	TRANSMISSION COVER GASKET
25	1	18110-B	TRANSMISSION COVER
26	14		¼-20 × ½ LONG ROUND HD. SCREW
27	1		¼" PIPE PLUG
28	2	15065-A	CLAMP WASHER
29	2		N.D. 43207 BALL BR'G.
30	2	18022-A	BEARING COVER
31	2	18089-A	BEARING COVER GASKET
32	2	18004-A	GEAR SPACER
33	1	18014-A	58 T. GEAR
34	1	18015-A	GEAR SPACER
35	1	18013-B	FIRST REDUCTION SHAFT
36	1	18016-A	31 TOOTH GEAR
37	2		N.D. 3207 BALL BR'G.
38	1	18017-A	BEARING SPACER
39	1	18019-A	69 T. GEAR
40	6		TRU. # 5100-137
41	1	18021-A	GEAR SPACER
42	1	18018-B	SECOND REDUCTION SHAFT
43	1	18020-A	20 T. GEAR
44	1	18076-A	GEAR SPACER
45	2	18010-A	BROACHED BEARING SPACER
46	2	18026-A	BEARING CLAMP RING
47	1		N.D. # Z499507 BALL BR'G.
48	1	18105-B	LOWER SAW PULLEY FOR 4V-18,
	1	24007-C	LOWER SAW PULLEY FOR 4V-24, 4V-36, 4V-60
49	1	18024-A	69 T. GEAR
50	1	18074-A	SHIFT HUB
51	1	18073-A	SHIFT RING SPACER
52	2	18179-A	1 5/16 GROB SNAP RING
53	2		¼-20 × 4" LONG HEX HEAD BOLT
54	1	18072-A	SHIFT RING
55	1	18023-B	SAW PULLEY SHAFT
56	1	18011-A	20 T. GEAR
57	1	18012-A	GEAR SPACER
58	1		N.D. 43207 BALL BR'G.
59	1	18007-A	58 T. GEAR
60			¼-20 × 2½" LONG SOC. HEAD BOLT
61	1	18071-A	SHIFT RING
62	1	18006-B	IDLER SHAFT
63	2		ORANGE # 7113-C.T NEEDLE BR'G.
64	1	18005-A	31 T. GEAR
65	1	18001-B	INPUT SHAFT
66	1	18055-C	DRIVE PULLEY FOR 4V-18
	1	24001-C	DRIVE PULLEY FOR 4V-24, 4V-36, 4V-60
67	1	S-2079-A	RUBBER TIRE FOR 4V-18
	1	S-1361-A	RUBBER TIRE FOR 4V-24, 4V-36, 4V-60

FIRST USED ON 4V-18 SERIAL # 249

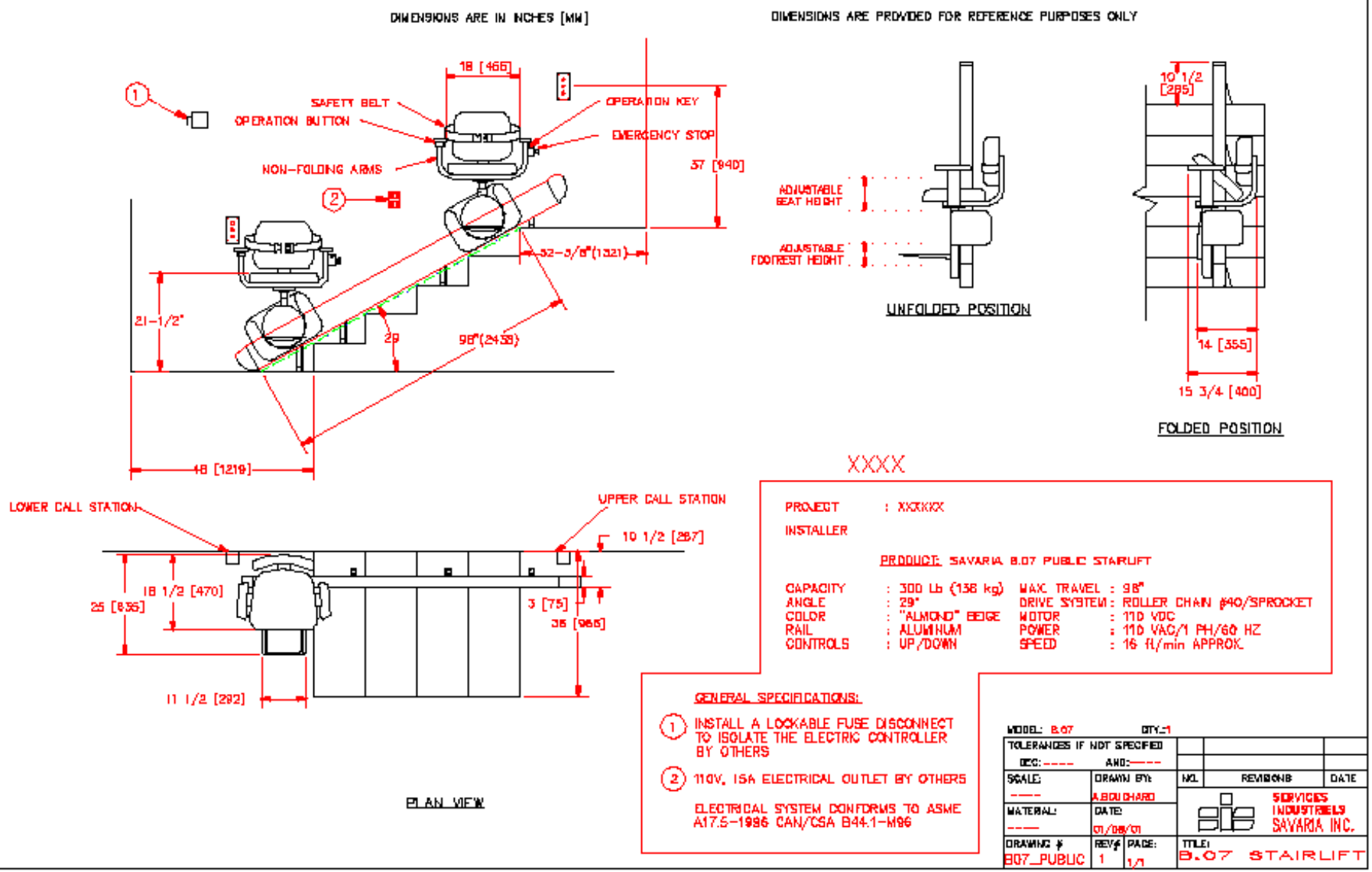
GROB INC. GRAFTON, WIS.

