ASIAN INSTITUTE OF TECHNOLOGY

PRODUCT DESIGN AND DEVELOPMENT

PROJECT 2

AUTOMATIC SELF-CLEANING TOILET SEAT

ASIAN INSTITUTE OF TECHNOLOGY

AUTOMATIC SELF-CLEANING TOILET SEAT

Students: Dang Ngoc Anh
Ly Tan Huy
Nguyen Tung Lam
Doan Thanh Son
Vu Xuan Truong
Nguyen Van Ut
Bui Dinh Vuong

Instructor: Dr. Pisut Koomsap

Content

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- Objective of Project
- Concept Development Process
- Process Driven Design
- Product Architecture
- Detail Design
- Design for Manufacturing
- Design Prototype
- Testing and Refinement
- Demonstration

I. Introduction

II. Concept development process

1. Defining the target
2. Identifying customer needs
3. Establishing target specification
4. Generating concepts
5. Selecting concept

II. Concept development process

1. DEFINING THE TARGET

Product description:

Automatic self-cleaning toilet seat

Key business goals:

- ✓ Product introduced in third quarter of 2006
- ✓ 50% gross margin
- ✓ 10% share of product market by second quarter of 2007

Primary market: Public toilet owners, building, super department

Secondary market: middle and upper class families

Stakeholders: Users
Retailer
Sales force
Production
Legal department

II. Concept development process

COMPETITORS

PORCELIAN : using water and dryer to clean, it can be use both manual and automatic with rotating toilet seat
http://www.emediawire.com/releases/2005/6/emw253629.htm

II. Concept development process

2. IDENTIFINE CUSTOMER NEEDS

Customer needs	Survey results	
	Yes	No
I want the toilet seat always to be cleaned before I use it	15	0
I want an automatic self-cleaning toilet seat (ASTS)	13	2
I want the ASTS to be quiet in operating	12	3
I want a compact size ASTS	15	0
I want that the ASTS operates simply		
I want the ASTS to be waterproof		
I want that the control system can be easily maintained and repaired		
I want the seat to be cleaned fast by the self-cleaning cleaning system		
I want that the ASTS looks similar to traditional one		
I want the ASTS system to be reliable and safe for users		
I want the ASTS system to be durable		
I want the ASTS system to be easy for installing		
I want the ASTS is cheap		
I want the ASTS to not affect the habitude of the users		

II. Concept development process

2. IDENTIFINE CUSTOMER NEEDS

No.		Needs	Imp.
1	The ASTS	is reliable	5
2	The ASTS	is compact size	5
3	The ASTS	cleans the seat fast	5
4	The ASTS	does not affect the habitude of users	4
5	The ASTS	operates simply	4
6	The ASTS	is water-proof	5
7	The ASTS	consumes small amount of energy and material	4
8	The ASTS	can be easily accessed for maintenance and repair	4
9	The ASTS	is easily installed	3
10	The ASTS	functions quietly	3
11	The ASTS	lasts a long time	4
12	The ASTS	is cheap	4

II. Concept development process

3. ESTABLISHING TARGET SPECIFICATION

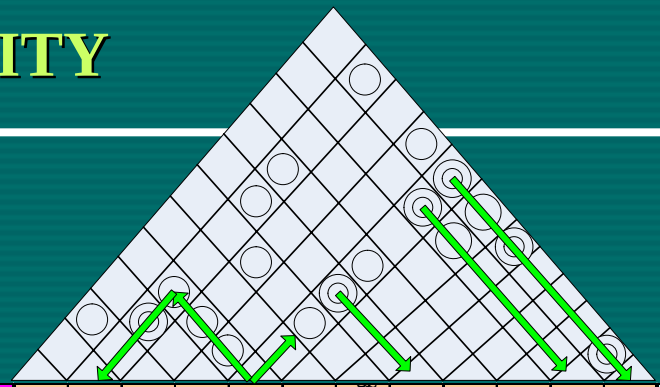
No	Need Nos.	Metric	Imp	Units
1	1	Hygiene	5	Vietnamese standard
2	2, 4	Additional volume	5	dm^3
3	3	Operating time	5	s
4	4	Shape of the ASTS	4	Subj.
5	5	Simple structure and familiar devices	3	Subj.
6	6	Water-proof	5	Subj.
7	7	Average cost for 1000 times of cleaning	4	$
8	5, 8	Time to disassemble/assemble for maintenance	4	min
9	5, 9,	Time to install	4	min
10	10	Noise	3	dB
11	11	Time between maintenances	4	month
12	5, 12	Unit manufacturing cost	4	VND

II. Concept development process

HOUSE OF QUALITY

	METRIC	Hygiene (Vietnamese Standard Test)	Volume	Operating time	Shape of the ASTS	Simple structure and familiar devices	Water-proof	Average cost for 1000 times of cleaning	Time to disassemble/assemble	Time to install	Noise	Time between maintenances	Unit manufacturing cost	Nomarlized score
	NEED	1	2	3	4	5	6	7	8	9	10	11	12	
1	is reliable	5	6	6	9	1.5	1.5	11.3	15.1					15.1
2	is compact size	5	6	6	8	1.3	1.2	8.0	10.7				3	10.7
3	cleans the seat fast	5	7	7	9	1.3	1.2	7.7	10.3					10.3
4	does not affect the habitude of users	4	5	5	8	1.6	1.2	7.7	10.3					10.3
5	operates simply	4	7	7	8	1.1	1	4.6	6.1					6.1
6	is water-proof	5	6	8	8	1.3	1	6.7	8.9			1		8.9
7	consumes small amount of energy and material	4	7	8	7	1	1.2	4.8	6.4					6.4
8	can be easily accessed for maintenance and repair	4	7	8	8	1.1	1	4.6	6.1					6.1
9	is easily installed	3	8	7	8	1	1	3.0	4.0					4.0
10	functions quietly	3	7	9	7	1	1	3.0	4.0		9			4.0
11	lasts a long time	4	7	8	8	1.1	1.2	5.5	7.3			9		7.3
12	is cheap	4	6	6	8	1.3	1.5	8.0	10.7				9	10.7
Total absolute score		186	201	194	125	146	216	58	55	36	36	75	128	
Percentage (%)		12.8	14	13	8.6	10	15	4	3.8	2.5	2.5	5.15	8.8	

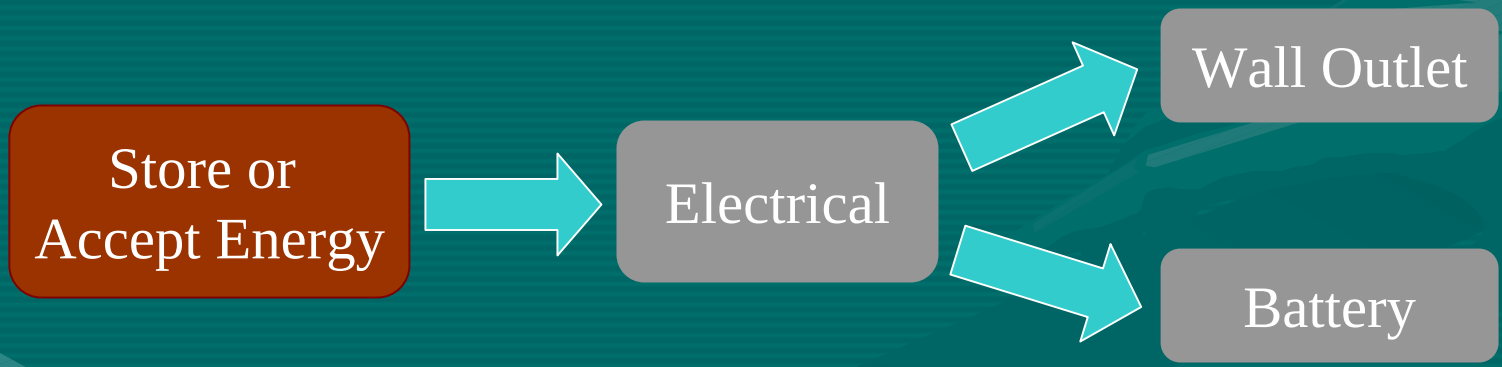
HOUSE OF QUALITY



	NEED	METRIC	Hygiene (Vietnamese Standard Test)	Volume	Operating time	Shape of the ASTS	Simple structure and familiar devices	Water-proof	Average cost for 1000 times of cleaning	Time to disassemble/assemble	Time to install	Noise	Time between maintenances	Unit manufacturing cost	Importance	Our current product	Company A	Our future product	Improvement ratio	Sales impact	Score	Nomarlized score
			1	2	3	4	5	6	7	8	9	10	11	12								
1	is reliable		9		3			9							5	6	6	9	1.5	1.5	11.3	15.1
2	is compact size			9		3	3							3	5	6	6	8	1.3	1.2	8.0	10.7
3	cleans the seat fast		3		9										5	7	7	9	1.3	1.2	7.7	10.3
4	does not affect the habitude of users			9	3	9									4	5	5	8	1.6	1.2	7.7	10.3
5	operates simply				3		9								4	7	7	8	1.1	1	4.6	6.1
6	is water-proof							9					1		5	6	8	8	1.3	1	6.7	8.9
7	consumes small amount of energy and material		3		1				9						4	7	8	7	1	1.2	4.8	6.4
8	can be easily accessed for maintenance and repair						9			9					4	7	8	8	1.1	1	4.6	6.1
9	is easily installed			3			1				9				3	8	7	8	1	1	3.0	4.0
10	functions quietly											9			3	7	9	7	1	1	3.0	4.0
11	lasts a long time												9		4	7	8	8	1.1	1.2	5.5	7.3
12	is cheap													9	4	6	6	8	1.3	1.5	8.0	10.7
	Total absolute score		186	201	194	125	146	216	58	55	36	36	75	128	1455						74.7	100
	Percentage (%)		13	14	13	8.6	10	15	4	3.8	2.5	2.5	5.2	8.8	100							

