AT73.06: Product Design and Development

Final Presentation & Demo of Prototype

Project 2 : Designing & Manufacturing of a Coin Sorting Machine

Product Development Team

Mr. Amit Kumar
Mr. Suchart Nachaisit
Mr. Jakra Tandhavatana

Presentations Contents

Objective of the Project

$$

10 Baht   5 Baht   1 Baht   50 Satang   25 Satang

Progress Presentation (Contd)

Mission Statement

Product Description   :   Portable, trustful and compact   Coin Sorter

Primary Market   :   Household Purpose

Customer Survey Summary

No of customer included = 12

Customer Needs	Survey Result
My sorter must perform correctly at each time	YES – 12 NO - 0
My sorter must be safe for children	YES – 12 NO – 0
I want to start my sorter by pressing button	YES – 12 NO - 0
I want to carry my sorter at any place	YES – 7 NO – 5

Customer need & Importance

Need – Metrics Matrix

HOQ

Progress Presentation (Contd)

House of Quality

	Speed	Machine cap.	Repeatability	Accuracy	Importance	Imp. ratio	Sales point	Scores	% Scores
Stacking of coins	9	9	3	3	5	1	1.2	6	7.48
Counting of coins	3	1	9	9	5	1	1.2	6	7.48
Reliability of M/C	9	9	9	9	5	1	1.3	6.5	8.10
Fast operation	9	3	3	3	4	1	1.1	4.4	5.49
Total score	319	318	215	212					
% Imp. score	11.7	11.6	7.84	7.7					
	1	2	3	4					

Progress Presentation (Contd)

Analysis of HOQ

percentage importance of product specification

1. Speed of coin sorter machine (coin/minute)   11.7 %
2. Machine capacity (No. of coin/single drop)   11.6 %
3. Repeatability   7.84 %
4. Accuracy   7.70 %

Concept Generation : Concept Combination Table

| External Energy	Moving of coins	Sorting of coins one by one
Rotary Motor with Transmission	Belt Conveyor	Holes along the coin movement
Manually Operated Handle with Transmission	Bowl Feeder	Photo Detector
Magnetic Vibration	Roller Feeder	Weight Detector
	Rotating Plate with Slot	

Progress Presentation (Contd)
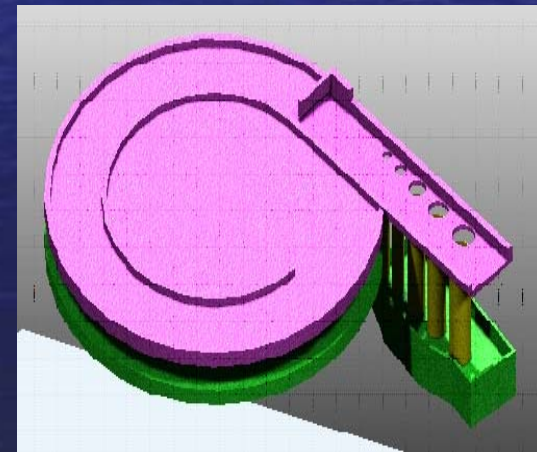
Potential Concept

1. Rotating Plate Coin Sorter
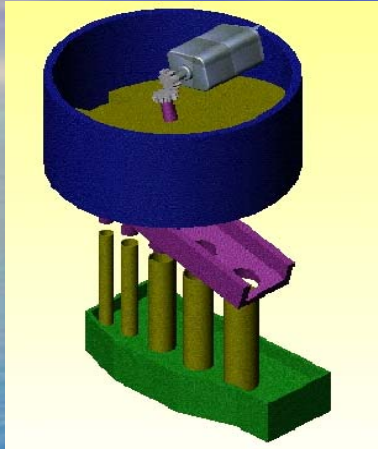
2. Belt Conveyer Coin Sorter
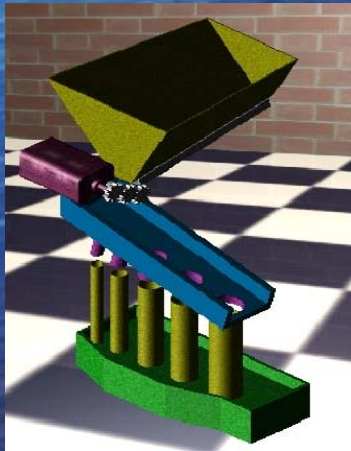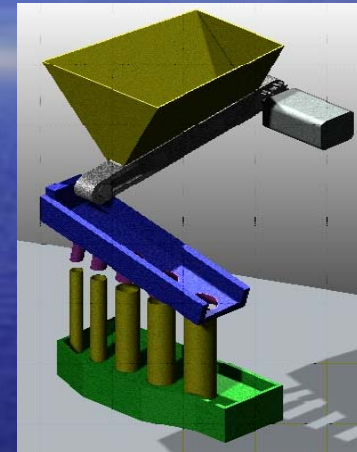
3. Roller Coin Sorter


4. Bowl Feeder Coin Sorter

Progress Presentation (Contd)

Concept Selection : Concept Scoring Matrix

Selected Concept : Rotating Plate Coin Sorter

Selection Criteria	Wei... (In...				3		4	
				Rat.	Wt. Score	Rat.	Wt. Score
Stacking of sorted coins	0.				4	0.4	4	0.4
Counting of coins	0.				4		4	0.4
Soft corners - safe for children	0.						3	0.15
Reliability					3	0.6	4	0.8
Stability of stacked of coins	0.				4	0.2	4	0.2
Ease of Manufacture	0.				3	0.6	4	0.8
Durable	0.				3	0.3	4	0.4
Less Maintenance	0.				3	0.3	4	0.4
Fast Operation of Sorting	0.0				4	0.2	4	0.2
Portable Size	0.0				4	0.2	5	0.25
Total Score						3.4		4
Rank		**1**	**3**		**3**		**2**	
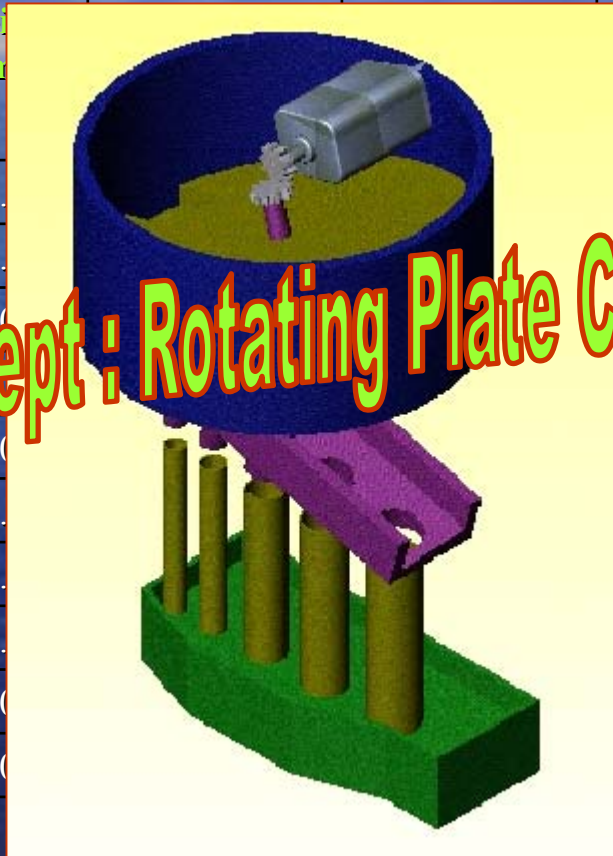
Process Driven Design Phase