TRANSMISSION ASSEMBLY
FOR GROB 4V-18, 4V-24, 4V-36, 4V-60 SAVIS

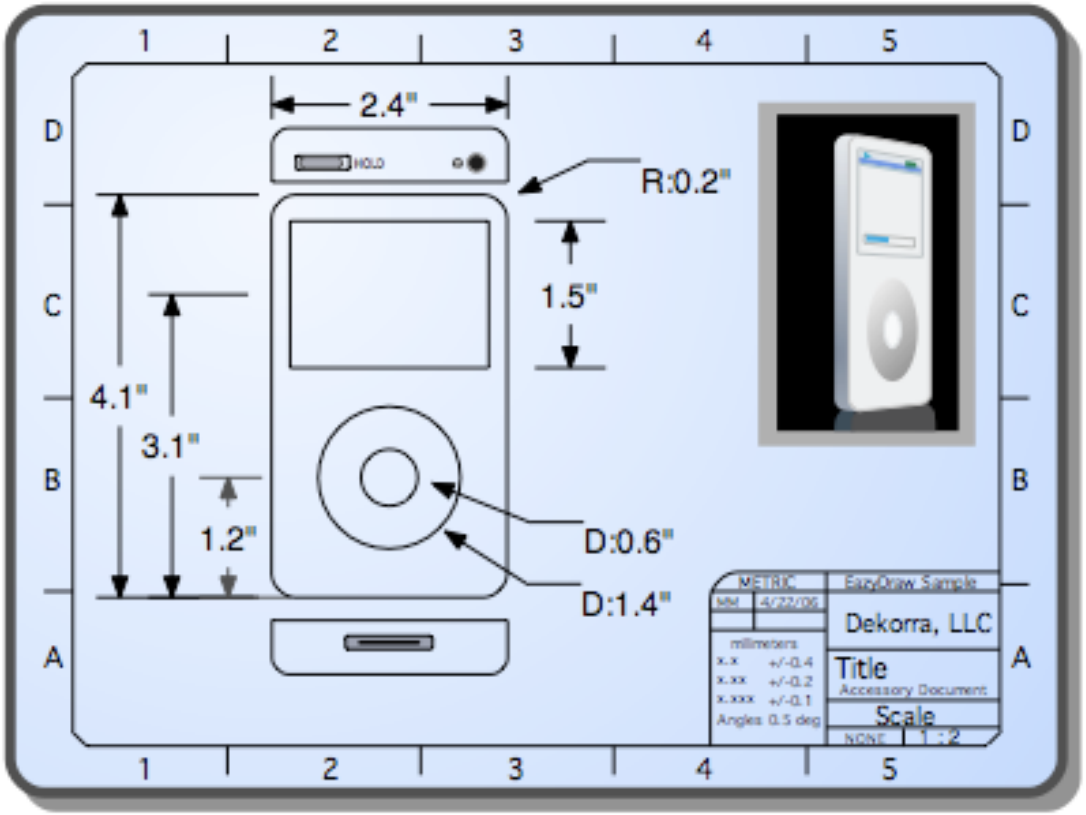
NO. REQ'D	PATT. NO.	MATERIAL	HEAT TREATMENT

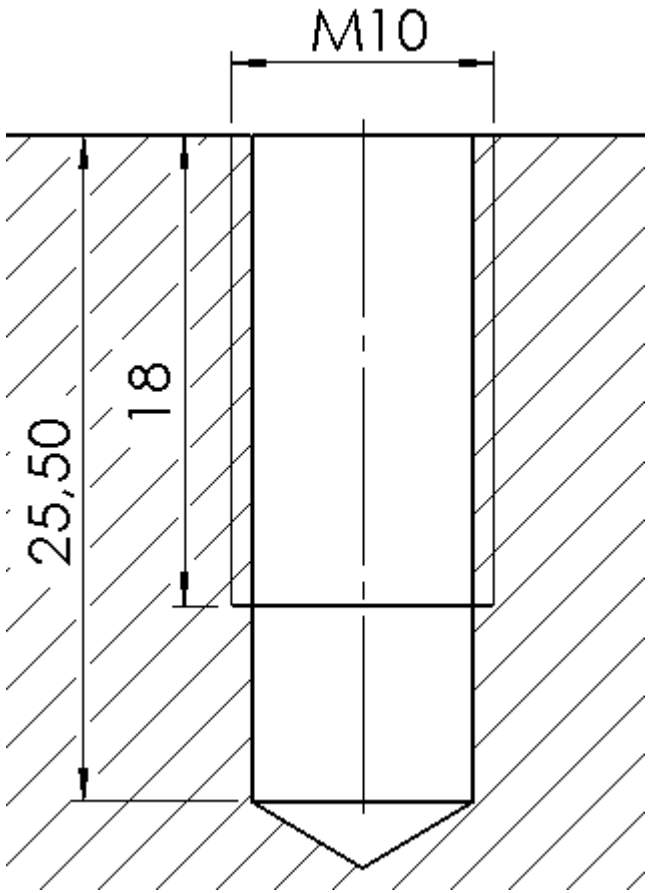
DRN. W.S.S. | TR. | CH.
DATE 2-26-68 | SCALE | O. K.

DWG. NO. 18180-C


DIMENSIONS ARE IN INCHES [MM]
DIMENSIONS ARE PROVIDED FOR REFERENCE PURPOSES ONLY
18 [466]
SAFETY BELT
OPERATION BUTTON
NON-FOLDING ARMS
OPERATION KEY
EMERGENCY STOP
37 [940]
32-3/8"(1321)
21-1/2"
29
98"(2438)
48 [1219]
ADJUSTABLE SEAT HEIGHT
ADJUSTABLE FOOTREST HEIGHT
UNFOLDED POSITION
10 1/2 [285]
14 [355]
15 3/4 [400]
FOLDED POSITION
LOWER CALL STATION
UPPER CALL STATION
10 1/2 [267]
25 [635]
18 1/2 [470]
3 [75]
35 [965]
11 1/2 [292]
PLAN VIEW
XXXX
PROJECT : XXXXXX
INSTALLER
PRODUCT: SAVARIA B.07 PUBLIC STAIRLIFT
CAPACITY : 300 Lb (136 kg)
ANGLE : 29°
COLOR : "ALMOND" BEIGE
RAIL : ALUMINUM
CONTROLS : UP/DOWN
MAX. TRAVEL : 98"
DRIVE SYSTEM : ROLLER CHAIN #40/SPROCKET
MOTOR : 110 VDC
POWER : 110 VAC/1 PH/60 HZ
SPEED : 16 ft/min APPROX.
GENERAL SPECIFICATIONS:
1 INSTALL A LOCKABLE FUSE DISCONNECT TO ISOLATE THE ELECTRIC CONTROLLER BY OTHERS
2 110V, 15A ELECTRICAL OUTLET BY OTHERS
ELECTRICAL SYSTEM CONFORMS TO ASME A17.5-1996 CAN/CSA B44.1-M96
MODEL: B.07 QTY.:1
TOLERANCES IF NOT SPECIFIED
DEC:---- AND:----
SCALE: ----
DRAWN BY: A.BOUCHARD
MATERIAL: ----
DATE: 01/08/01
DRAWING #: B07_PUBLIC
REV'#: 1
PAGE: 1/1
NO. REVISIONS DATE
SERVICES INDUSTRIELS SAVARIA INC.
TITLE: B.07 STAIRLIFT

More Examples





GEOMETRIC TOLERANCING

(TYPICAL)

Form Characteristics

- FLATNESS
- STRAIGHTNESS
- ANGULARITY
- PERPENDICULARITY
- PARALLELISM
- ROUNDNESS
- CYLINDRICITY
- PROFILE
- PROFILE

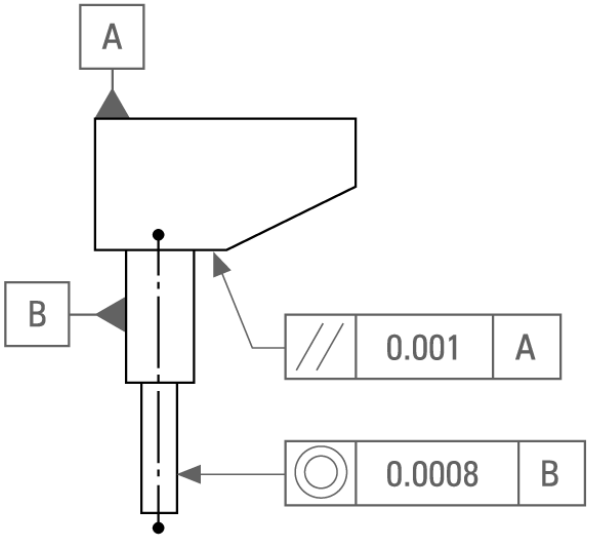
Position Characteristics

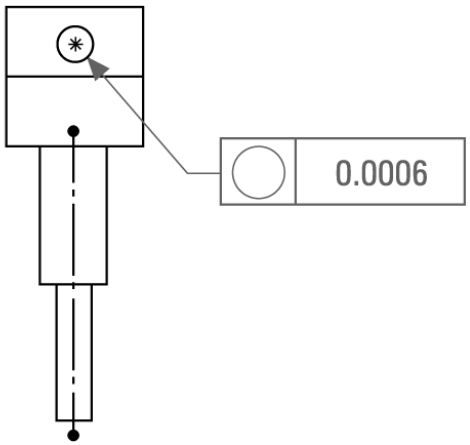
- TRUE POSITION
- CONCENTRICITY
- SYMMETRY

