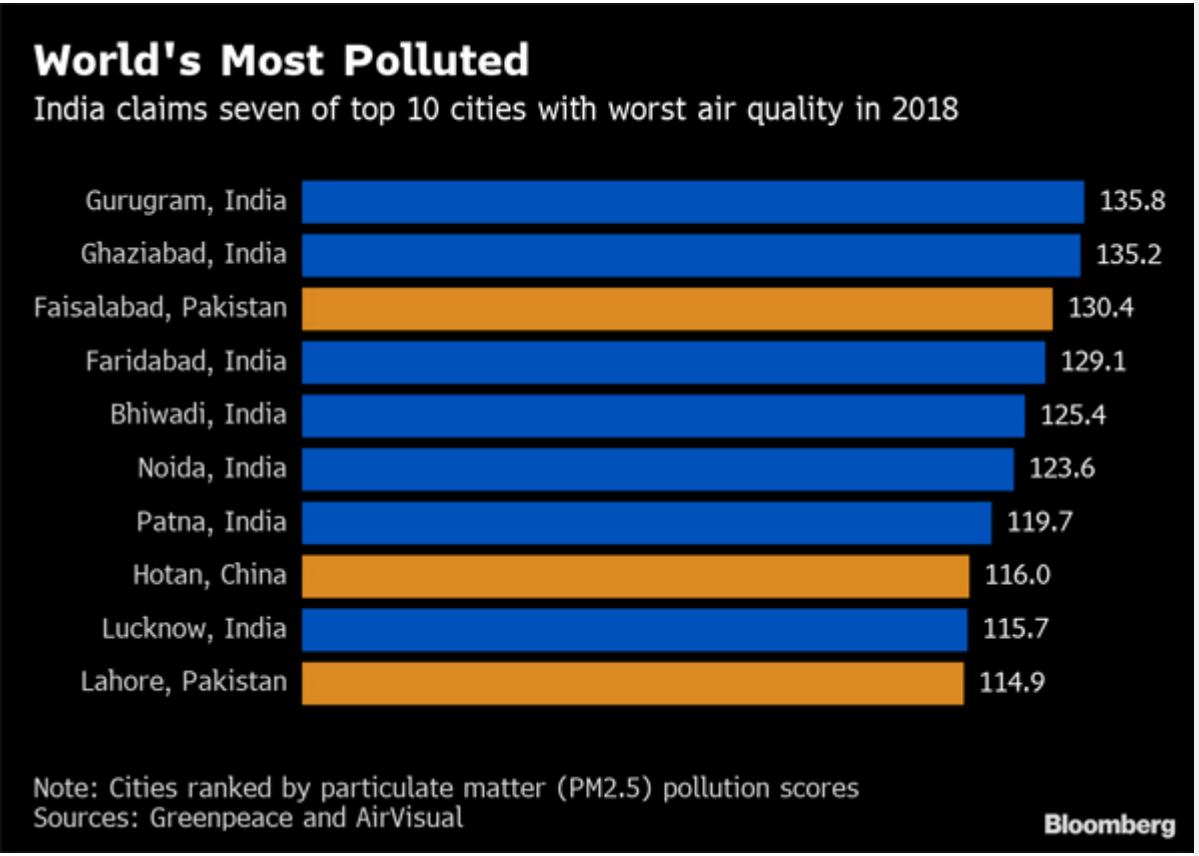
Design Practicum
From Concept to Design -- A Case Study

Dr. Arpan Gupta
Assistant Professor
School of Engineering
IIT Mandi, Kamand

agupta@iitmandi.ac.in
Room no : 202, A4 building
South Campus



Dubious distinction

Fifteen cities from India figure among the 20 most polluted places across the globe

Rank	City	2018*
1	Gurugram	135.8
2	Ghaziabad	135.2
3	Faislabad, Pakistan	130.4
4	Faridabad	129.1
5	Bhiwadi	125.4
6	Noida	123.6
7	Patna	119.7
8	Hotan, China	116
9	Lucknow	115.7
10	Lahore, Pakistan	114.9
11	Delhi	113.5
12	Jodhpur	113.4
13	Muzaffarpur	110.3
14	Varanasi	105.3
15	Moradabad	104.9
16	Agra	104.8
17	Dhaka, Bangladesh	97.1
18	Gaya	96.6
19	Kashgar, China	95.7
20	Jind	91.6

*Average PM2.5 in µg/m³

WHO Guideline

Fine Particulate Matter (PM2.5) allowed levels

10 µg/m3 annual mean
25 µg/m3 24-hour mean

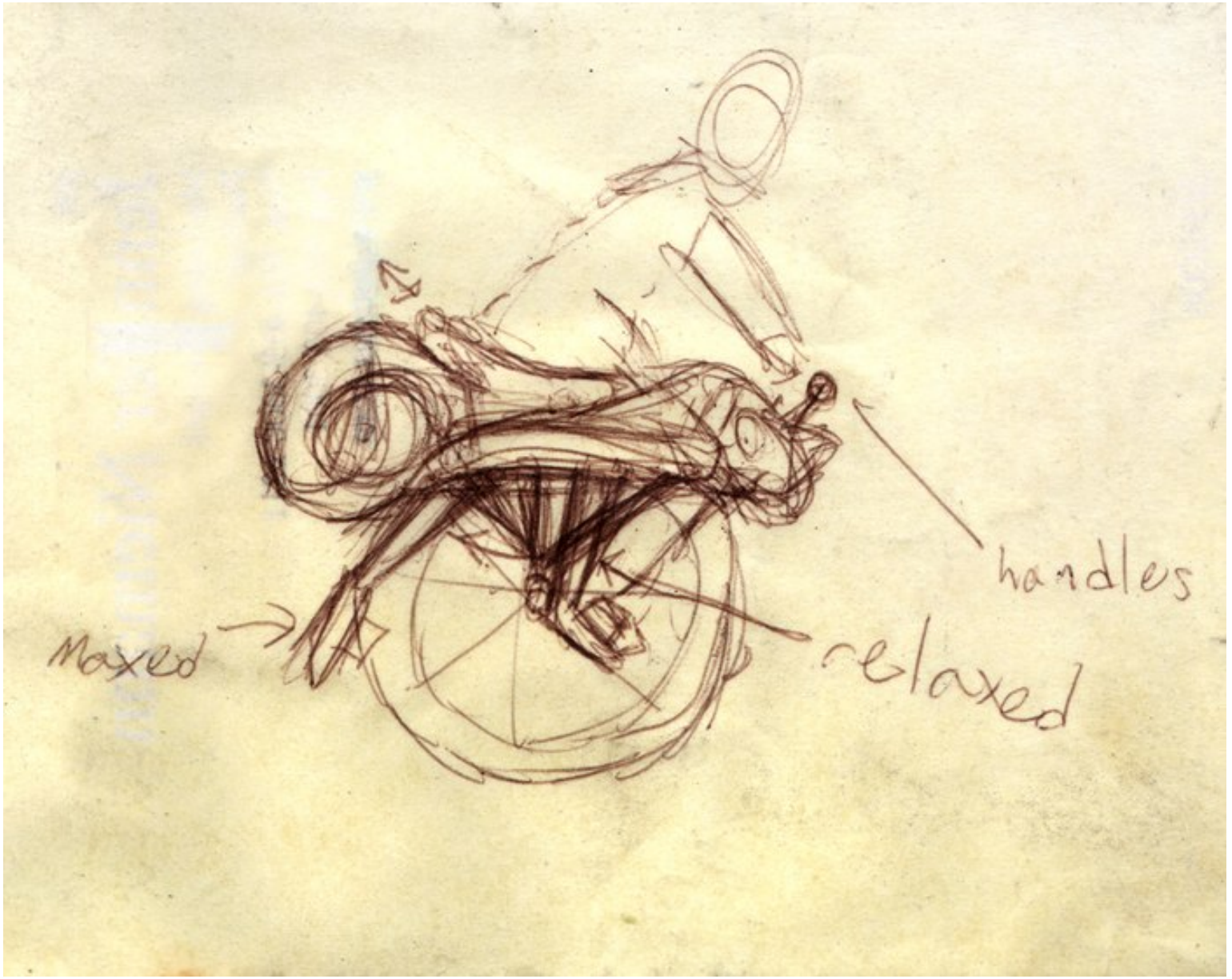
https://economictimes.indiatimes.com/news/politics-and-nation/7-of-the-top-10-most-polluted-cities-in-the-world-are-in-india/articleshow/68264913.cms
https://www.thehindu.com/sci-tech/energy-and-environment/fifteen-of-the-20-most-polluted-cities-in-the-world-are-in-india/article26440603.ece
https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health

Related problems

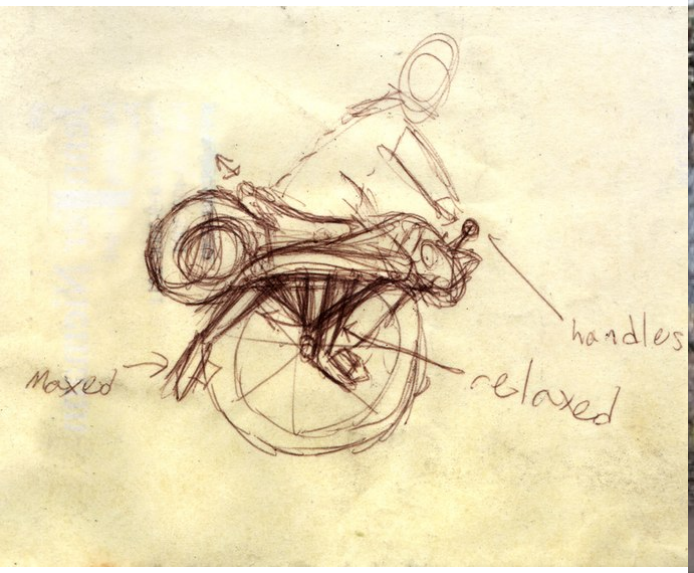
- Pollution
- Traffic
- Parking
- ....

- What is the cause?
- What can be possible solutions?

Sketch



Sketch to Final Product



Inventor of Ryno – Portland Engineer – Chirs Hoffmann.

