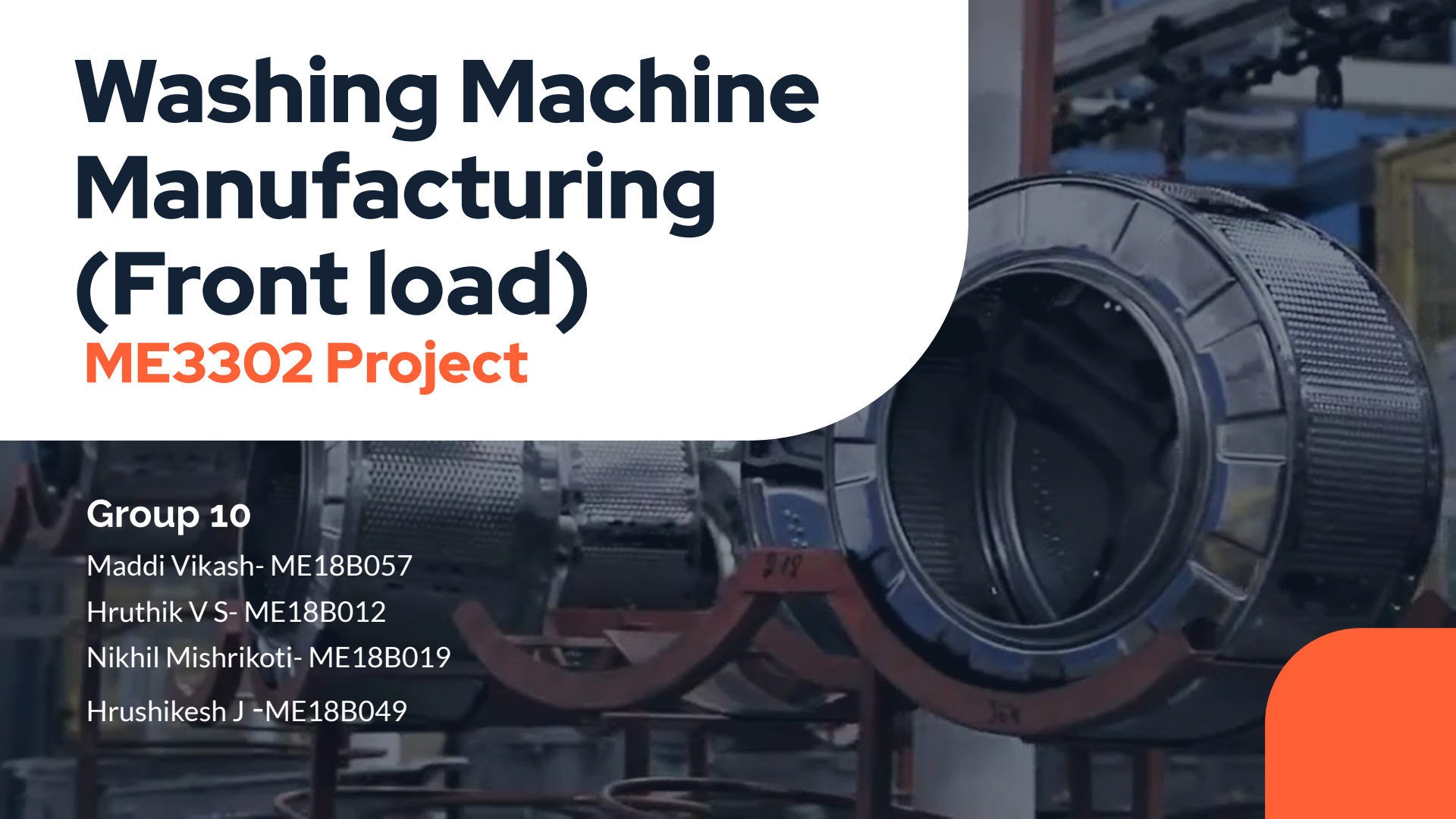
Washing Machine Manufacturing (Front load)

ME3302 Project



Group 10

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1 Introduction

History

- Mechanical washing machines appeared in the early 1800s.Early models **cleaned clothes by rubbing them** while later models cleaned clothes by **moving them through water.**
- **Steam powered** commercial washing machines appeared in the 1850s but home washing machines remained entirely hand powered until the early **1900s**, when several Started making electrical machines
- The Automatic Electric Washer Company and Hurley Machine Corporation both began selling electric washers in 1907, while Maytag offered an electric wringer washer in 1911.
- In 1947, Bendix offered the first fully automatic washing machine, and by 1953 spin-dry machines overtook the wringer types in popularity.
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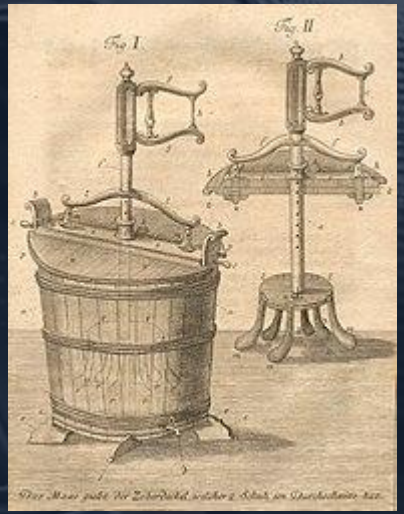


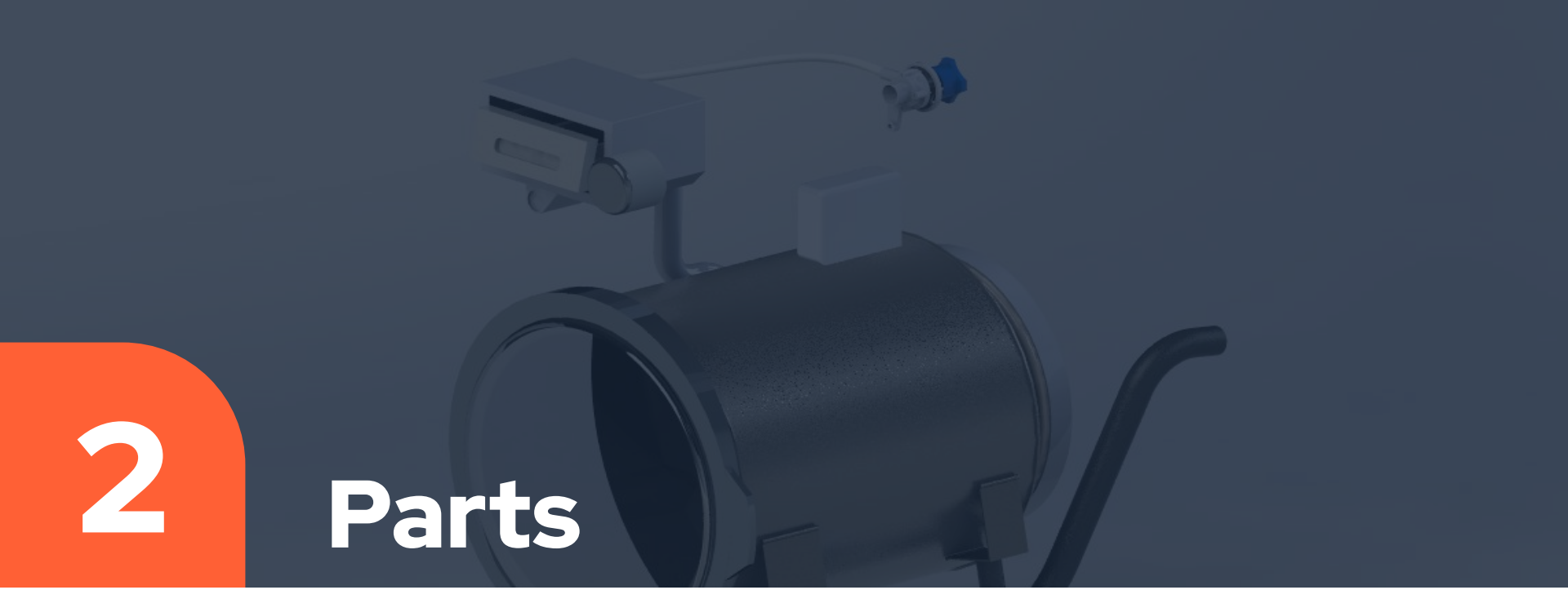
How it works ?

Washing:

- Contains an inner tub - with holes - and outer tub - without holes - to store water.
- Rotates to and fro , controlled electronically , to simulate hand washing.
- side paddles on the inside drum lift the clothes and move them in and out of the water. This provides the mechanical action (scrubbing) needed to remove soil from fabric.
- Does not require that the clothes be surrounded by water at all times, **so consumes much less water** than a standard top loader.

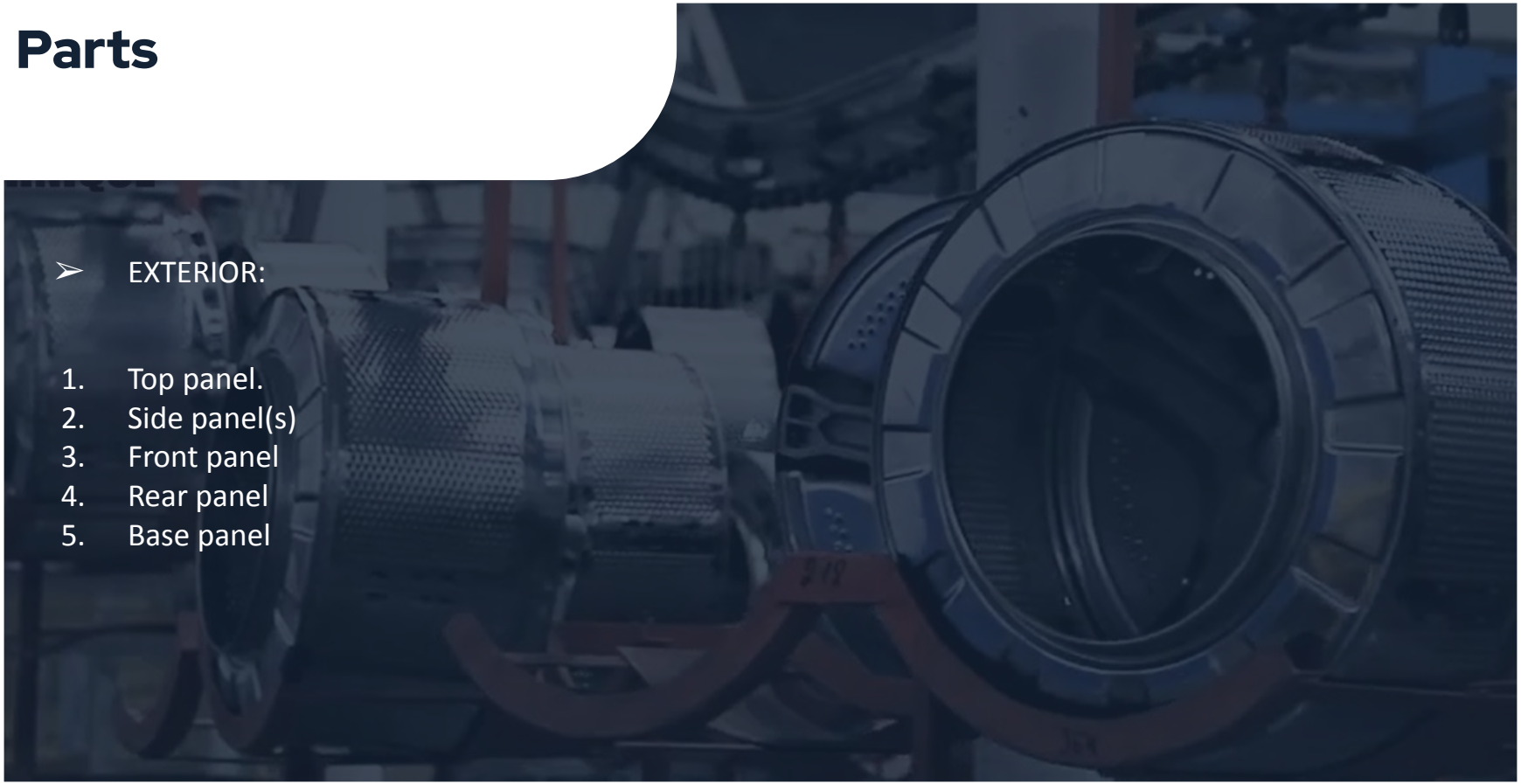
Drying :

The unit uses **centrifugal force** to remove as much water from the clothes as possible. When the motor is moving in the **spin direction, the pump removes** the water from the tub and discards it through the drain pipe.