II. Concept development process

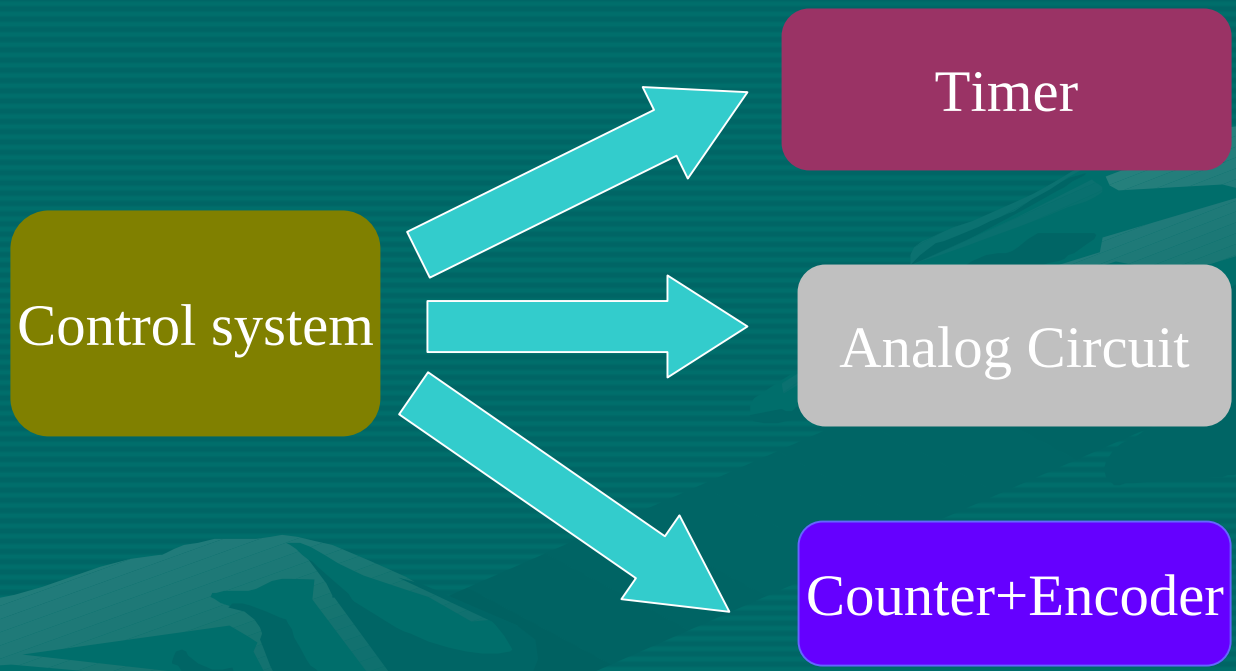
4. GENERATING CONCEPTS



Classification tree for energy

II. Concept development process

4. GENERATING CONCEPTS



Classification tree for control system

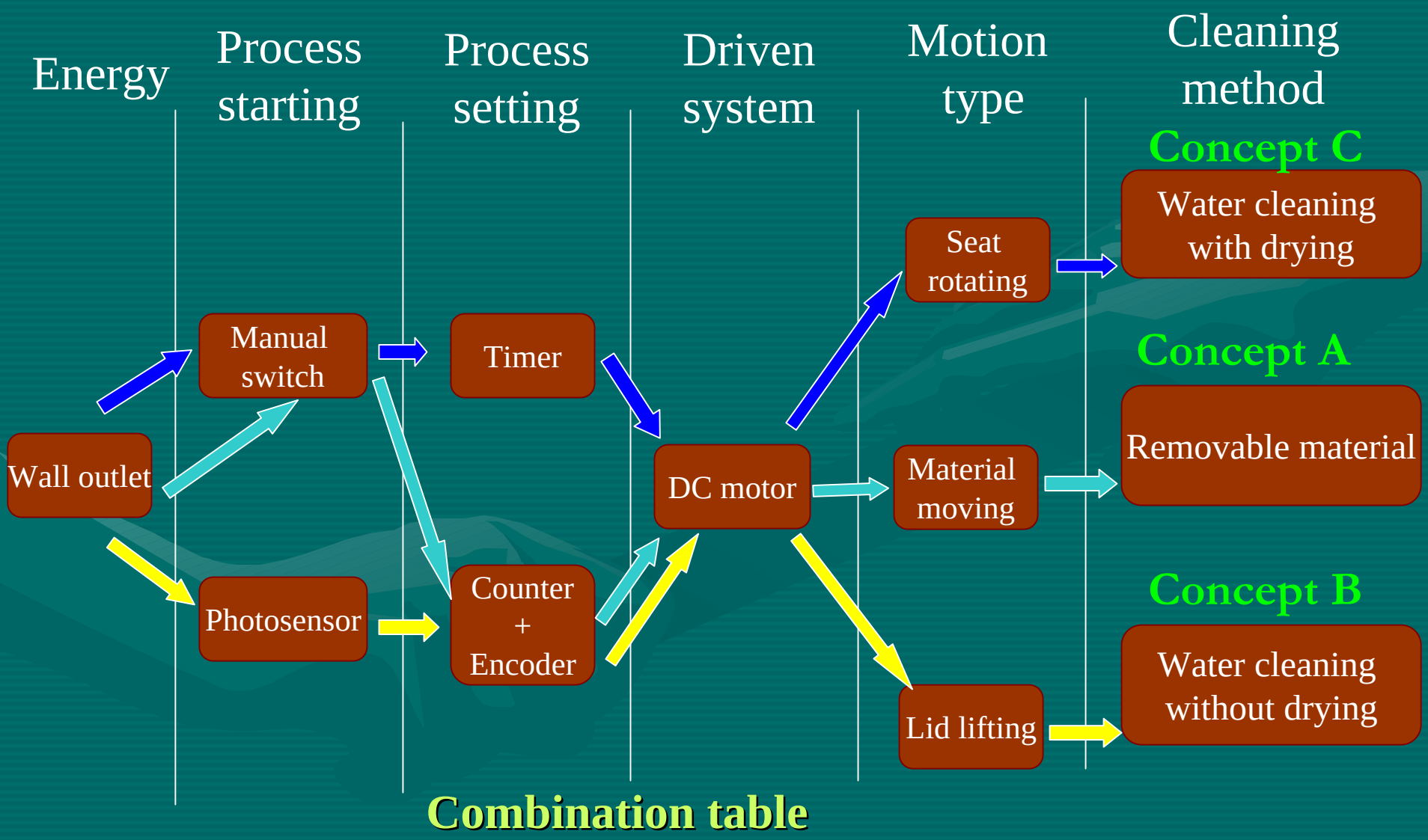
II. Concept development process

4. GENERATING CONCEPTS

Classification tree for cleaning system

II. Concept development process

4. GENERATING CONCEPTS



Combination table

CONCEPT A

CONCEPT B

CONCEPT C

II. Concept development process

5. SELECTING CONCEPT

Selection criteria	Weight	Concepts					
		A (ref)		B		C	
		rating	weighted score	rating	weighted score	rating	weighted score
Reliability	0.2	4	0.8	4	0.8	4	0.8
Additional volume	0.15	4	0.6	4	0.6	3	0.5
Safety for users	0.1	3	0.3	2	0.2	3	0.3
Simple structure	0.1	5	0.5	3	0.3	3	0.3
Operating time	0.15	4	0.6	3	0.45	3	0.5
Cleaning cost	0.1	4	0.4	3	0.3	3	0.3
Durability	0.1	3	0.3	3	0.3	3	0.3
Ease of manufacture	0.1	3	0.3	2	0.2	2	0.2
Total score		**3.2**		2.65		2.6	
Rank		**1**		2		3	
Continue?		**yes**		no		no	

II. Concept development process

5. SELECTING CONCEPT

Selected concept

III. PROCESS-DRIVEN DESIGN PHASES

Manufacturability design goals

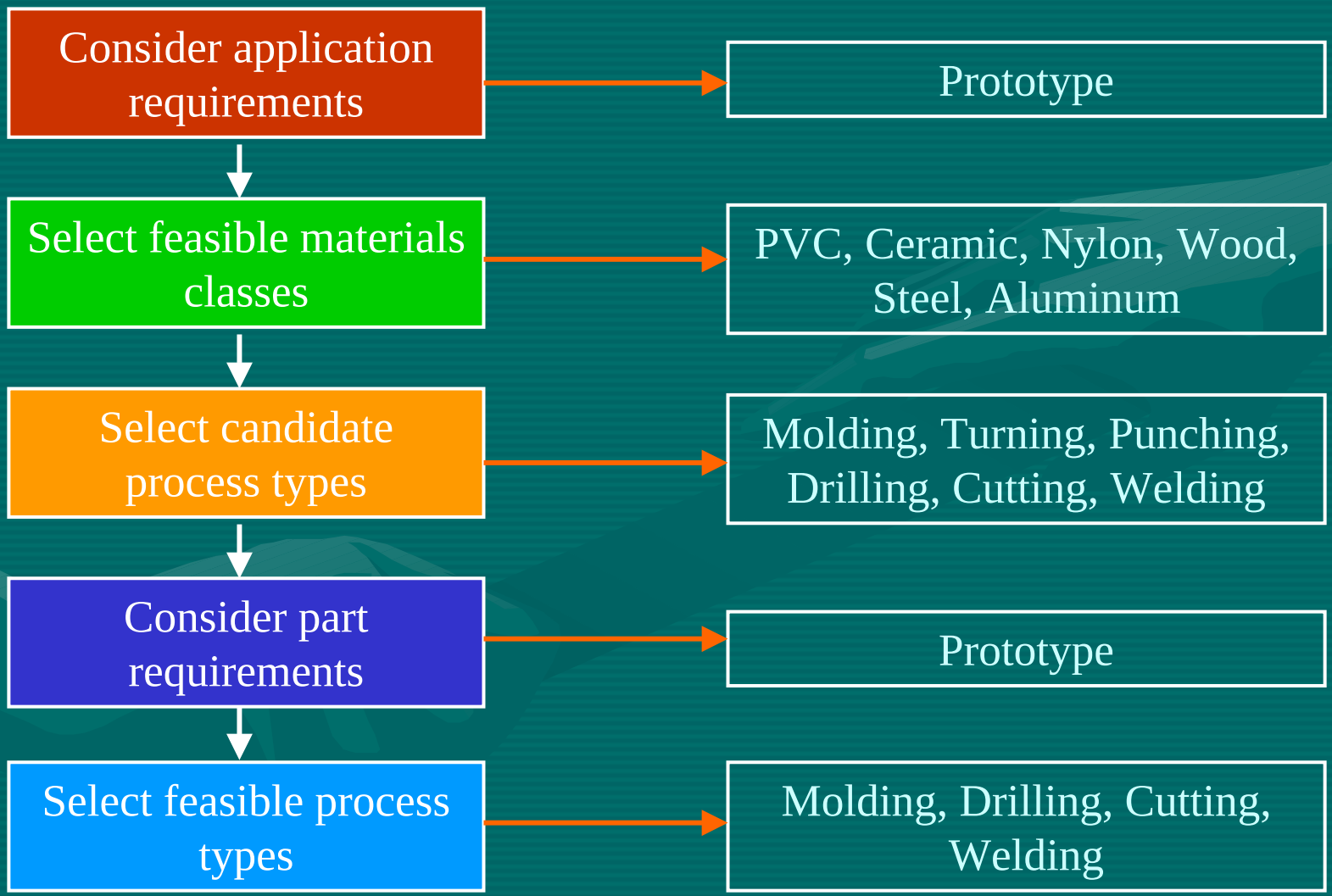
- ✓ Minimum number of parts and part types
- ✓ Multi-use components
- ✓ Standard manufacturing techniques

Product and process plan

- ✓ Component types: external and designed components
- ✓ Product architecture
- ✓ Assembly concept: frame-based structure
- ✓ Materials and process selection.

