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Plastic door trim Design Process study

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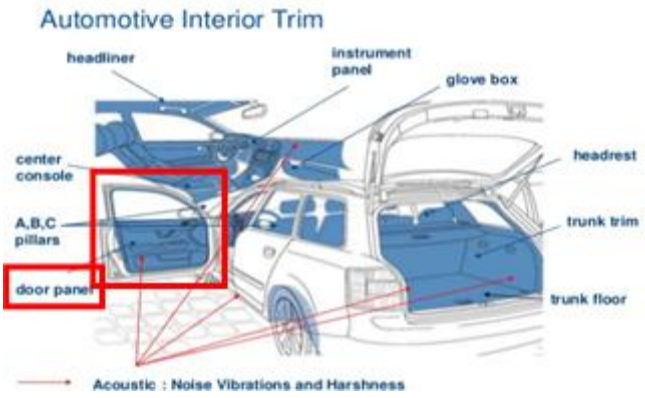
Abstract
We live in an age of ever-increasing product complexity, rapidly evolving technologies and global competition for new and improved products more quickly with world class level of quality and reliability. To excel in the competition and reduce the design lead time product engineers use several techniques like optimization, Design of Experiments FEA and Rapid prototyping etc. Wall thickness of any component is a vital design decision that affects structural performance, material utilization, and processing costs. Protection, vehicle dynamics, aesthetics, and strength are all important factors to consider when designing the door assembly..Apart from the above, door trim should be designed to reduce BSR (buzz, squeak, and rattle) during vehicle operation. Stiffness is a critical engineering requirement that, if not met, will result in higher BSR levels and door trim part failure.

Index Terms- plastic door , door trim ,door trim design

INTRODUCTION

An interior part that is attached to the door's inner side. This product improves the appearance of a number of design requirements in terms of protection, aesthetics, and functionality, among other things.



They are also supposed to keep the dashboard and pillars' content theme going before they publish their ideas. A car door is a complicated module made up of a variety of fixed and movable subassemblies and components.
It's also crucial to consider important factors including vehicle dynamics and strength when designing the door assembly. We will look at the overall door trim design process and how and where to increase the door trim's stiffness, which take into account the conditions, comfort level, and position of use..If the stiffness is greater than the standard, the door trim plastic parts would be softer, violating consistency and safety standards. Trim sections would not meet the practical and safety criteria if it is lower.

STEPSOF DESIGN AND DEVELOPMENTS OF DOOR TRIM .

Step1 :-Concept Engineering

- Benchmarking
- Concept design
- Packaging/Split
- CAS (studio surface)review.
- Engineering feasibility.

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Step 2:-Details Engineering& digital validation :-

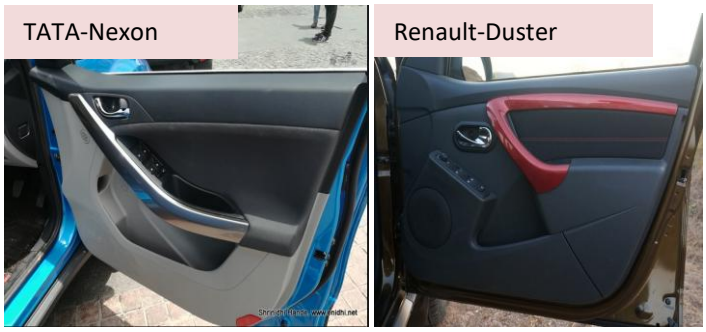
- Master section generation.
- BOM detailing.
- Engineering data creation(3D design).
- Manufacturing & assembly process definition.
- DVP (design validation plan).
- DFMEA CAE /CFD /MOLD FLOW.

I. DETAILS OF DOOR TRIM PROCESS

Step 1 :Door Concept engineering.

A) Benchmarking:

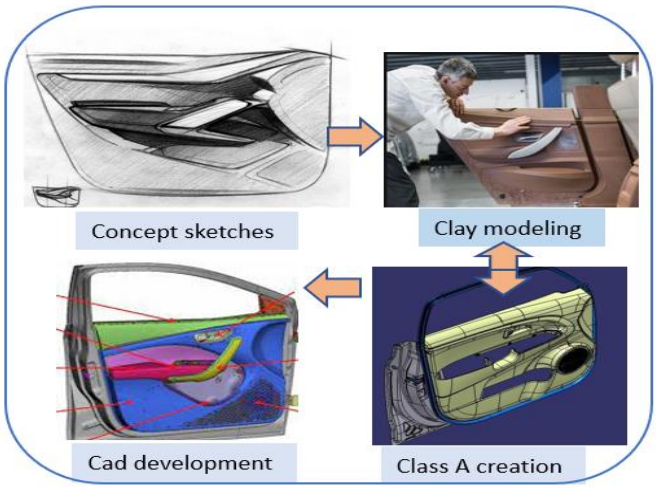
Is a continuous process of comparing goods, services, and activities to the toughest rivals or market leaders, and then applying that information to our design to achieve the desired solution with the most up-to-date concept.