2 Parts

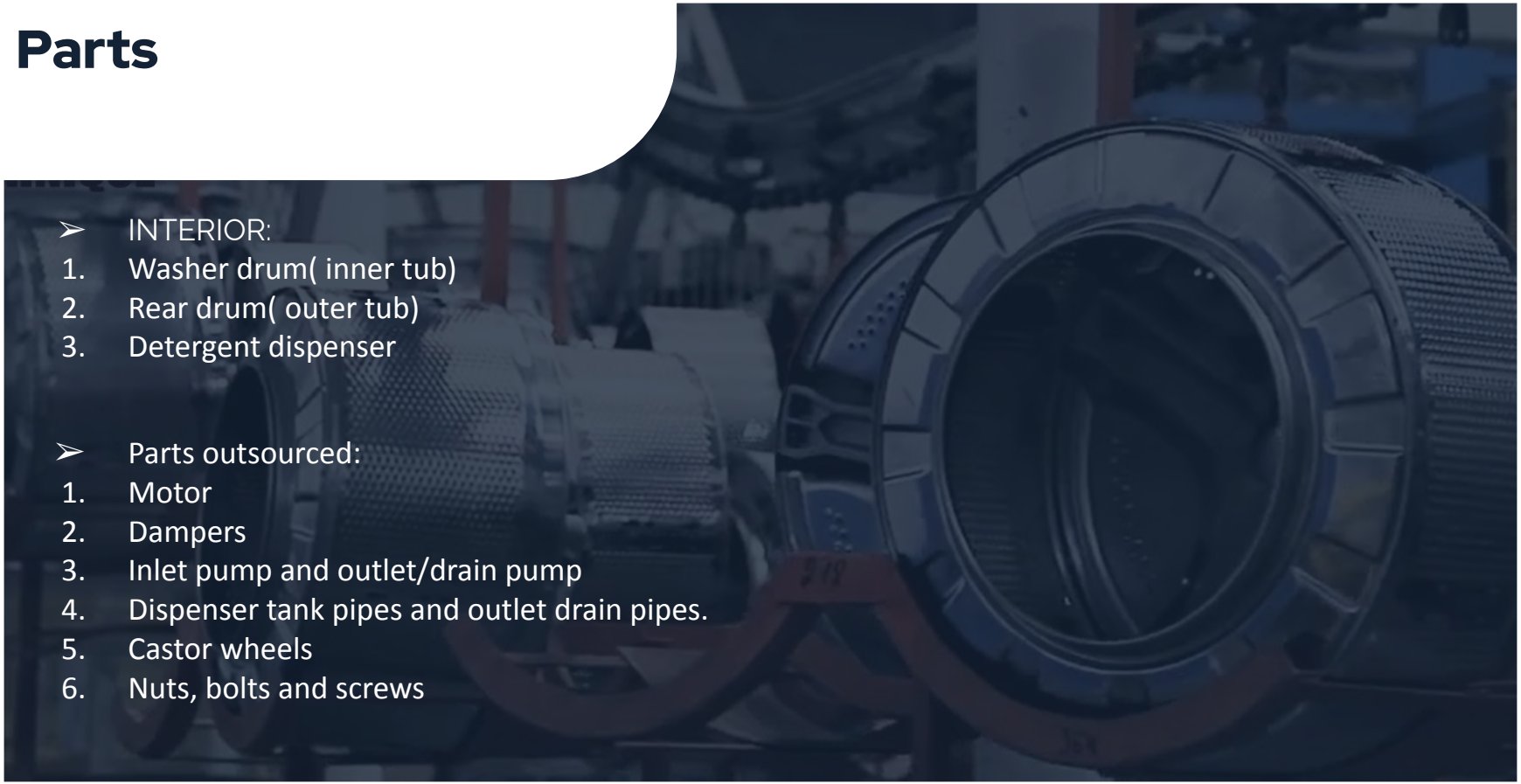
Parts



➢ EXTERIOR:

1. Top panel.
2. Side panel(s)
3. Front panel
4. Rear panel
5. Base panel

Parts



➢ INTERIOR:

1. Washer drum(inner tub)
2. Rear drum(outer tub)
3. Detergent dispenser

➢ Parts outsourced:

1. Motor
2. Dampers
3. Inlet pump and outlet/drain pump
4. Dispenser tank pipes and outlet drain pipes.
5. Castor wheels
6. Nuts, bolts and screws

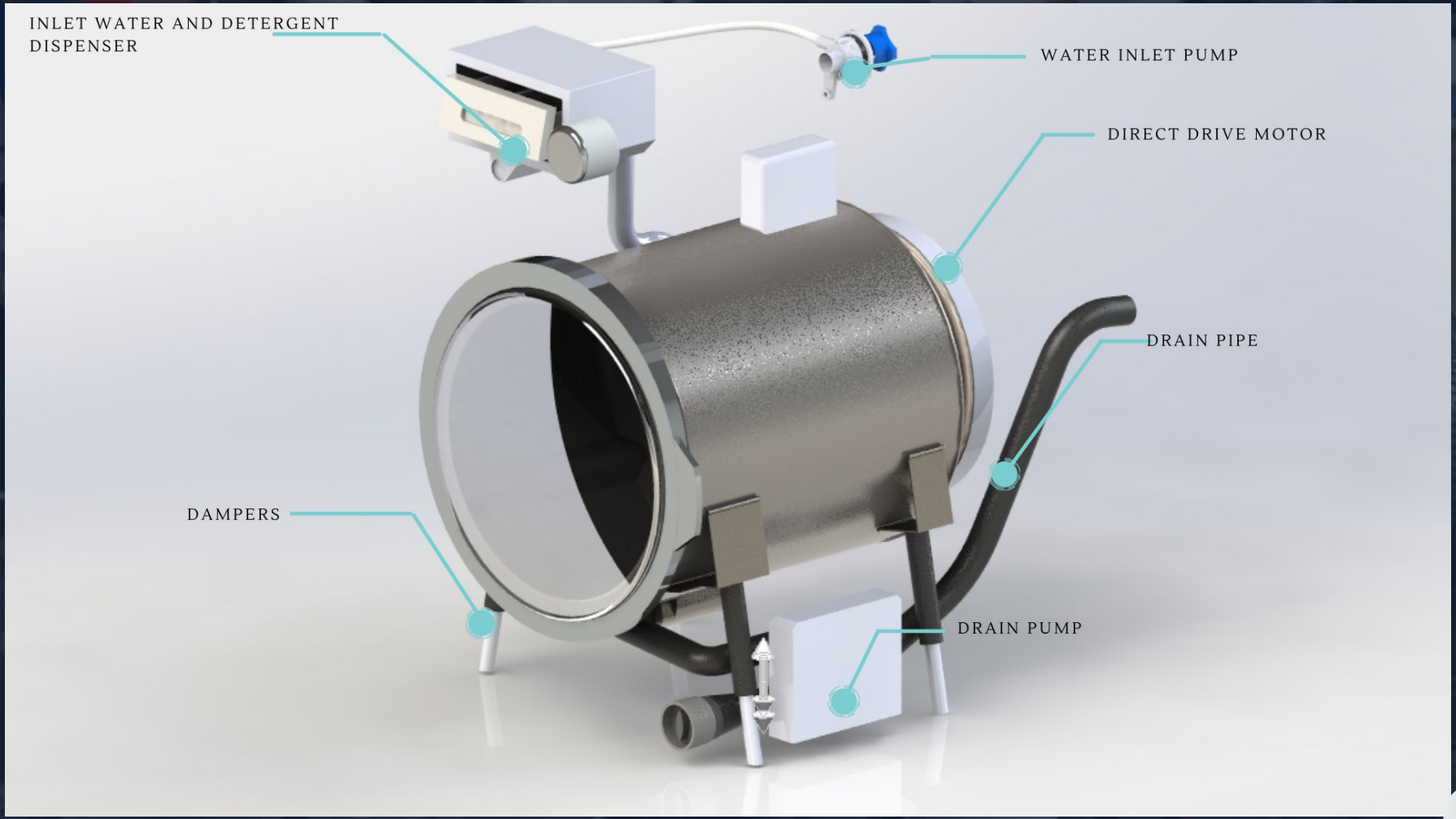
3 Parts details and CAD models

Solidworks Renders

Rendered on

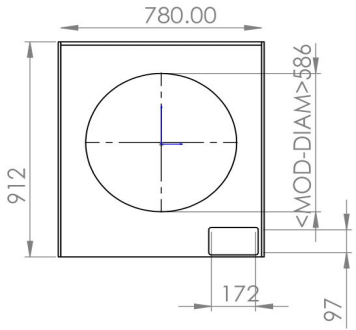
SOLIDWORKS | 2020

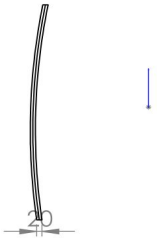
Solidworks Renders

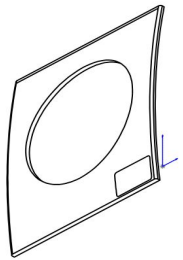

INLET WATER AND DETERGENT DISPENSER
WATER INLET PUMP
DIRECT DRIVE MOTOR
DRAIN PIPE
DAMPERS
DRAIN PUMP

Front Panel

- About:
  - The frontmost covering and protection of washing machine, has the following parts:
    - Front panel+door latch/lid
    - Also has detergent and drain housing.
    - A glass door/lid
- Material:
  - Galvanised steel, stainless steel , glass(for the door)
- Manufacturing process:
  - Shearing, Punching, pressing , thermoforming (for glass), CNC machining, AWJM(applicable for all panels)







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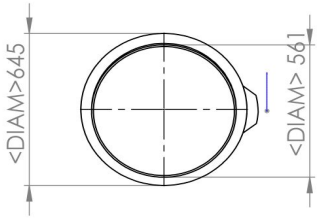

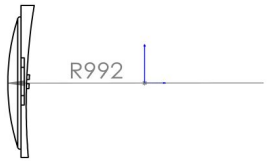

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Group 10

TITLE: DOOR

SIZE	DWG. NO.	REV
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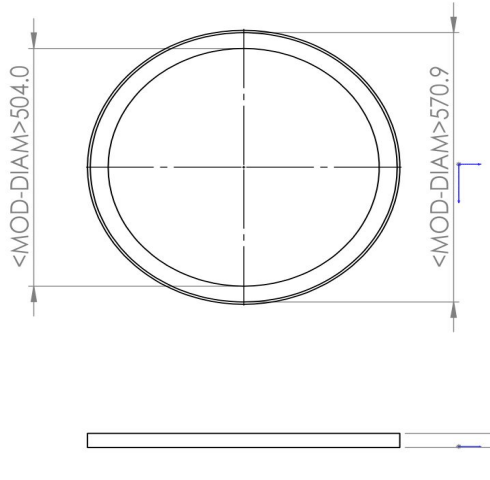

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Group 10

TITLE:

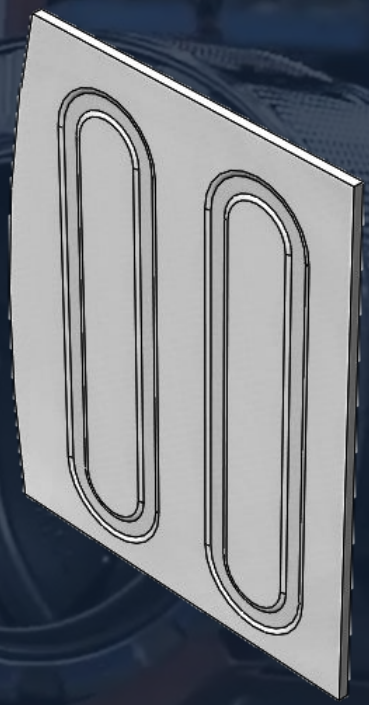
RUBBER SEAL

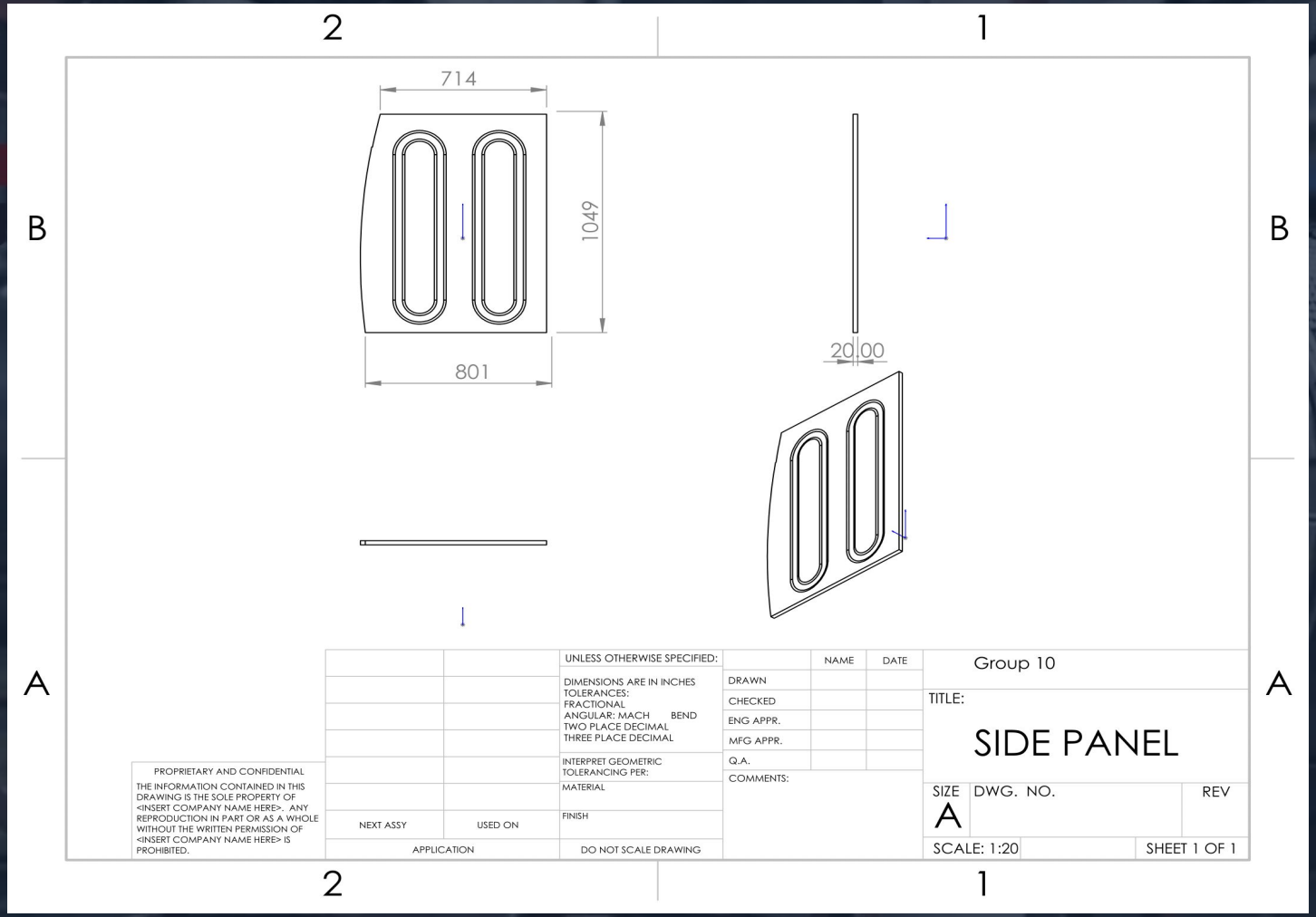
SIZE	DWG. NO.	REV
A		

SCALE: 1:10 SHEET 1 OF 1

Side Panels

- About:
  - ➔ The side covering and protection of washing machine
- Material:
  - ➔ Galvanised steel, stainless steel
- Manufacturing process:
  - ➔ Shearing, Die Pressing