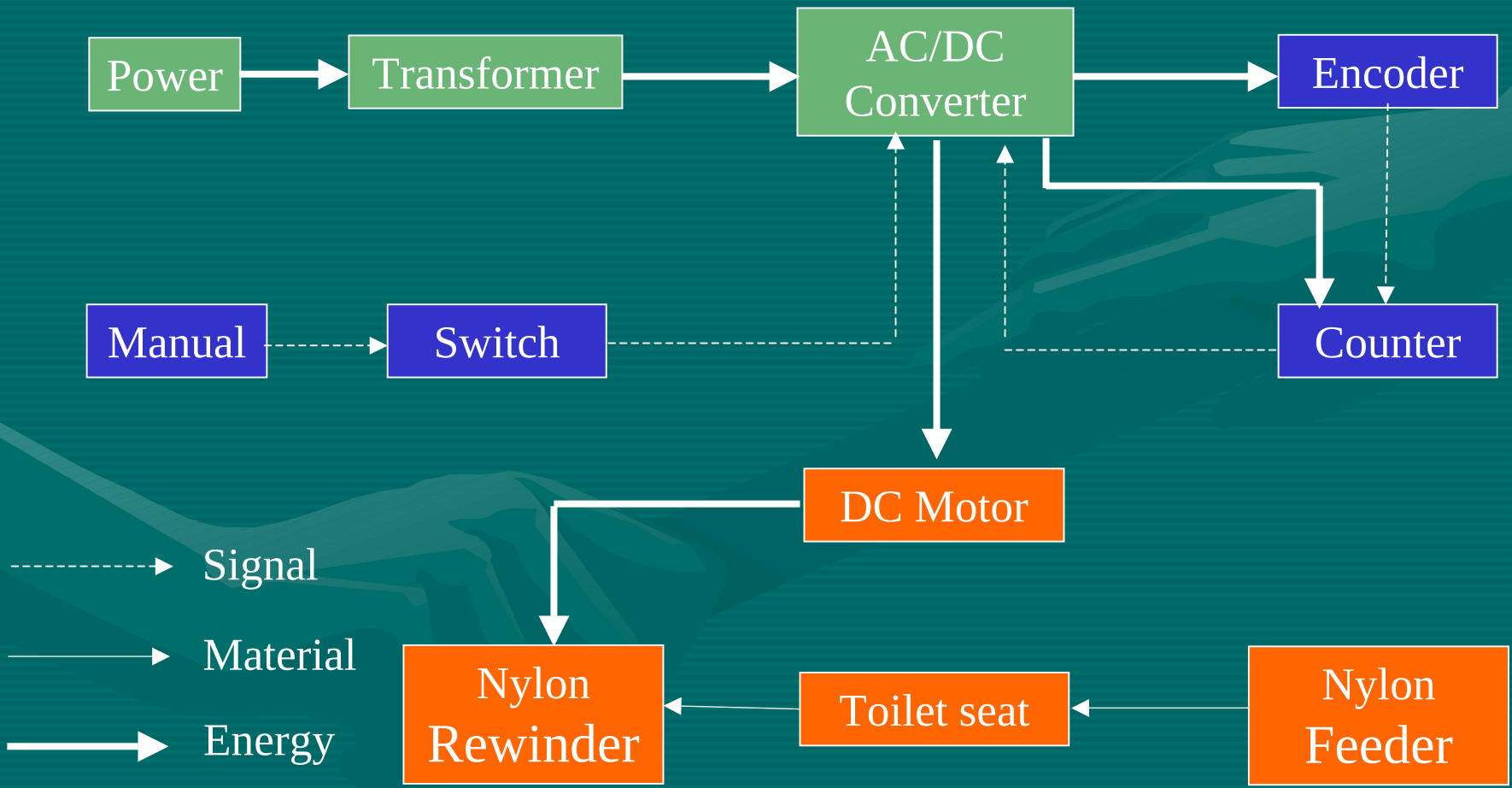
III. PROCESS-DRIVEN DESIGN PHASES

Materials and process selection: **Materials – First approach**



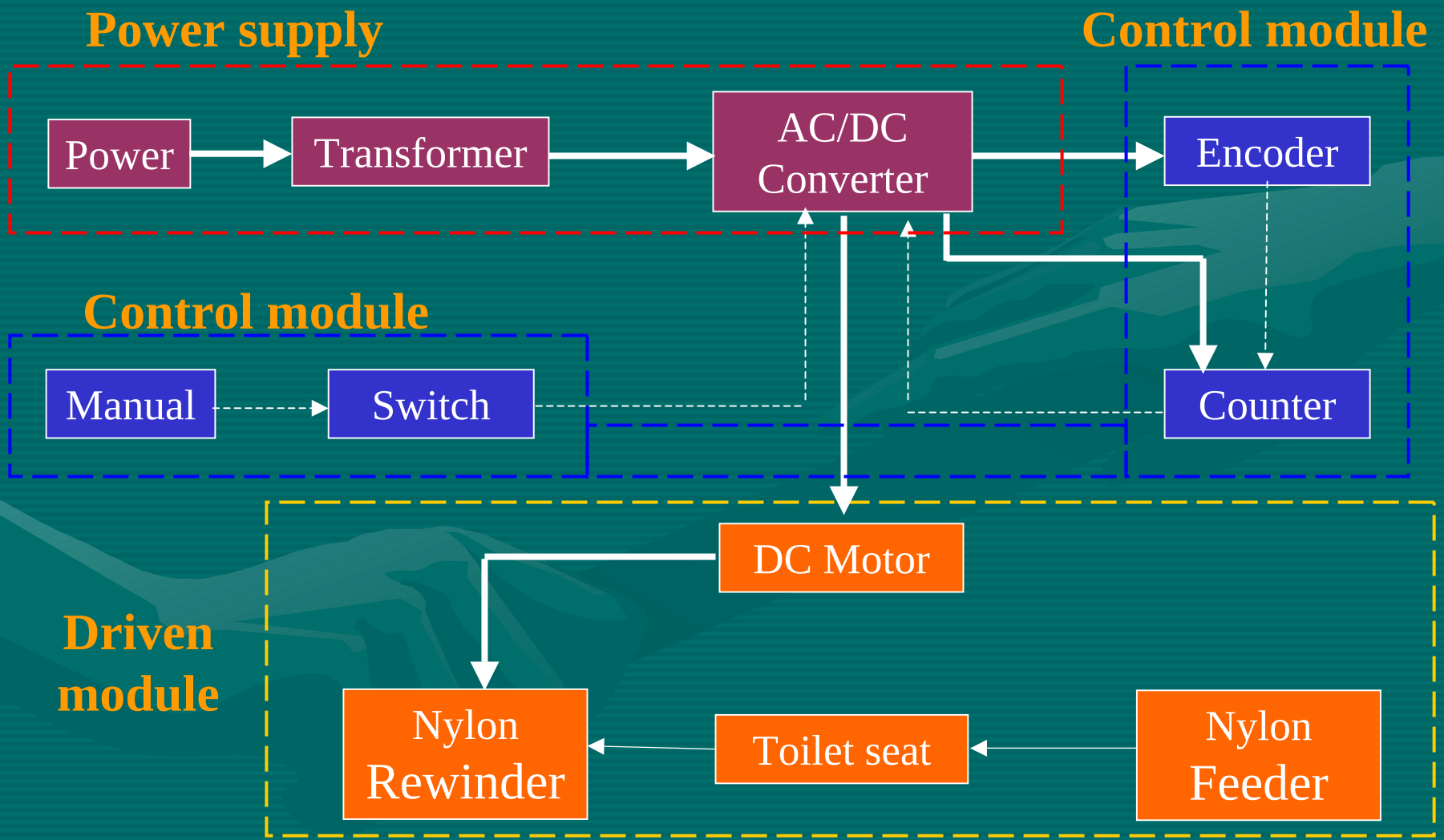
IV. PRODUCT ARCHITECTURE

1. Create a schematic of the product



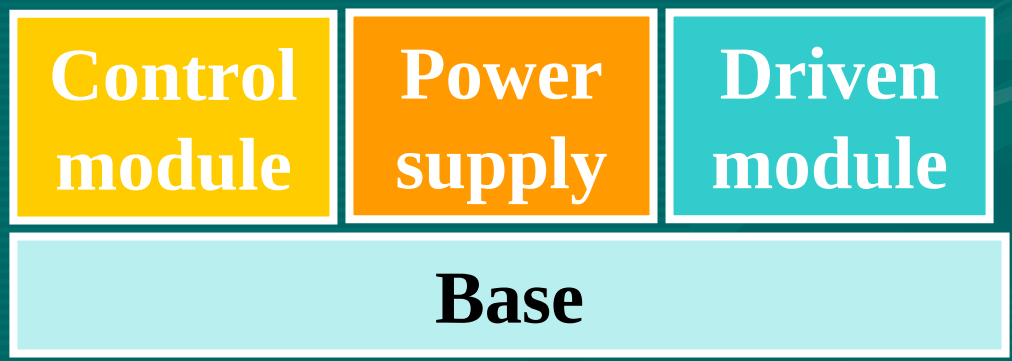
IV. PRODUCT ARCHITECTURE

2. Cluster the elements of the schematic