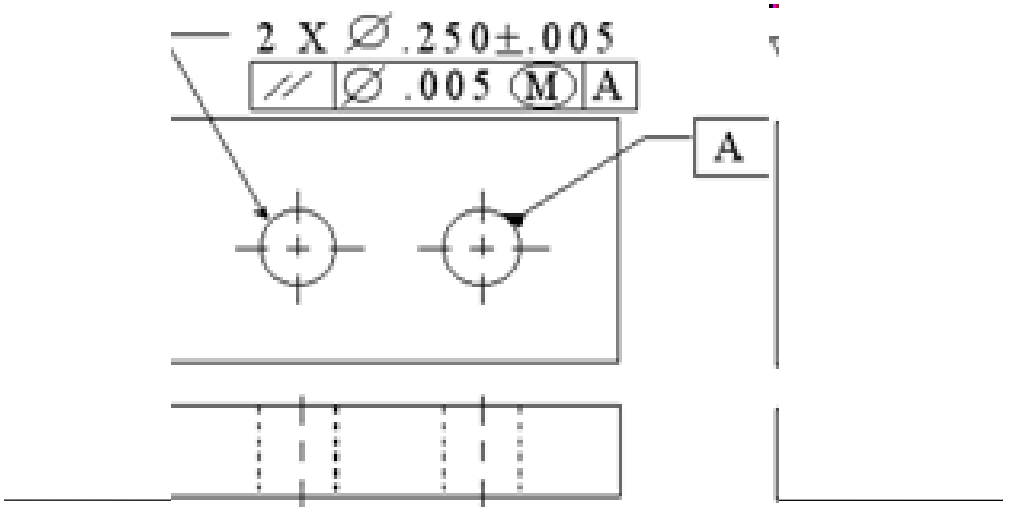
Datum Identification –A– (Example)

FEATURE CONTROL | A | .005 (Example)

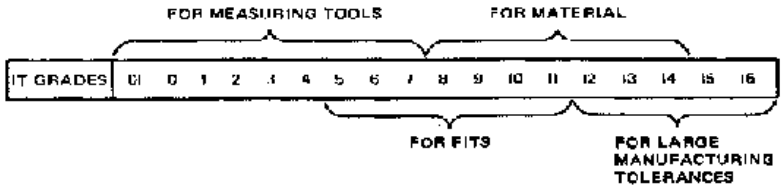
NOTE: Thin Section min to .125"
Thick Section .500" upwards







Engineering Tolerances



Engineers Edge

Basic Sizes		International Tolerance Grades																
Over	Up to and Including	IT 01	IT 0	IT 1	IT 2	IT 3	IT 4	IT 5	IT 6	IT 7	IT 8	IT 9	IT 10	IT 11	IT 12	IT 13	IT 14	IT 15	IT 16
0	3	0.0003	0.0005	0.0008	0.0012	0.002	0.003	0.004	0.006	0.010	0.014	0.025	0.040	0.060	0.100	0.140	0.250	0.400	0.600
3	6	0.0004	0.0006	0.001	0.0015	0.0025	0.004	0.005	0.008	0.012	0.018	0.030	0.048	0.075	0.120	0.180	0.300	0.480	0.750
6	10	0.0004	0.0006	0.001	0.0015	0.0025	0.004	0.006	0.009	0.015	0.022	0.036	0.058	0.090	0.150	0.220	0.360	0.580	0.900
10	18	0.0005	0.0008	0.0012	0.002	0.003	0.005	0.008	0.011	0.018	0.027	0.043	0.070	0.110	0.180	0.270	0.430	0.700	1.100
18	30	0.0006	0.001	0.0016	0.0026	0.004	0.006	0.009	0.013	0.021	0.033	0.052	0.084	0.130	0.210	0.330	0.520	0.840	1.300
30	50	0.0008	0.001	0.0016	0.0026	0.004	0.007	0.011	0.016	0.025	0.039	0.062	0.100	0.160	0.250	0.390	0.620	1.000	1.600
50	80	0.0008	0.0012	0.002	0.003	0.005	0.008	0.013	0.019	0.030	0.046	0.074	0.120	0.190	0.300	0.460	0.740	1.200	1.900
80	120	0.001	0.0015	0.0025	0.004	0.006	0.010	0.015	0.022	0.035	0.054	0.087	0.140	0.220	0.350	0.540	0.870	1.400	2.200
120	180	0.0012	0.002	0.0035	0.005	0.008	0.012	0.018	0.025	0.040	0.063	0.100	0.160	0.250	0.400	0.630	1.000	1.600	2.500
180	250	0.002	0.003	0.0046	0.007	0.010	0.014	0.020	0.029	0.046	0.072	0.115	0.185	0.290	0.460	0.720	1.150	1.850	2.900
250	315	0.0025	0.004	0.006	0.008	0.012	0.016	0.023	0.032	0.052	0.081	0.130	0.210	0.320	0.520	0.810	1.300	2.100	3.200
315	400	0.003	0.005	0.007	0.009	0.013	0.018	0.025	0.036	0.057	0.089	0.140	0.230	0.360	0.570	0.890	1.400	2.300	3.600
400	500	0.004	0.006	0.008	0.010	0.015	0.020	0.027	0.040	0.063	0.097	0.155	0.250	0.400	0.630	0.970	1.550	2.500	4.000
500	630	0.0045	0.006	0.009	0.011	0.016	0.022	0.030	0.044	0.070	0.110	0.175	0.280	0.440	0.700	1.100	1.750	2.800	4.400
630	800	0.005	0.007	0.010	0.013	0.018	0.026	0.035	0.050	0.080	0.125	0.200	0.320	0.500	0.800	1.250	2.000	3.200	5.000
800	1000	0.0055	0.008	0.011	0.015	0.021	0.029	0.040	0.056	0.090	0.140	0.230	0.360	0.560	0.900	1.400	2.300	3.600	5.600
1000	1250	0.0065	0.009	0.013	0.018	0.024	0.034	0.046	0.066	0.105	0.165	0.260	0.420	0.660	1.050	1.650	2.600	4.200	6.600
1250	1600	0.008	0.011	0.015	0.021	0.029	0.040	0.054	0.078	0.125	0.196	0.310	0.500	0.780	1.250	1.950	3.100	5.000	7.800
1600	2000	0.009	0.013	0.018	0.025	0.035	0.048	0.065	0.092	0.150	0.230	0.370	0.600	0.920	1.500	2.300	3.700	6.000	9.200
2000	2500	0.011	0.015	0.022	0.030	0.041	0.057	0.077	0.110	0.175	0.280	0.440	0.700	1.100	1.750	2.800	4.400	7.000	11.000
2500	3150	0.013	0.018	0.026	0.036	0.050	0.069	0.093	0.135	0.210	0.330	0.540	0.860	1.350	2.100	3.300	5.400	8.600	13.500

Engineering Tolerances (ISO)

- IT01, IT0, IT1, IT2, IT3, IT4, IT5, IT6.. Production of gauges and instruments.
- IT 5, IT6, IT7, IT8, I9, IT10, IT11, IT12...Precision and general Industry.
- IT11, IT14, IT15, IT16..Semi finished products
- IT16, IT17, IT18 ..Structural Engineering

Engineering Tolerances (English System)

- RC: Running and sliding

  (Allowance >0, Max Clearance >0)
- LC: Clearance and locational

  (Allowance =0, Max Clearance >0)
- LT: Transition locational

  (Allowance <0, Max Clearance >0)
- LN: Interference locational

  (Allowance <0, Max Clearance =0)
- FN: Force and shrink

  (Allowance <0, Max Clearance <0)

Example (ISO)