By utilization of develop door trims , adopt good theme, mounting strategy, lesson and learn to design door to avoid further issue .

B) Concept design :

We need to generate sketches , then base on sketches clay model Generated for see overall physical geometr



Then base on final clay model A class surface need to design.
with A class cad surface some fine tunning in clay model need done tosee physical clay model appearance.

C) Packaging /Part Split

Many different packaging items are made using various designs and manufacturing techniques. These various products demonstrate how groundbreaking nature has resulted in a variety of products based on plastic behaviors and processing

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capabilities. The majority of these materials are thermoformed extruded film and board.
Base on packaging study parts will split in multiple parts base on feasibility & aesthetics.

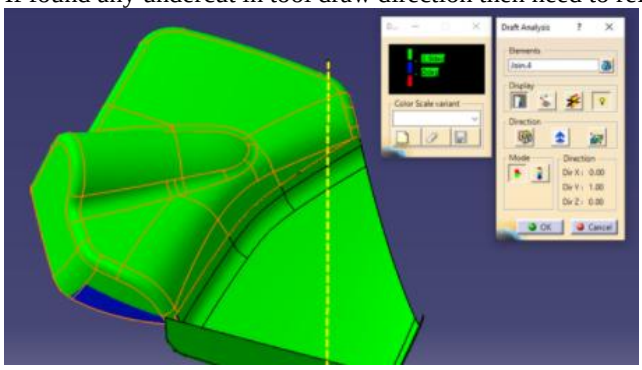
D)

E) **Review of CAS (studio surface)**

After generation of CAS its need review for its surface quality ,tooling analysis, regularity analysis And Ergonomics checks.
Manufacturing feasibility & prosses selection.

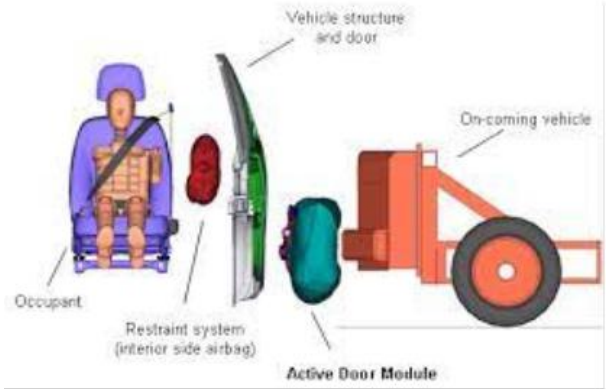
Surface quality: checking the one surface tangent quaternity with other surface ,if its not in tangent then refiment of style need to doo up to its become all surface tangent.
Tooling analysis.

Tooling analysis: need to check primary its draft analysis by considering suitable mold draw direction.
If found any undercut in tool draw direction then need to refine the style for make its feasible by removing its undercut.



Regularity analysis: Many different packaging items are made using various designs and manufacturing techniques. These various products demonstrate how groundbreaking nature has resulted in a variety of products based on plastic behaviors and processing capabilities. The majority of these materials are thermoformed extruded film and board.
Automobile regulations are meant to benefit customers and protect the environment, but if they are not followed, they will be ineffective.

ECE R21 This Regulation applies to the interior fittings of vehicles.



Ergonomic check:

as a scientific discipline that employs biotechnology and engineering concepts to enhance the satisfaction of staff and customers.

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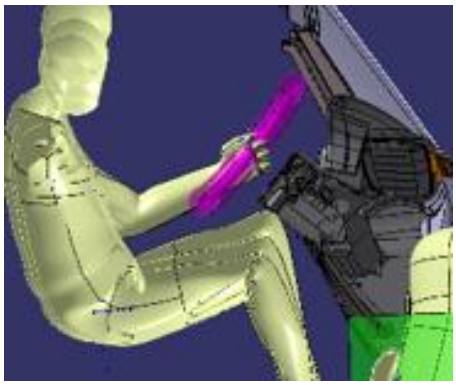