1. Manufacturability Design Goals

- Minimize the number of parts (e.g. Fasteners)

- Manufacturing Constraints – Conventional Process to be used

- Standard DC Motor, and Fasteners.

2. Product and Process Plan

- Division between standard and designed components

- Product architecture.

- Assembly Concept - Stacked construction

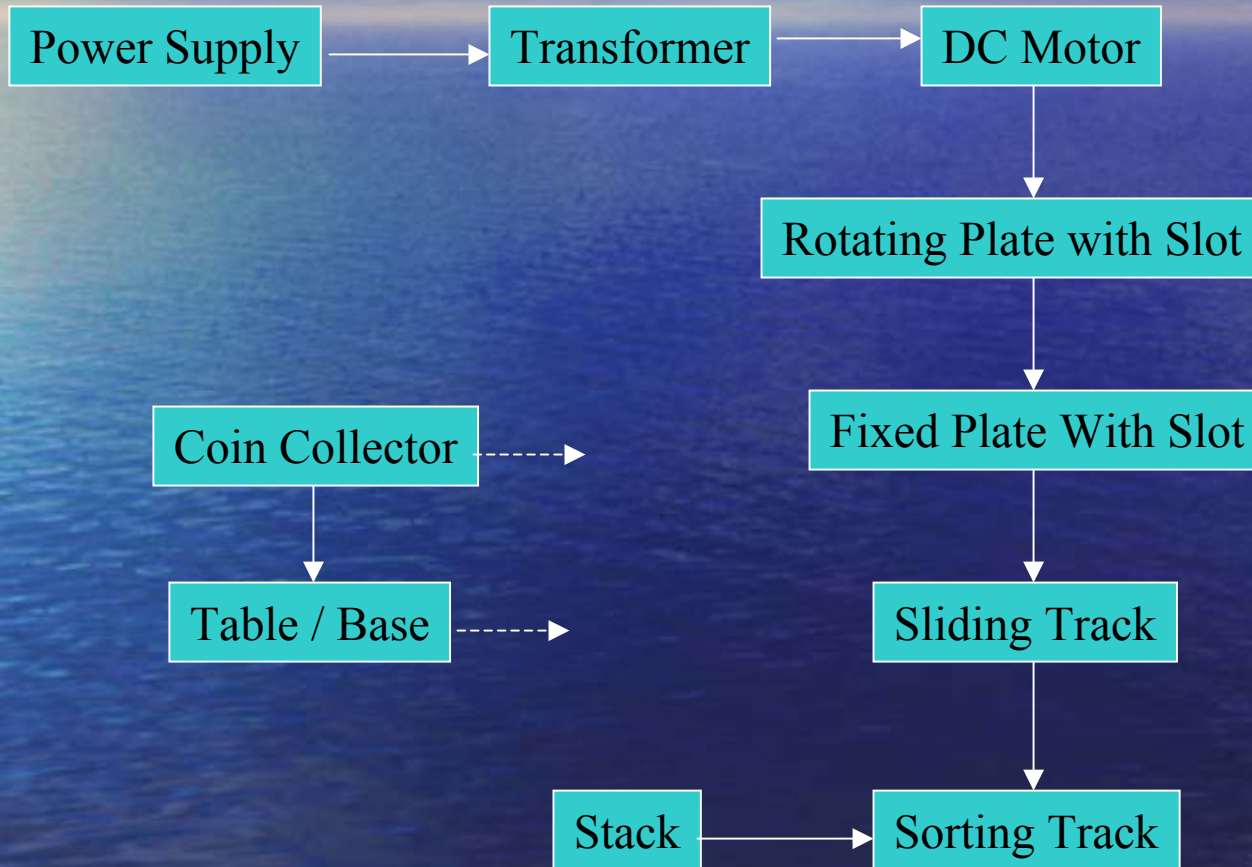- Material and Process class for key component - First Material Approach

Process Driven Design (Contd)

Material-First Approach

```
Consider Application        Prototype, no load, no wear
Requirements
        ↓
Select Feasible             Acrylic, Aluminum, PVC
Material Class(es)
        ↓
Select Candidate            Turning, Drilling, Tapping, Milling
Process Types               Boring, Sheet Metal, Shaping
        ↓
Consider Part Requirements  Prototype, Not for mass production
        ↓
Select Feasible             Drilling, Turning, Tapping, Milling
Process Type(s)
```

Product Architecture

1. Schematic of the coin sorter

```
Power Supply  ──────▶  Transformer  ──────▶  DC Motor
                                                 │
                                                 ▼
                                      Rotating Plate with Slot
                                                 │
                                                 ▼
Coin Collector  ------▶               Fixed Plate With Slot
       │                                         │
       ▼                                         ▼
Table / Base  ------▶                    Sliding Track
                                                 │
                                                 ▼
           Stack  ──────▶               Sorting Track
```

Product Architecture (Contd)