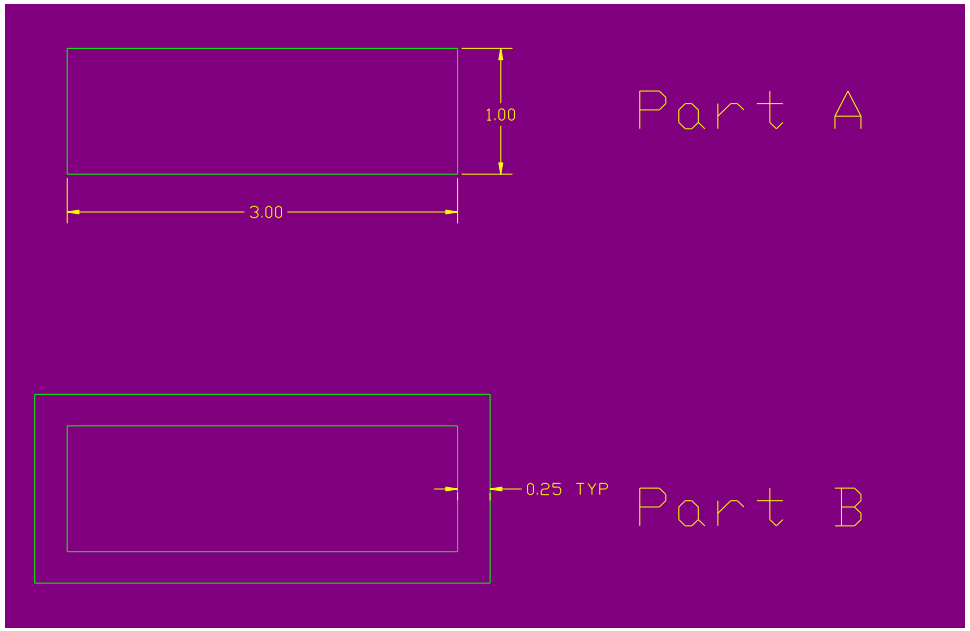
- Fit 6 H7/n6:
  - Metric: Preferred Hole Basis (H)
  - Allowance: -0.016
  - Max. Clearance: 0.004
  - Hole Limits: 6.012 / 6.000
  - Shaft Limits: 6.016 / 6.008
  - Hole Tolerance: 0.012
  - Shaft Tolerance: 0.008
  - Type of fit: Transition

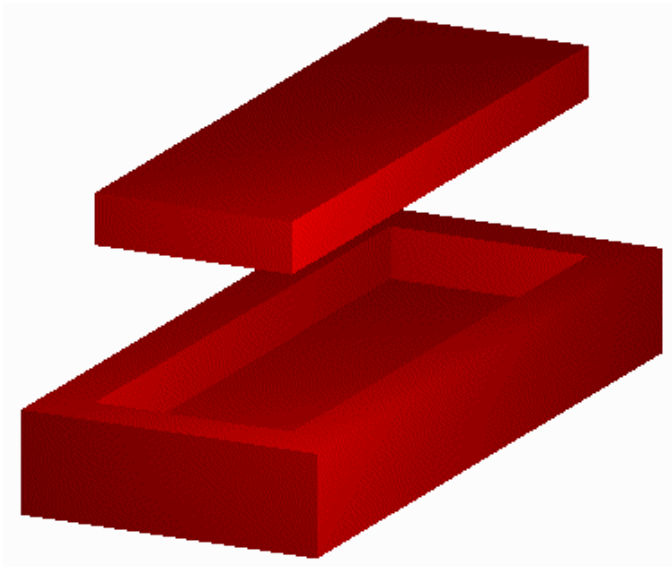
Example (English System)

- Fit 0.25 FN 1:
  - English: Preferred Precision Fit, Hole Basis
  - Allowance: -0.00075
  - Max. Clearance: -0.00010
  - Hole Limits: 0.25040 / 0.25000
  - Shaft Limits: 0.25075 / 0.25050
  - Hole Tolerance: 0.00040
  - Shaft Tolerance: 0.00025
  - Type of fit: Force

Example

- Part A fits into part B
- All dimensions for part A are held ✎0.010
- Specify the dimensions and tolerance for B with an allowance of 0.010