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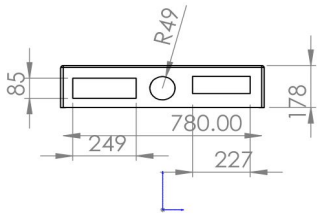
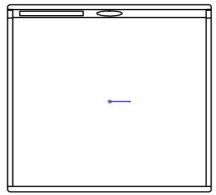
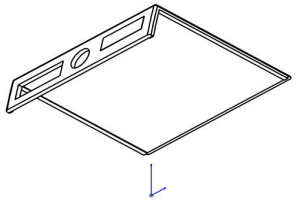
Group 10
TITLE:
SIDE PANEL
SIZE
A
DWG. NO.
REV
SCALE: 1:20
SHEET 1 OF 1

Top Panel

- About:
  - ➔ The topmost covering and protection of washing machine
- Material:
  - ➔ Galvanised steel, stainless steel
- Manufacturing process:
  - ➔ Shearing, Die pressing







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TITLE:

SIZE	DWG. NO.	REV
A	TOP PANEL	

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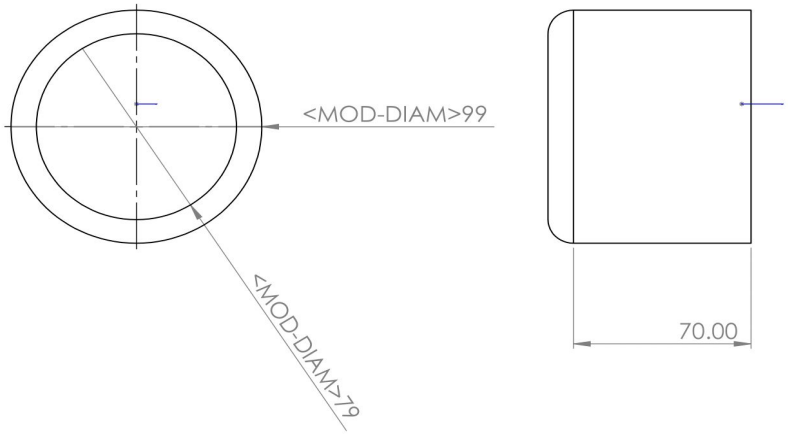

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APPLICATION		DO NOT SCALE DRAWING			

Group 10

TITLE:

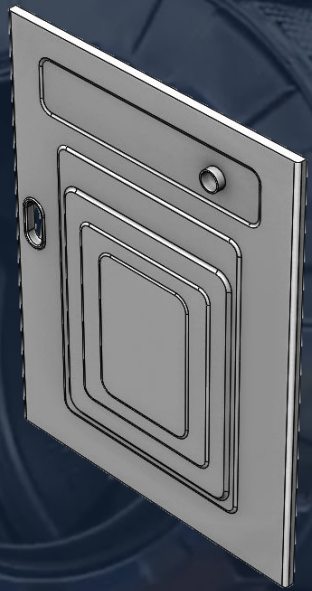
SELECTOR KNOB

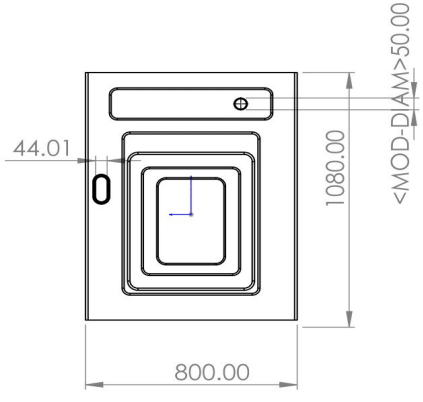
SIZE	DWG. NO.	REV
A		

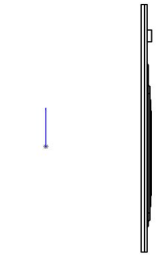
SCALE: 1:2 SHEET 1 OF 1

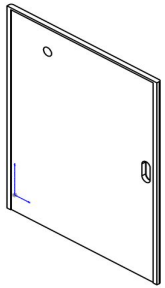
Rear Panel

- About:
  - The rear covering and protection of washing machine
  - Has entry ports for water and power cable port.
- Material:
  - Galvanised steel, stainless steel
- Manufacturing process:
  - Shearing, Die pressing and punching









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Group 10

TITLE:

BACK PANEL

SIZE	DWG. NO.	REV
A		

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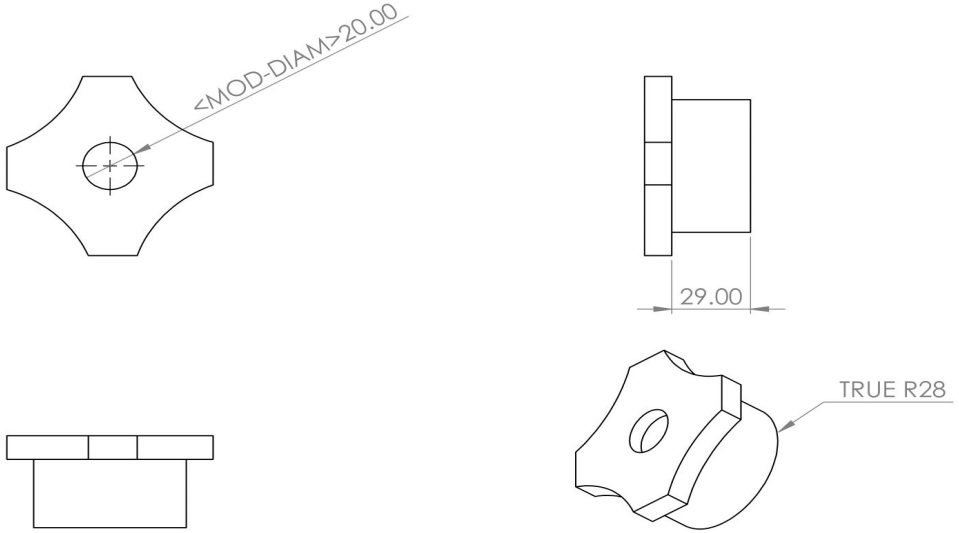

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Group 10

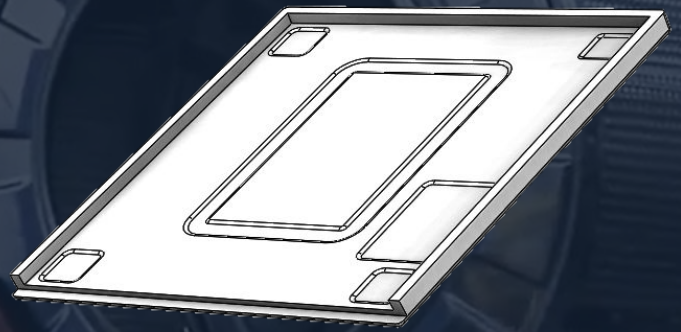
TITLE:

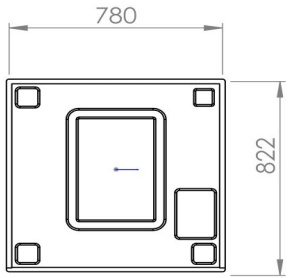
INLET FITTING

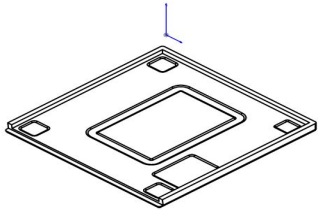
SIZE	DWG. NO.	REV
A		
SCALE: 1:1		SHEET 1 OF 1

Base Panel (Cabinet)

- About:
  - ➔ The base covering and protection of washing machine
  - ➔ Is made of 4 different parts for improved strength and stiffness .
- Material:
  - ➔ Galvanised steel, stainless steel
- Manufacturing process:
  - ➔ Shearing, Pressing, all the 4 parts bolted/welded together
  - ➔ Deburring and finishing operations (for all panels)







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APPLICATION		DO NOT SCALE DRAWING			

Group 10

TITLE:

SIZE	DWG. NO.	REV
B	BOTTOM PANEL	

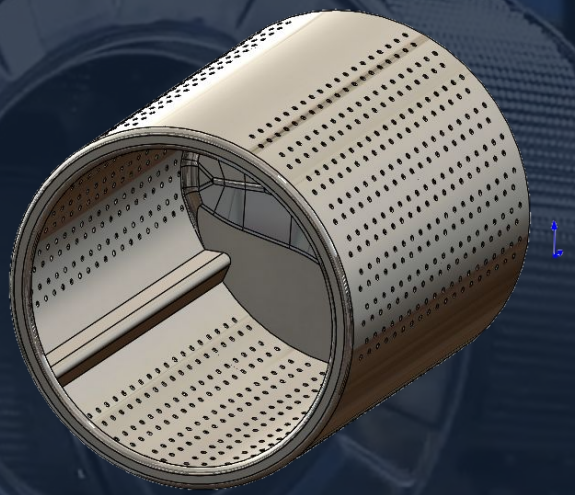
SCALE: 1:20 SHEET 1 OF 1

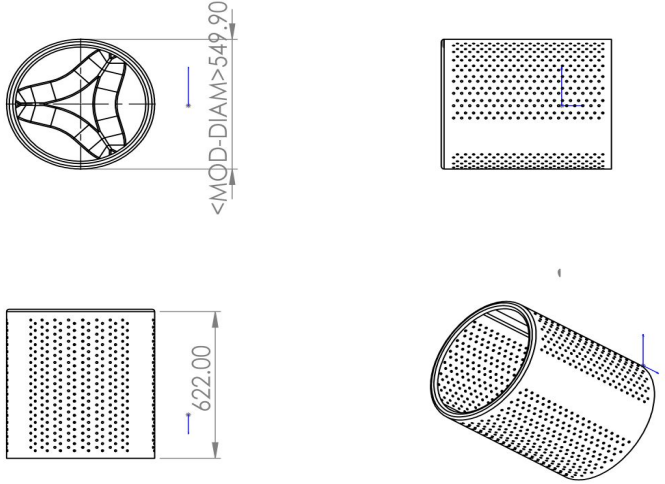
Washer Drum

- About:
  - ➔ Vital part that does the washing through agitation.
  - ➔ It is perforated for removing water from the washed clothes when it rotates at very high speeds during spinning/drying operation.
  - ➔ Rotates along the horizontal axis with the help of motor

- Material:
  - ➔ Galvanised steel

- Manufacturing process:
  - ➔ Punching press (for punching holes), Round folding , welding





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APPLICATION		DO NOT SCALE DRAWING			

Group 10

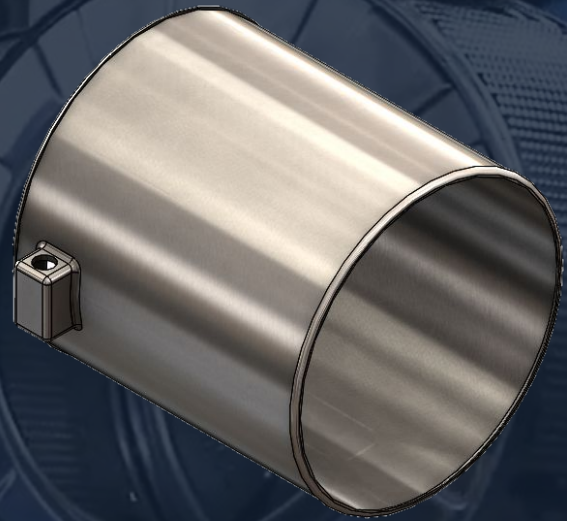
TITLE:

INNER TUB

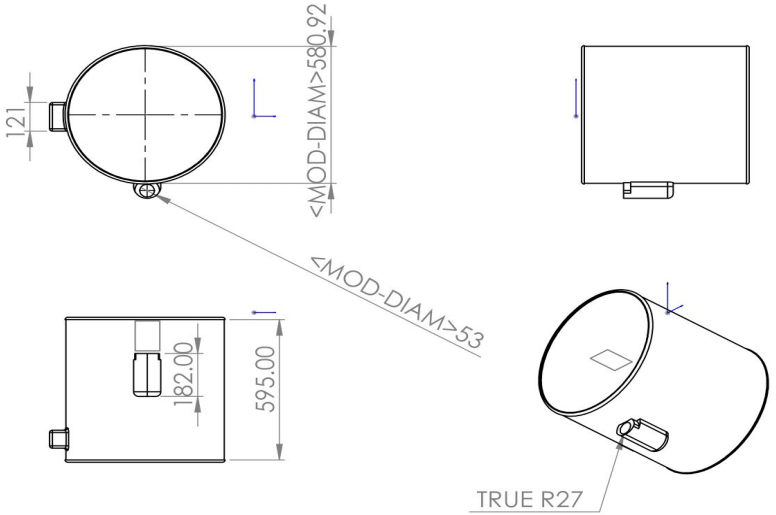
SIZE	DWG. NO.	REV
A		

SCALE: 1:10 SHEET 1 OF 1

Rear drum(outer tub)



- About:
  - ➔ Seals the washer drum to prevent leakage of water.
  - ➔ Rotates along with the washer drum
  - ➔ Counter weights added for more stability.
- Material:
  - ➔ Plastic
- Manufacturing process:
  - ➔ Injection molding



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Group 10

TITLE: OUTER TUB

SIZE	DWG. NO.	REV
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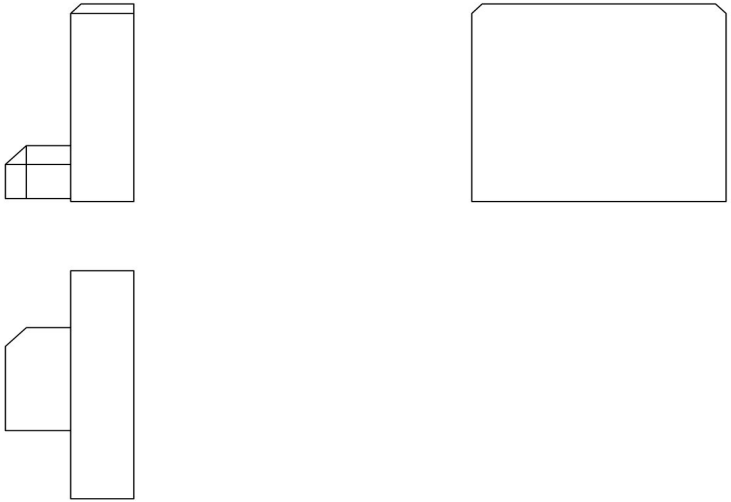
SCALE: 1:20 SHEET 1 OF 1

Motor and drain pump

- Motor:
  - ➔ Main Driving force of the machine
  - ➔ An electronic controller controls the speed and direction of rotation of the drums for agitation and spinning.
- Drain pump:
  - ➔ Pumps the used water out of the machine through outlet drain pipes.