Idea generation

- Think out of the box!
- Innovation
- Brainstorming session helps
- Individually note/draw multiple solution in your diary
- Consult other experts
-

Literature review/Prior Art Search

- Segway – use concept of inverted pendulum.
- Patent search
- www.freepatentsonline.com
- www.google.com/patents
- patft.uspto.gov/
-

Secure | https://patents.google.com/?q=unicycle&oq=unicycle

Google Patents

unicycle

SEARCH TERMS

unicycle × or + Synonym

+ Synonym

SEARCH FIELDS

Date · Priority

YYYY-MM-DD — YYYY-MM-DD

+ Inventor

+ Assignee

Patent Office · Language

Status · Type

About 6,965 results

Sort by · Relevance · Grouped by · None · Results / page · 10

Powered **unicycle**

~~US~~ • US3399742A • Franklin S Malick • Franklin S. Malick

Priority 1966-06-23 • Filing 1966-06-23 • Grant 1968-09-03 • Publication 1968-09-03

Although not limited thereto, the drive means and the control means of the present invention are particularly adapted for use on a one-wheeled vehicle commonly known as a **unicycle**. As is known, **unicycles** support a rider who, after acquiring the necessary skill, is able to balance the vehicle while ...

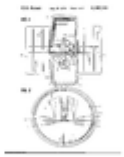
Motorized **unicycle**

~~US~~ • US3260324A • Caesar R Suarez • Caesar R Suarez

Priority 1963-11-12 • Filing 1963-11-12 • Grant 1966-07-12 • Publication 1966-07-12

July 12, 1966 C.' R. SUAREZ 3,260,324 MOTORIZED **UNICYCLE** Filed NOV. l2. 1963 FI- E- 4/ INVENTOR. Y gm/ 4f :DT-EQ2- www United States Patent O 3,260,324 MOTORIZED **UNICYCLE** Caesar R. Suarez, P.0. Box 5702 Annex Station, rl`ucson, Ariz. Filed Nov. 12, 1963, Ser. No. 322,700 1 Claim. (Cl. 180-10) The ...

Motorized **unicycle** wheel



~~US~~ • US4109741A • Charles L. Gabriel • Gabriel Charles L

Priority 1977-07-29 • Filing 1977-07-29 • Grant 1978-08-29 • Publication 1978-08-29

I claim: 1. A power operated **unicycle** wheel, comprising a fixed member, foot supporting pedals mounted on the fixed member for angular rocking movement with the fixed member, a rotatable member comprising a cup shaped body rotatably mounted on the fixed member and forming a hollow body therewith, ...

Unicycle having an eccentric wheel

~~US~~ • US5002295A • Fuh T. Lin • Pro-China Sporting Goods Industries Inc.

Priority 1990-04-19 • Filing 1990-04-19 • Grant 1991-03-26 • Publication 1991-03-26

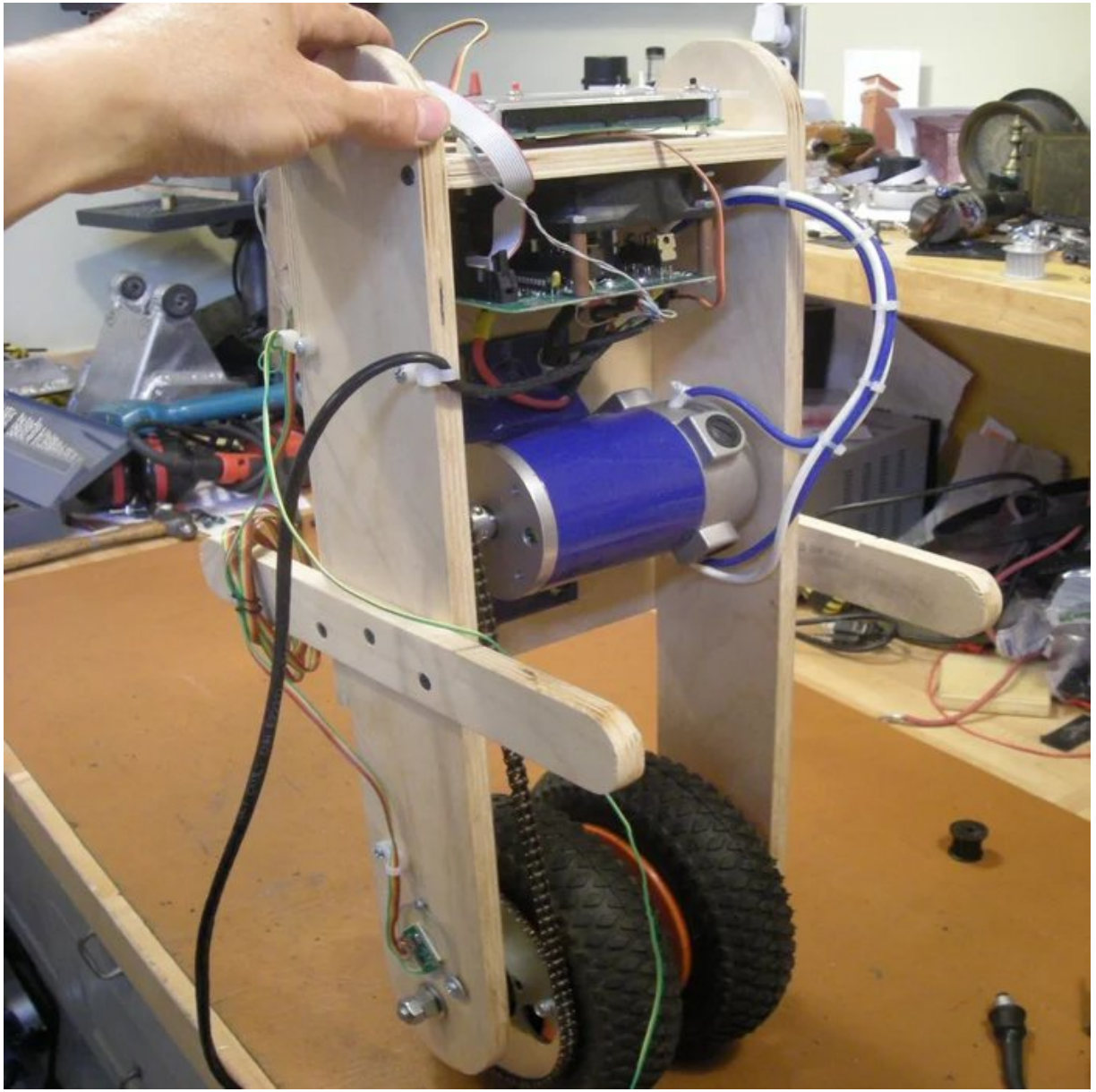
3. A **unicycle** comprising a seat provided on an upper end of a frame fork, and a pair of foot pedals provided on a lower end of said frame fork; a wheel having an outer rim and an inner rim provided therein, a plurality of

Examples

- One wheeled vehicle – patent search
- Ryno Patents.

Concept and Prototype

- Inverted pendulum
- Gyroscope



Failure are part of process

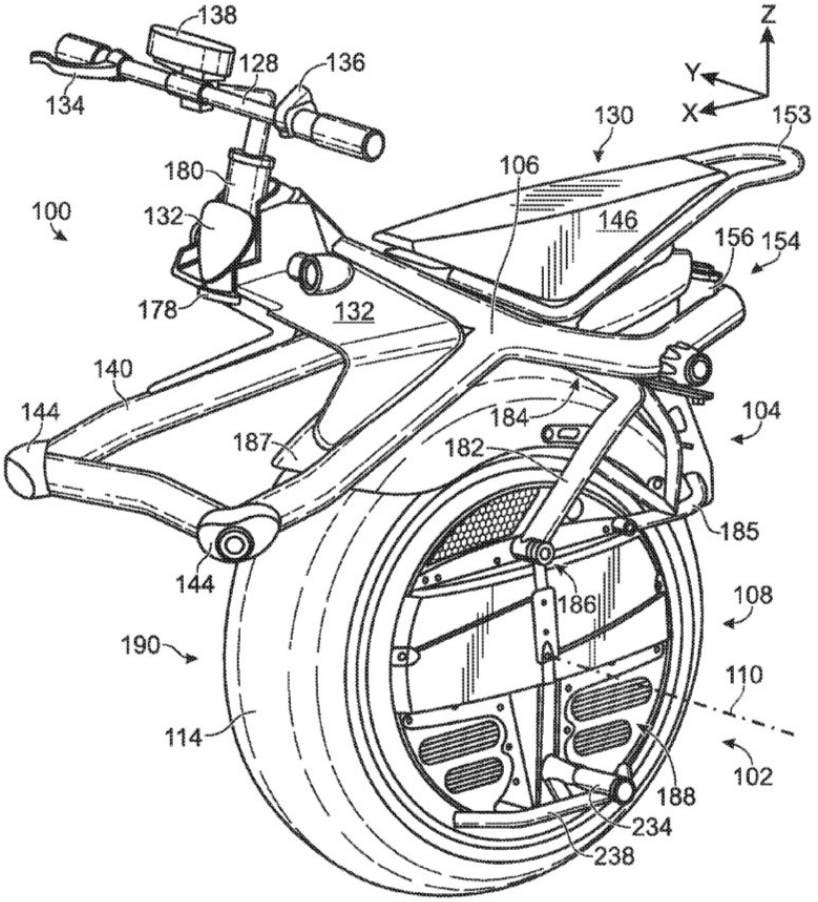

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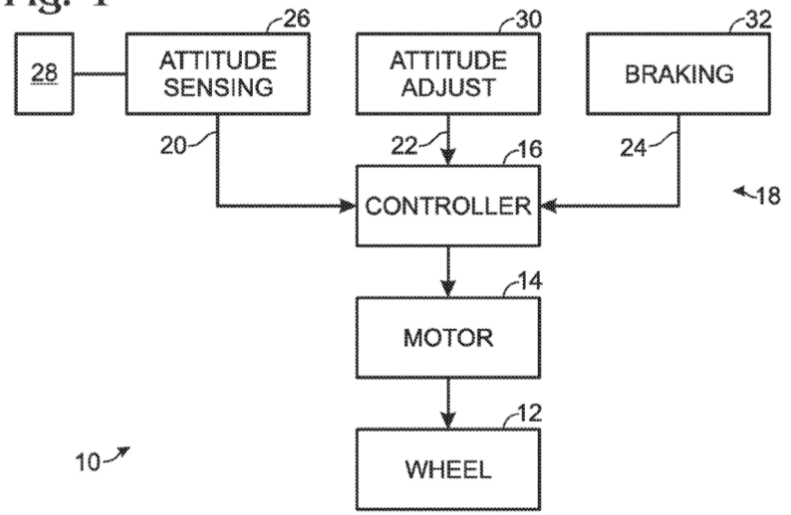
Fig. 1