2. Cluster the element

Power module

Power transmission

Structure module

Coin separation module

Sorting module

Power Supply → Transformer → DC Motor → Rotating Plate with Slot → Fixed Plate With Slot → Sliding Track → Sorting Track → Stack
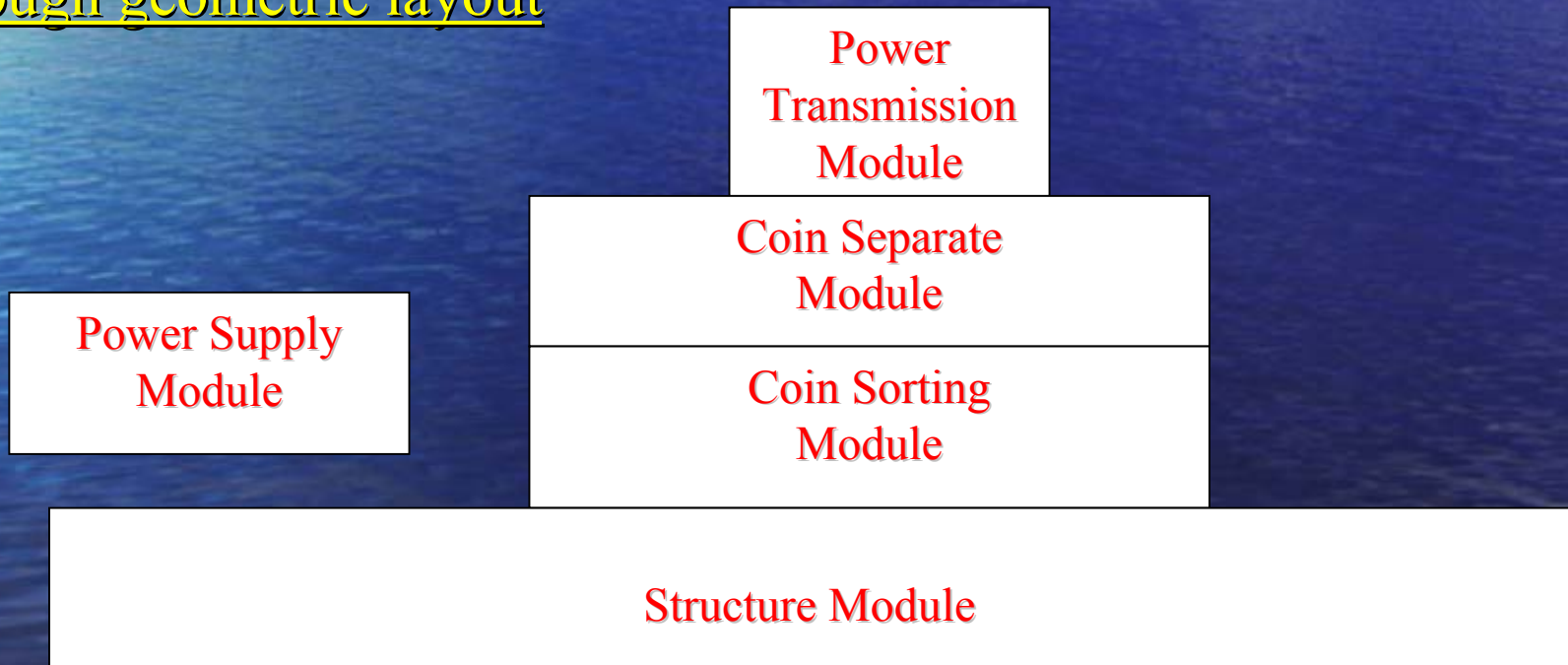
Coin Collector → Table / Base
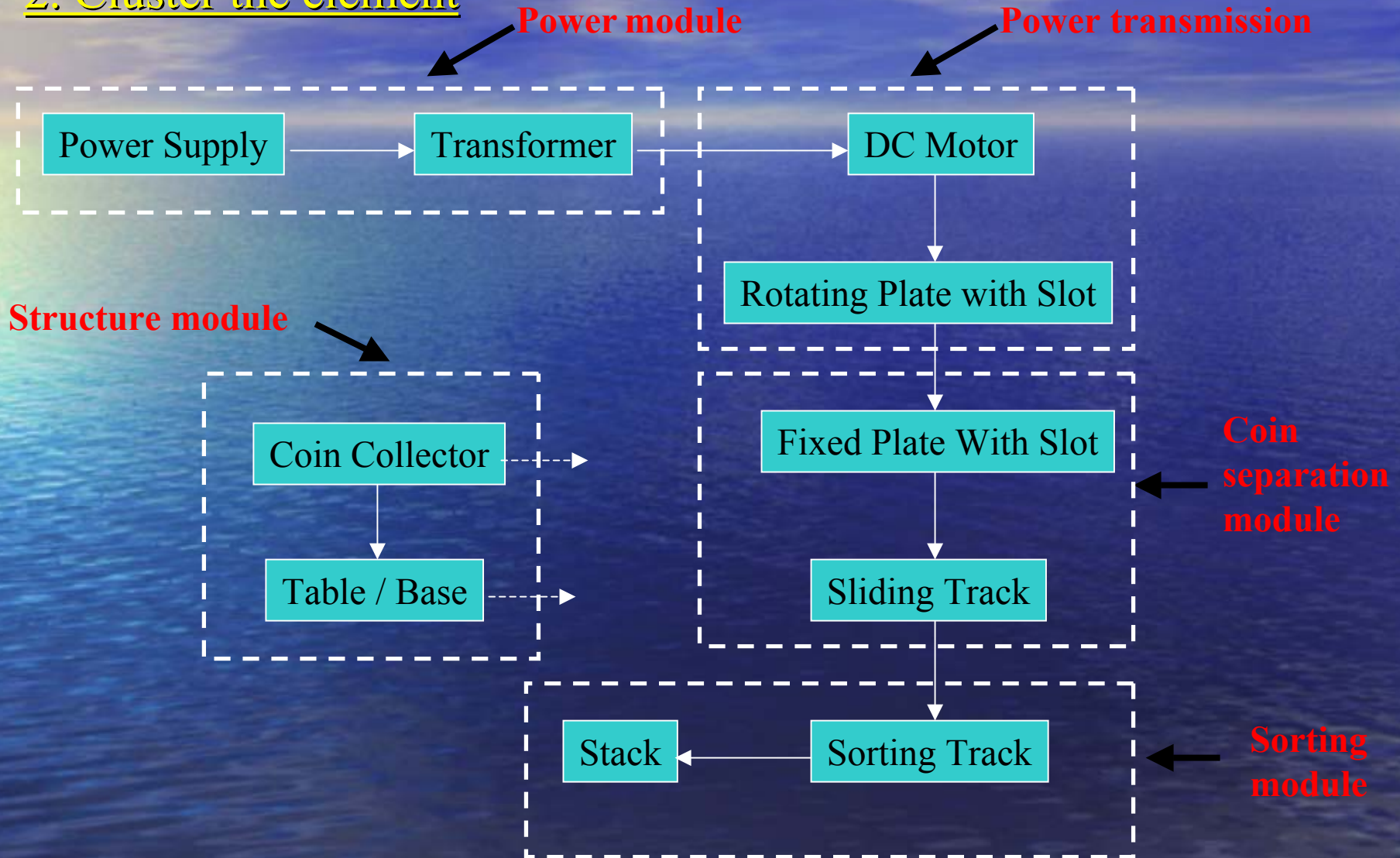
Product Architecture (Contd)