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Group 10

TITLE:

DRAIN PUMP

SIZE	DWG. NO.	REV
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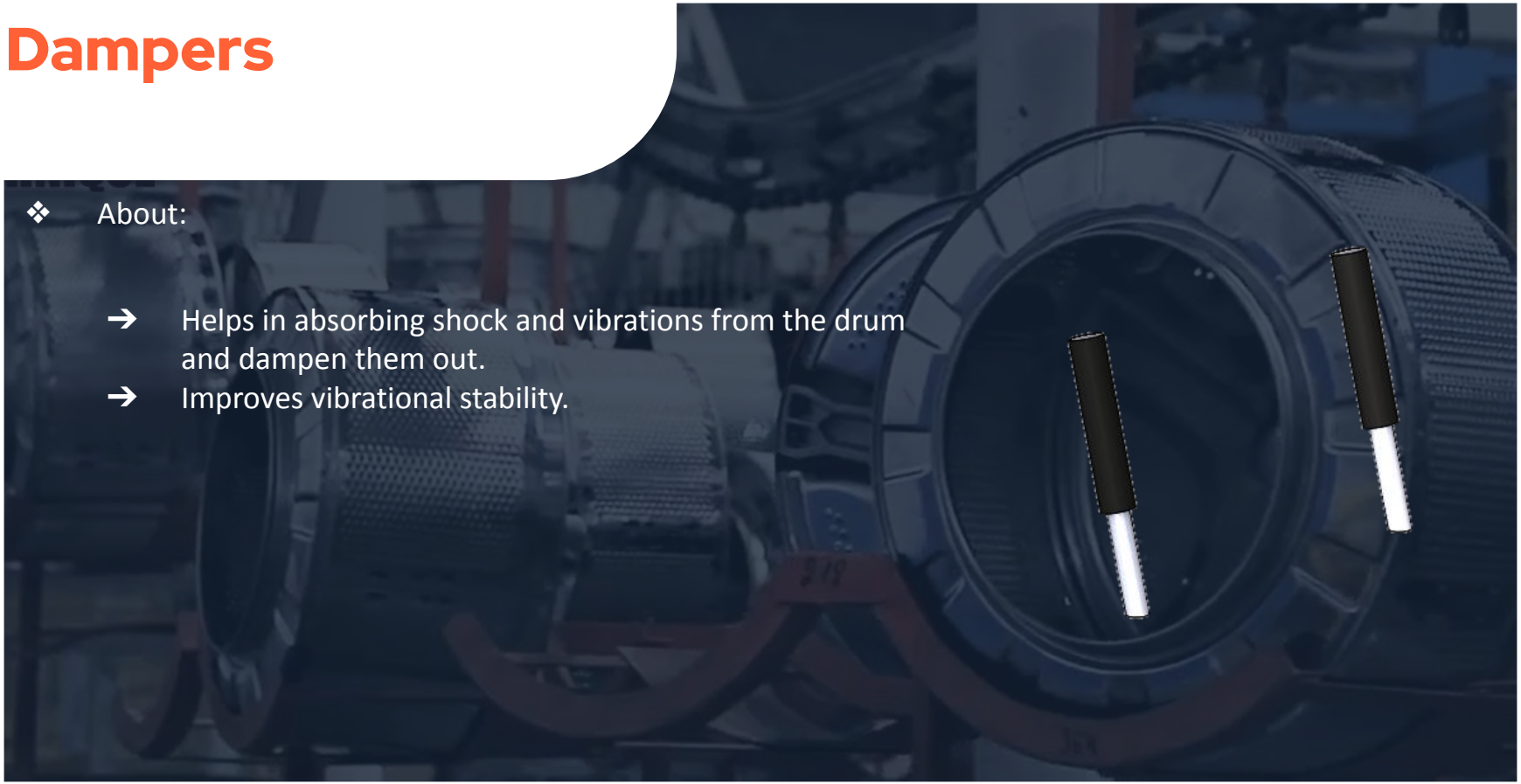
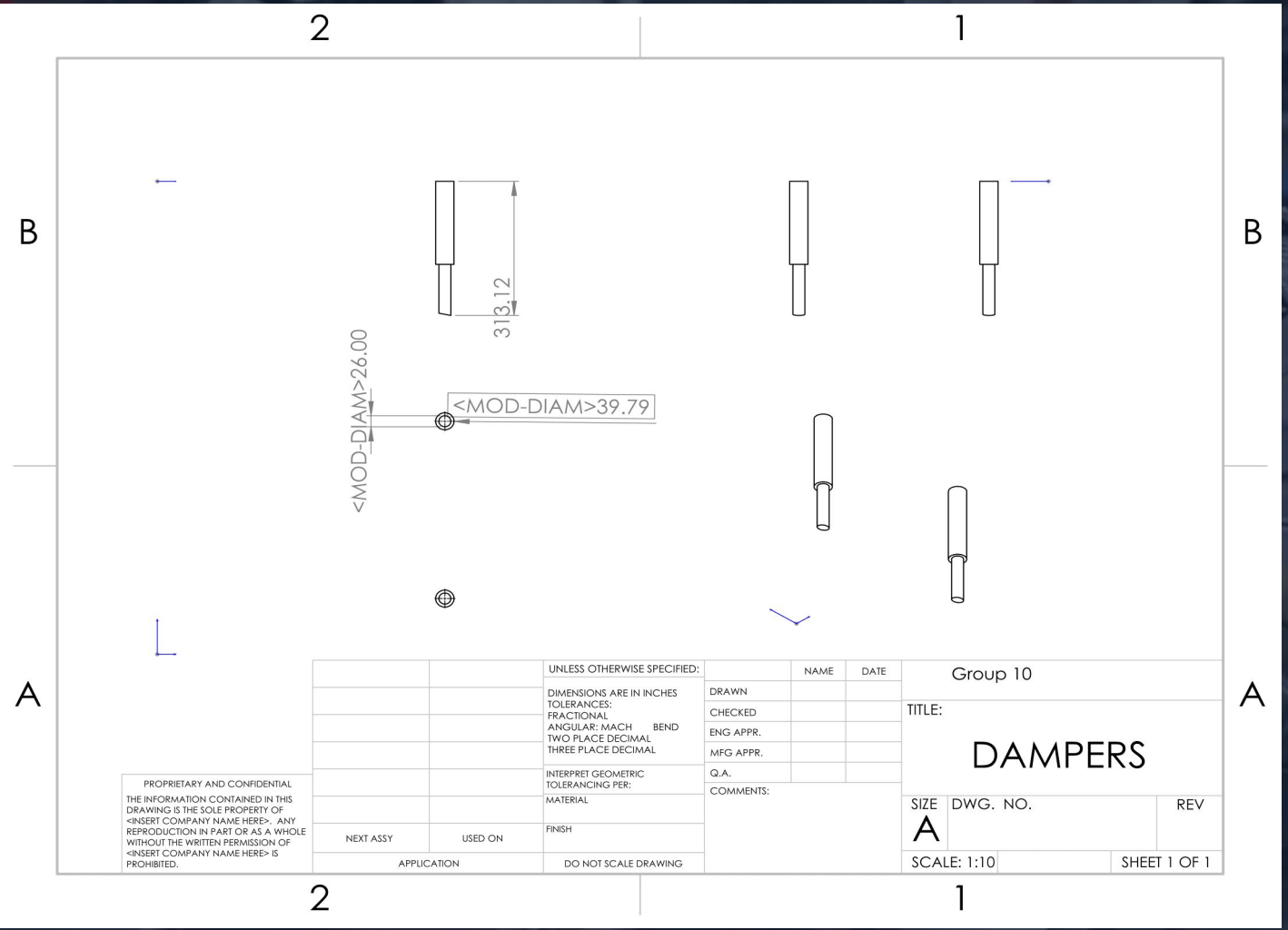
Dampers



- About:
  - Helps in absorbing shock and vibrations from the drum and dampen them out.
  - Improves vibrational stability.


2
1
B
B
A
A
313.12
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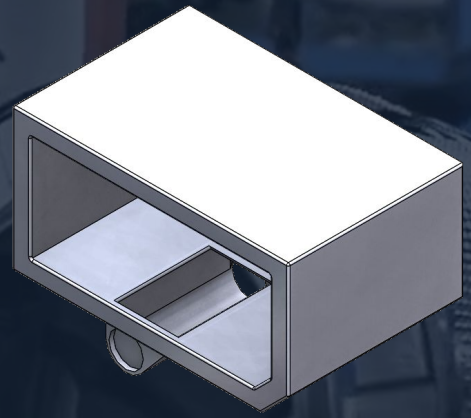
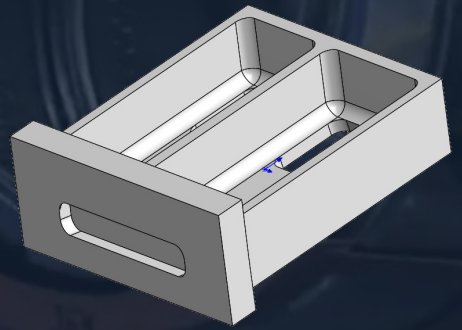
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL
ANGULAR: MACH BEND
TWO PLACE DECIMAL
THREE PLACE DECIMAL
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
Group 10
TITLE:
DAMPERS
SIZE
A
DWG. NO.
REV
SCALE: 1:10
SHEET 1 OF 1
PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.

Detergent Dispenser

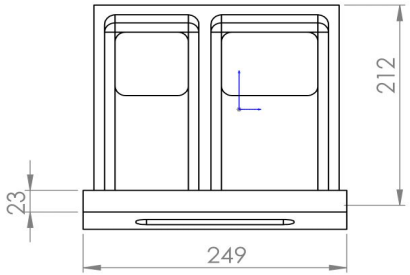
- About:
  - A tray like structure where detergent is put before washing begins (can be seen on the top-left part on the front side)
  - The detergent is automatically used up by the machine while washing and mixes it with water in the right proportion.

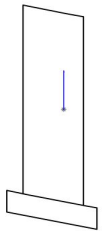


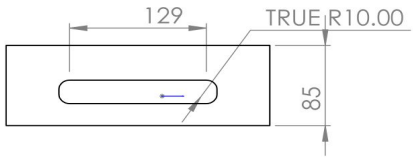


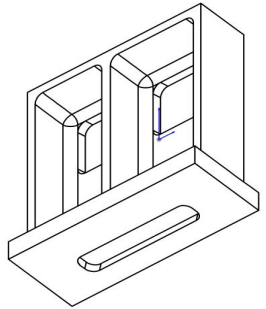
- Material:
  - Plastic

- Manufacturing process:
  - Injection molding









		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
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			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

Group 10

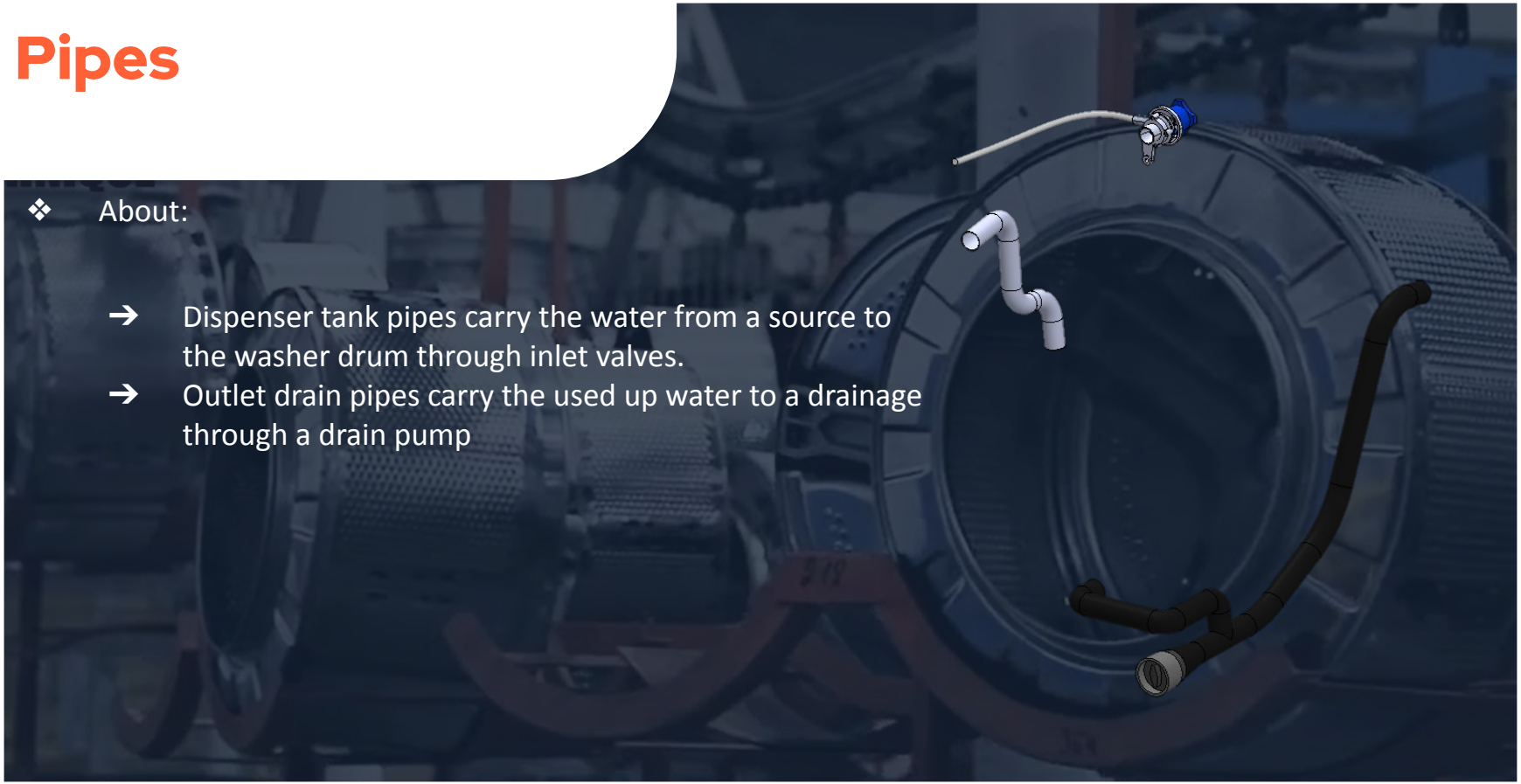
TITLE:

DETERGENT DISPENSER

SIZE	DWG. NO.	REV
A		

SCALE: 1:5 SHEET 1 OF 1

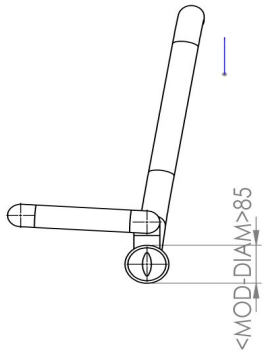
Pipes

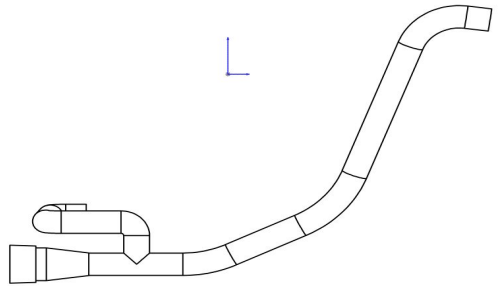


❖ About:

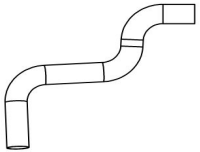
➔ Dispenser tank pipes carry the water from a source to the washer drum through inlet valves.