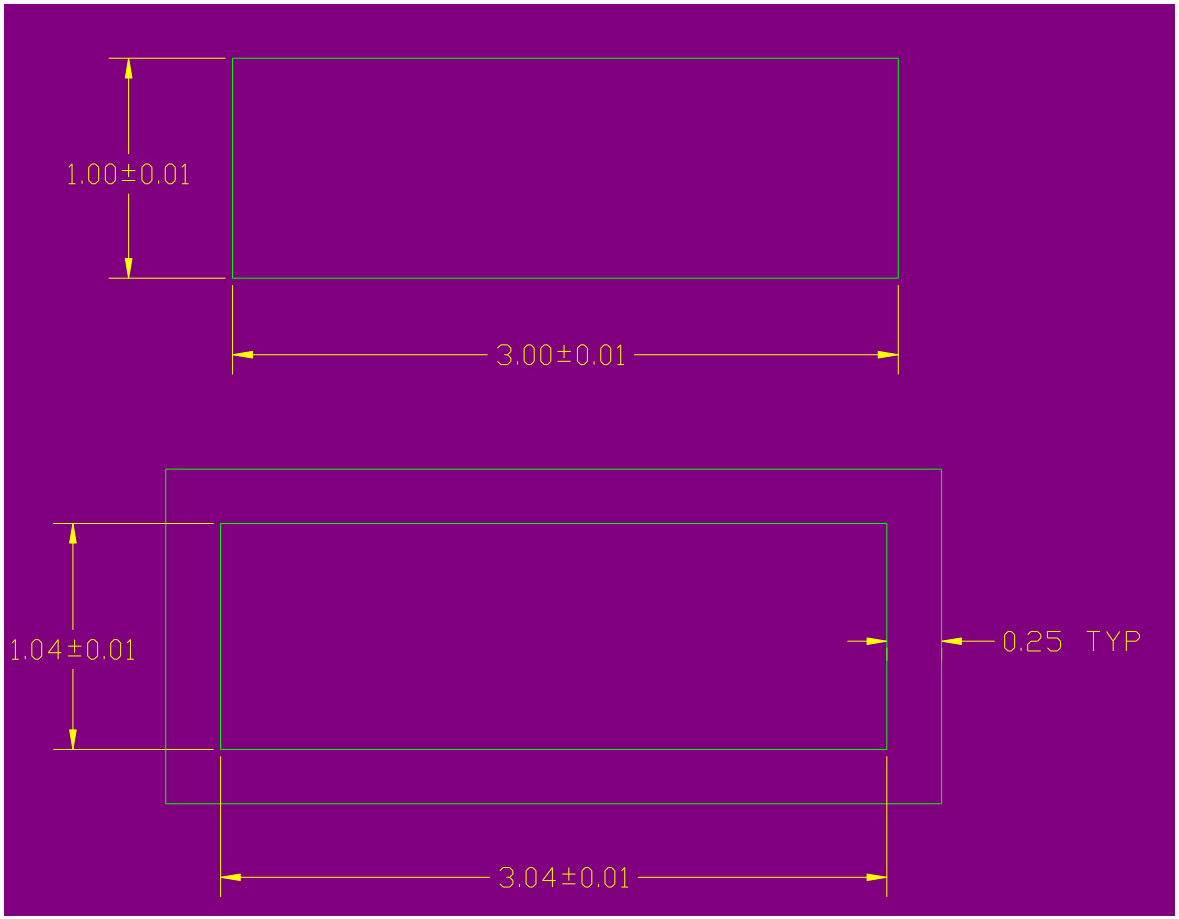


Example

- Solution with allowance of .010

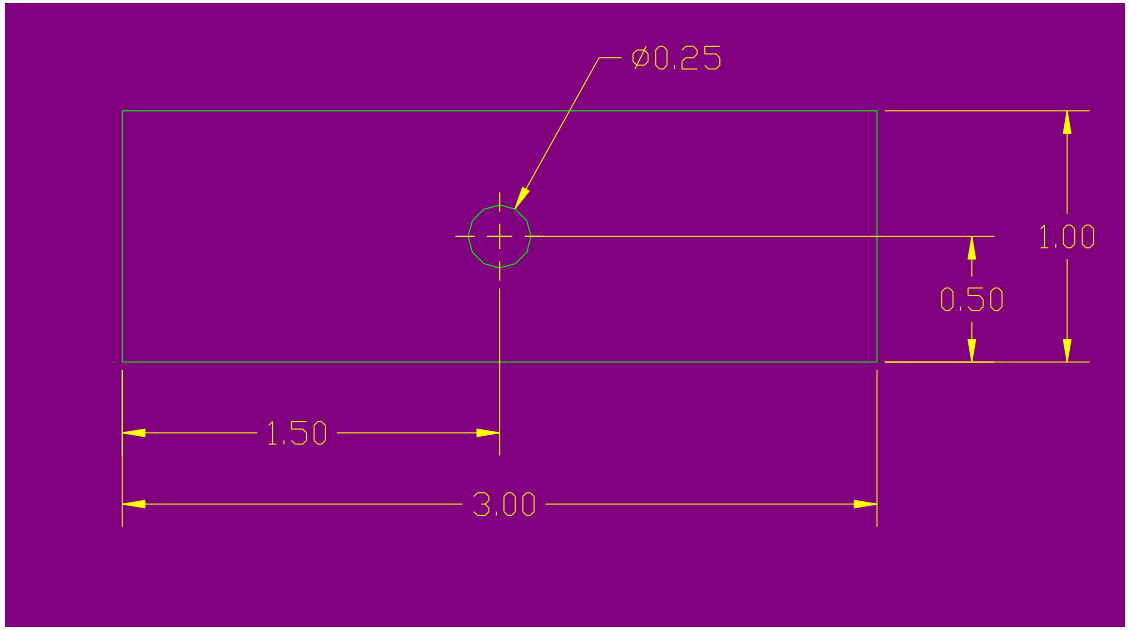
Part A

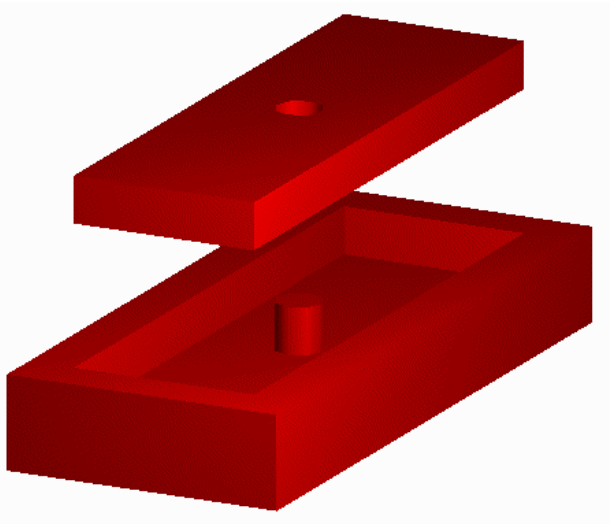
Part B



Example

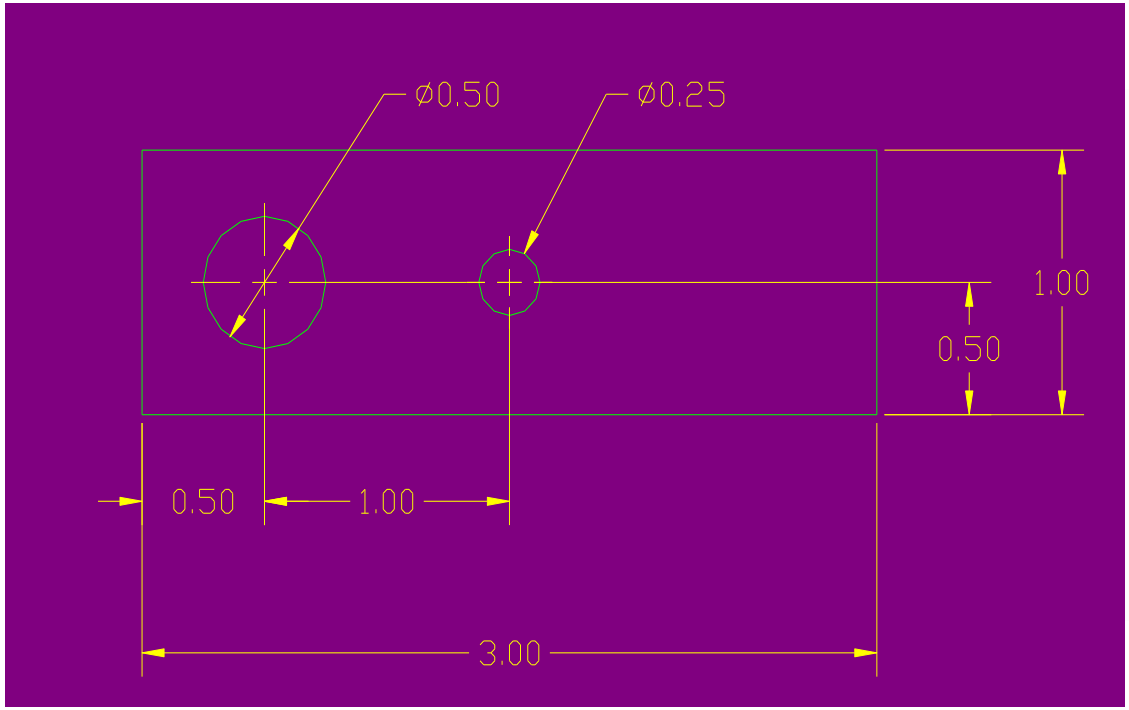
- Allowance equals 0.010
- Specify dimensions and tolerance for part B

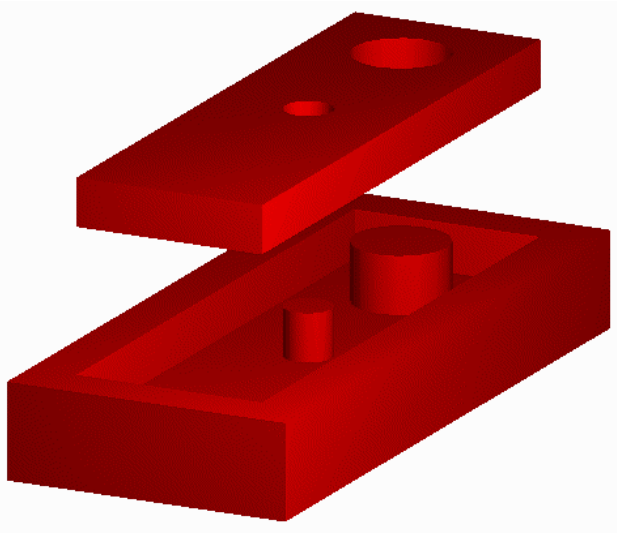




Example

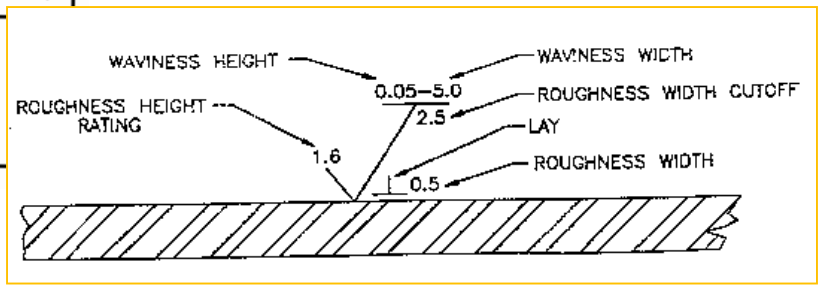
- Allowance equals 0.010
- Specify dimensions and tolerance for part B