Chunks

1. Power module
2. Power transmission
3. Coin separation module
4. Sorting module
5. Structure module

Each Chunk designed by a different Group / Vendor

3. Rough geometric layout

Power Transmission Module

Coin Separate Module

Power Supply Module

Coin Sorting Module

Structure Module

Detail Designing Phase

1. Power Module

Main Supply	Transformer

AC 220 Volt   **Step Down, 24 Volt**

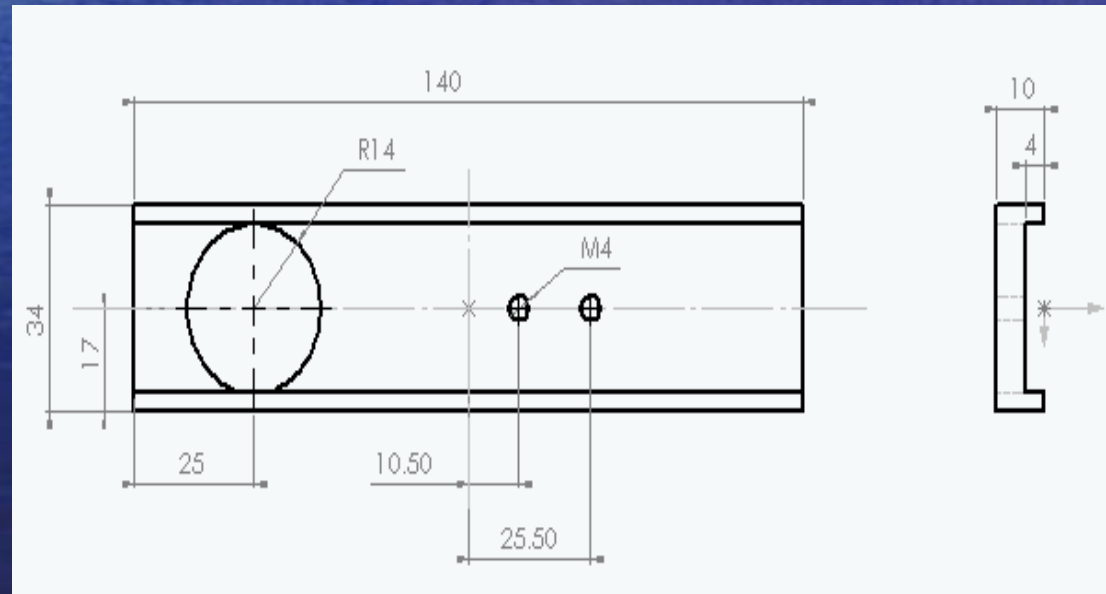## 2. Power Transmission Module

DC Motor	Rotating Plate with slot
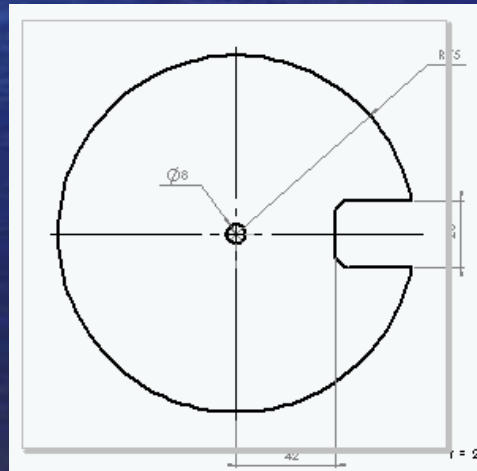
3. Coin Separation Module
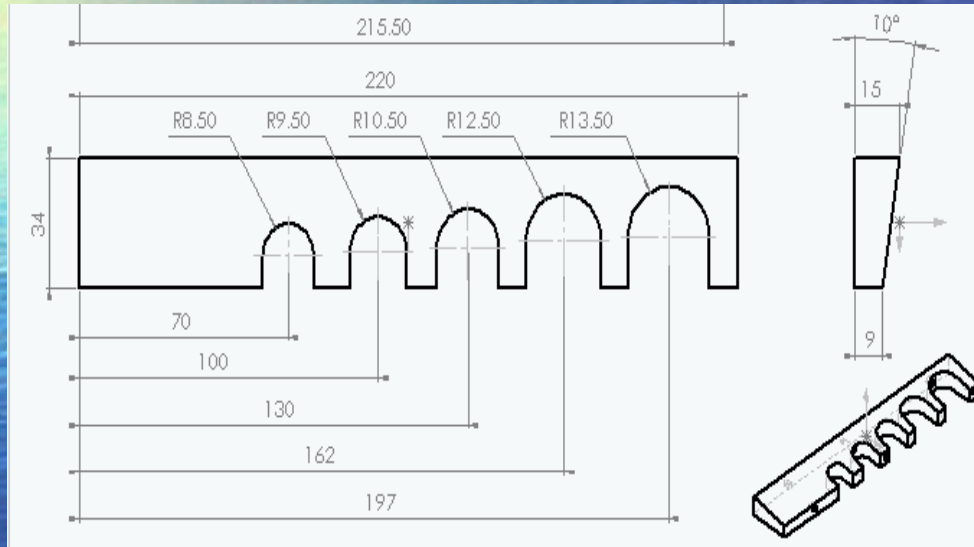
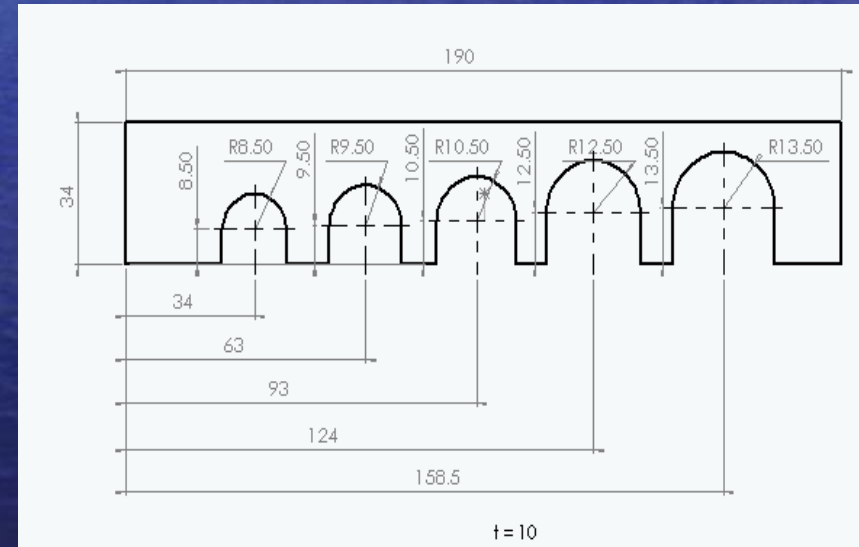Fixed Plate with slot
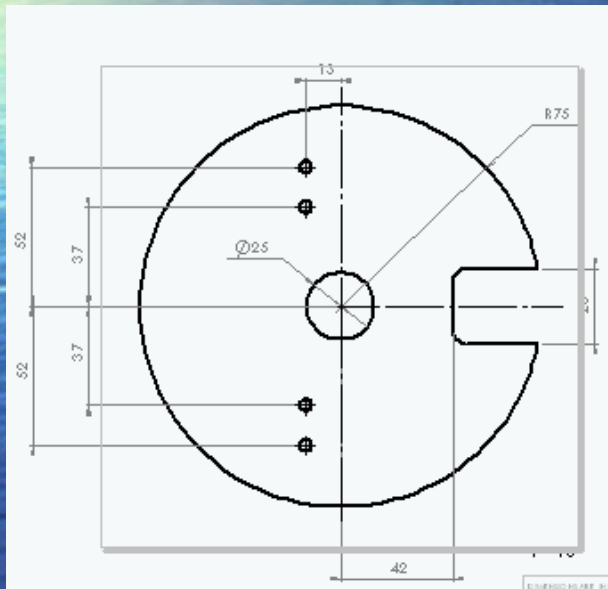
Sliding Track with hole