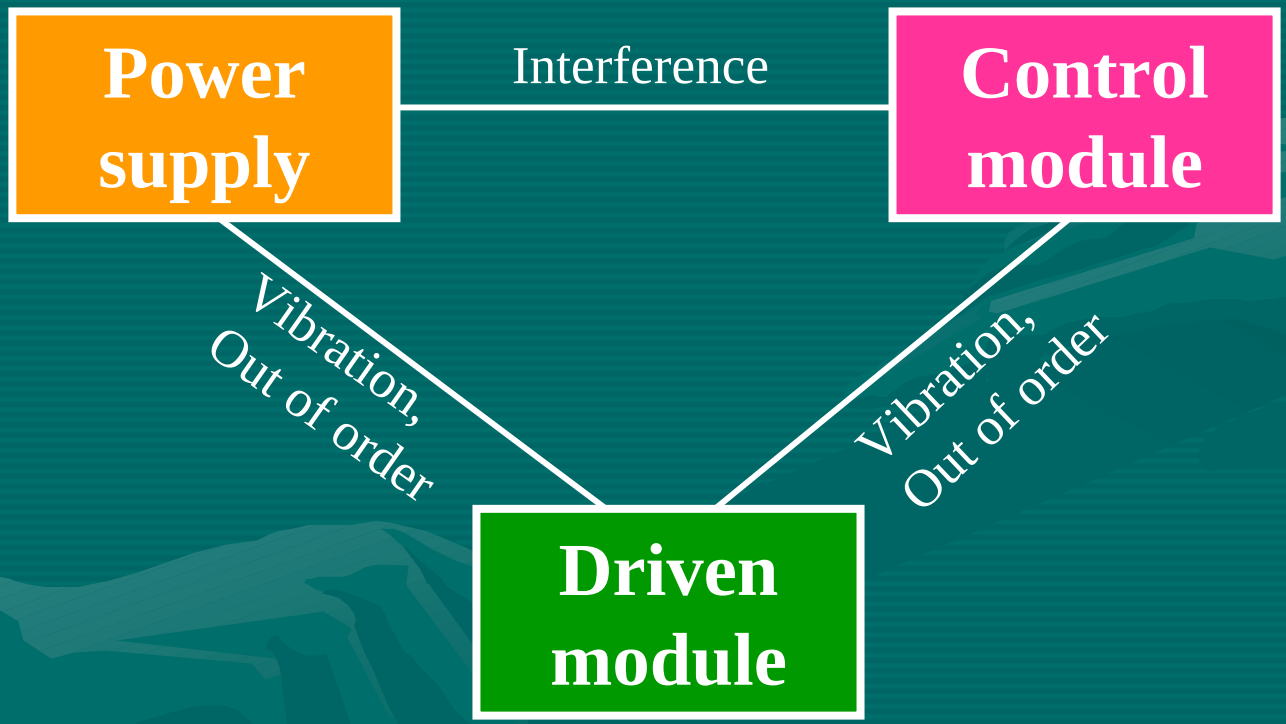
IV. PRODUCT ARCHITECTURE

3. Create a rough geometric layout

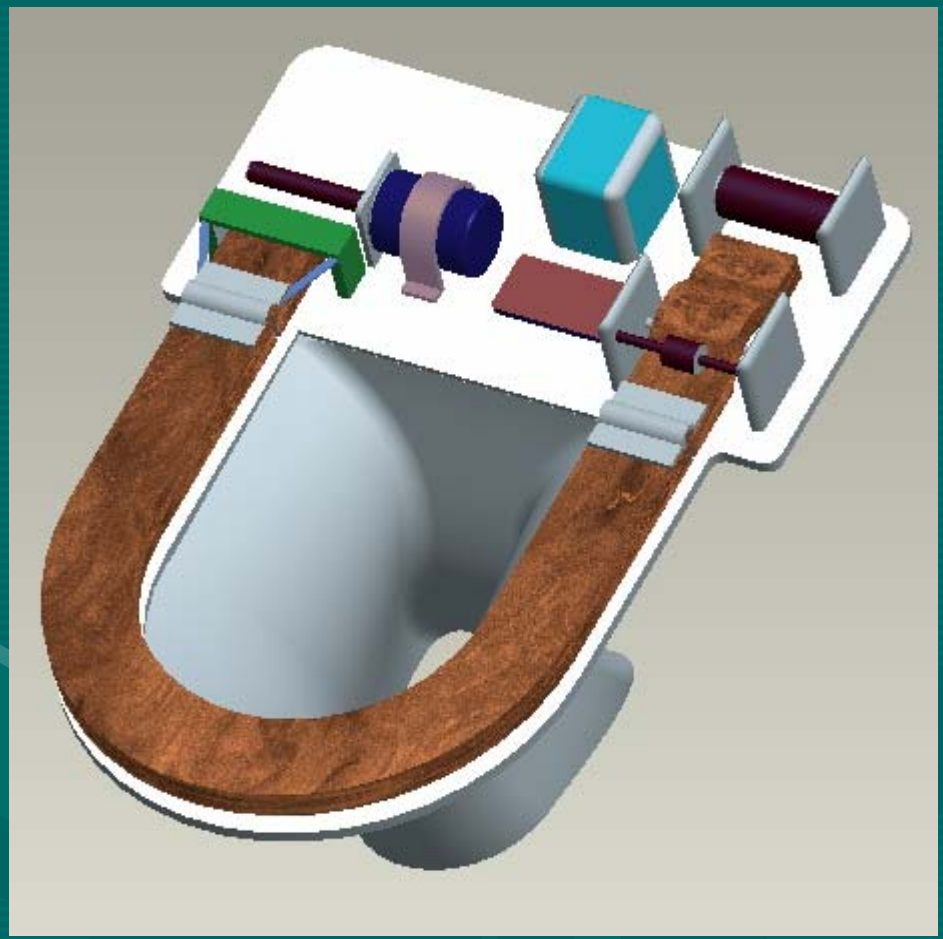


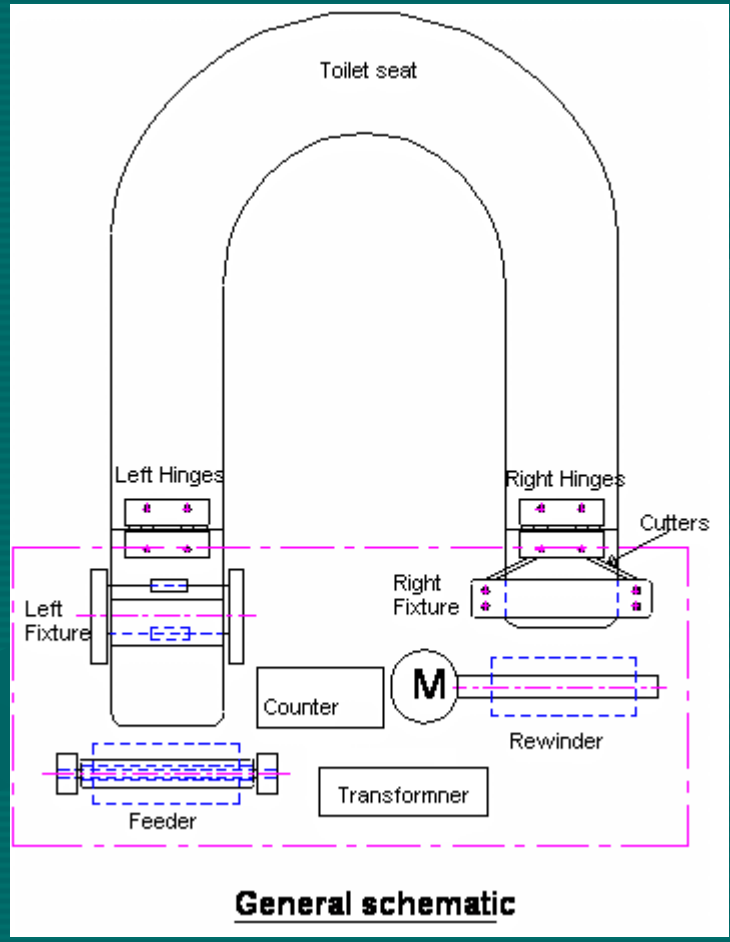
IV. PRODUCT ARCHITECTURE

4. Identify the fundamental and incidental interactions



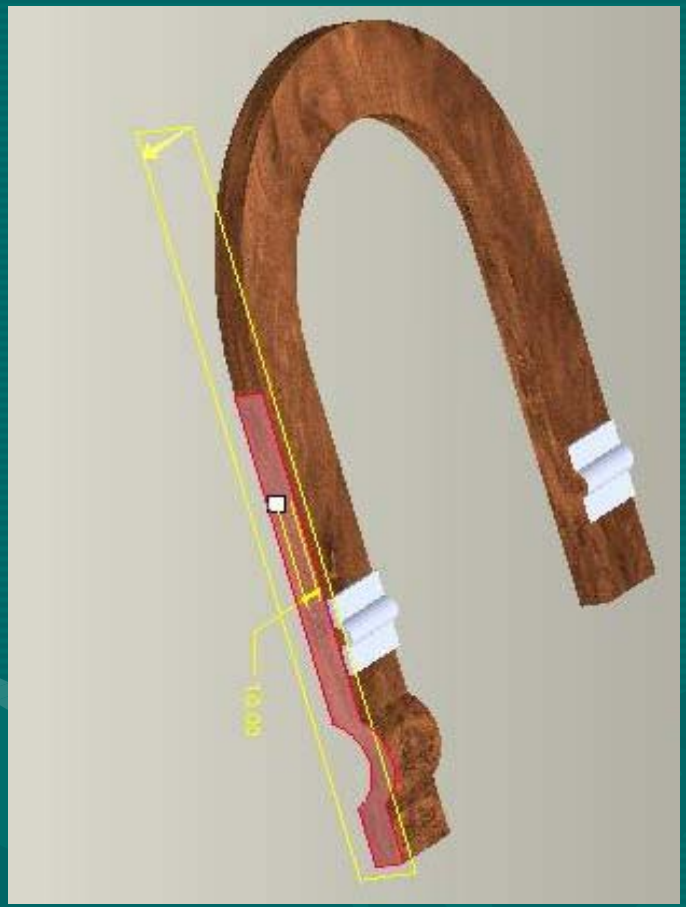
VI. DETAIL DESIGN