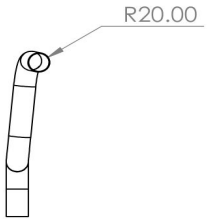
➔ Outlet drain pipes carry the used up water to a drainage through a drain pump





		UNLESS OTHERWISE SPECIFIED:		NAME	DATE	Group 10
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ANGULAR: MACH BEND TWO PLACE DECIMAL THREE PLACE DECIMAL	DRAWN			TITLE: OUTLET DRAIN PIPE
			CHECKED			
			ENG APPR.			
			MFG APPR.			
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			
		MATERIAL	COMMENTS:			SIZE A / DWG. NO. / REV
NEXT ASSY	USED ON	FINISH				
APPLICATION		DO NOT SCALE DRAWING				SCALE: 1:10 / SHEET 1 OF 1





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			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

Group 10

TITLE:

DISPENSER-TANK PIPE

SIZE	DWG. NO.	REV
A		
SCALE: 1:10		SHEET 1 OF 1

CAD model of the Washing machine

Designed on

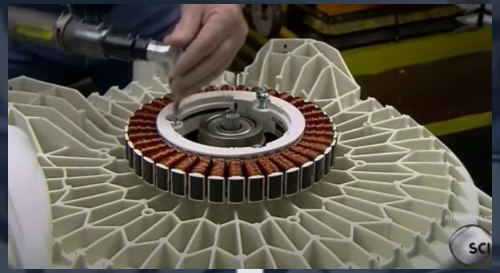
SOLIDWORKS | 2020

Click on image to Open **.STEP file**

4 Assembly

Inner tub

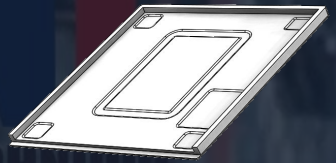
Motor



Washer unit sub-assembly

Outer plastic tub

Cabinet panel

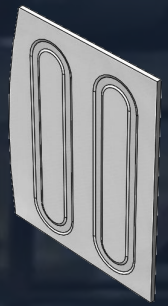


Suspension rods

Front panel

top panel

Main Assembly line

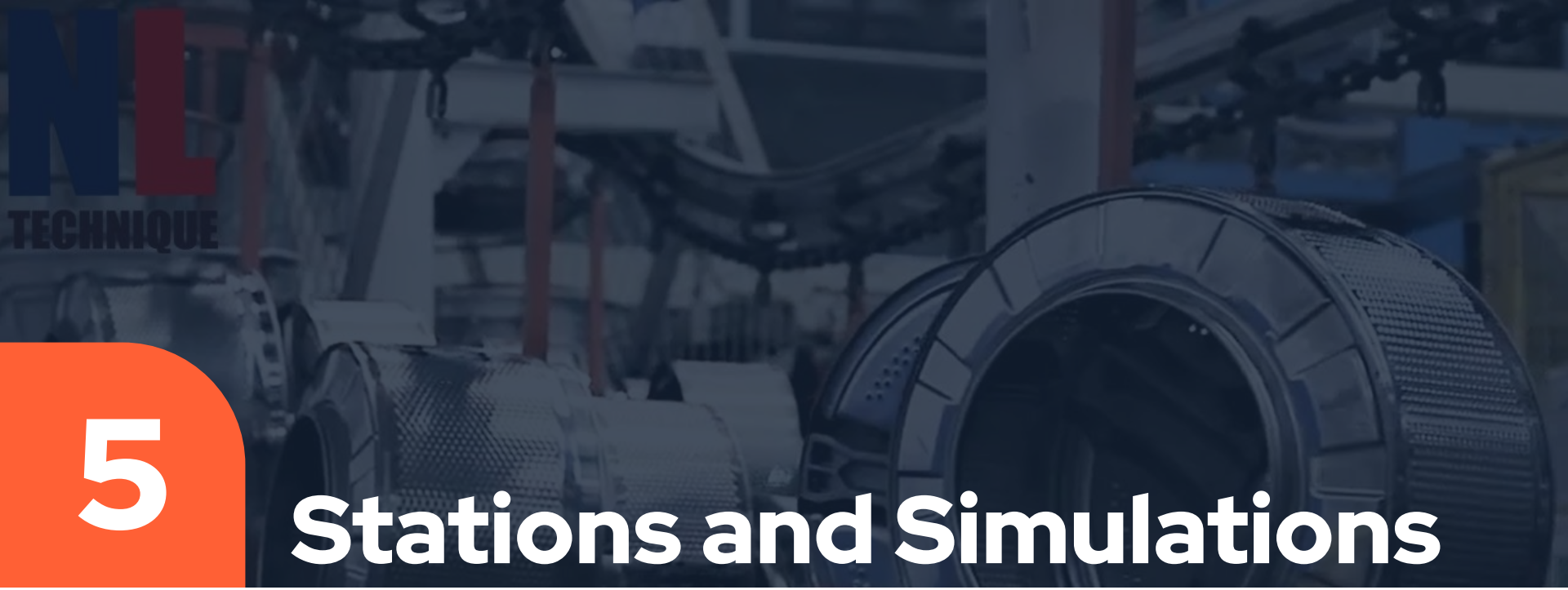


Side panels

Washer unit subassembly

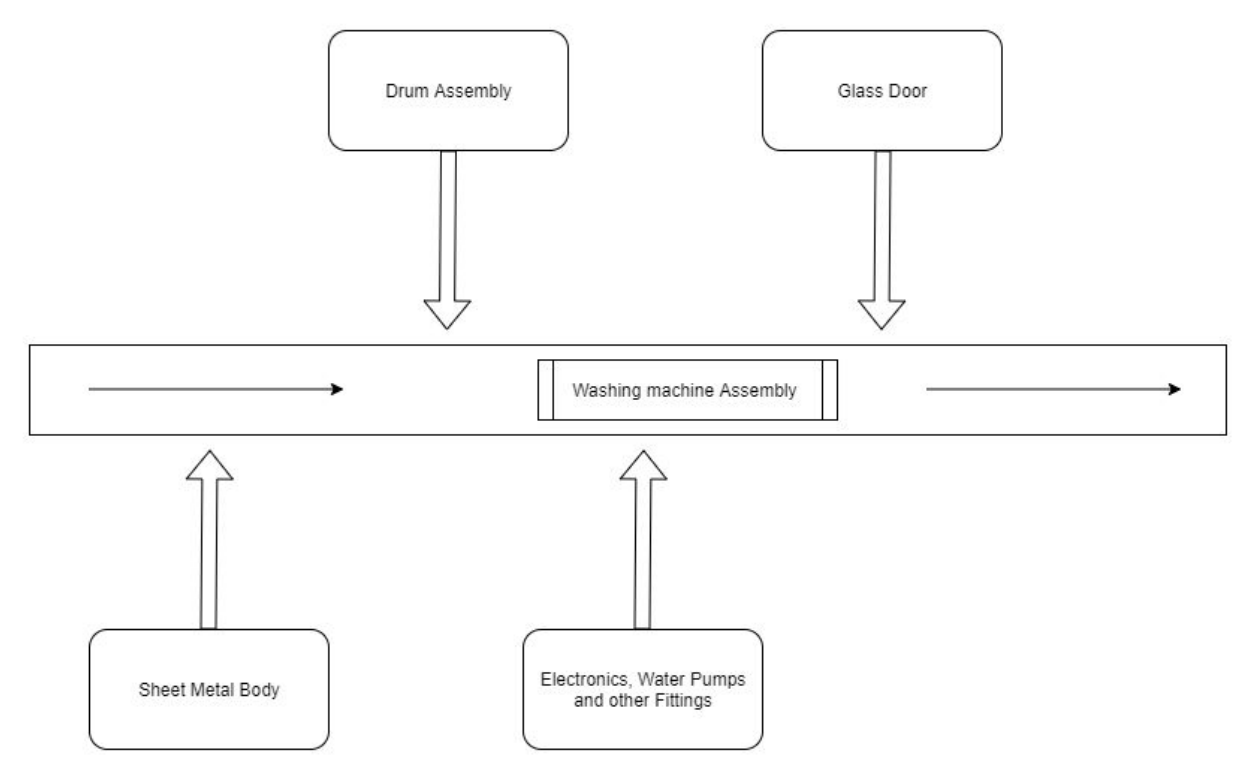
drain pump

rear panel



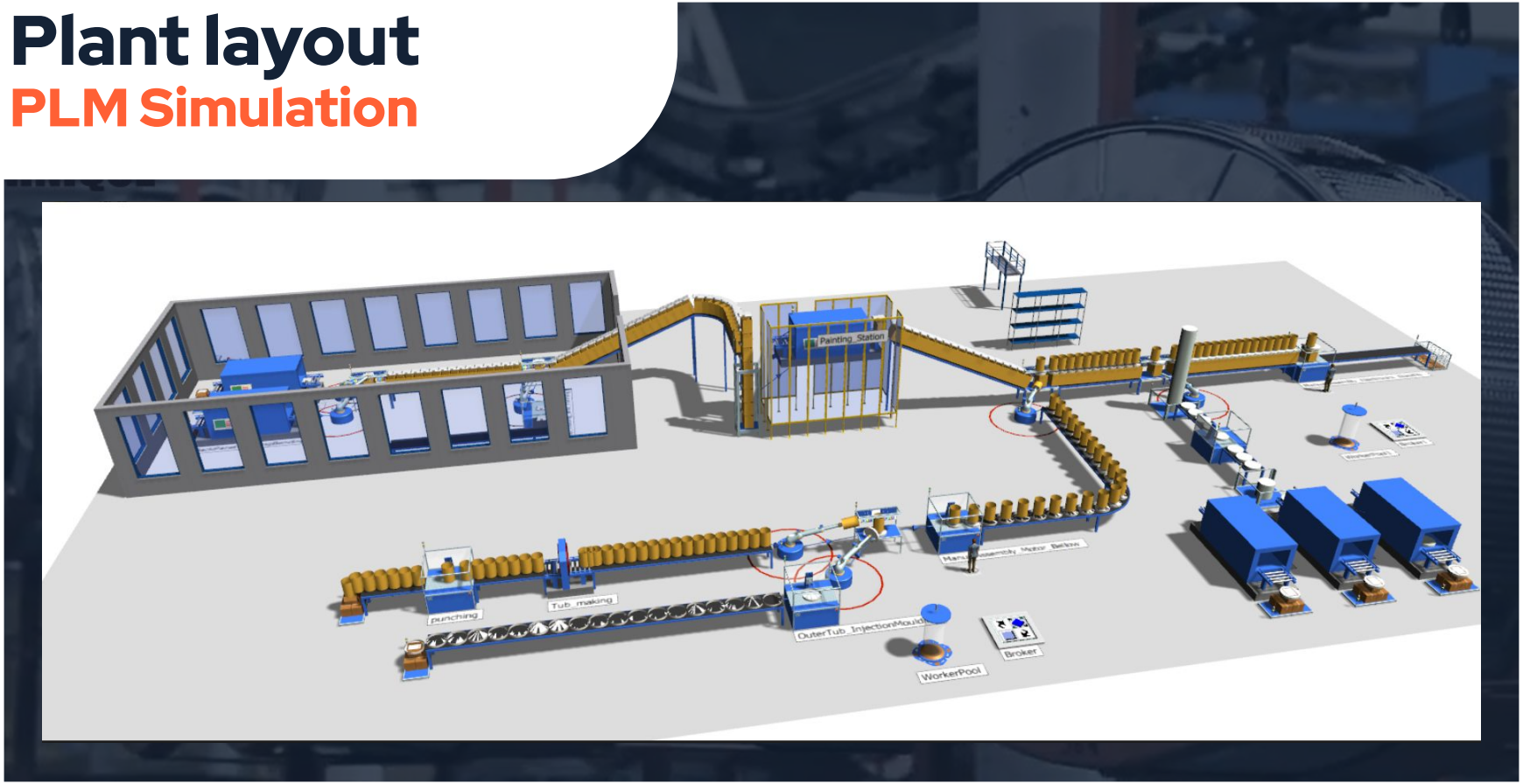
5 Stations and Simulations

Factory Line Diagram

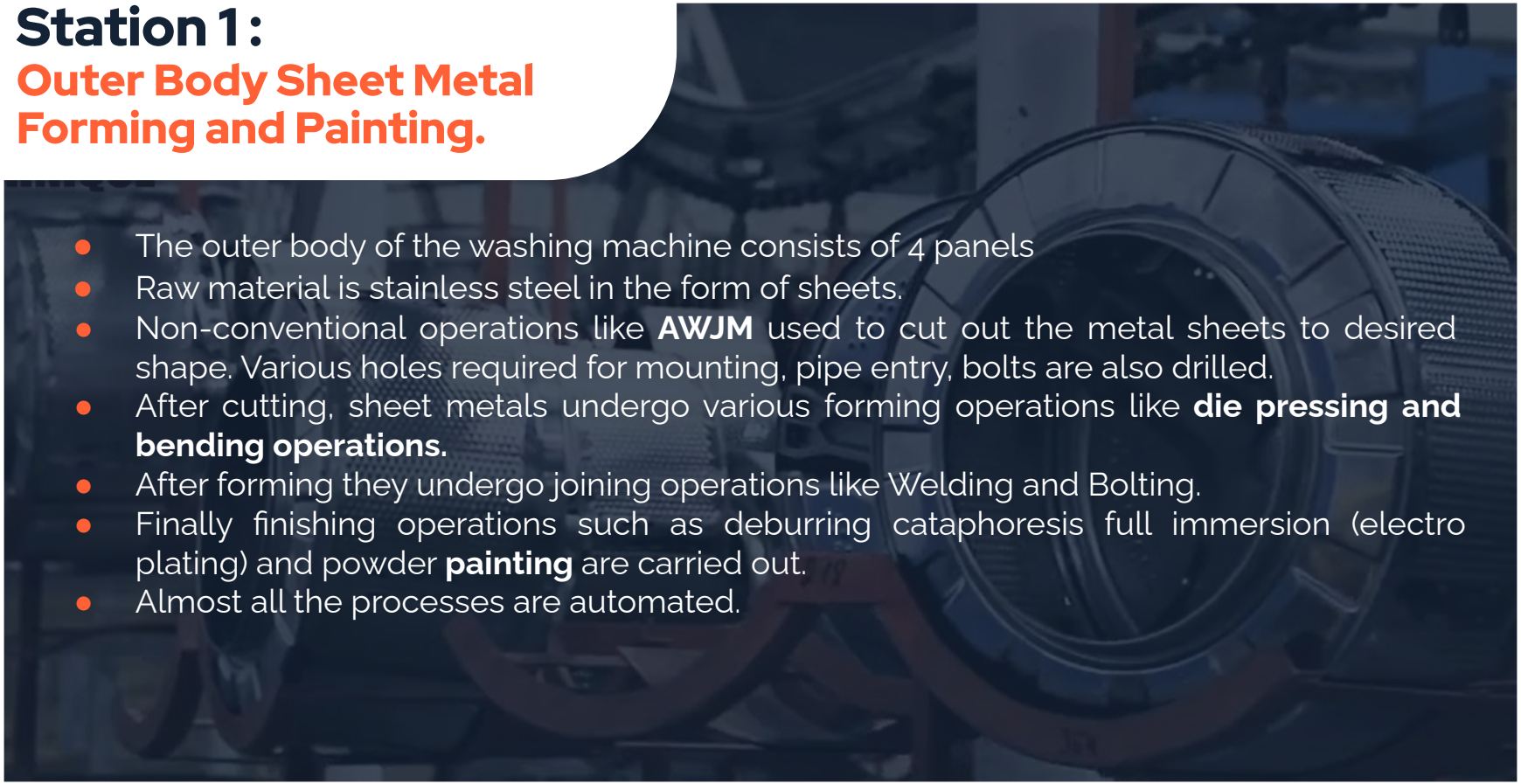


Plant layout

PLM Simulation



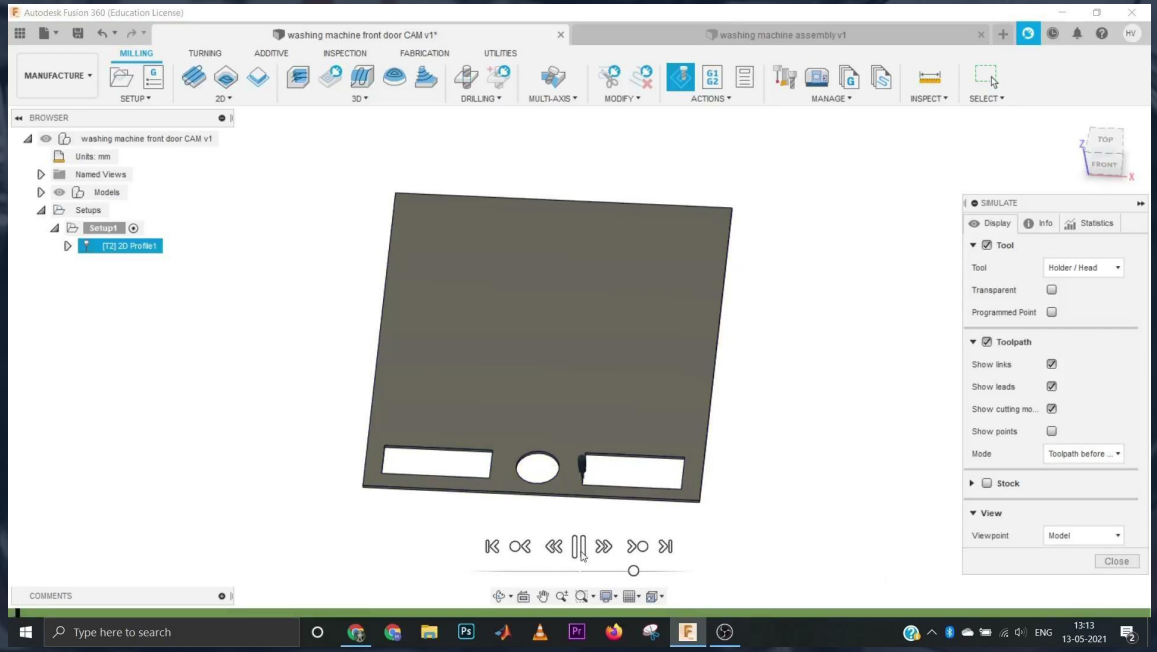
Station 1 :
Outer Body Sheet Metal Forming and Painting.



- The outer body of the washing machine consists of 4 panels
- Raw material is stainless steel in the form of sheets.