Detail Designing Phase (Contd)
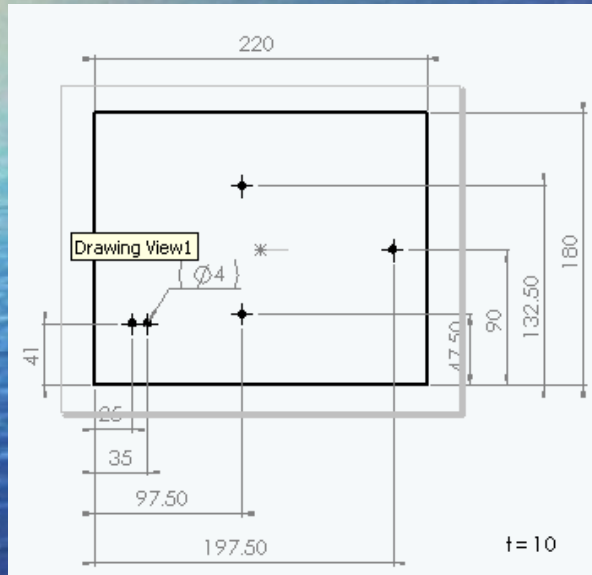
4. Sorting module

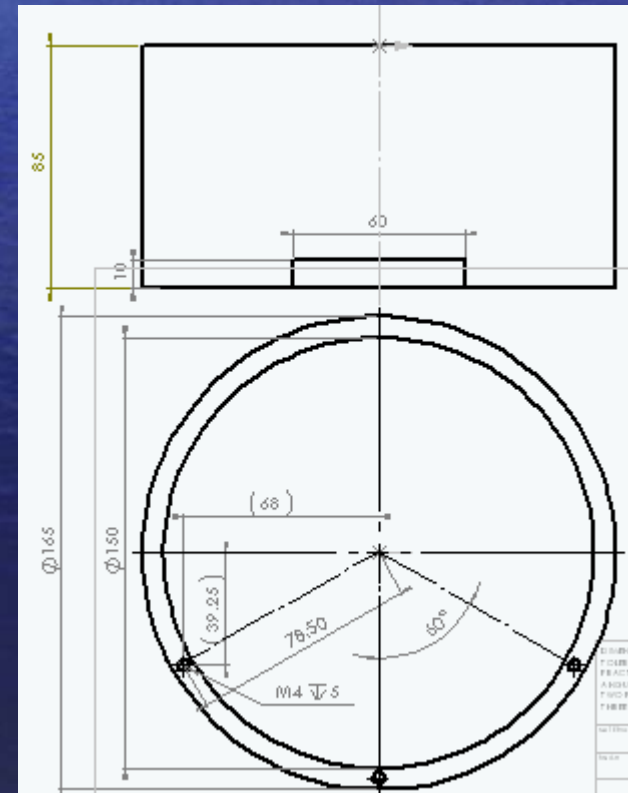Sorting Track

Stack Base Plate

Detail Designing Phase (Contd)

5. Structure Module
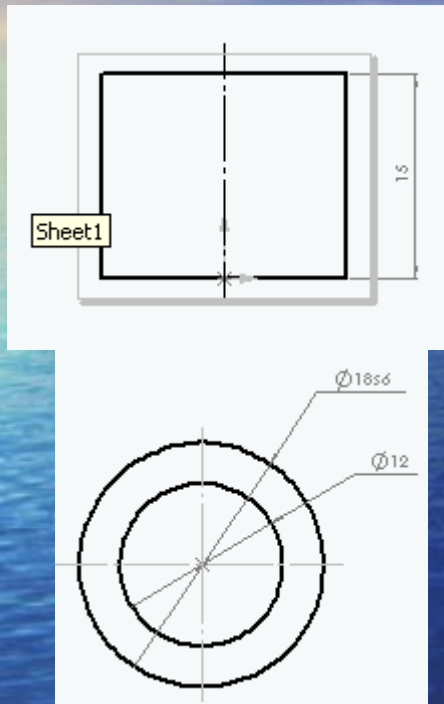
Base Table and support

Hopper for Coin

Detail Designing Phase (Contd)