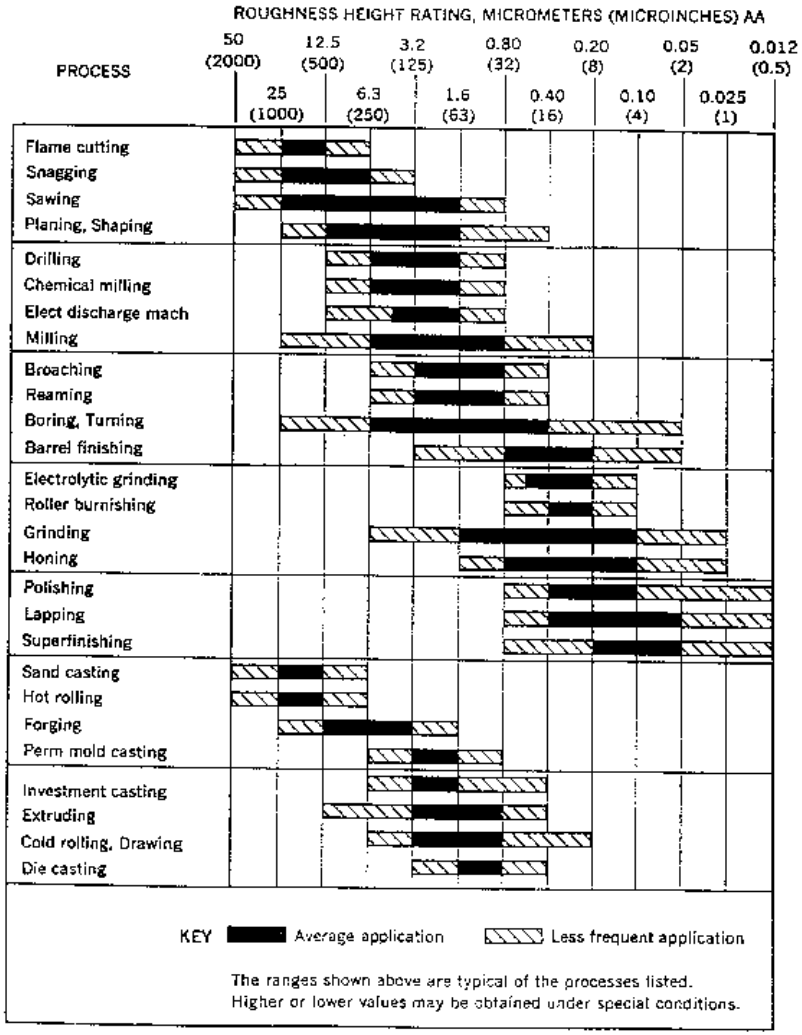


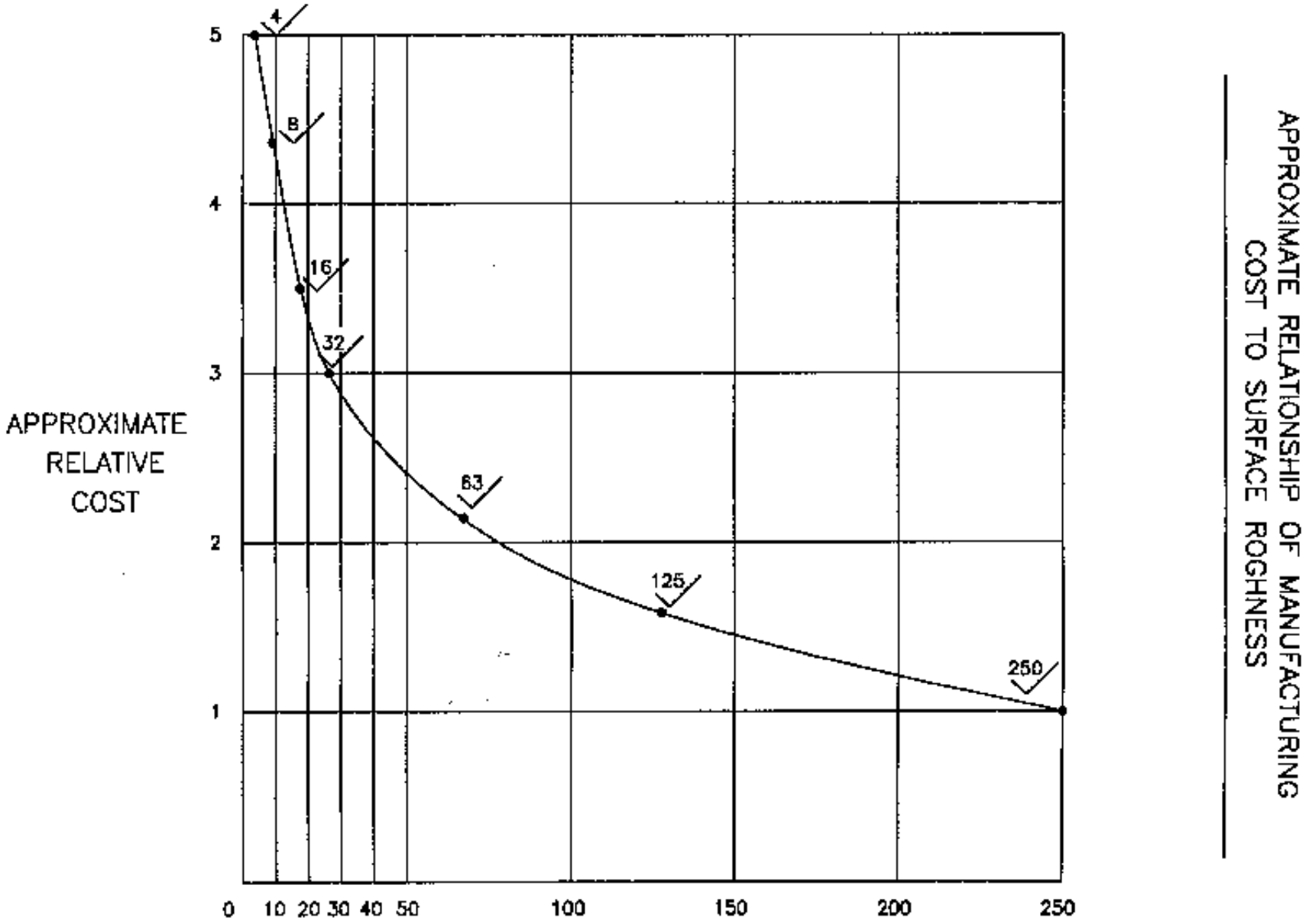
Surface Texture Control Symbols

SYMBOL	INTERPRETATION	SYMBOL	INTERPRETATION
1.6	Roughness height rating is placed at the left of the long leg. The specification of only one rating shall indicate the maximum value and any lesser value shall be acceptable.	1.6 0.8 0.05-5.0 ⊥	Lay designation is indicated by the lay symbol placed at the right of the long leg.
1.6 0.8	The specification of maximum value and minimum value roughness height ratings indicates permissible range of value rating.	1.6 0.8 0.05-5.0 2.5 ⊥	Roughness-width cutoff rating is placed below the horizontal extension. When not value is shown, 0.80 is assumed.
1.6 0.8 0.05	Maximum waviness height rating is placed above the horizontal extension. Any lesser rating shall be acceptable.	1.6 0.8 0.05-5.0 2.5 ⊥ 0.5	Where required, maximum roughness width rating shall be placed at the right of the lay symbol. Any lesser rating shall be acceptable.
1.6 0.8 0.05-5.0	Maximum waviness width rating is placed above the horizontal extension and to the right of the waviness height rating. Any lesser rating shall be acceptable.	1.6 3.5	Material removal by machining is required to produce the surface. The basic amount of stock provided for material removal is specified at the left of the short leg of the symbol.
90%	Minimum requirements for contact or bearing area with a mating part or reference surface shall be indicated by a percentage value placed above the extension line as shown. Further requirements may be controlled by notes.	1.6	Removal of material is prohibited.