- Non-conventional operations like **AWJM** used to cut out the metal sheets to desired shape. Various holes required for mounting, pipe entry, bolts are also drilled.
- After cutting, sheet metals undergo various forming operations like **die pressing and bending operations.**
- After forming they undergo joining operations like Welding and Bolting.
- Finally finishing operations such as deburring cataphoresis full immersion (electro plating) and powder **painting** are carried out.
- Almost all the processes are automated.

AWJM Cutting CAM Simulation

Cutting Time Duration = **7 sec**



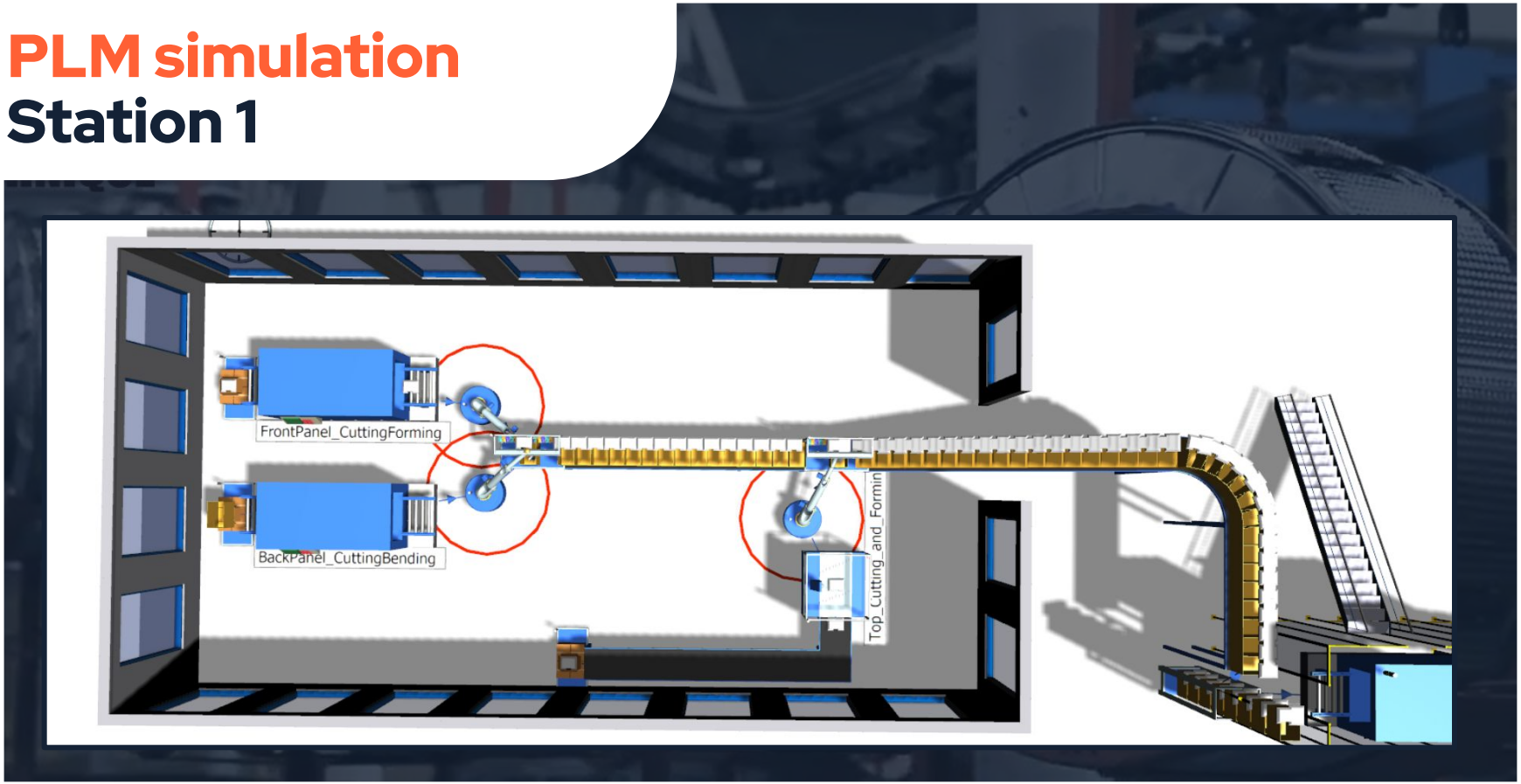
Sequence of Operations

- The sheet metals are cut into specific lengths and required dimensions using **AWJM.**
- The sheared part undergoes Punching and Pressing .
- A bending die bends the straight sheet metal into a U-shaped structure.
- This U-shaped structure forms the Rear panel + 2 adjacent side panels
- The front, top and bottom panels are formed separately as individual units
- First the front panel is bolted and welded to the U- shaped structure.
- This forms all the lateral sides of the outer body of the washing machine i.e, all the 4 sides except the top and bottom.
- Human workers fix the 4 sided body to an overhanging conveyor.
- This above component is made to undergo cataphoresis full immersion and then painted in the painting station along with the separate top and bottom panels (which will be fitted to the main body in the final assembly line).
- Station 1 comprises of all these processes and the output from station will be finished 4 sided washing machine body + *separate* top panel + *separate* bottom panel.