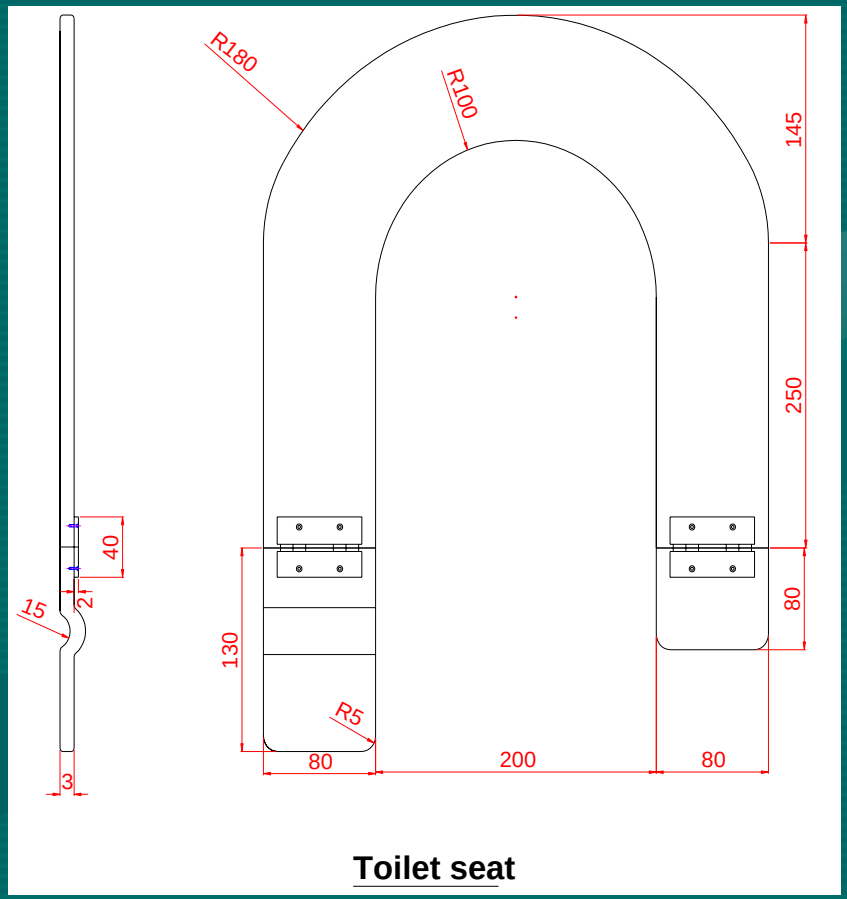




General schematic

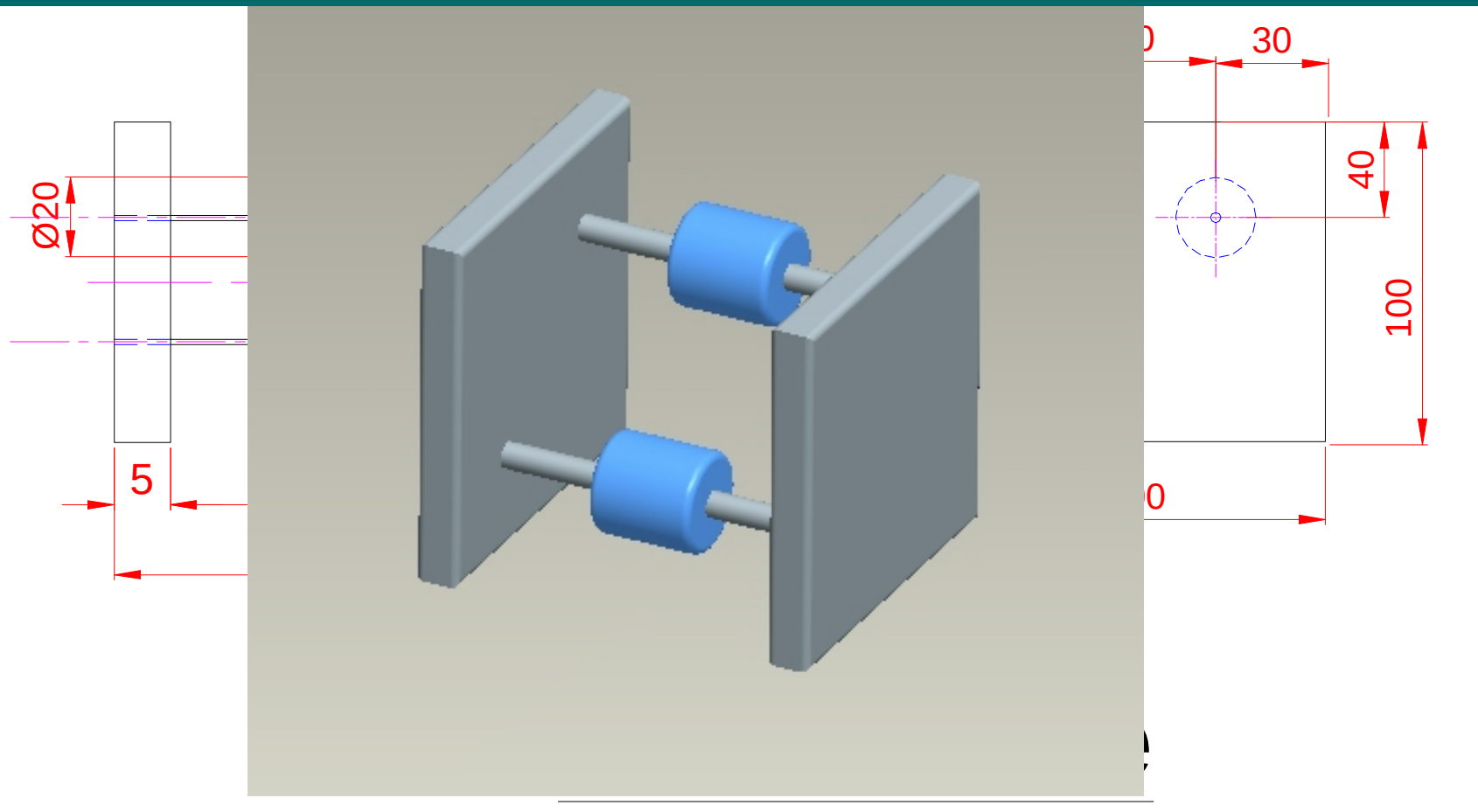
VI. DETAIL DESIGN





Toilet seat

VI. DETAIL DESIGN



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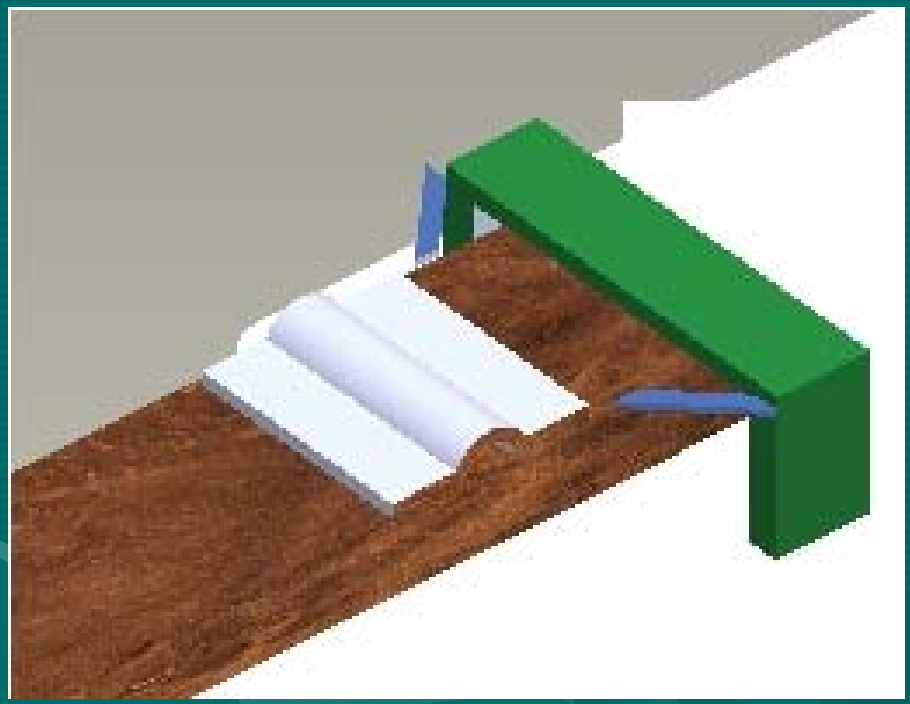
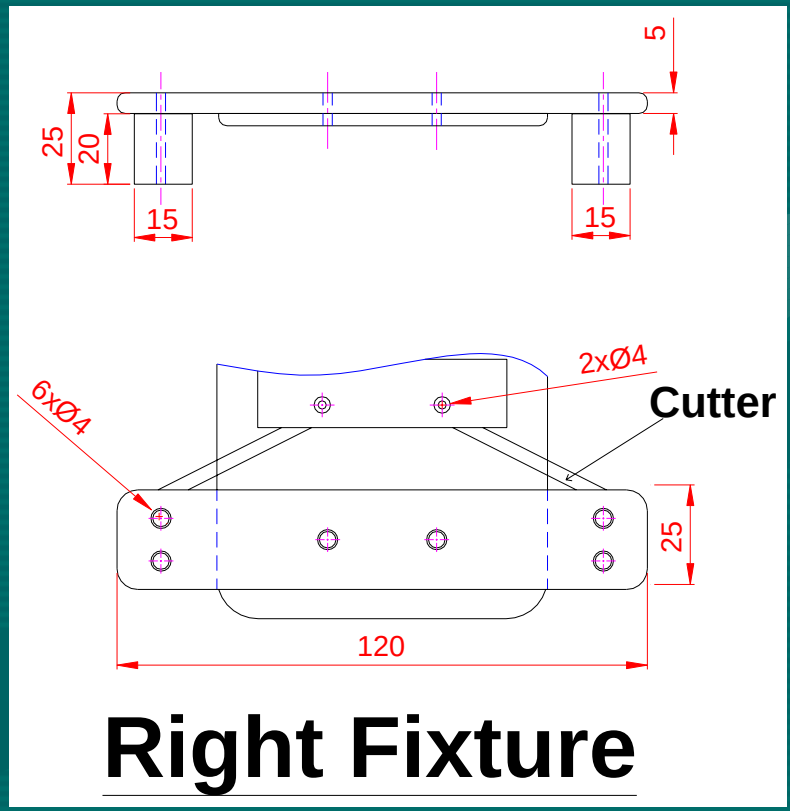
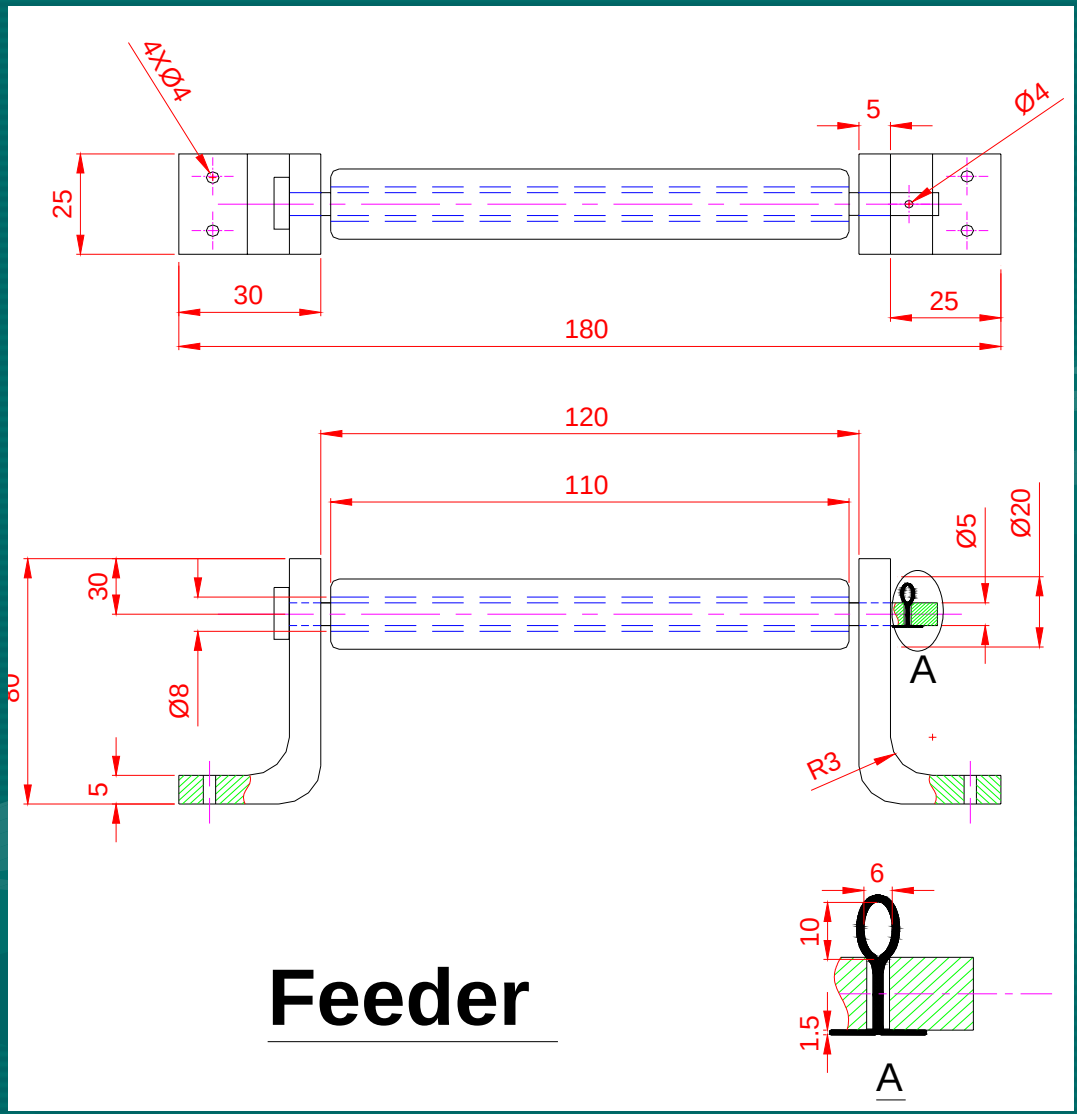