Others Part as Support

Bush Motor Shaft and Top Cover
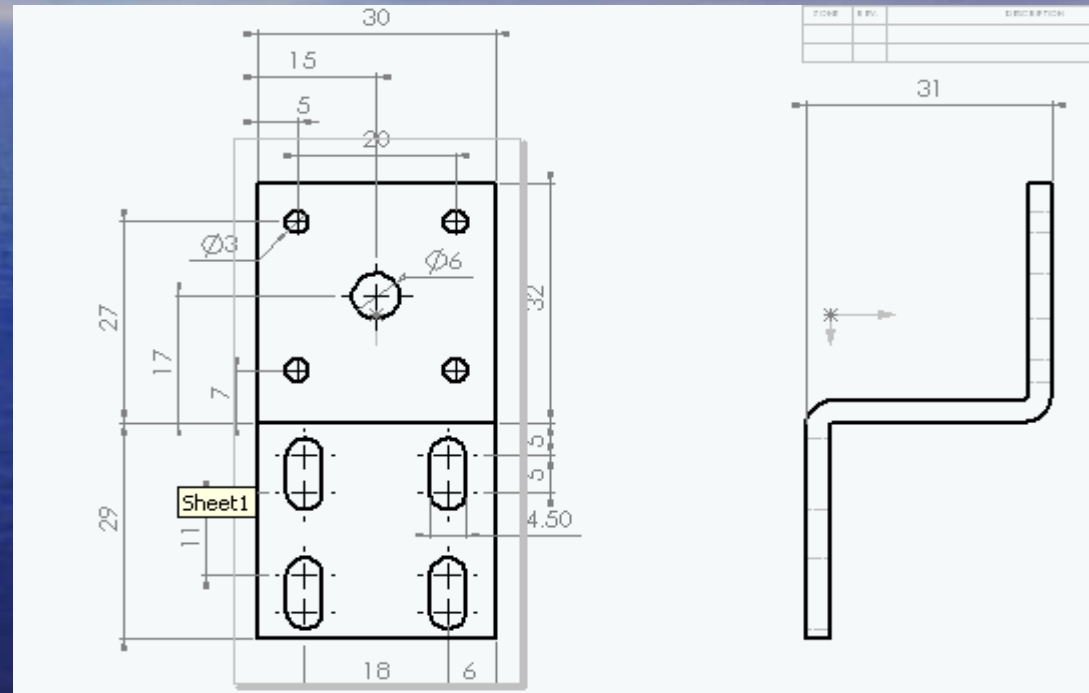
Support For Motor

Detail Designing Phase (Contd)

Top Cover

Motor Shaft

Detail Designing Phase (Contd)
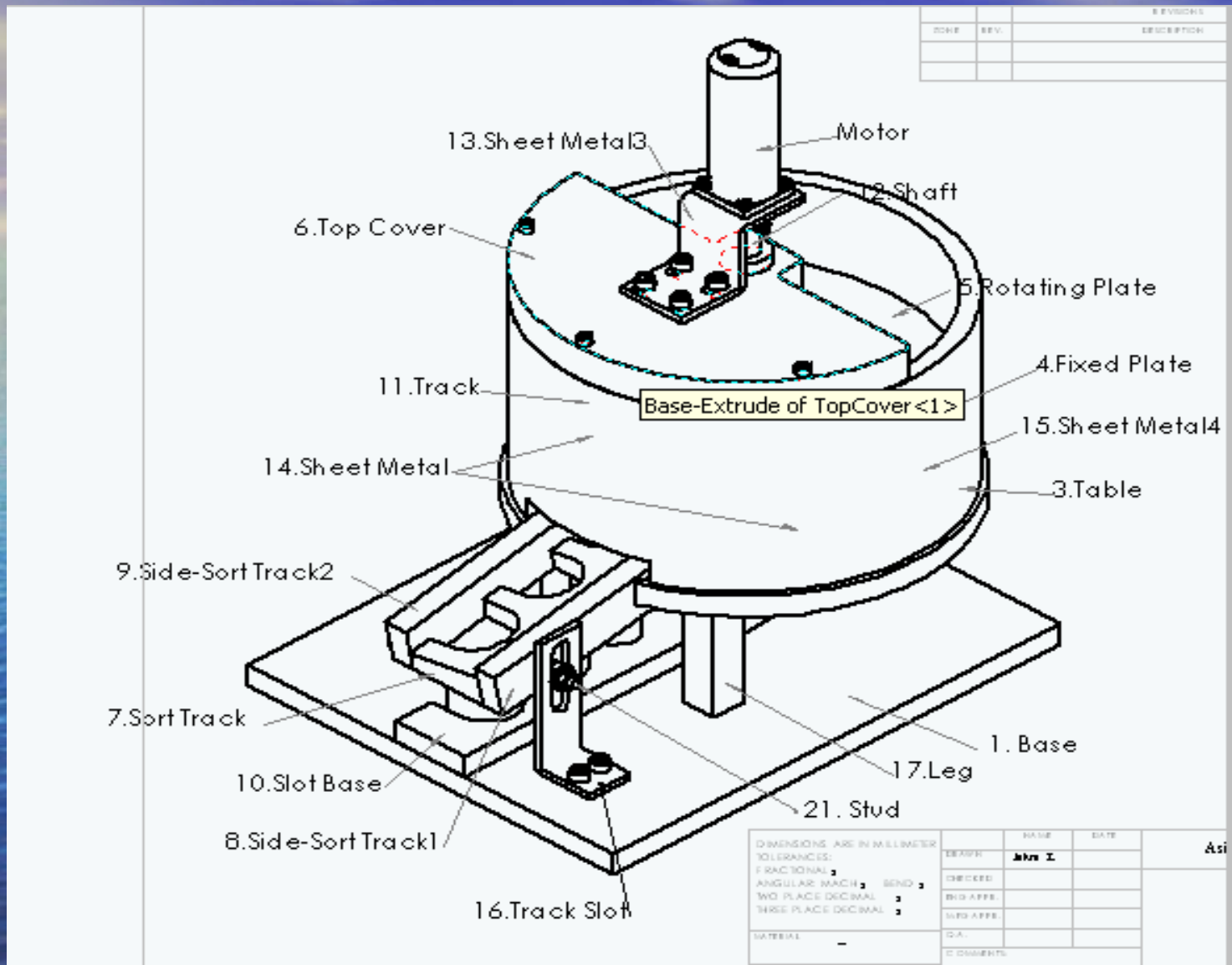
Complete Design

Design For Manufacturing

Efficient product Design which can be economically produced

Proposed Design → Manufacturing Costs Estimation

Reduce Component Costs | Reduce Assembly Costs | Reduce Supporting Production Costs

Consider the Impact of DFM Decisions on Other Factors

Recalculate the Manufacturing Costs → OK?