28
ATTITUDE SENSING
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ATTITUDE ADJUST
30
BRAKING
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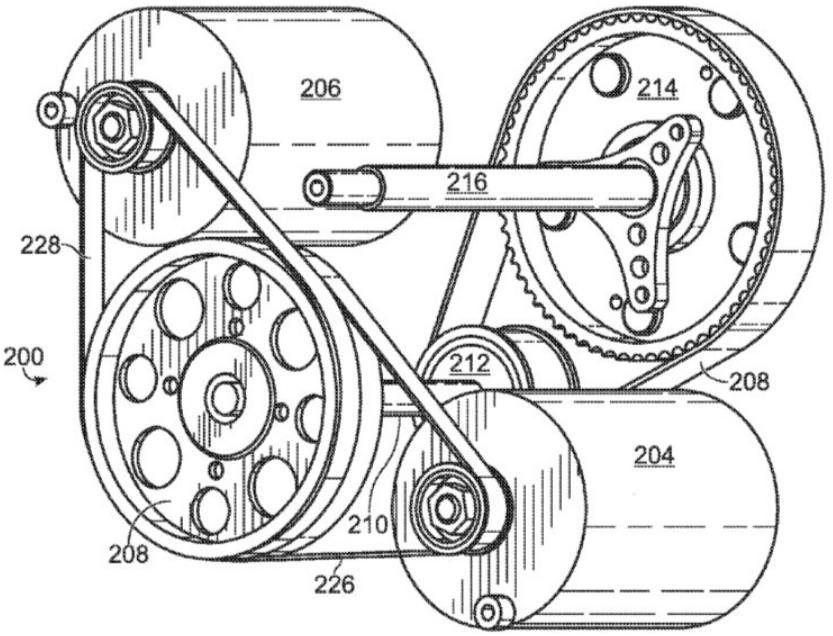
22
16
24
CONTROLLER
18
14
MOTOR
12
WHEEL
10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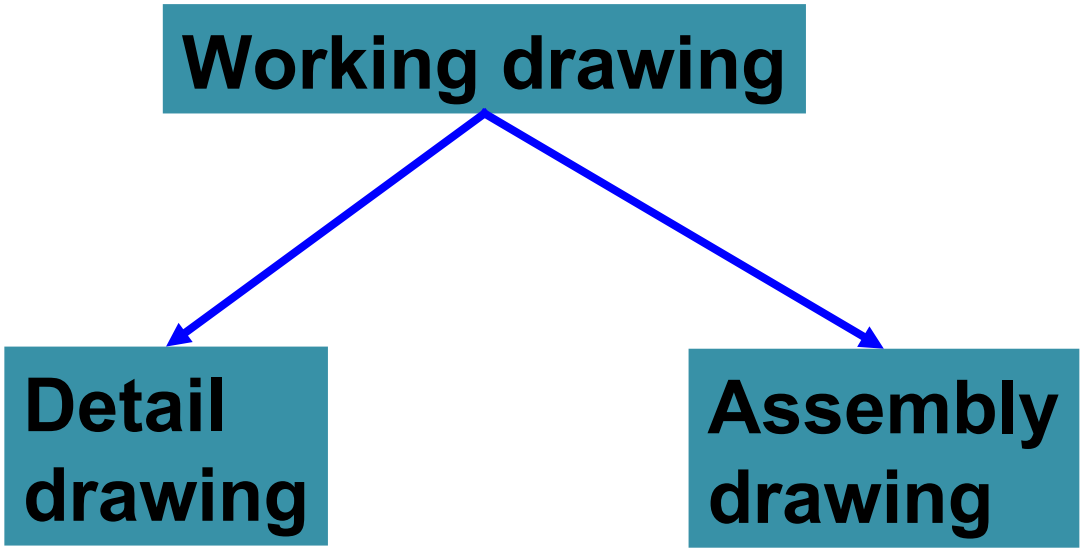
Production Drawings

- Production drawings (sometimes called Working drawings) are the complete set of drawings specifying the processing of individual part/component and assembly of all parts of the product.



- Generally consists of multiple drawings, on multiple sheets. A title block appears on each sheet.

Engg. Vs Production Drawings

- Engineering drawings define what the product should be.

Engineering drawing is the final output of the research, design and development phase of a project.

&

- Production drawings show how to manufacture the product.

Production engineers take the engineering drawings and decide how best to manufacture the product described by the drawings in their factory.

Parts of Production Drawings

Production Drawings has three main parts:

- Detail drawings of each non-standard part, usually one part per “sheet”.

- An assembly drawing showing all parts in a single drawing.

- A bill of materials (BOM). This is essentially a parts list.

Purpose

Detail production drawing conveys the ***information*** and ***instructions*** for manufacturing the part.

Assembly drawing conveys

- Completed shape of the product.
- Overall dimensions.
- Relative position of each part.
- Functional relationship among various components.

Information in Detail Drawings

1. General information → Title block

2. Part' s information

2.1 Shape description → Object's views

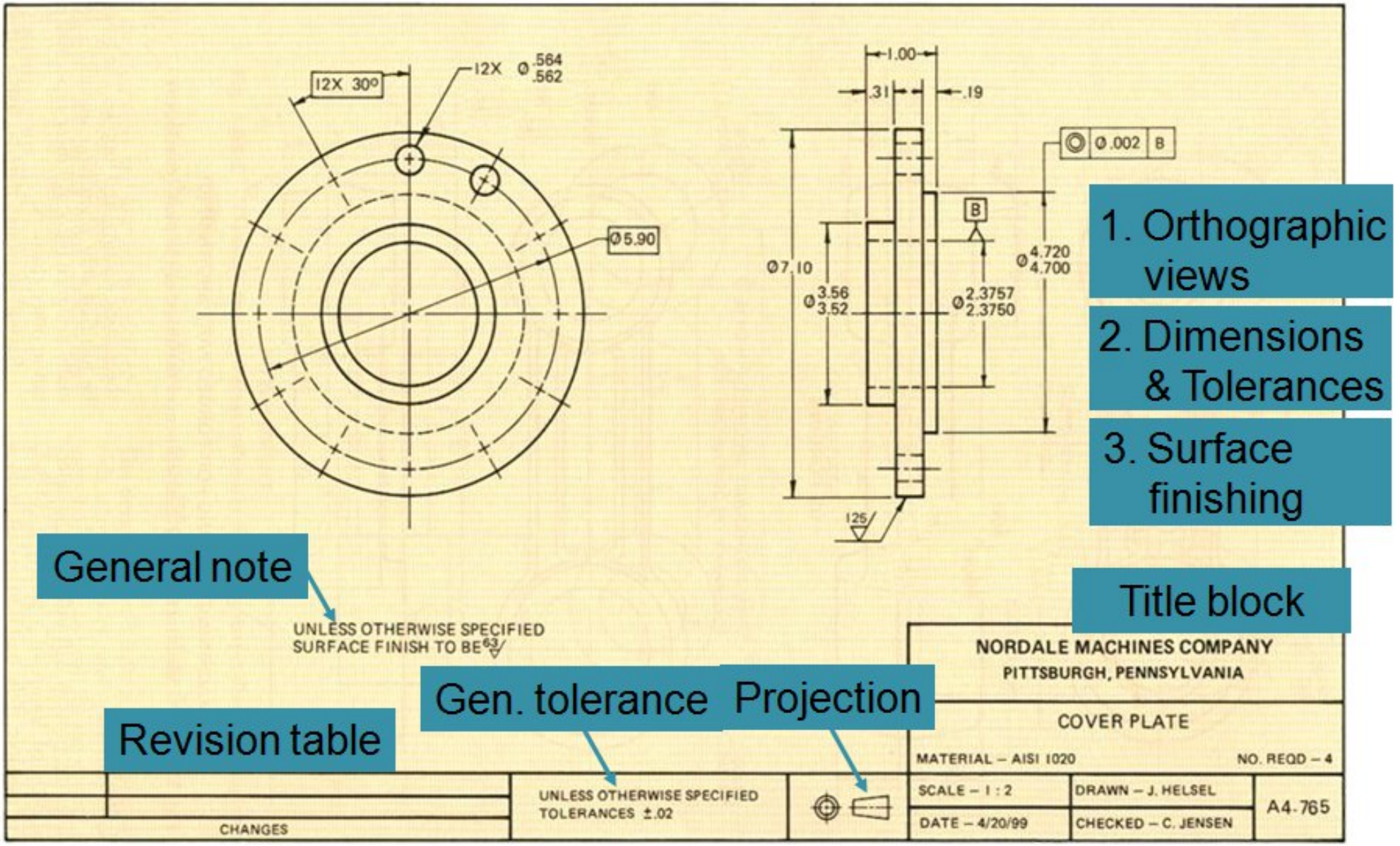
2.2 Size description → Dimensions and Tolerances