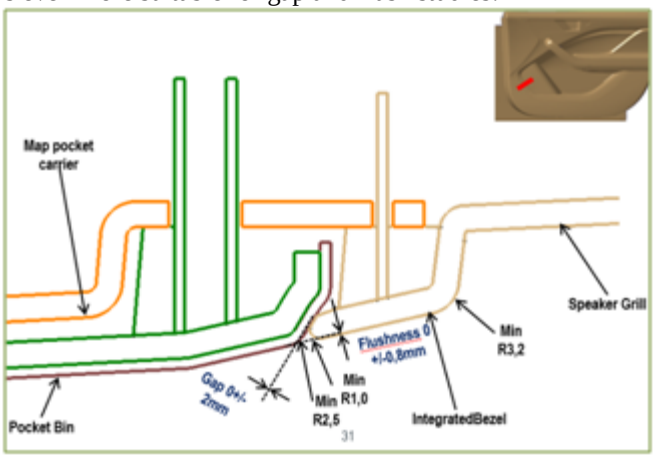
Engineering feasibility :

- Packaging and Environmental data Study
- Feature list checking / PMXU Validation
- System Design Specifications Validation (Customer specific)
- Functional and Regulation
- Production & Assembly Requirements

Step 2 :Detail engineering& design validation.

A) Master section :

Are design guidelines that decide component packaging after technical (styling definition or Class- A) considerations. It is even more suitable for gap and flush studies.



B) BOM generation:

The produced BOM contains all necessary production details, such as the product layout, a description of materials and purchased components, a cutting list, and a general list of parts, among other things.

C) Engineering data generation

B&C -Surface generation & Feasibility:

B surface : Next step is to design B surface for input which is usually the surface where all engineering aspect & support creation area done.

The B- surface creation is performed using surface operation in which is Offset from Class A with dimension propositional to the thickness of part.

Generally for door thickness will kept between 2.3-3mm.

C surface :

Which is an intermediate surface between A and B , is used to closed surface appearance of design.

C- surface generated by using boundary of surface

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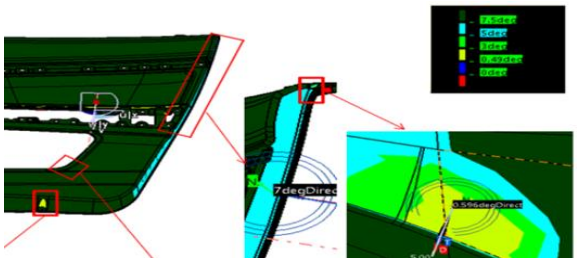
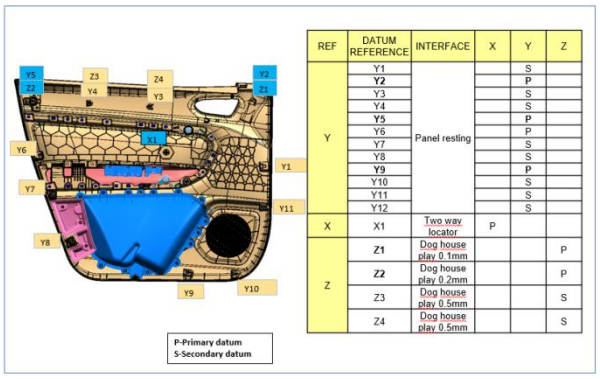
Closing surface for solid :
Combination of all A, B & C is foam a closed surface ,
Its directly form Solid body

Feasibility :after solid body its need check its draft analysis
To avoid any undercut formation , if there is undercut need to refine the cad for avoid undercut.



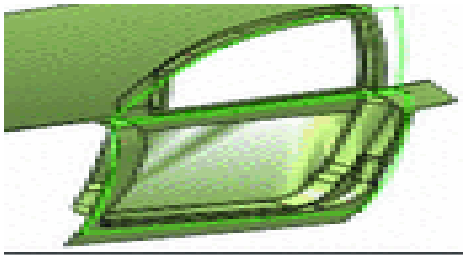
Mounting & Locating principle definition RPS:
After the Closed volume design next step to generate futures that for mount the door on the panel for fixation.
But its decide is base on length , width, height , geometry of part , weight of part , function , durability & On RPS .
This all factor need to consider for mount the part to achieve its fit & finish.



REF	DATUM REFERENCE	INTERFACE	X	Y	Z
Y	Y1	Panel resting		S	
	Y2			P	
	Y3			S	
	Y4			S	
	Y5			P	
	Y6			P	
	Y7			S	
	Y8			S	
	Y9			P	
	Y10			S	
	Y11			S	
	Y12			S	
X	X1	Two way locator	P		
Z	**Z1**	Dog house play 0.1mm			P
	Z2	Dog house play 0.2mm			P
	Z3	Dog house play 0.5mm			S
	Z4	Dog house play 0.5mm			S

P-Primary datum
S-Secondary datum

DMU-Clash, clearance ,packagingAnd assembly:
Clash : By using DMU to avoid physical part issue we can eliminate clash is in cad design stage.