Surface Roughness



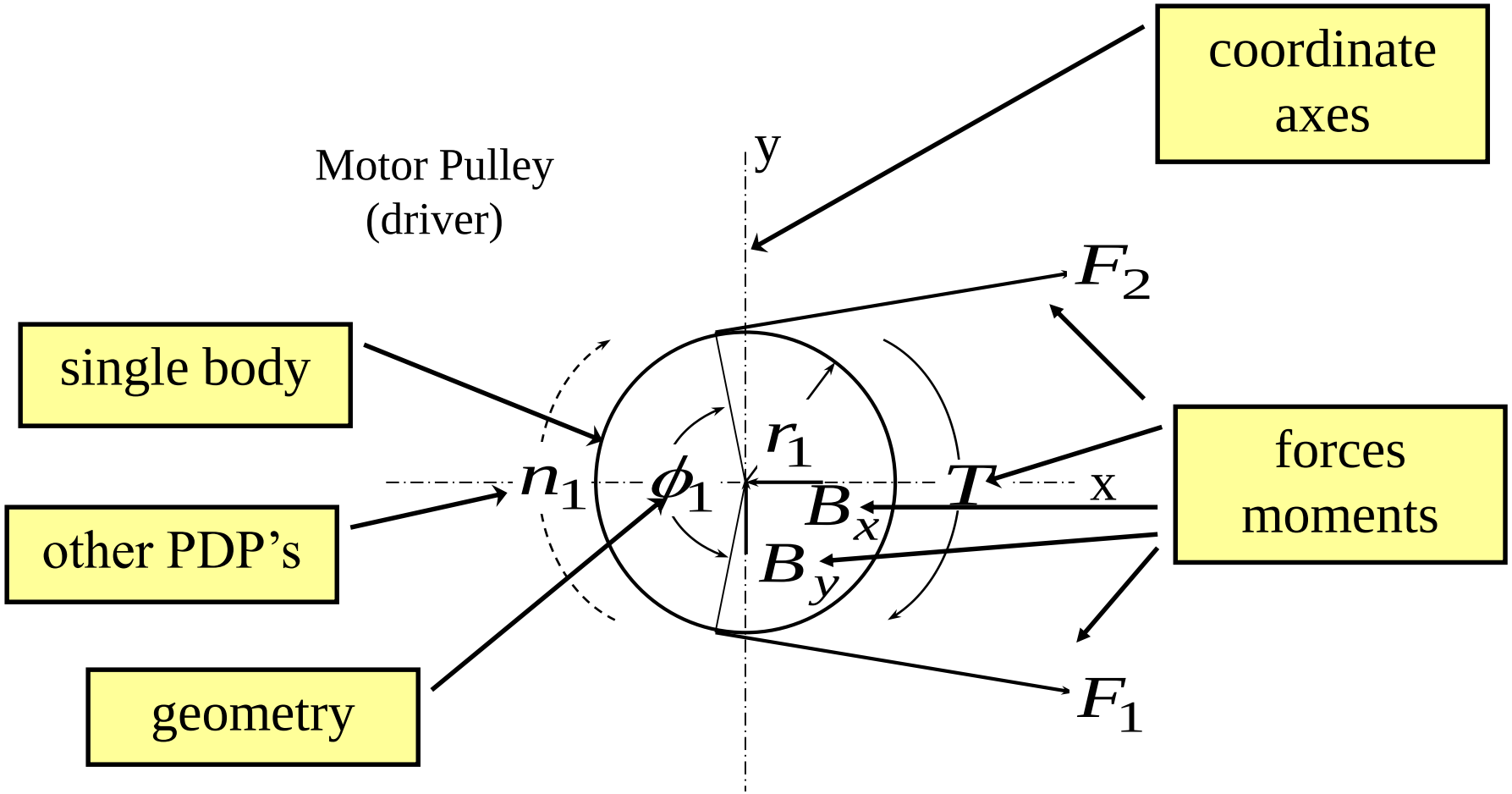


APPROXIMATE RELATIONSHIP OF MANUFACTURING COST TO SURFACE ROGHNESS

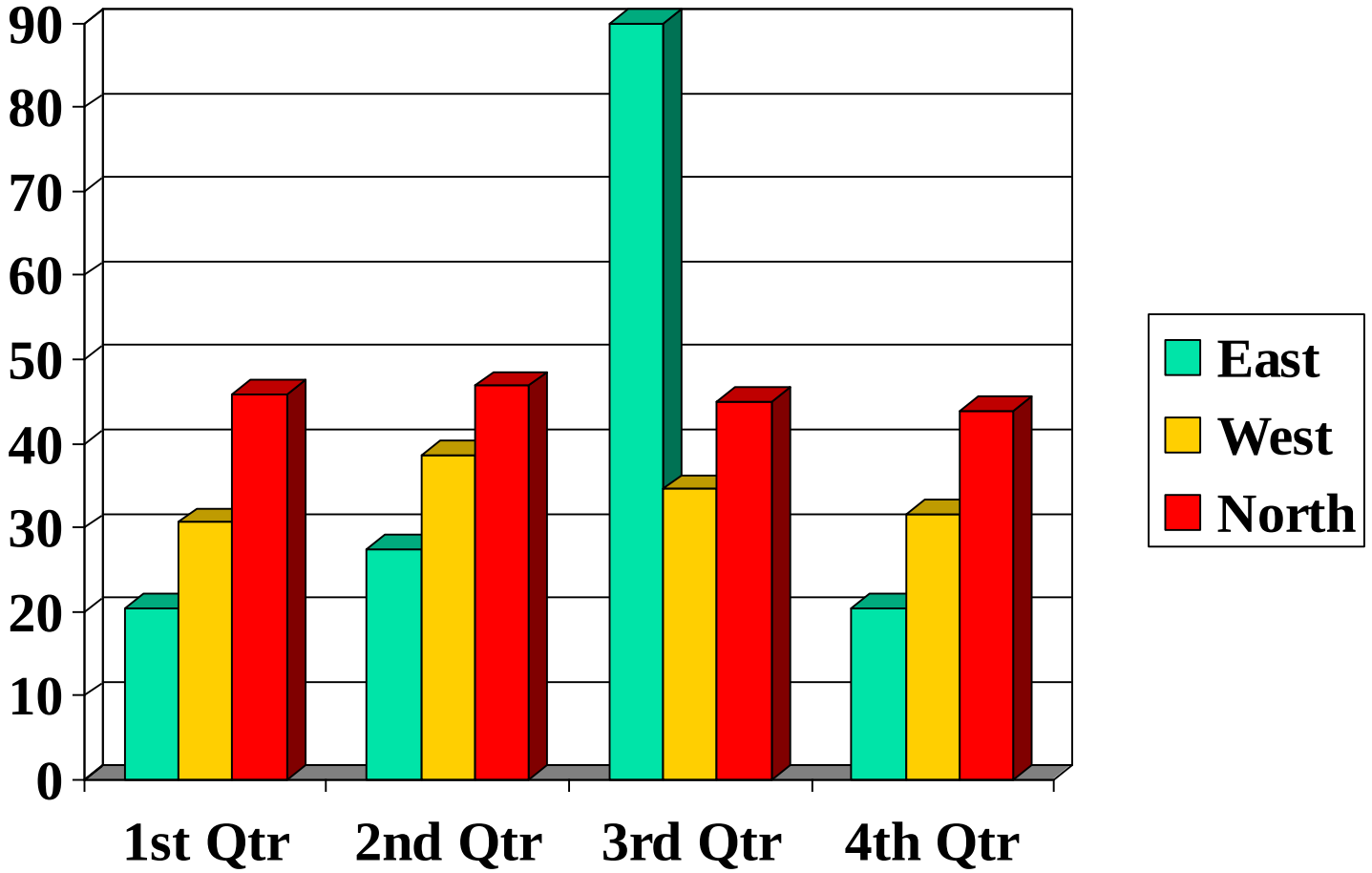
Graphic Communications – Illustrations

- ***Charts*** - portray relationship(s) among numerical data, for example sales versus time.
- ***Diagrams*** - explain how something works or the relationship between the parts. E.g. free body diagrams to analyze static equilibrium forces and moments.
- ***Schematics*** - uses abstract symbols E.g. piping schematic, or electronics schematic.
- ***Figures*** - illustrates textual material
- ***Sketches*** - hand-drawn preliminary, or rough "drawings", drawn without the use of drawing instruments.