No

Yes

Acceptable Design
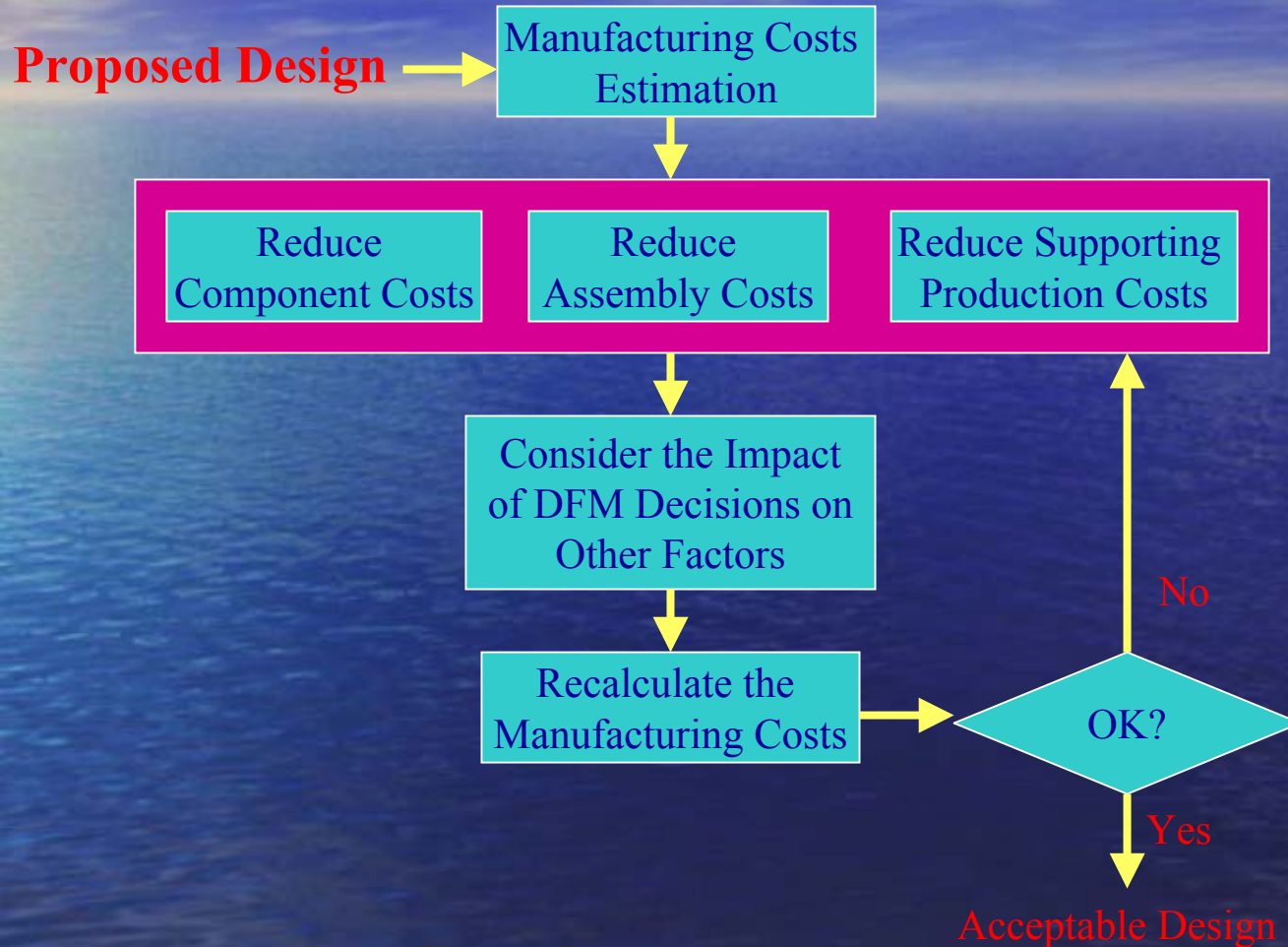
For the Coin Sorter Project – Cost analysis is Neglected

Design For Manufacturing (Contd)

Manufacturability Analysis Worksheet

Part or Operation	Qty	Type	Assembly				Part Elimination				Assessment			
			H	I	S	C	Motion	Mat'l	Ass'y	CFE	V	M	UI	Note
Base	1	2	0	0	0	0	N	N	Y	0	0	0	0	
Housing	1	2	0	-	0	0	N	N	Y	0	0	0	0	
Base Table	1	2	+	0	0	0	N	N	Y	0	0	0	0	
Fixed Plate	1	2	-	-	-	-	N	N	Y	0	0	0	0	
Rotating Plate	1	2	+	0	-	0	Y	Y	Y	0	0	0	0	