2.3 Specifications →
Part number, name, number required
Type of material used

General notes

- Surface finish
- General tolerances
- Heat treatment

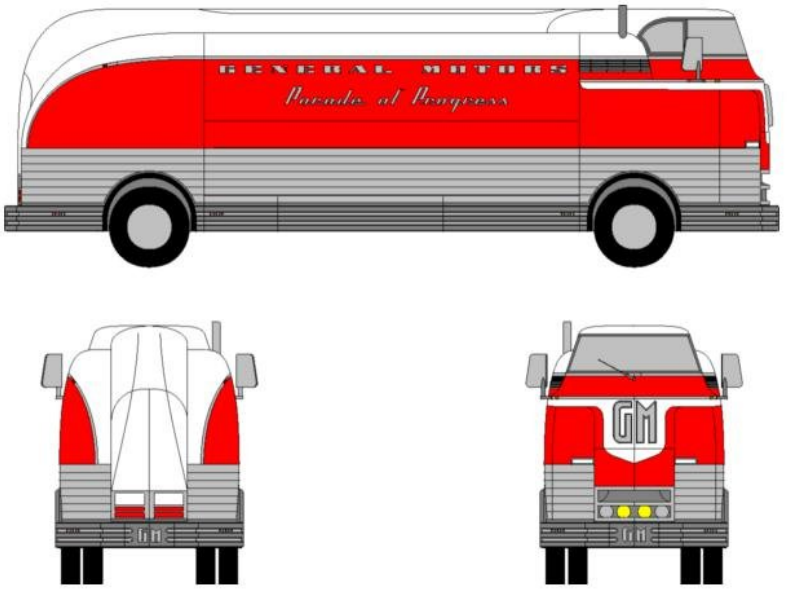
Interpreting Detail Drawings



Types of Assembly Drawing

Outline Assembly Drawing

- Gives a general graphic description of exterior shape
- Used for part catalogs and installation manuals, or for production when the assembly is simple enough to be visualized

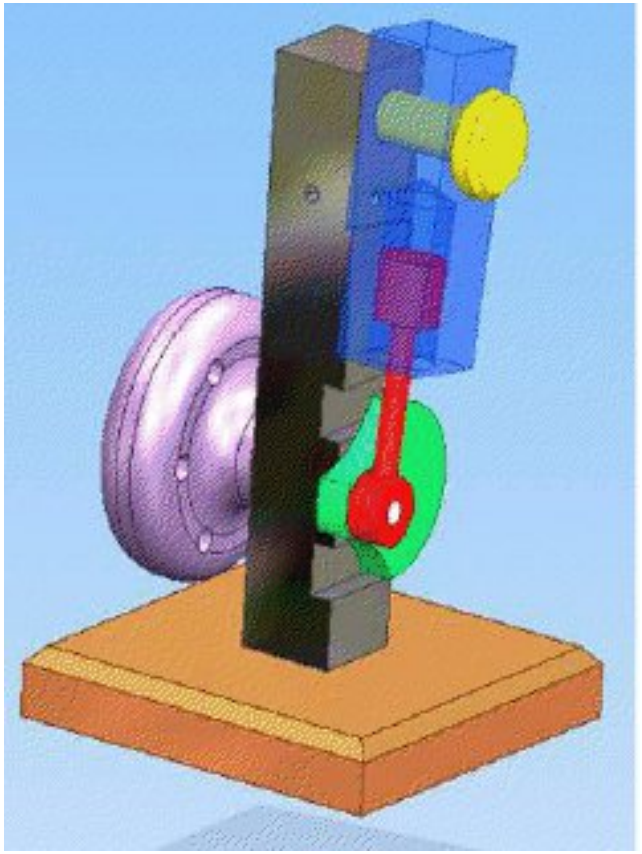


Bus Outline Assembly

Types of Assembly Drawing

Pictorial Assembly Drawing

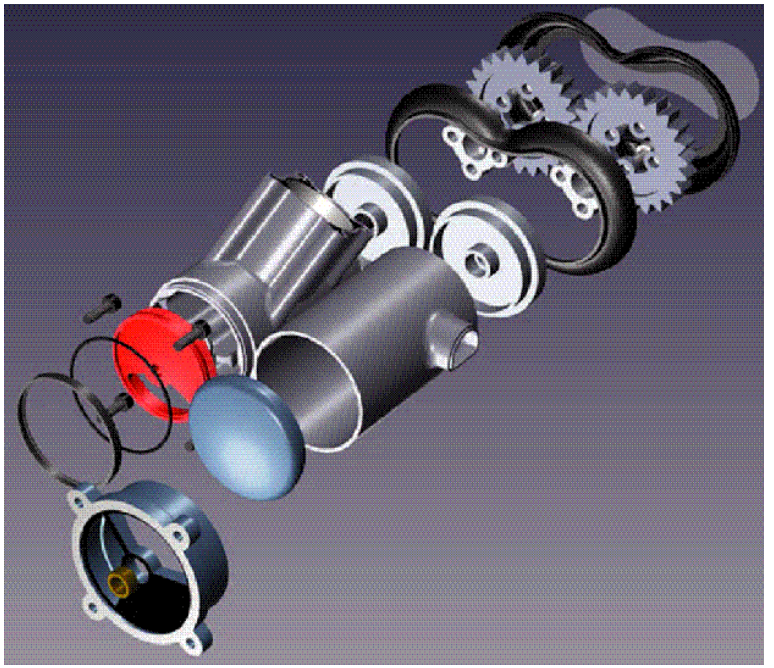
- Pictorial assembly is normally an isometric view.
- Gives general graphic description of each part
- Used in Sales promotion installation and maintenance manuals.



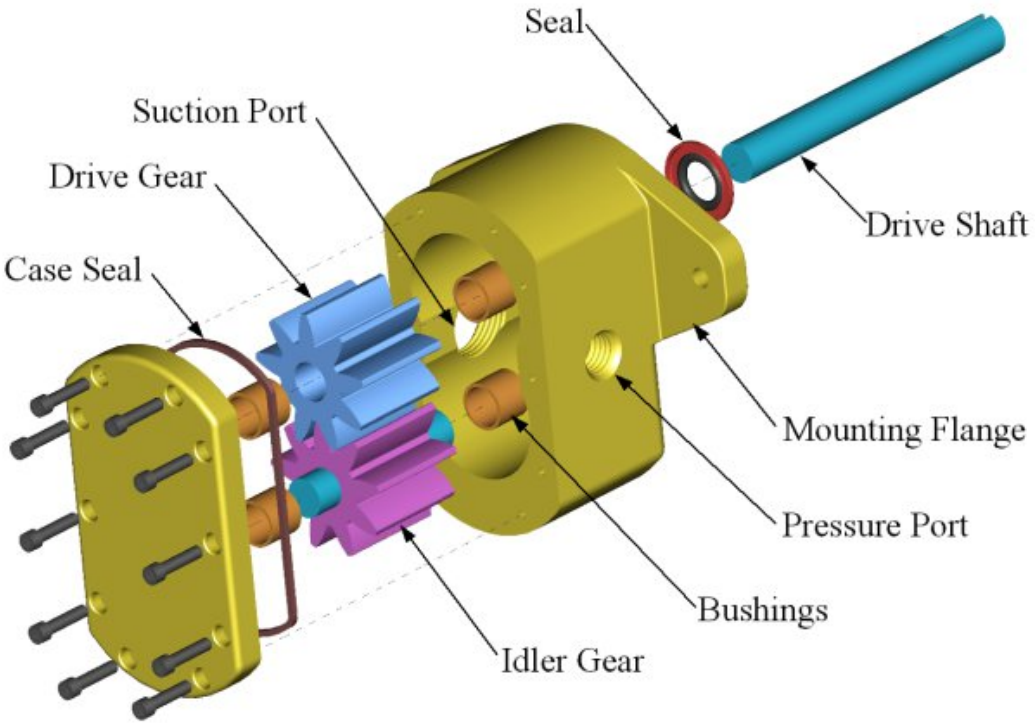
Types of Assembly Drawing

Exploded Pictorial Assembly Drawing

- Gives general graphic description of each part.
- Are used to show how individual components fit together