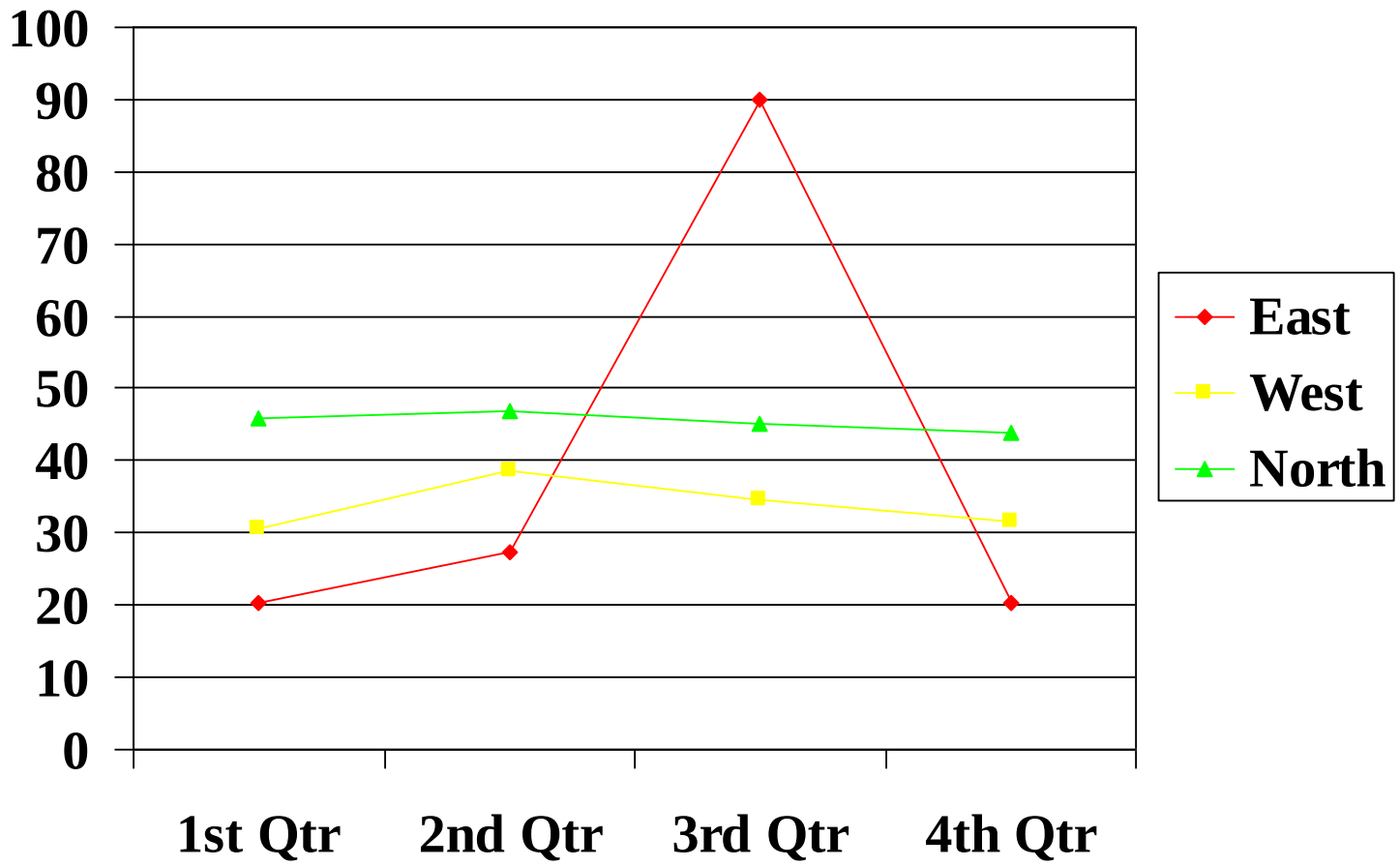
Free Body Diagram



Bar Charts


90
80
70
60
50
40
30
20
10
0
1st Qtr
2nd Qtr
3rd Qtr
4th Qtr
East
West
North

Line Chart


100
90
80
70
60
50
40
30
20
10
0
1st Qtr
2nd Qtr
3rd Qtr
4th Qtr
East
West
North

Gantt Chart

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9
Task	1/22-1/26	1/27-2/2	2/3-2/9	2/10-2/16	2/17-2/23	2/24-3/2	3/3-3/9	3/10-3/16	3/17-3/23
Design Problem Formulation									
1.1 Site Visit									
1.5 Benchmarking									
1.6 Contact Customers									
1.7 Determine PDP/DV/SEP									
1.10 Outline Work Scope									
1.8 Determine Schedule									
1.9 Calculate Budget									
1.4 Create EDS									
1.3 Satisfaction Curves									
1.2 Complete QFD/HOQ									
1.11Report 1									
Conceptual Design									
2.1,2,5,6,9 Generate Concepts									
2.7 Determine Physical Principles									
2.8 Conceptual Drawings									
2.3,4 Evaluate Concepts									
2.10 Report 2									
Configuration Design									
3.1,2,10 Determine Configuration									
3.3 Determine General Dimensions									
3.5,6 Estimate Forces									
3.9 Analyze Lifting Performance									
3.8 Analyze Tire/Wheel Performance									
3.4 Outline Cost Analysis									
3.7 Config. Sketches									

Written Design Communications

Letters / Email

- Brief communications, often < a page in length
- Sent to a few selected individuals
- On a specific, usually familiar, topic
- Email "letters" are informal in format and typically very brief.

Memoranda

- Longer than letter, from 3 to 9 pages,
- Sent to a broader audience
- Can cover more topics in greater depth than a letter.
- Memoranda often emailed as attachments

Written Design Communications

Test Reports

- Technical reports detailing engineering / scientific tests (on materials, prototypes and or products).
- Can vary in length from few pages to hundreds of pages.
- Contents include sections on: test objectives, test procedures, data/results, summary and recommendations.

Research Reports

- Similar to test reports
- But longer in length and broader in coverage
- Include additional sections such as: an abstract, background, literature review, laboratory/test program description and bibliography.

Owner Manuals

- Include sections on:
  - Setting-up / installing the product
  - Operating the product
  - Maintaining (i.e. clean, lubricate and adjust)
  - Repair, if necessary.
- Can vary in length from 1 page to hundreds of pages
- Illustrations usually very important

Engineering Change Notices

- Brief descriptions of changes made to a product

  (i.e. what, why, how)
- Detailed on a company-approved form
- Authorized (signed) and distributed to all the critical departments

Project Progress Reports

- Sent to clients and other stakeholders
- Covers project status re: workscope, schedule and budget
- Can vary in length from few to hundreds of pages
- Prepared weekly, monthly, quarterly, and annually

Design Reports

1. Introduction
2. Design Problem Formulation
3. Project Engineering
4. Concept Design
5. Configuration Design
6. Parametric Design
7. Prototype Tests
8. Final Design
9. Recommendations and Conclusions

Patent, Trademark and Copyright Information

Drawings, illustrations and textual materials are forms of *"intellectual property."*

Represent investment of company funds, and as assets, they can be protected by law under:

- patents
- trademarks or
- copyrights

Oral Presentations

How can we prepare for an excellent presentation?

1) Plan (time, topics, temperament)

2) Outline

3) Compose

4) Rehearse

5) Refine

An excellent presentation requires excellent preparation

Plan

Decide on:

- who our audience will be,
- what we wish to communicate,
- why we are giving the presentation, and
- how long it should be.

Outline

- Prepare a draft outline of the topics.
- If a group presentation, we need to agree upon responsibilities.
- Estimate the time to be devoted to each topic.
- Break up longer topics into smaller chunks.
- Combine or eliminate incidental topics.
- Discuss the draft outline with your co-workers.
- Confirm the draft outline with your immediate supervisor.

Compose

- Use the outline to compose 3x5 (or 5x7) note cards
- Write clear and concise statements for major ideas and facts
- Number each card in succession.
- Compose clear overhead slides/PowerPoint slides, use font > 20 pt.
- Prepare videos using CAD animations or camcorder movies
- Prepare posters, 35 mm slides, or working models, or demos

Rehearse

- Practice saying the note card phrases.
- Give our draft presentation to some friendly co-workers.
- Rehearse using the intended room and audio visual aids.
- Video tape and critically evaluate our delivery and visual aids.

Refine

- Revise or re-write our note cards.
- Eliminate confusing visual aids.
- Refine our visual aids.
- Revise presentation room layout or equipment.

Execution Guidelines

1. Make our listeners physically comfortable. Seating, lighting, room temperature, noise level and ventilation.
2. Expect & accept that we will be somewhat nervous. Convert nervousness to enthusiasm.
3. Take a deep breath and relax before beginning.
4. Start on time, stick to presentation schedule, and finish on time. Do not go over!
5. Pronounce clearly, sufficient volume, relaxed pace.

Execution Guidelines (continued)

6. Vary the pitch or tone of our voice occasionally.
7. Add enthusiasm to our delivery.
8. Use visual aids judiciously (sparingly).
9. Use appropriate gestures and avoid annoying mannerisms.
10. Make frequent eye contact with our audience.
11. Use a pointer when appropriate.
12. Relax and “enjoy the ride.”

Summary

- Flow of design information
- Responsibility for “details”
- Graphic communication
- Written communication
- Oral presentations