$\sum Qty = 65$

$\sum CFE = 39$

$Count\_Ratio = \dfrac{\sum Qty - \sum CFE}{\sum Qty} = 0.4$

It Should be close to one, That mean $\sum$ CFE must be 0. This design has scope of part elimination
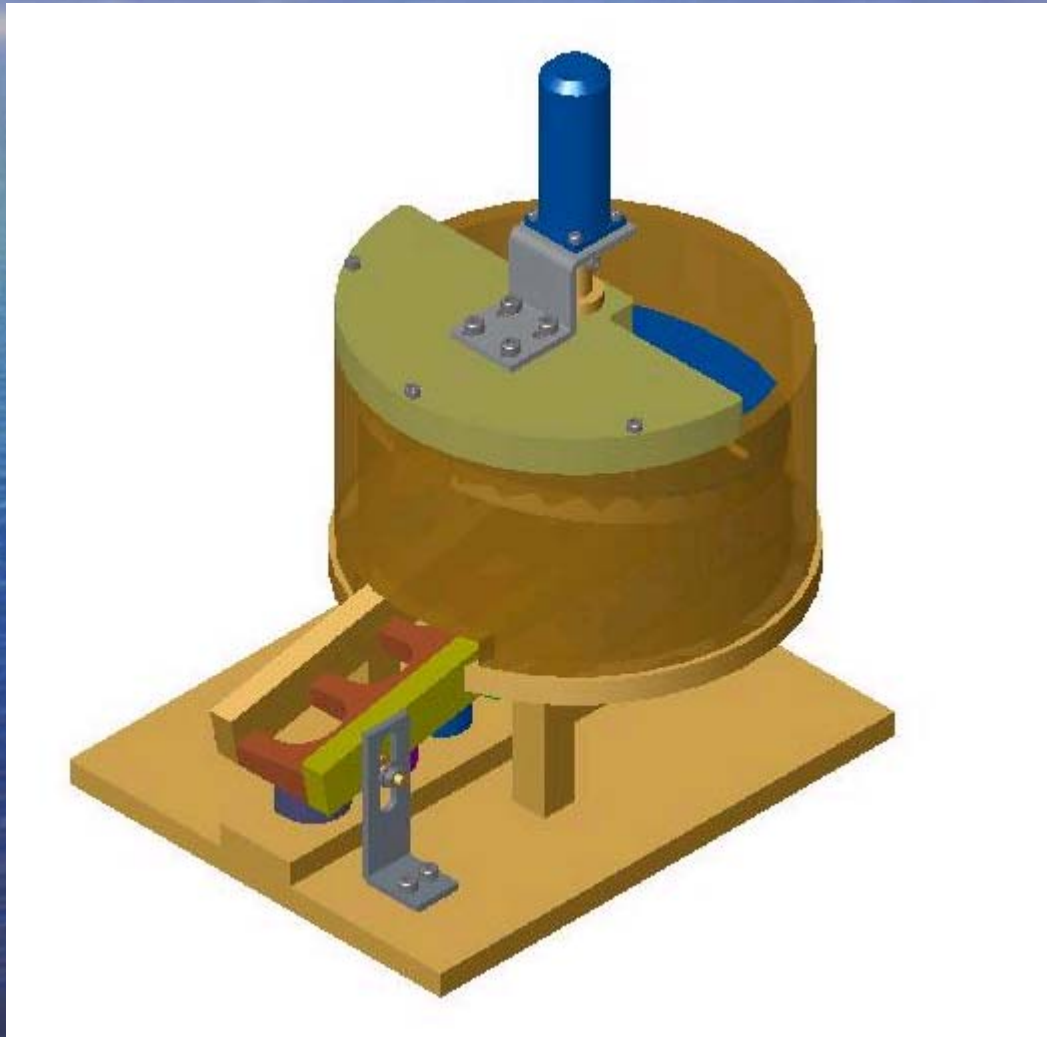
Design For Manufacturing (Contd)

Manufacturability Analysis Worksheet : Compete Sheet

1	2	3	Assembly				Part Elimination				Assesment			
			4	5	6	7	8				9	10	11	12
Part	Qty	Type 2	H	I	S	C	Motion	Mat'l	Assy	CFE	V	M	UI	Notes
Base	1	2	0	0	0	0	N	N	Y	0	0	0	0	
Housing	1	2	0	-	0	0	N	N	Y	0	0	0	0	
Table	1	2	+	0	0	0	N	N	Y	0	0	0	0	
Fixed plate	1	2	-	-	-	-	N	N	Y	0	0	0	0	
Rotating plate	1	2	+	0	-	0	Y	Y	Y	0	0	0	0	
Top cover	1	2	+	0	0	0	N	N	Y	0	0	0	0	
Sort track	1	2	+	-	-	0	N	Y	Y	0	0	0	0	
Side-sort track1	1	2	+	0	-	-	N	N	Y	0	0	0	0	
Side-sort track2	1	2	+	0	-	-	N	N	Y	0	0	0	0	
Slot Base	1	2	+	0	0	-	N	N	N	1	0	0	0	
Track	1	2	0	-	-	-	N	Y	Y	0	0	0	0	
Shaft	1	2	+	0	0	0	Y	Y	Y	0	0	0	0	

Design Simulation with 3D solid model :

Solidworks **3D Software**

Prototype Manufacturing

Physical

Prototype

Coin Sorter

Process Used   :   Drilling, Tapping, Turning, Milling, Sheet Metal

Material Used   :   PVC, Paper, Acrylic, Aluminum, Steel

Prototype Manufacturing (Contd)

No.	Part Name	Qty	Material	Standard
1	Base	1	Acrylic	
2	Housing	1	PVC	
3	Table	1	Acrylic	
4	Fixed plate	1	Acrylic	
5	Rotating plate	1	Al	
6	Top cover	1	Acrylic	
7	Sort track	1	Acrylic	
8	Side-sort track1	1	Acrylic	
9	Side-sort track2	1	Acrylic	
10	Slot Base	1	Acrylic	
11	Track	1	Acrylic	
12	Shaft	1	St42	
13	Sheet metal	2	St37	
14	Sheet metal2	1	St37	
15	Sheet metal3	1	St37	
16	Sheet metal4	2	St37	
17	Track slot	1	Acrylic	
18	Wiper Blade	1	St37	
19	Leg	3	St42	
20	Retainer	2	St42	
21	Bush	1	Brass	
22	Stud	1	Brass	
23	Motor	1	-	
24	Socket Head Cap Screw_AM	3	Steel	B18.3.1-3x0.5x20 Hex-SHCS-20NHX
25	Socket Head Cap Screw_AM Socket Head Cap Screw_AM	4	Steel	B18.3.1-4x0.7x12 Hex-SHCS-12NHX
26	Socket Head Cap Screw_AM Socket Countersunk Head	4	Steel	B18.3.1-2.5x0.45x8 Hex-SHCS-8NHX
27	Screw_AM Socket Head Cap Screw_AM	1	Steel	B18.3.1-3x0.5x5 Hex-SHCS-5NHX

Testing of Prototype

- Initially prototype tested by dropping only single coin .

- Prototype tested for bunch of coins.

- Each time, movement of subassembly and reliability of the product is checked

Results from Testing :

1. Coin found stuck in between rotating plate and fixed plate.

2. Sliding track angle not enough for sliding the coins.

Refinement & Conclusion

1. For the coin stucking problem, one spring is attached to the motor shaft and fixed plate

2. Extra material inserted to increase the sliding track angle.

SUCCESSFULLY COMPLETION

OF

DESIGN AND MANUFACTURING OF COIN SORTING MACHINE.