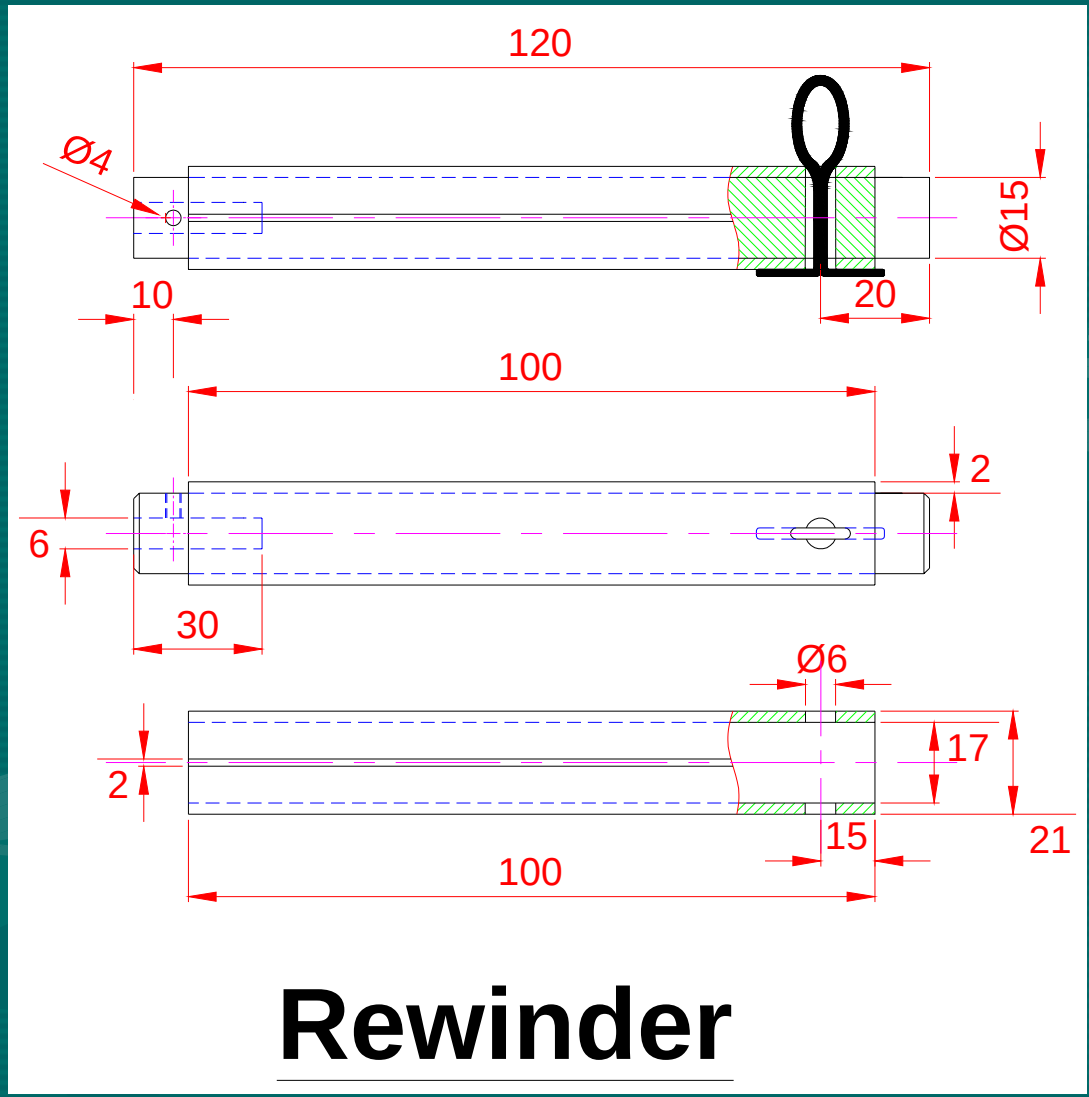


Right Fixture

VI. DETAIL DESIGN

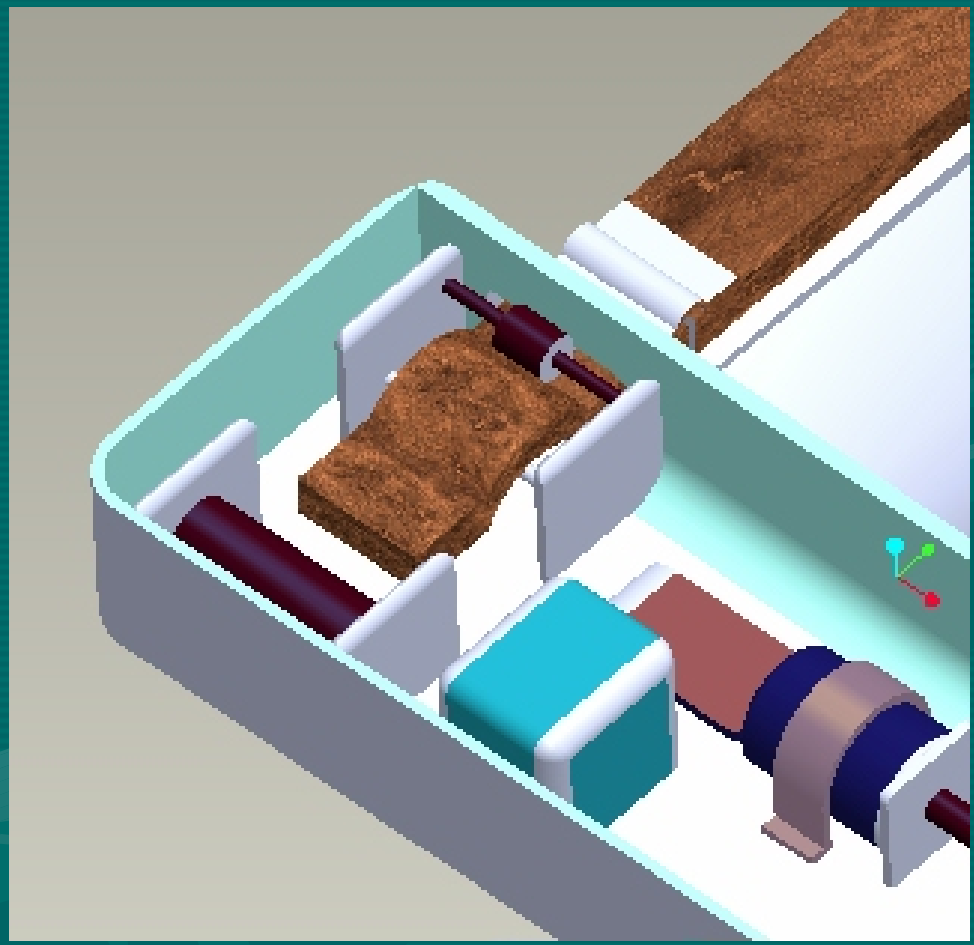


VI. DETAIL DESIGN



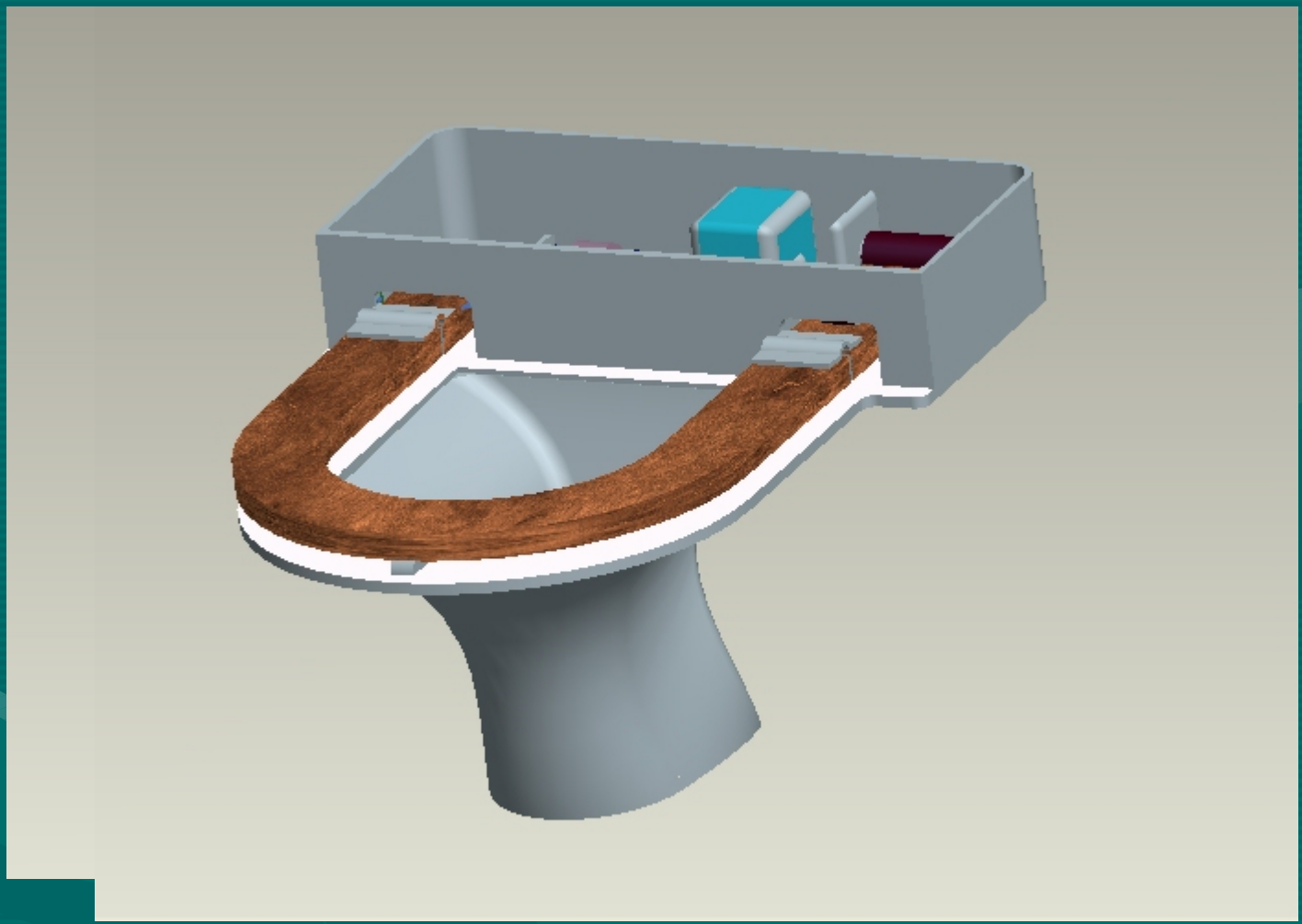
Rewinder

VI. DETAIL DESIGN



Encoder