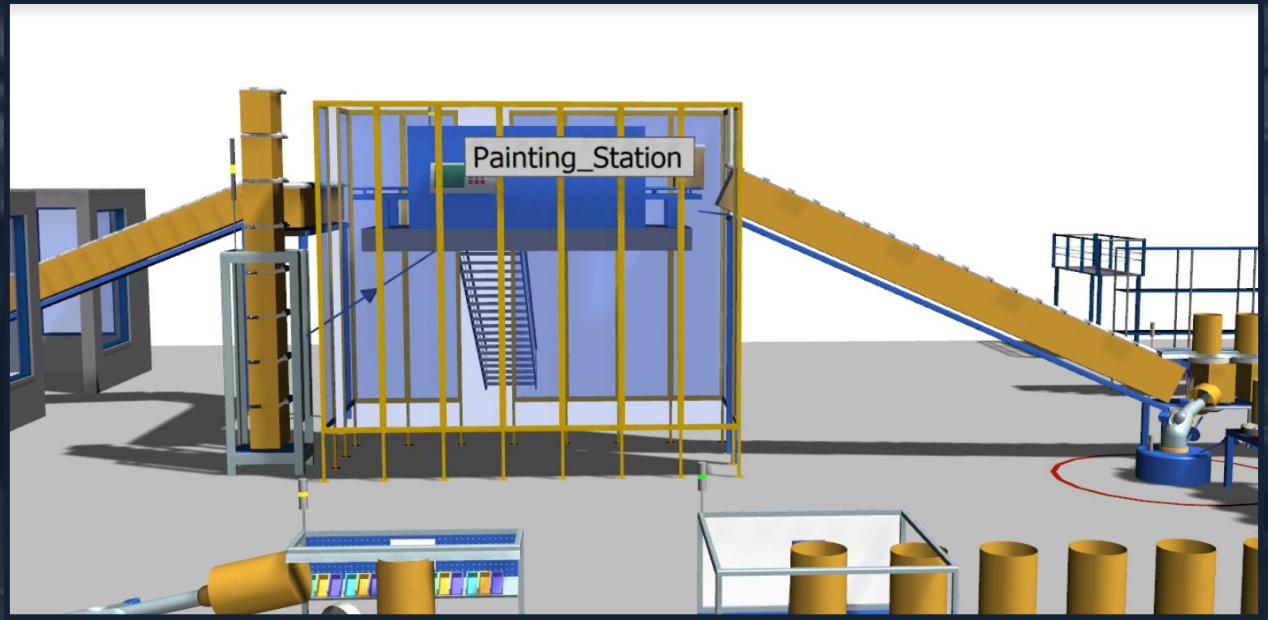





PLM simulation
Station 1

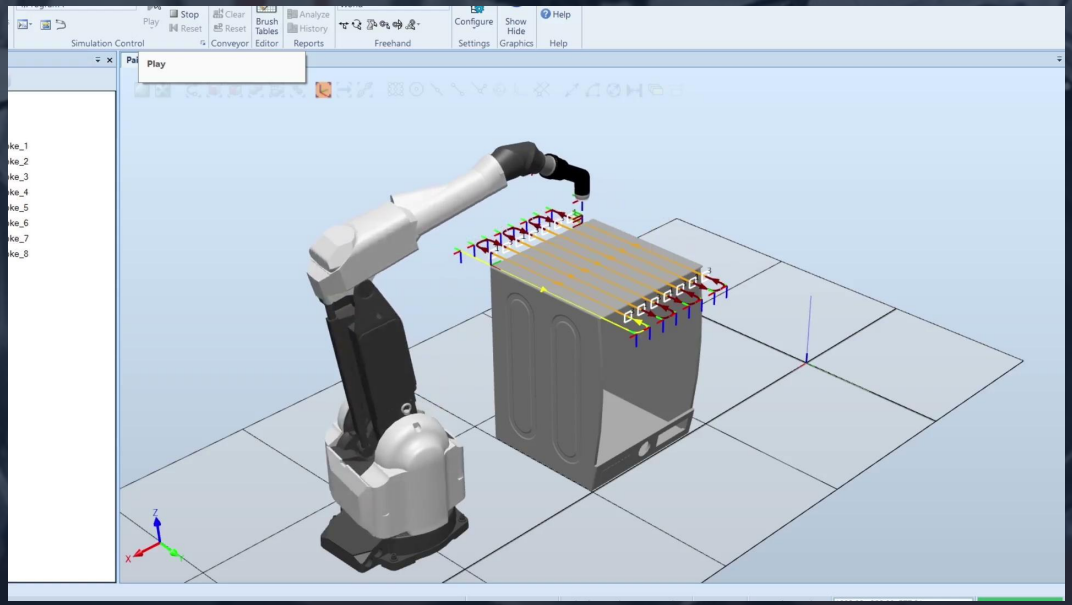


Painting station



Painting Simulation

Painting Time Duration = **6 x 15 = 90 sec**

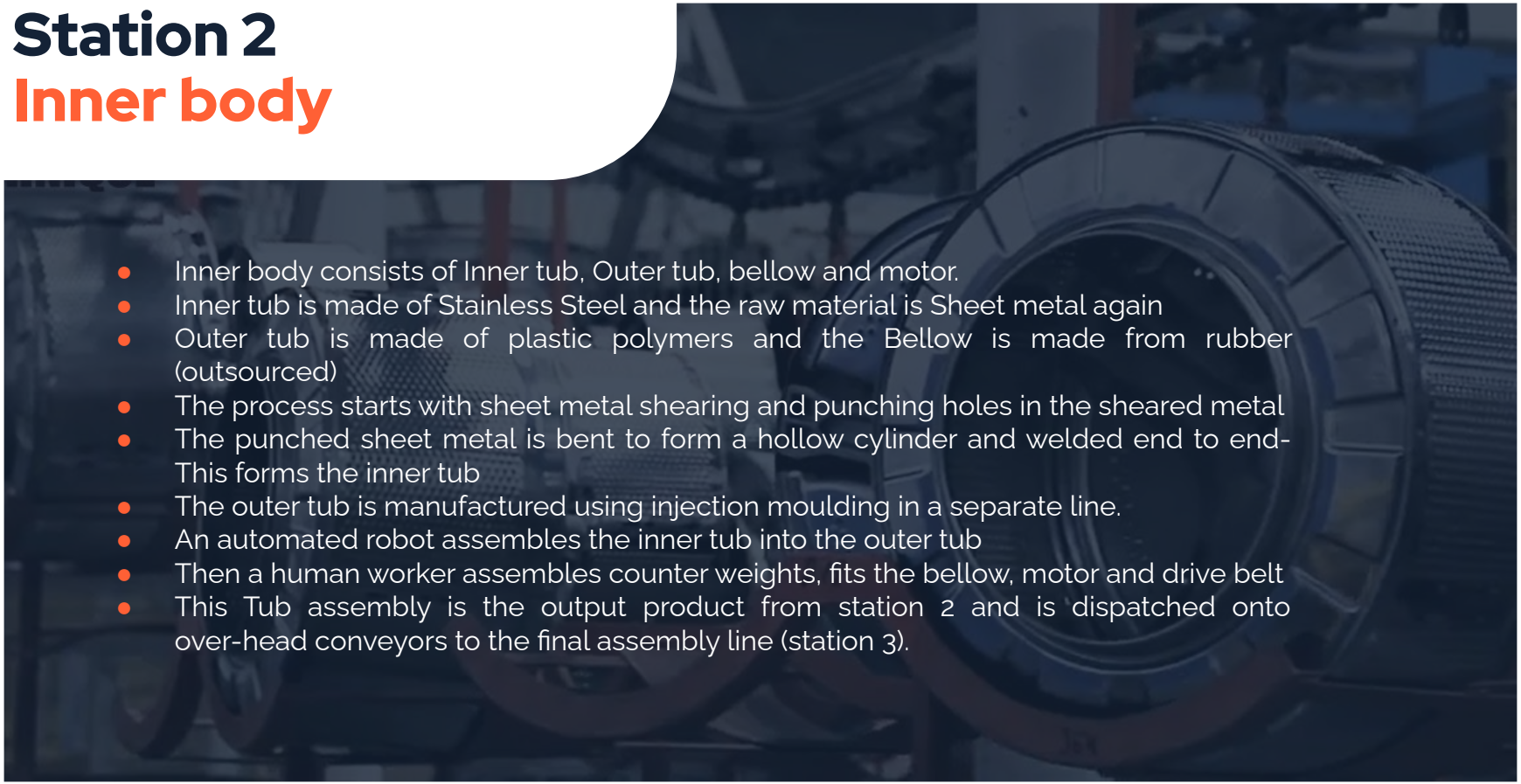


Time analysis

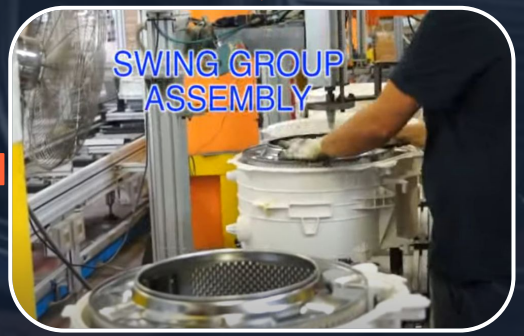
Processes	U-Shape Panel	Front	Top	Bottom
AWJM Cutting	8	7	8	8
Drilling	7	5	7	7
Bending	15	12	15	15
Total	**30 sec**	**25 sec**	**30 sec**	**30 secs**

Welding front panel to U-shaped body	**15 secs**
Painting	**90 secs**

Station 2
Inner body

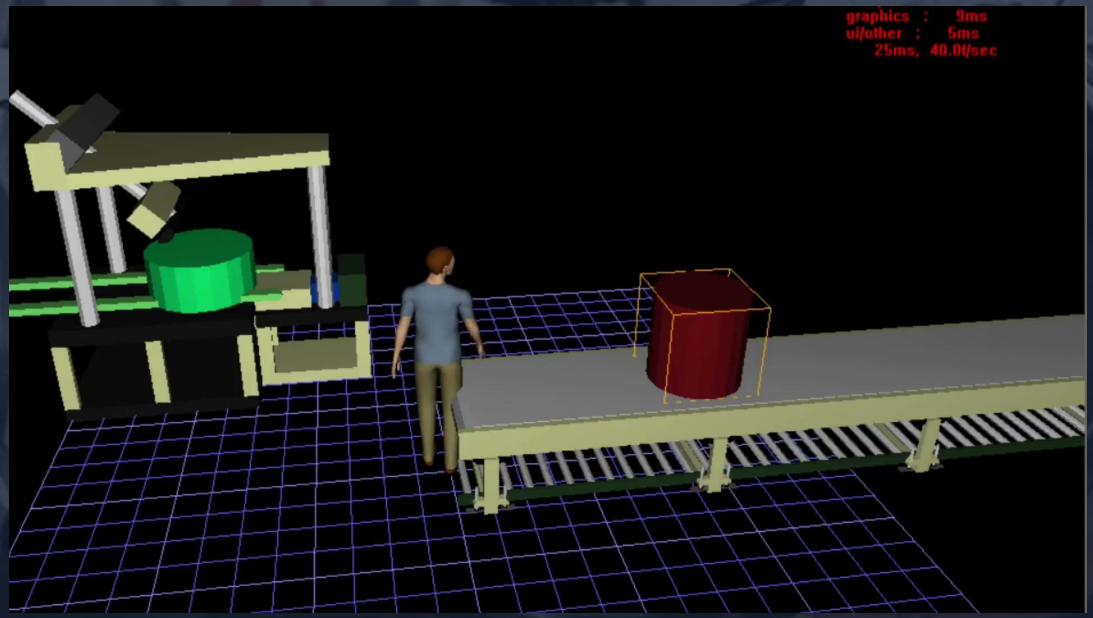


- Inner body consists of Inner tub, Outer tub, bellow and motor.
- Inner tub is made of Stainless Steel and the raw material is Sheet metal again
- Outer tub is made of plastic polymers and the Bellow is made from rubber (outsourced)
- The process starts with sheet metal shearing and punching holes in the sheared metal
- The punched sheet metal is bent to form a hollow cylinder and welded end to end- This forms the inner tub
- The outer tub is manufactured using injection moulding in a separate line.
- An automated robot assembles the inner tub into the outer tub
- Then a human worker assembles counter weights, fits the bellow, motor and drive belt
- This Tub assembly is the output product from station 2 and is dispatched onto over-head conveyors to the final assembly line (station 3).