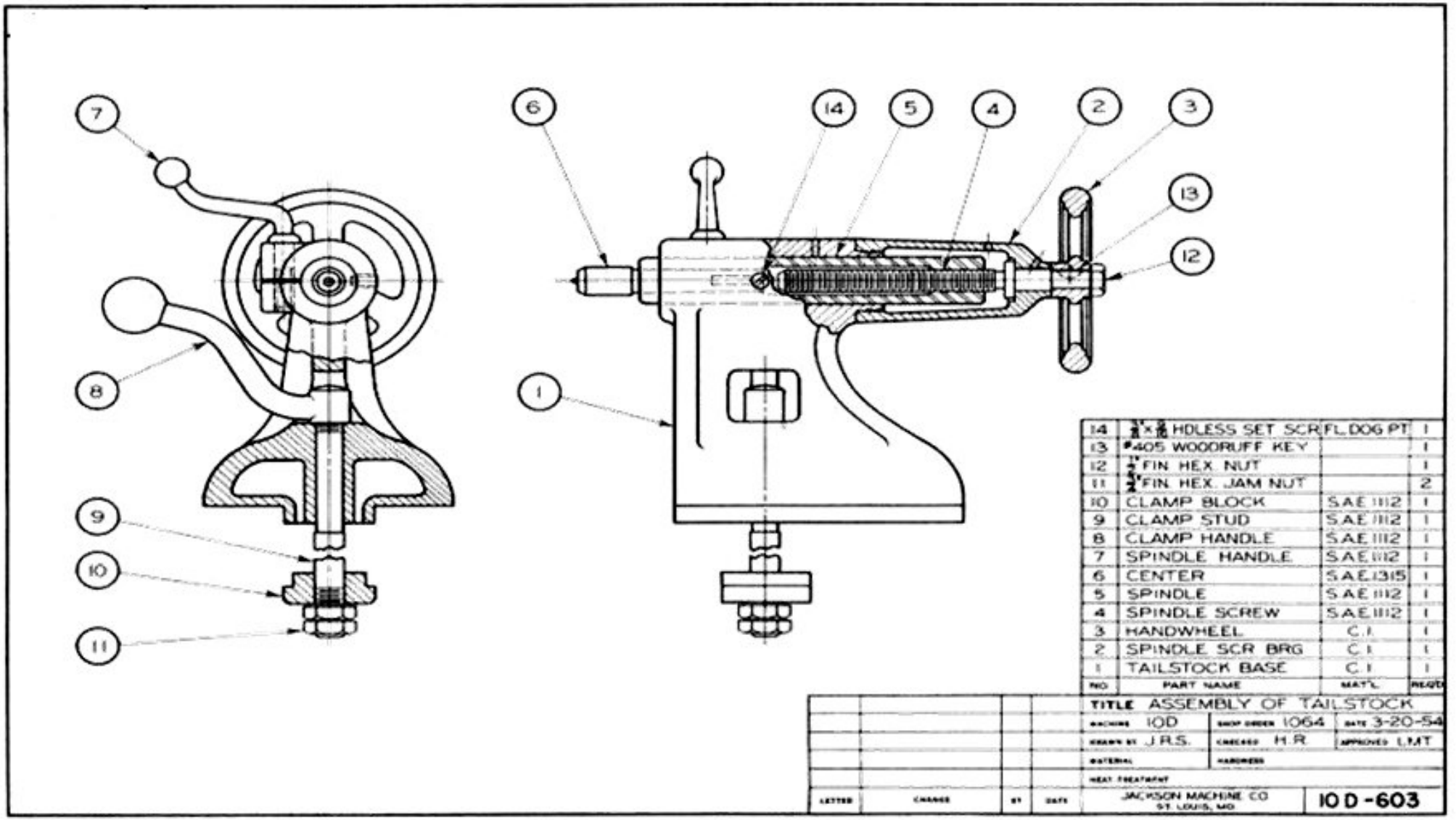
Exploded Pictorial Assembly



Types of Assembly Drawing

General Assembly Drawing

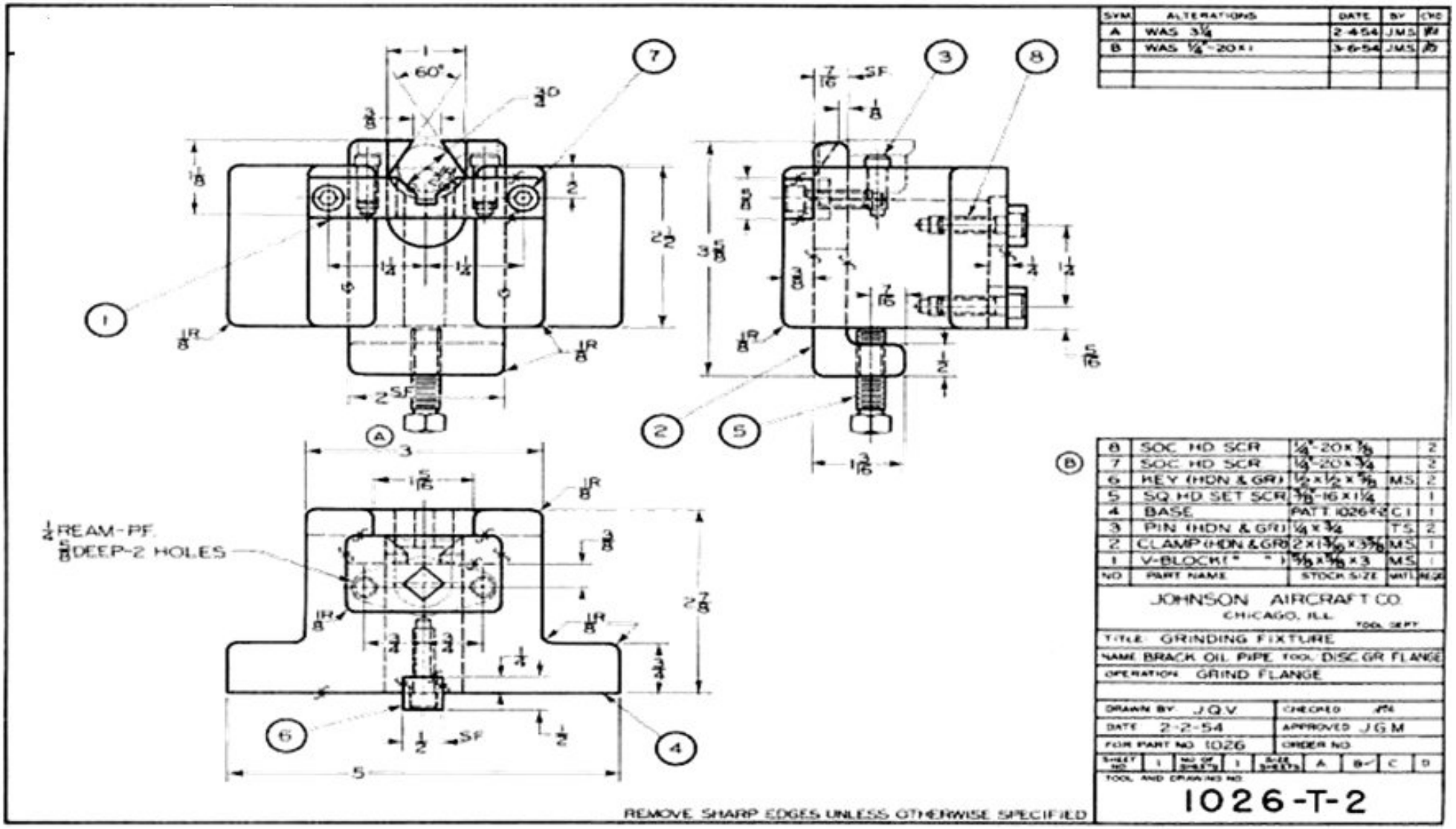
All parts are drawn in their working position



Types of Assembly Drawing

Detail Assembly Drawing

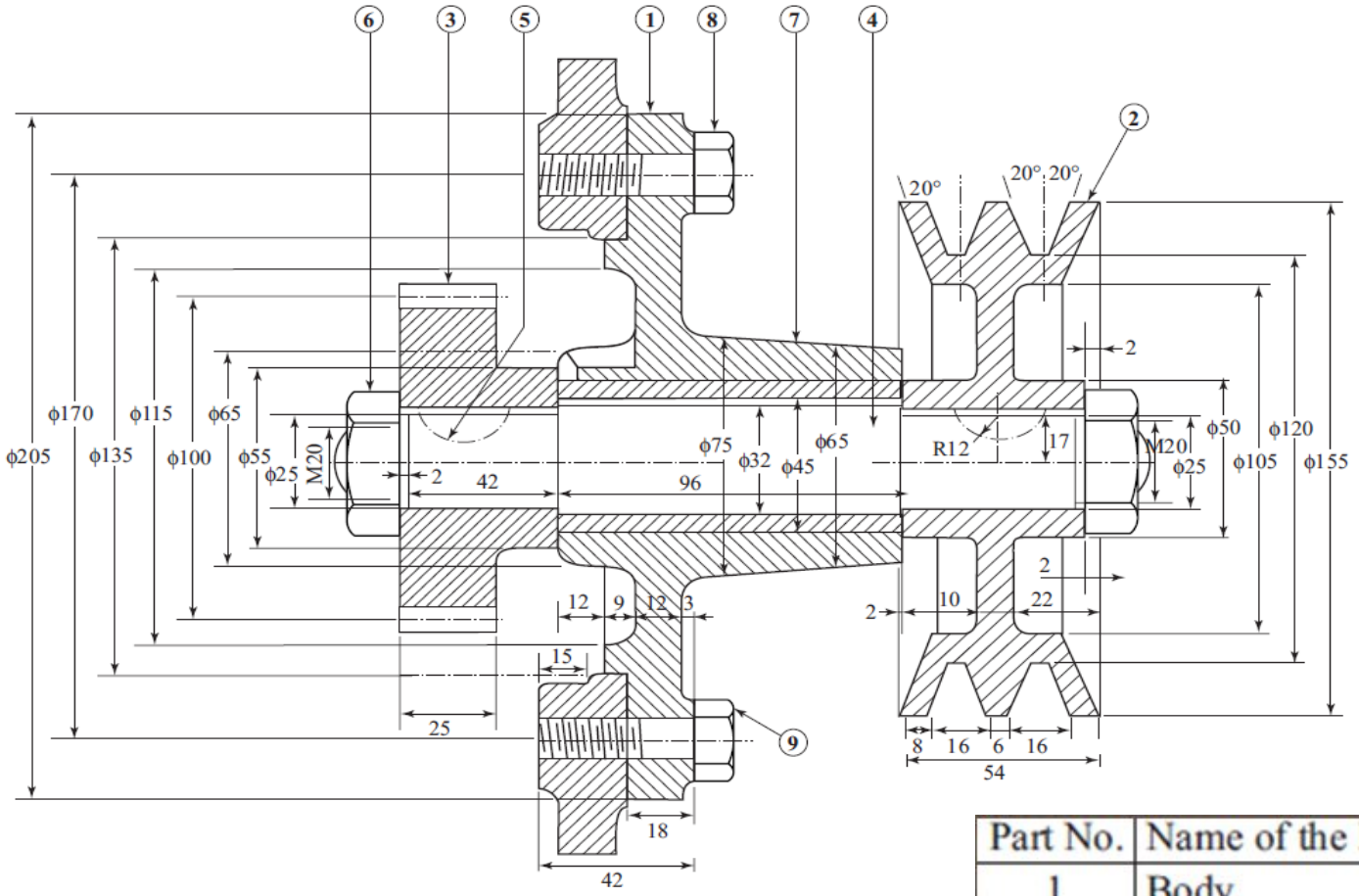
All parts are drawn in their working position with a completed dimensions



Engineering BOM

- In engineering BOM the information normally included in the part list consist of:
  - Name of the part
  - Part material such as cast iron or bronze
  - No./quantity of part
  - The company assigned part number
  - Other Information

BOM Examples



Assembled sectional view of a belt drive

Part No.	Name of the Part	Material	Quantity
1	Body	Cast iron	1
2	Pulley	Cast iron	1
3	Gear	Cast iron	1
4	Shaft	Mild steel	1
5	Woodruff key	Cold rolled mild steel	2
6	Nut	Mild steel	2
7	Bush bearing	Gun metal	1
8	Screw	Mild steel	4
9	Machine screw	Mild steel	2