VI. DETAIL DESIGN

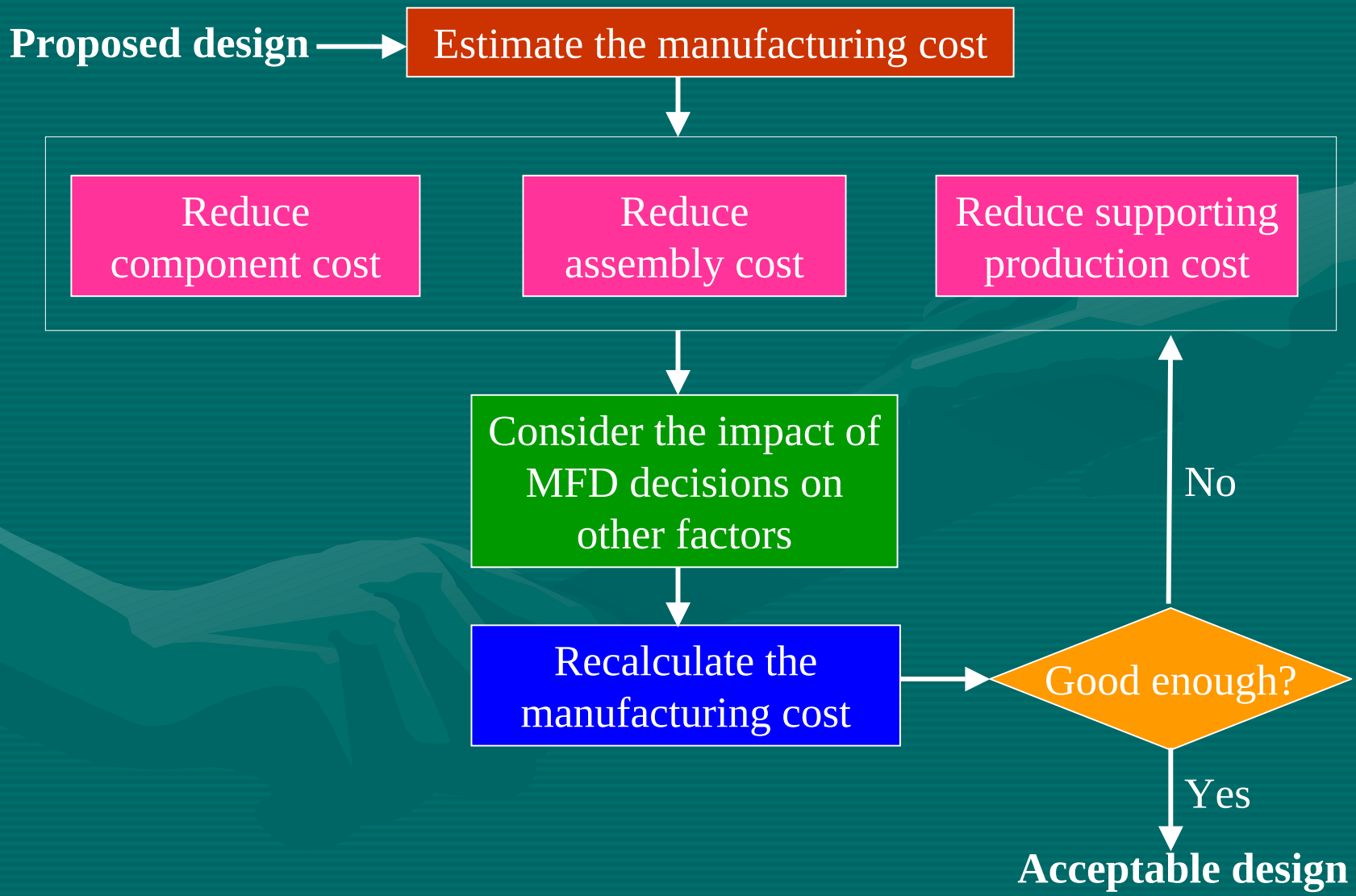


Box

VI. DETAIL DESIGN

VII. DESIGN FOR MANUFACTURING

DFM methodology



VII. DESIGN FOR MANUFACTURING

Manufacturability analysis worksheet (manufacturing improvement)