Clearance :to achieve Gap & flush of one part with other parts ,
Its important to keep desired clearance between parts.

D) Manufacturing & assembly process definition :
For any assembly its important to designed process flow .
Its contain part fitment sequence , tool requirement for assembly , number operation , cycle time.

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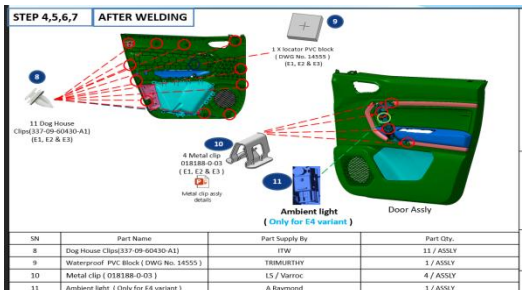

SN	Part Name	Part Supply By	Part Qty.
8	Dog House Clips(337-09-60430-A1)	ITW	11 / ASSLY
9	Waterproof PVC Block (DWG No. 14555)	TRIMURTHY	1 / ASSLY
10	Metal clip (018188-0-03)	LS / Varroc	4 / ASSLY
11	Ambient light (Only for E4 variant)	A Raymond	1 / ASSLY

E) GD &T(Geometry dimensions & its tolerances) :

GD&T is used to design, manufacture, and inspect components by designers, production planners, inspectors, machinists, and supplier quality workers.
GD & T drawing used to control the part quality base on thererequirement &application.

F) CAE

Material Details:
Commonly used material for door & its child parts are according to theirfunctionality and behavior.
There are many materials used for this whole assembly, some of them are listed below,
PP, PPTF20 , PPTD20, ABS

Material properties : PPTD20
Young's modulus: 1800MPA
Poisson's ratio: 035
Tensile Strength: 17 MPA
Density: 1.05 kg/m3
Shrinkage:0.9

a) FAE Analysis:
Hyper mesh is use to find the stiffness of door trim
.Plastic flow of material starts at yield point. This can cause permanent deformation ofmaterial. Considering part fitment and functioning we have to avoid plastic deformation in the material. This loading study is done up to yield point of different materials accordingly.

FAE Result:
Stiffness at door trim map pocket area :
stiffness is very important parameter for door design its directly impact on passenger safety , its help to avoid passenger injury while in side impact & also important for life of door.
As per OEM definition maximum displacement allowable at 50N is 5mm & at 100N its 8mm.

1. Displacement at 50 N :

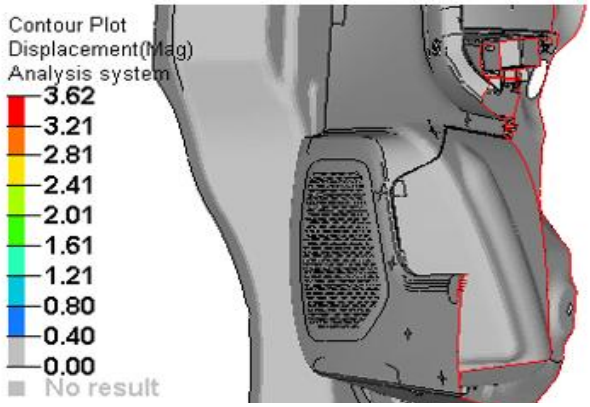

Fig 5.1: map pocket area Stiffens rigidity at 100

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2. Displacement at 100 N :