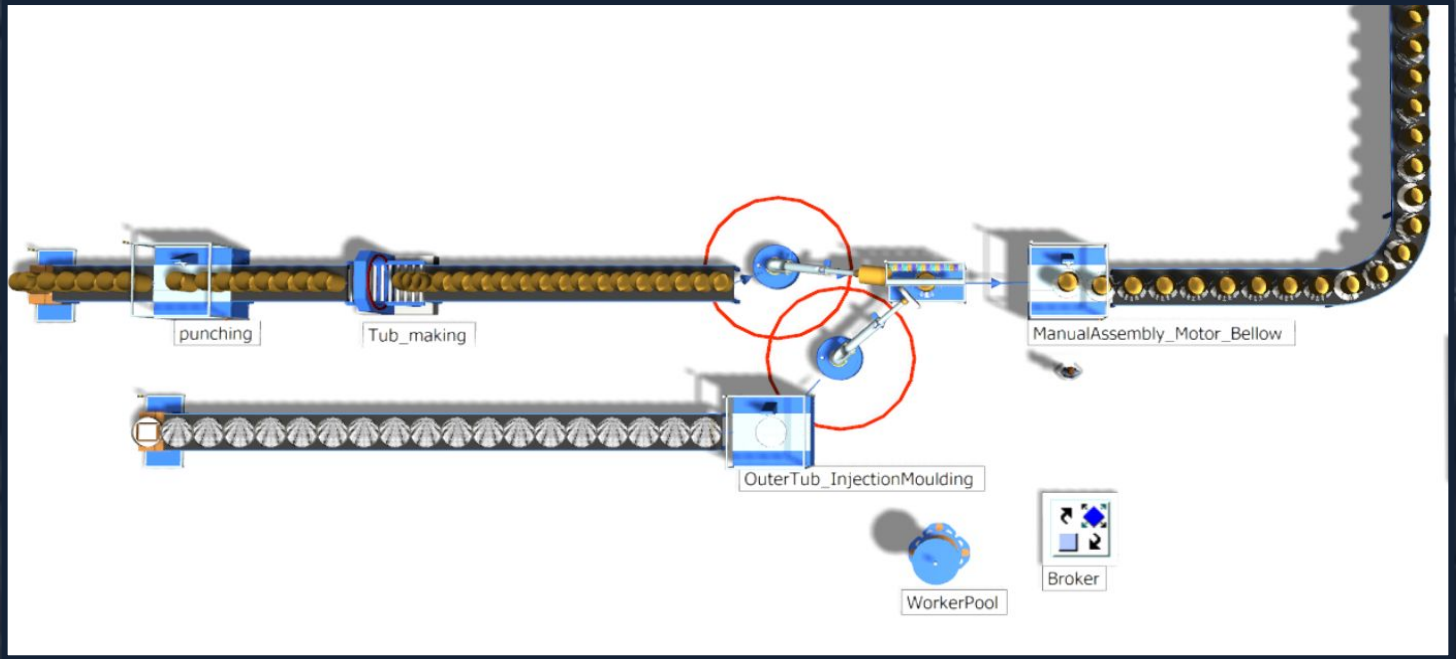

SWING GROUP
ASSEMBLY

Tub Placement
Jack Simulation

Time Duration = **12 sec**



PLM simulation
Station 2

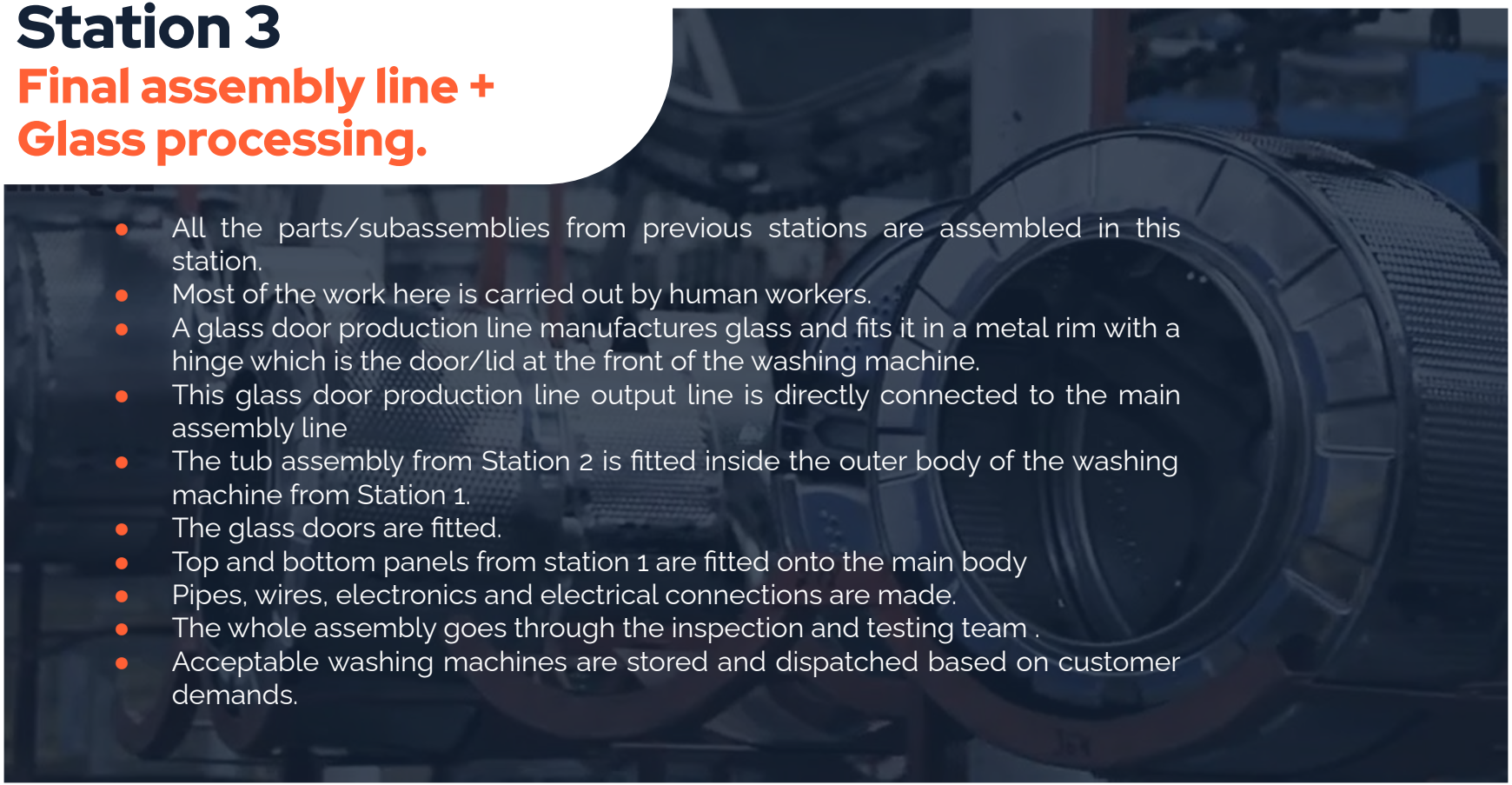


Time analysis

	Processes	Time
Inner Tub	Punching	10 secs
	Bending	15 secs
	Total	**25**
Outer Tub	Injection moulding	25 secs
	Total	**25 secs**
Automated Assembly		**10 secs**
Manual Assembly of Motor, Bellow, Tub fitting		**30 secs**

Station 3

Final assembly line + Glass processing.



- All the parts/subassemblies from previous stations are assembled in this station.
- Most of the work here is carried out by human workers.
- A glass door production line manufactures glass and fits it in a metal rim with a hinge which is the door/lid at the front of the washing machine.
- This glass door production line output line is directly connected to the main assembly line
- The tub assembly from Station 2 is fitted inside the outer body of the washing machine from Station 1.
- The glass doors are fitted.
- Top and bottom panels from station 1 are fitted onto the main body
- Pipes, wires, electronics and electrical connections are made.
- The whole assembly goes through the inspection and testing team .
- Acceptable washing machines are stored and dispatched based on customer demands.

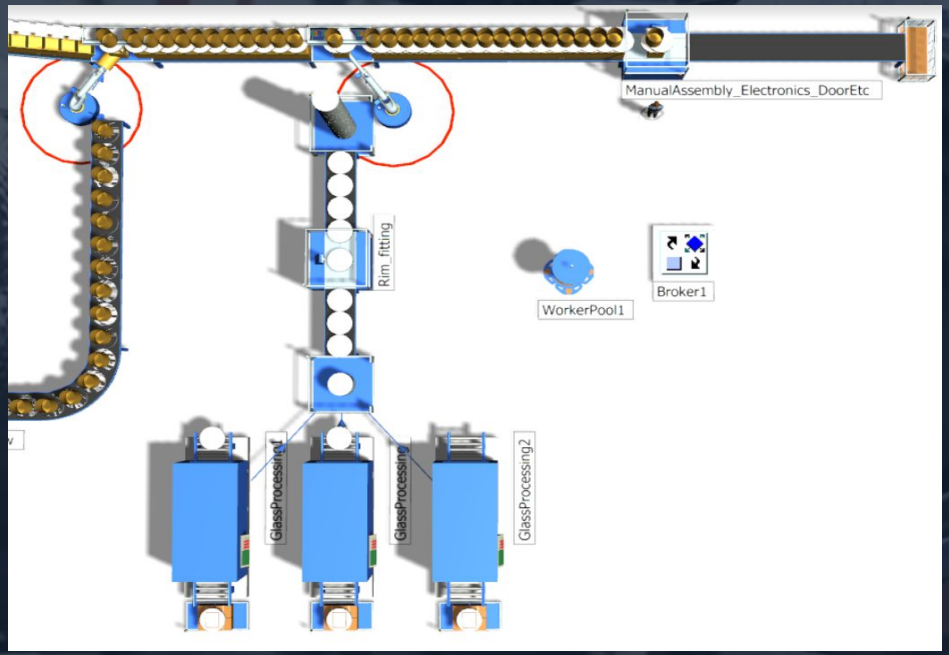
Time analysis Glass door

Processes	Time(in secs)
Glass processing	120
Rim fitting	20
Total	140

Time analysis:
Final assembly

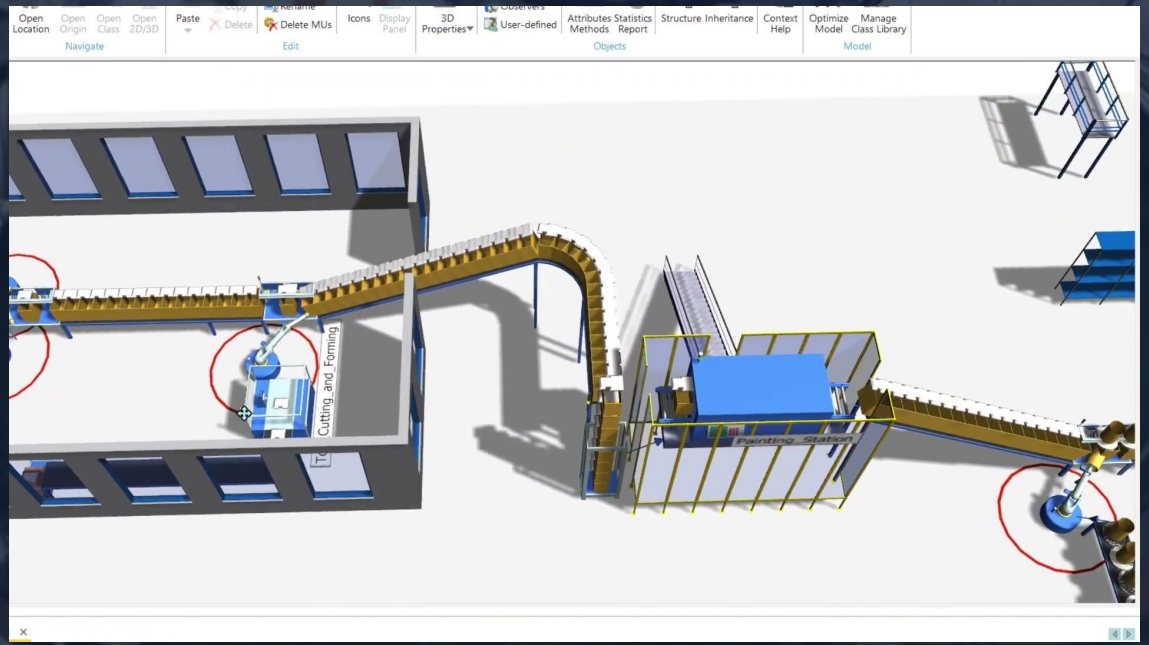
Processes	Time(in secs)
Fitting tub into outer body	10
Fitting glass door, top and bottom panels	100
Fitting pipes, electronics and electrical connections	20
Inspection	30
Testing	20
Total	**3 mins**

PLM simulation
Station 3



Video Animation of Plant

Throughput per hr = **30 Parts/hr**



6 Financial aspects

Machinery & Equipment

Item/ Machine	Qty.	Cost in INR
General purpose lathe	1	₹3,45,000
Shearing machine 1550 mm blade	3	₹11,25,000 x 3
Power press 30 ton capacity	2	₹1,65,000 x 2
Automated bending press	2	₹5,00,000 x 2
Spot welding machine	2	₹25,000 x 2
Painting robot	2	₹1,00,000 x 2
Arc welding machine 300 Amp	4	₹15,000 x 4

Machinery & Equipment

Item/ Machine	Qty.	Cost in INR
Glass cutting machinery	1	₹2,84,000
Robotic manipulator	2	₹30,00,000 x 2
Double end grinding machine 200 mm	1	₹10,000
Portable electric drill machine	2	₹5000 x 2
Air compressor	1	₹25,000
Office & furniture	1	₹40,00,000

Raw materials

Raw mater per each unit = 7500

Item/ Machine	Qty.	Cost in INR
Sheet metal (per ton)	Tentative	₹80,000
Aluminium sheets(per ton)	Tentative	₹1,95,000
¼ HP elect-motor 1440 RPM	1	₹1000
Bakelite moulded components	1	₹100
Plastic(per ton)	Tentative	₹39000
Rubber(per ton)	Tentative	₹168150
Paints(per ton)	Tentative	₹250000

Working capital

Item/ Machine	No	Salary in INR
Manager	1	₹65,000
Sales officer	1	₹40,000
Accountant	1	₹40,000
Technicians	5	₹45,000 x 5
Supervisor	3	₹25,000 x 3
Workers	15	₹15,000 x 15

Financial Analysis

Calculations are per month :

Total capital = Fixed capital (Rent)+ working capital

Total capital = ₹15,00,000 + ₹6,70,000 = ₹21,70,000

Total Recurring expenditure = utilities + other contingent expenses + Miscellaneous expenses

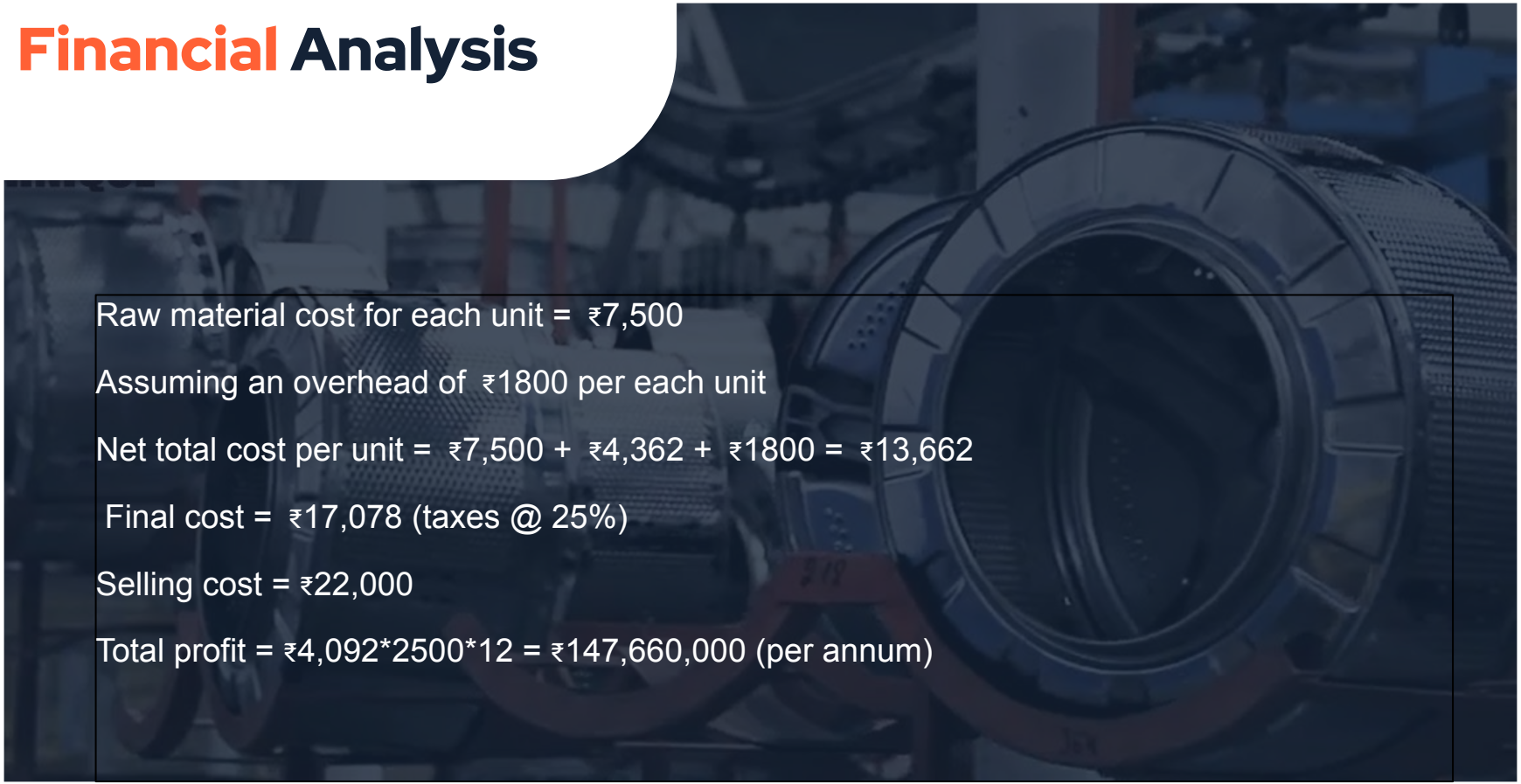
Total Recurring expenditure = ₹8,00,000

Machinery and equipment = ₹35,00,000

Total cost = ₹1,04,70,000

Cost per unit = total cost / units per month = ₹4362.5

Financial Analysis



Raw material cost for each unit = ₹7,500

Assuming an overhead of ₹1800 per each unit

Net total cost per unit = ₹7,500 + ₹4,362 + ₹1800 = ₹13,662

Final cost = ₹17,078 (taxes @ 25%)

Selling cost = ₹22,000

Total profit = ₹4,092*2500*12 = ₹147,660,000 (per annum)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