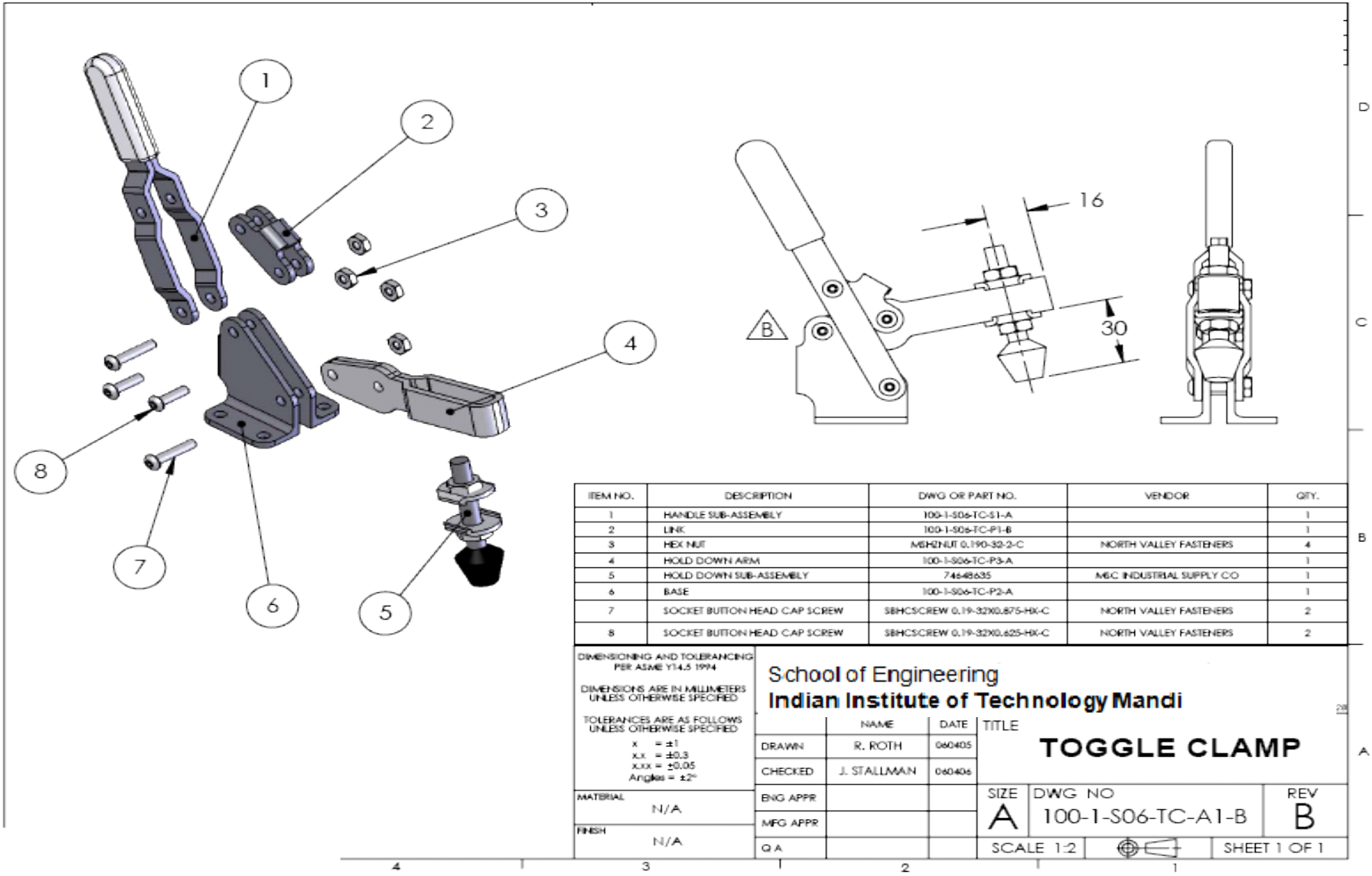
BOM Examples

NUMBER	PART NAME	REQ'D	MATERIAL	DRAWING NUMBER
1	LATHE CENTER	1	4340 STEEL	A041501
2	SLEEVE	1	1040 STEEL	A102304
3	TAILSTOCK	1	C.I.	A110503
4	.375 – 32UNEF -3B HEX NUT	1	STD	NA
5	1.50 x .375 – 32UNEF -3A SLOT HDLS, DOG PT, SS	1	STD	NA
6	1.00 x .4375 -20UNF -2A FL HD, CAP SCR	2	STD	NA
7	END COVER	1	C.I.	A102703
8	HANDLE	1	C.I.	A071401
9	#405 WOODRUFF KEY	1	STD	NA
10	ADJUSTMENT SCREW	1	4130 STEEL	A091104
11	.750 – 10UNC – 2B HEX NUT	1	STD	NA
12	HAND WHEEL	1	C.I.	A071402

Example of Production Drawing

- Toggle Clamp (Assembly Drawing)
- Handle (Subassembly Drawing)
- Link (Detail Drawing)
- Base (Detail Drawing)
- Hold Down Arm (Detail Drawing)
- Handle Half (Detail Drawing)

Toggle Clamp (Assembly Drawing)



ITEM NO.	DESCRIPTION	DWG OR PART NO.	VENDOR	QTY.
1	HANDLE SUB-ASSEMBLY	100-1-S06-TC-S1-A		1
2	LINK	100-1-S06-TC-P1-B		1
3	HEX NUT	MSHZNUT 0.190-32-Z-C	NORTH VALLEY FASTENERS	4
4	HOLD DOWN ARM	100-1-S06-TC-P3-A		1
5	HOLD DOWN SUB-ASSEMBLY	74648635	MSC INDUSTRIAL SUPPLY CO	1
6	BASE	100-1-S06-TC-P2-A		1
7	SOCKET BUTTON HEAD CAP SCREW	SBHCSCREW 0.19-32X0.875-HX-C	NORTH VALLEY FASTENERS	2
8	SOCKET BUTTON HEAD CAP SCREW	SBHCSCREW 0.19-32X0.625-HX-C	NORTH VALLEY FASTENERS	2

DIMENSIONING AND TOLERANCING PER ASME Y14.5 1994

DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED

TOLERANCES ARE AS FOLLOWS UNLESS OTHERWISE SPECIFIED

x = ±1
x.x = ±0.3
x.xx = ±0.05
Angles = ±2°

MATERIAL N/A

FINISH N/A

School of Engineering
Indian Institute of Technology Mandi

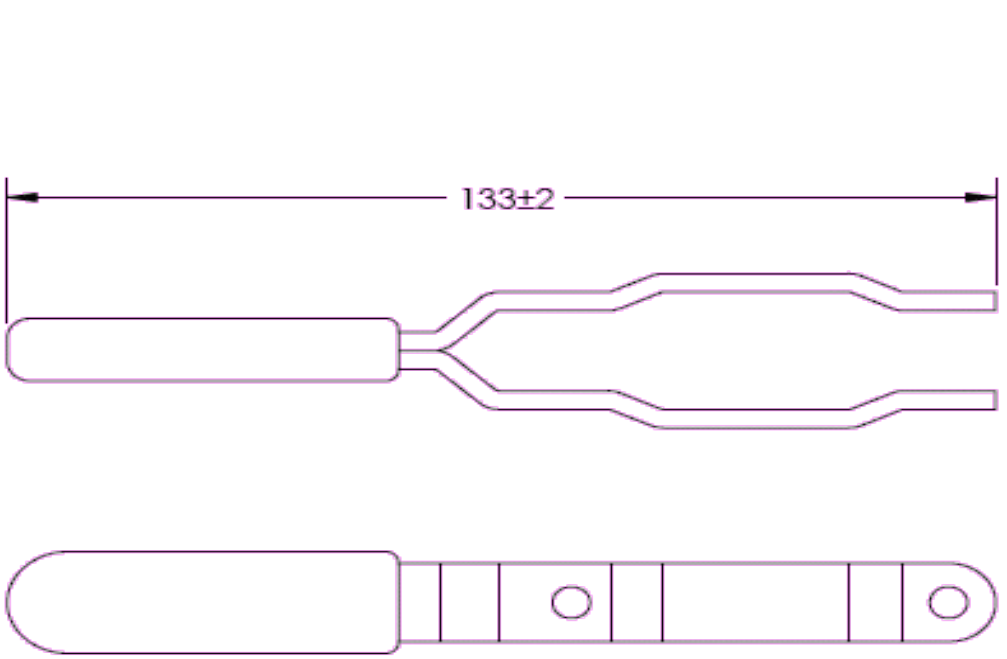
	NAME	DATE
DRAWN	R. ROTH	060405
CHECKED	J. STALLMAN	060406
ENG APPR		
MFG APPR		
Q A		

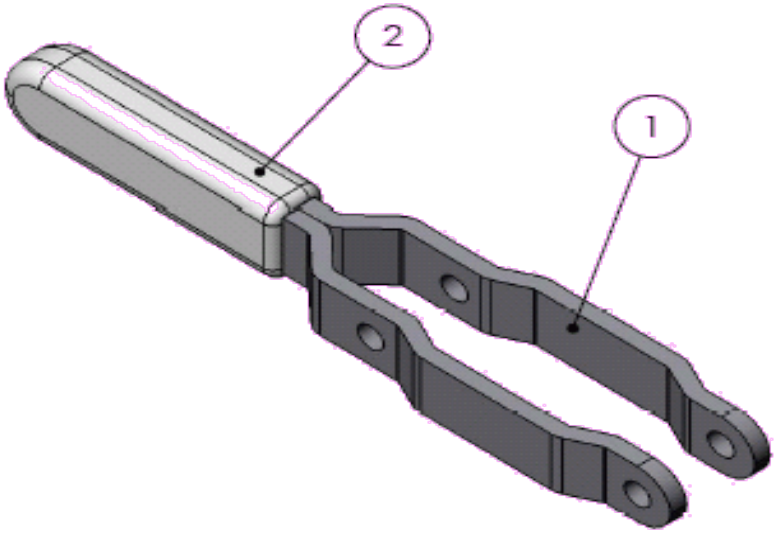
TITLE: **TOGGLE CLAMP**

SIZE A | DWG NO 100-1-S06-TC-A1-B | REV B

SCALE 1:2 | SHEET 1 OF 1

Handle (Subassembly Drawing)





ITEM NO	DESCRIPTION	DWG or PART NO	VENDOR	QTY
1	HANDLE-HALF	100-1-S06-TC-P4-A		2
2	HANDLE GRIP	00341479	CO (800-645-7270)	1