No.	Part or operation	Q'ty	Type	Assembly				Part elimination				Assessment			
				H	I	S	C	Motion	Mat'l	Ass'y	CFF	V	M	UI	Note
1	Transformer	1	2	+	+	0	0	N	Y	N	0	2	-	0	Ex.
2	AC/DC converter	1	2	+	+	+	+	N	Y	N	0	2	-	0	Ex.
3	Encoder	1	2	+	+	-	-	N	Y	Y	0	2	-	0	Ex.
4	Counter	1	2	+	+	+	+	N	Y	N	0	2	-	0	Ex.
5	Switch	1	2	+	+	0	0	N	Y	Y	0	2	-	0	Ex.
6	DC motor	1	2	+	+	0	0	N	Y	Y	0	2	-	0	Ex.
7	Toilet seat	1	2	+	0	0	0	N	Y	Y	0	0	+	0	New
8	Nylon	1	2	0	0	+	0	Y	Y	Y	0	0	0	0	New
9	Nylon feeder	1	2	+	+	0	+	Y	N	Y	0	0	+	0	New
10	Nylon rewinder	1	2	+	+	0	+	Y	N	Y	0	0	+	0	New
11	Cutter	2	2	+	0	+	0	N	Y	Y	0	0	0	0	New
12	Pin	2	2	+	+	0	0	N	N	Y	0	0	0	0	New
13	Rollers	2	2	+	+	0	0	Y	N	Y	0	0	+	0	New
14	Hinges	2	2	+	+	0	0	N	N	N	2	2	+	0	Ex.
15	Screws	10	1	+	+	0	0			Y	10	2	+	0	Ex.
16	Wire	1	2	0	0	0	0	N	Y	Y	0	2	+	0	Ex.
17	Cover box	1	2	0	0	0	0	N	N	Y	0	0	+	0	New

VII. DESIGN FOR MANUFACTURING

Evaluating DFM

$$Count\_ratio = \frac{\sum Qty - \sum CFE}{\sum Qty} = \frac{30 - 12}{30} = 0.6$$

With the good design the count ratio is equally to 1. We try to reduce the type 1 function as much as possible (separate fastener).

$$Value\_ratio = \frac{\sum (2\ \&\ 3\_value\_rating)}{\sum Qty} = \frac{9}{30} = 0.3$$

Because many our part are new design, so we have to improve it by reduced the new part and increased the building block part and off-the-shelf purchased part.

VII. DESIGN FOR MANUFACTURING

Bill of Material (BOM)

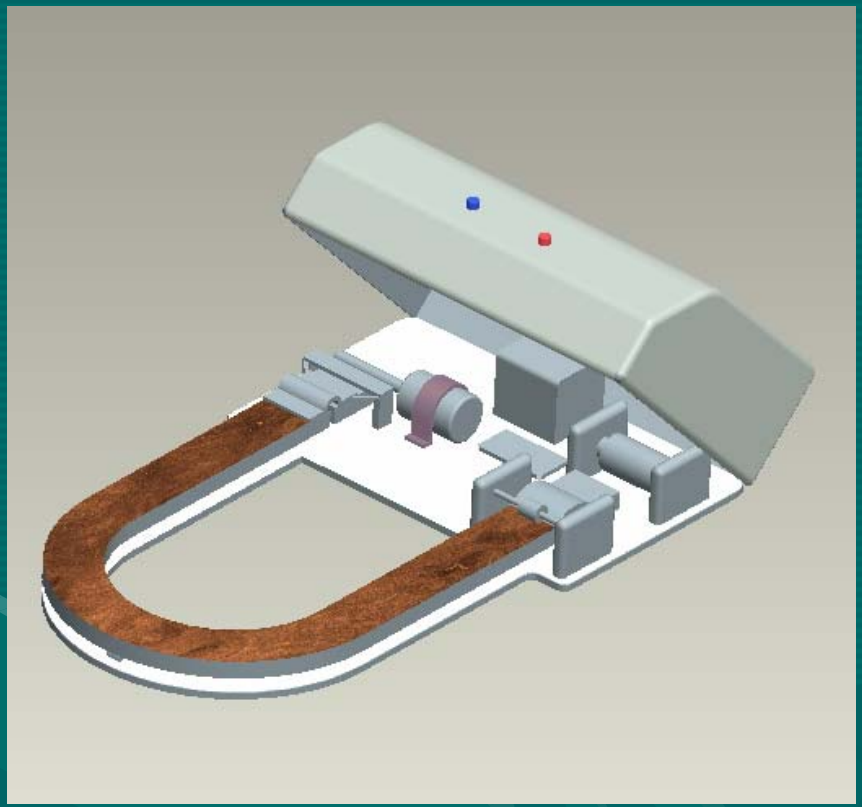
No.	Part or operation	Units	Quantity	Material	Standard
1	Transformer	pcs	1		
2	AC/DC converter	pcs	2		
3	Encoder	pcs	1	Steel	
4	Counter	pcs	1		
5	Switch	pcs	1		
6	DC motor	pcs	1		
7	Toilet seat	pcs	1	PVC	
8	Nylon	m	100	Plastic	
9	Nylon Feeder	pcs	1	PVC	
10	Nylon Rewinder	pcs	1	PVC	
11	Cutter	pcs	1	Stainless steel	Vietnamese Std
12	Pins	pcs	1	Stainless steel	Vietnamese Std
13	Rollers	pcs	2	Synthetical plastic	Vietnamese Std
14	Hinges	pcs	2	Stainless steel	Vietnamese Std
15	Screws	pcs	10	Stainless steel	Vietnamese Std
16	Wire	m	2	copper	Vietnamese Std
17	Cover	pcs	1	wood	

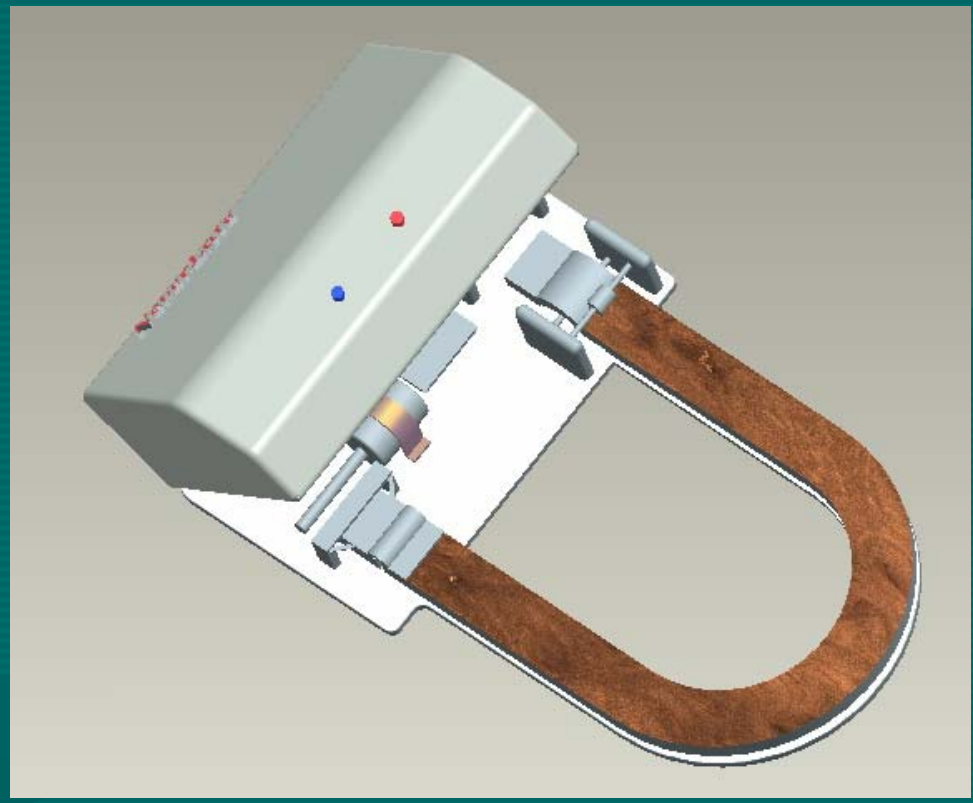
VII. DESIGN FOR MANUFACTURING

Bill of materials with estimated cost

No.	Part or operation	Purchased Materials x1000 VND	Assembly (labour) x1000VND	Total unit variable cost x1000VND
1	Transformer	30	2	32
2	AC/DC converter	5	2	7
3	Encoder	5	2	7
4	Counter	25	2	27
5	Switch	5	2	7
6	DC motor	80	5	85
7	Toilet seat	100	5	105
8	Nylon	2	2	4
9	Nylon Feeder	4	2	6
10	Nylon Rewinder	4	2	6
11	Cutter	4	2	6
12	Pins	2	2	4
13	Rollers	15	4	19
14	Hinges	5	3	8
15	Screws	10	5	15
16	Wire	5	5	10
17	Cover box	40	5	45
Total cost		341	52	393

VIII. PROTOTYPE





VIII. PROTOTYPE

Physical prototype

IX. TESTING AND REFINEMNET

Motor

Problem: not enough torque force to roll the nylon sheet

Solution: using motor with added gear-box to increase torque

Friction force

Problem: shape of toilet seat have a high fiction at curve and at surface that contact to base

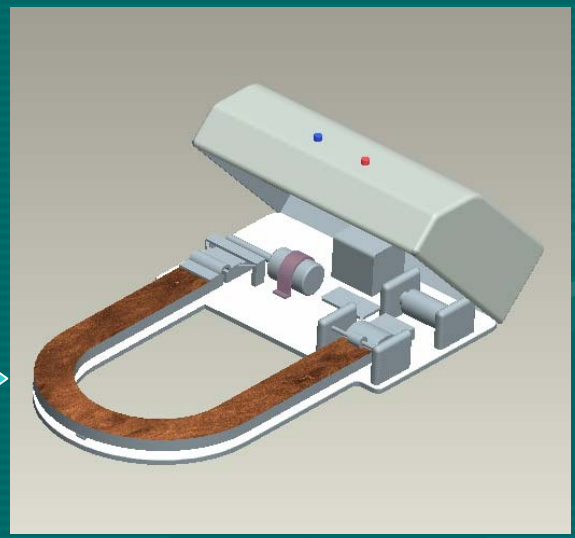
Solution: polish at the corner, decrease contact area between the seat and the base

Fixing toilet seat

Problem: not stabilization and difficult to rewind the nylon

Solution: Fixing one head and extra cutter

X. CONCLUSION



X. CONCLUSION

- ✓ A prototype is developed
- ✓ Product protects people by using a nylon sleeve covering the toilet seat
- ✓ Prototype test showed supportive result

XI. COMING SOON

- ✓ Alarm Signal for changing nylon
- ✓ Automatic cleaning for both toilet seat and human body


Thank you for your attention
Q&A
Neverlate
Mr. NGUYEN TUNG LAM
103181
Mr. VU XUAN TRUONG
103177
Mr. DOAN THANH SON
103179
Mr. BUI DINH VUONG
103184
9 14:15