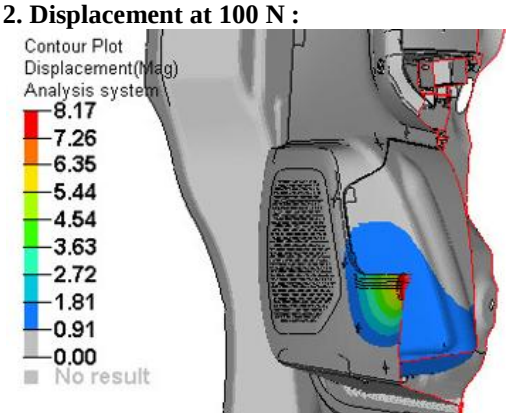

Fig 5.2: map pocket area Stiffens rigidity

Force VS displacement result

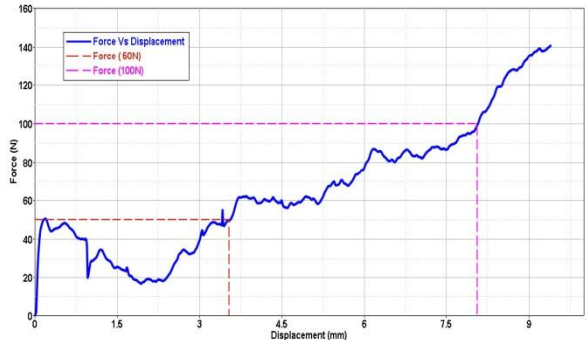

Fig 5.3: Force Vs displacement

At the 50 N force Displacement is 3.74 mm < 5mm, Test may pass
At the 100 N force Displacement is 8.06 mm > 8 mm, Test may pass
As we can observe from the above diagram that the displacement valueis below the given value from the customer, so the design change has not required at particular area.
Highlighted area having robust ribbing structure
The stiffening ribbing structure has been provide to the door trim pocket area as per bench mark part.
This directly helps the structure to become more robust & provide, proper stress distribution.

b) Mold flow analysis:

Mold flow is to provide premanufacturing parametres of injection moulding such as Flow , temperature variation, defect, pressure requirement , tonnage, cooling time , cycle time, overall capacity warpage, weld line.
If any defect found any defect we can change our design base on mold flow result to avoid actual issue.

Temperature distribution :

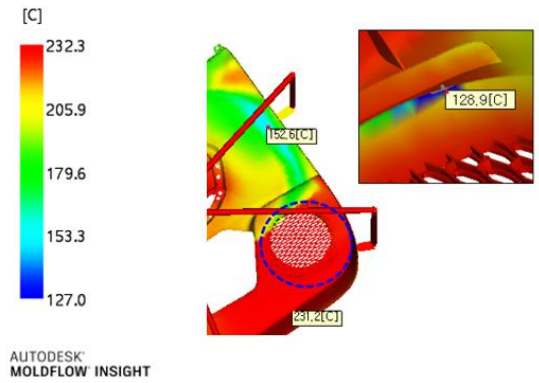

Fig 5.4: Temperature distribussion

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Deflection :

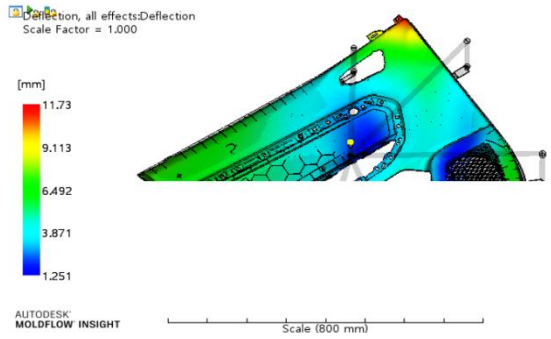

Fig 5.5: Door deflection

Mold flow Result:

Analysis Result		Unit
General Wall Thickness	2.3	mm
Fill time	8.03	sec
Pressure at V/P switchover	31	MPa
Holding pressure/time	22/10	MPa/sec
Cooling time	50	Sec
Clamping Tonnage	1427	Ton's
Part weight	-	g
Temperature drop	105	℃
Warpage all Direction	1.2~11.7	mm
Warpage X direction	-4.8~5.5	mm
Warpage Y direction	-4.9~7.2	mm
Warpage Z direction	-6.5~10.6	mm

Observation from mould flow :

- The injection time is about 8.0sec
- The maximum clamping tonnage is 1427Ton
- The injection pressure is 31Mpa. As injection, pressure tends to be slightly high (It can affect product quality.)
- Refer to the location of weld line and air trap.
- The maximum temperature variation is 105℃. Temperature variation is caused by short shot on the rib and

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boss

- Maximum deflection of ‘ Z ’ axis 17.1mm. The center area goes up and end area goes down
- Weld line area is a ‘A’ surface area.
- Sink marks should be considered

IV CONCLUSION

Base on the door stiffness analysis ,we have achieve the OEM standard stiffness value , base on that no need to improved further design & also from mold flow analysis we have find out the
Value of injection time, Clamping machine tonnage,
Injection pressure, location of weld line,air trap ,temperature variation, sink mark & most important deflection of parts.

Also we have get proper idea & processing of industrial Door design process .If we follow the process we can avoid & control on development problem & save time.

ACKNOWLEDGMENT

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[3] S. Vinay Seeba1, S. Srikari2, V. K. Banthia 3 “DESIGN AND ANALYSIS OF A PLASTIC DOOR MODULE FOR CAR BODY APPLICATION“
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