DIMENSIONING AND TOLERANCING PER ASME Y14.5 1994

DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED

TOLERANCES ARE AS FOLLOWS UNLESS OTHERWISE SPECIFIED

x = ±1
xx = ±0.3
xxx = ±0.05
Angles = ±2°

MATERIAL: N/A

FINISH: N/A

School of Engineering
Indian Institute of Technology Mandi

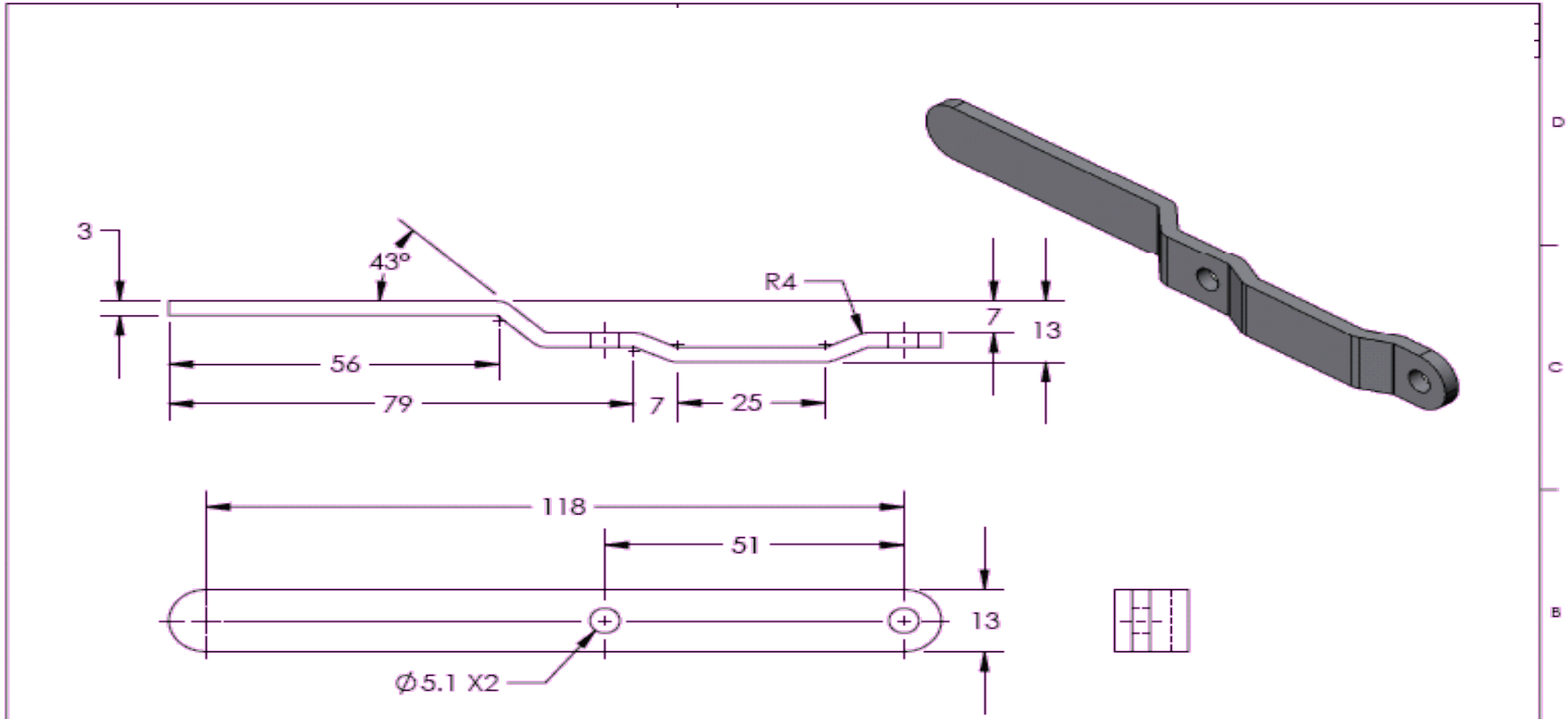
	NAME	DATE
DRAWN	R. ROTH	060407
CHECKED	J. STALLMAN	060408
ENG APPR		
MFG APPR		
QA		

TITLE: **HANDLE**

SIZE: A | DWG NO: 100-1-S06-TC-S1-A | REV: A

SCALE 1:2 | SHEET 1 OF 1

Handle Half (Detail Drawing)



DIMENSIONING AND TOLERANCING PER ASME Y14.5 1994

DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED

TOLERANCES ARE AS FOLLOWS UNLESS OTHERWISE SPECIFIED
x = ±1
xx = ±0.3
xxx = ±0.05
Angles = ±2°

MATERIAL: AISI 1020

FINISH: TUMBLED - BLACK

School of Engineering
Indian Institute of Technology Mandi

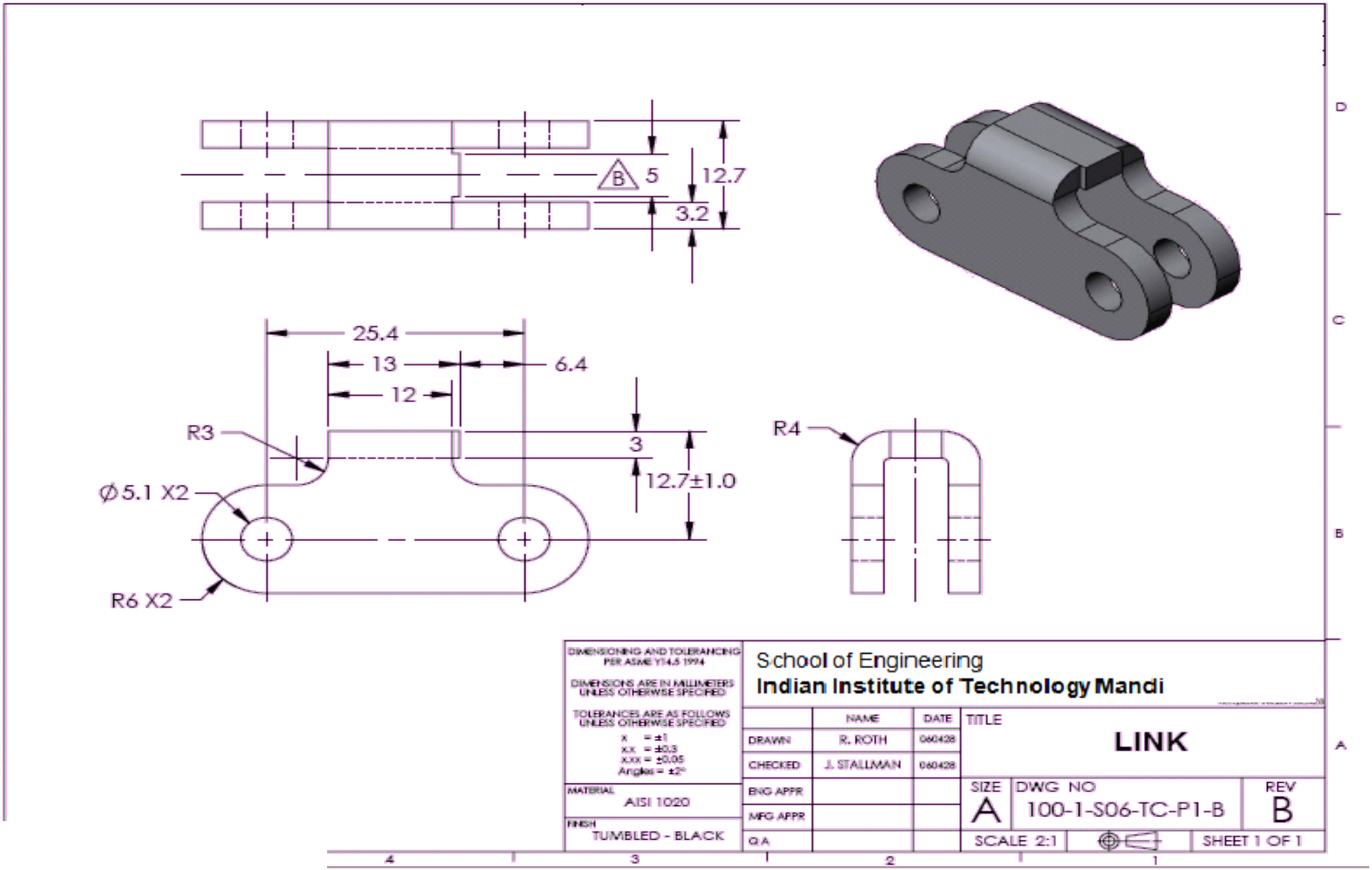
	NAME	DATE
DRAWN	R. ROTH	060405
CHECKED	J. STALLMAN	060406
ENG APPR		
MFG APPR		
QA		

TITLE: **HANDLE-HALF**

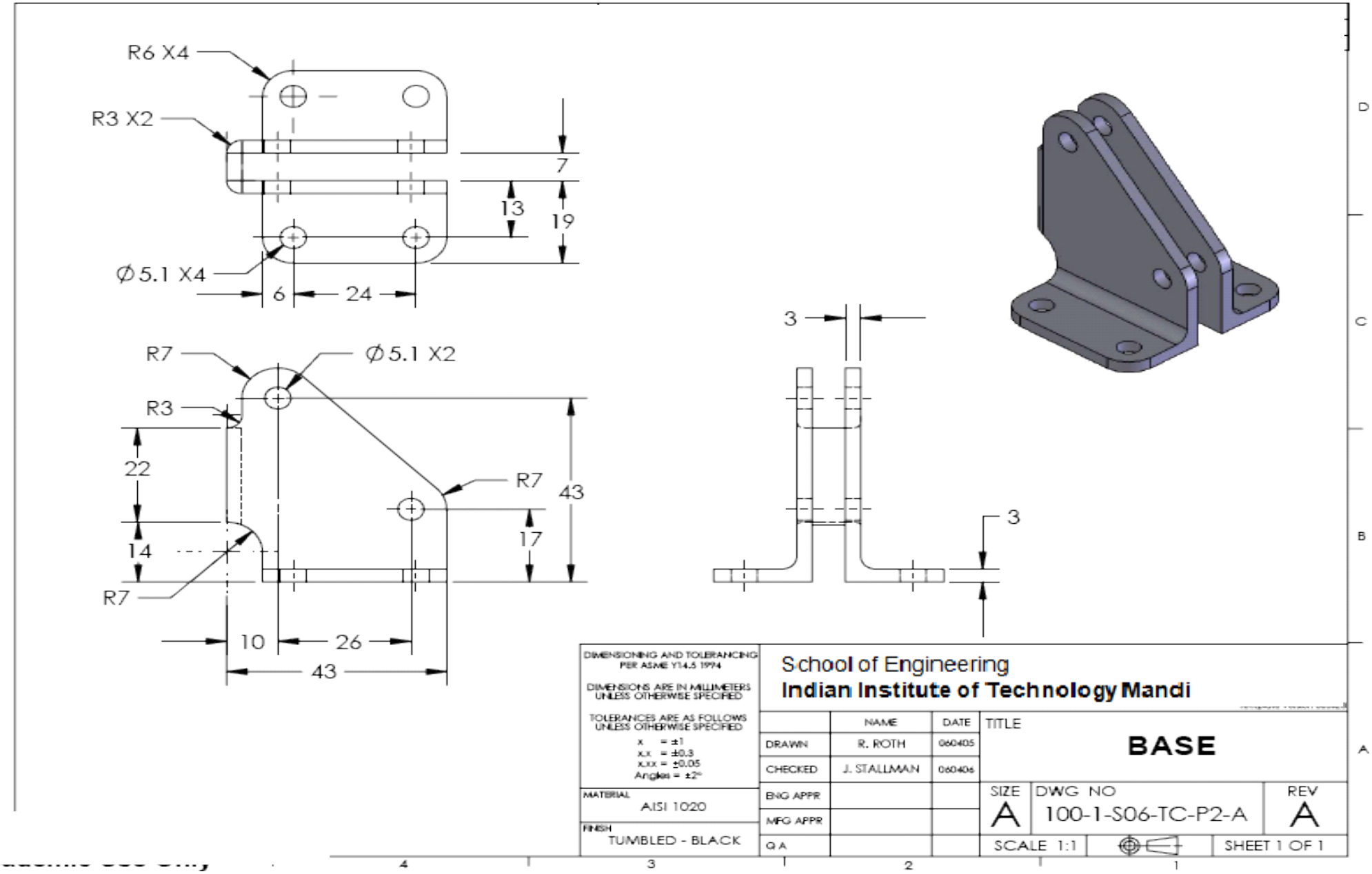
SIZE A | DWG NO 100-1-S06-TC-P4-A | REV A

SCALE 1:1 | SHEET 1 OF 1

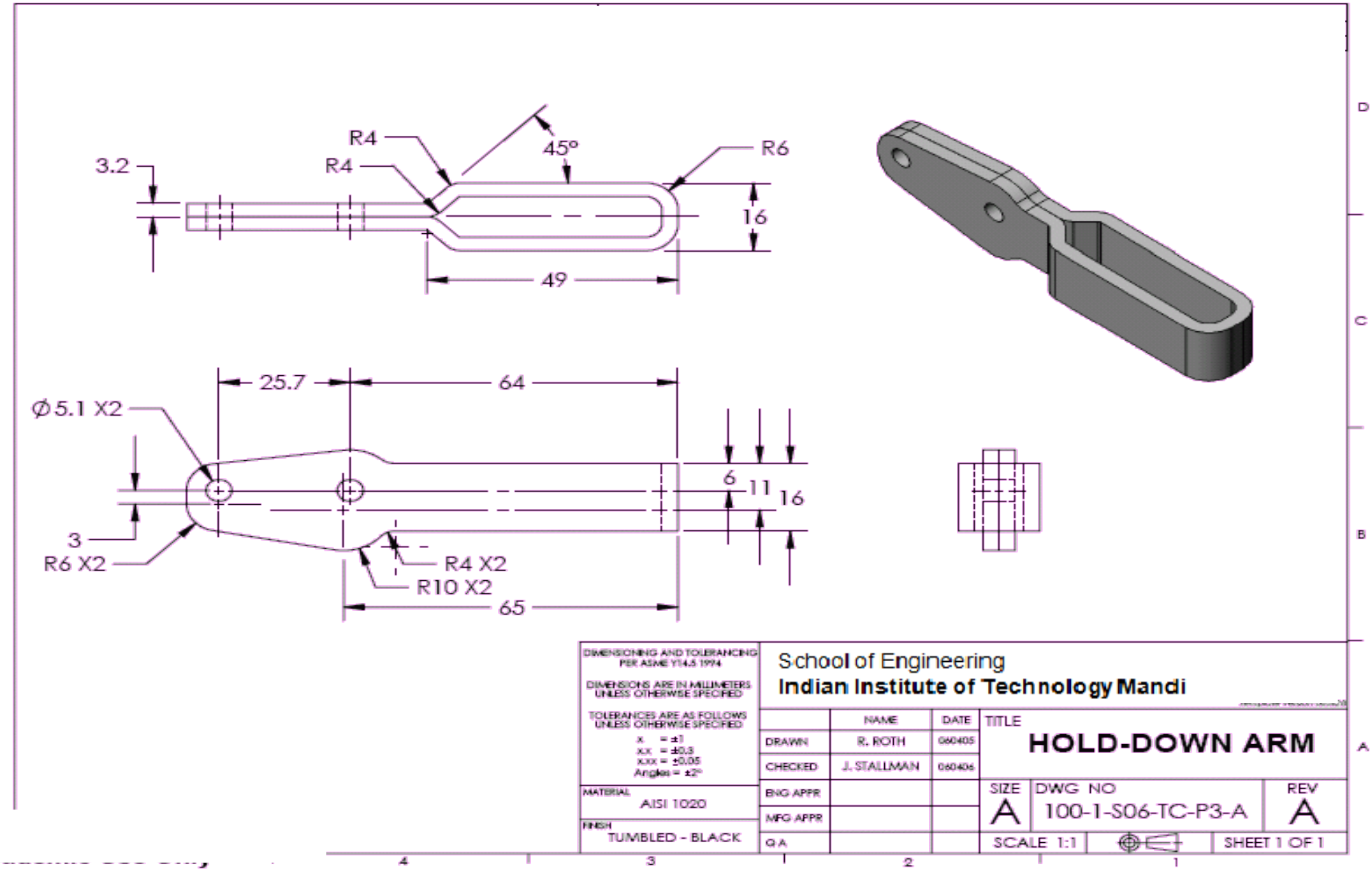
Link (Detail Drawing)



Base (Detail Drawing)



Hold Down Arm (Detail Drawing)



Practice Exercise

Draw (free hand sketch) working drawing, assembly drawing, production drawing of your product. → Detailed design report.

Material Selection

- Available materials
  - Acrylic/Perspex
  - Wood
  - Cast iron
  - Aluminium
  - Galvanized sheets

Design Process (Mechanical perspective)

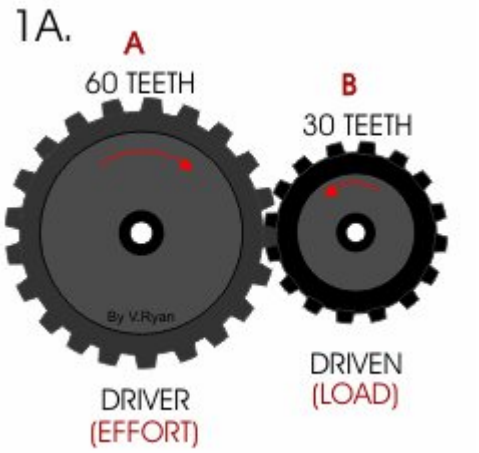
- Look for material properties
- Check for Maximum stress configuration
- Calculate maximum stress and compare with yield stress, -> factor of safety.
- Can do Finite Element Analysis (advanced)
- If required, do iterations.

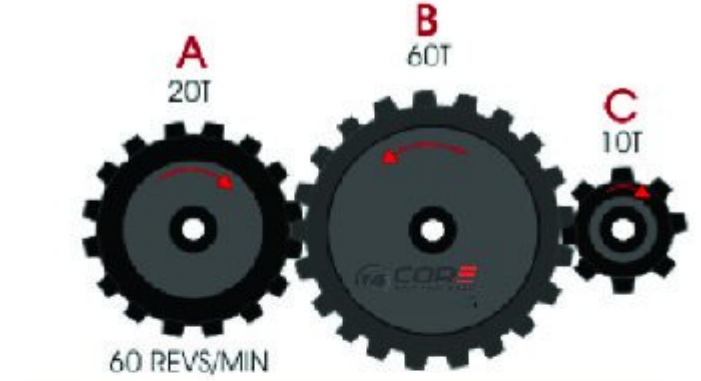
Available facility at
Mechanical workshop @ Kamand Campus

- Conventional Lathe Machine
- CNC Lathe Machine
- Conventional Milling Machine
- CNC Milling Machine
- Power Hacksaw machine
- Bench Grinding machine
- Pillar Drill Machine
- Sheet shearing machine
- Spot Welding machine
- Arc welding equipment
- Gas welding machine
- Foundry Tools
- Hand Tools

Some Mechanical Tools

- Gears – may be required to protect your motors and to obtain optimal speed of driven end





GEAR A	GEAR B	GEAR C
20T(teeth)	60T(teeth)	10T(teeth)

e.g 1

$$\frac{\text{Driven}}{\text{Driving}} = \frac{60}{20} = \frac{3}{1} > 3:1$$

$$\frac{60 \text{ rev/min}}{3} = 20 \text{ rev/min}$$

e.g 2

Find the gear ratio for B & C

$$\frac{\text{Driven}}{\text{Driving}} = \frac{10}{60} = \frac{3}{1} > 3:1$$

20rev/min*6=120rev/min

For every one rotation of GEAR B & GEAR C makes SIX rotations.

General formula
N1/N2 = T2/T1

N1, N2 – RPM of gear 1 and 2
T1, T2 – Number of Teeth on Gear 1 and 2

Some Tips

- Testing – Test your structure mechanically
- If required/possible, make multiple prototype and test in some adverse situations.
- Stability analysis
- Making of robot
- Keep time line in mind. Don’t keep things for last moment.
- Demonstrate working product in open house.
- Identify your customer. “User friendly”
- *Thank you! Hope the lecture has given you some inspiration for developing your project.*