PFC: Adjustment of a cluster on an existing instrument panel and design of the cluster frame

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Abstract

The topic of this project is due to a period of practices in Idiada Company, and for me, it has been a training exercise. As training in Design Engineering field, the adjustment of Seat Leon’s cluster frame in the FAW Sirius’ S80 instrument panel, has been done and therefore, the design of the cluster frame.

The adjustment has been realised since first, a feasibility study has been done in order to find the cheapest and also viable option. Once fixed kombi in the IP carrier, the design of the cluster frame has been done, beginning from the style surface, giving it volume, designing brackets, defining the parting line and sliders boundaries, giving draft in order to have a correct leaving of the mold, etc.

Once design has been finished, a thickness and stress analysis has been performed to verify the validity of the design. To end with it, an assembly sequence has been designed and the economic budget of a cluster frame production has been calculated.

1. Introduction

This hypothetical real project begins with the demand from an automotive company to do this adjustment and design since they cannot have the product ended for the deadline expected or for other reasons. Idiada provides this service as other companies do, to automotive groups.

This types of projects are coordinated by project managers who are engineers and they decide and validate designs, for the other hand, modellers are who create this parts in CAD Software, in this case Catia has been used. Once designed is given as valid, file is sent to the moldist and they give a feedback to project managers if part has to be modified or if everything is right and ready to be molded.

2. Feasibility

Feasibility is known as the study of viability that is done, checking all bindings that form both cars’ instrument panels. What has been done in this case is, the study of FAW’s fixations like kombi-IP carrier and cluster frame-kombi, making sections in all bindings and defining all RPS (Reference Positioning System), to know how all parts are fixed and constrained between them.

In seat Leon’s instrument panel has been done the same, in this case binding between cluster frame-slush as well.

Fig. 1. Section cut of FAW’s upper clipping.

Once all bindings are studied, this phase ends up with a set of conclusions that define how new kombi could fit and also the new cluster in the FAW’s instrument panel.

3. Occupant packaging

As an additional step that could not be done since it should have been checked by FAW, the area of dashboard’s view has been ensured according to SAE normative and percentiles used for automotive packaging. Taking the ball point and as an input and the 95 male percentile as reference, the H point is found, then, by taking SAE evolvents, dashboard location is validated since it is inside of the vision field.

Fig. 2. Verification of vision field.

Once feasibility conclusions are planned and vision field is verified, a sketching phase begins to come up with viable binding solutions.
4. Kombi’s replace
Thanks to this phase, lots of proposals are discarded since a solution shown graphically is always a better option than a one that is modelled directly. FAW’s kombi has been deleted and Seat’s one has replaced the old one, then new one’s bindings are studied if can screw and clip with the FAW’s IP carrier fixations.

Fig. 3. Proposal discarded in the sketching phase.

Taking into account all possibilities that are feasible, only one is chosen and this, tries to modify the minimum parts. The beginning will was a design that could fit in both instrument panels at the same time, but thanks to the survey done, it has come to the conclusion that it is impossible.

5. Adjustments
Final design to adapt kombi in the new instrument panel will consist on a modification of kombi’s front cover so it will be able to bind with original FAW’s brackets and RPS.

For the upper clipping it will incorporate same clips as FAW’s kombi and then, in order to save money in material expenses, old clips will be deleted. For the lower part, big tabs are designed in order to fit with the IP carrier holes and pins. Housing for cluster frame’s clips have been designed on the top of front kombi cover.
Nerves, holes and faces have been given a draft angle in order to have a good exit of the mold

Fig. 4. Proposal discarded in the sketching phase.

6. Cluster frame
Once kombi is located in a good position, cluster frame has been designed and modelled. Normal process of a cluster modelling would start with the sketch of the entire IP, then it would be modelled in clay, a 3D scanner would create a surface corresponding to the IP in clay. In the next step appear surfers, whom taking from base the surface scanned, create correct surfaces and valid to work on them, this surfaces are called style ones. In the last step appear CAD modellers, they are who give volume, nerves, brackets, tabs, etc. to the surface given by surfers.

In this case, since the environment is already designed, the cluster frame’s shape has been limited by the slush and kombi’s contour and shape.

Fig. 5. Design of the new cluster frame.

Once shape is decided, first step is to design the style surface which corresponds to A surface. A surface means the one that is visible to the driver, surfaces that are called B are hidden. As commented above, A surface are designed by surfers with specialized programs like Icem Surf or Alias, in this case it has been modelled with Catia.

Style surface inputs have been the dashboard contour and slush hole contour, making a union from these contours appears the A surface. Since Leon’s original cluster frame has a graven on the A surface, this one will also bring it, so the minimum draft from the principal demolding direction is 7 degrees to ensure the correct exit from the mold.

Fig. 6. Design of the new cluster frame.

Once this draft is reached, B surface is created and then the contour is modelled in order to avoid gaps between slush
and cluster frame. To give a draft, first a principal demolding direction had to be defined.

Once basic volume is modelled, the system to lock in a fixed position has to be defined. Since kombi presented the holes for Seat’s cluster frame’s lower RPS, new cluster includes same system. This one restricts cluster movement in z and in Y. For top part two brackets have been designed and they will work with a housing located in front kombi’s cover, with staples in it. This system will lock movement of the cover. It is missing to forbid movement in X direction. To achieve it, some holes have been designed in the slush in order to clip with four tabs located in the lateral sides of cluster frame. With this system, as commented above, locking in X direction is ensured.

All clips, brackets and tabs have been designed parting from a slider direction, then draft angle has been applied and as last step, slider boundary has been defined. All of them have also been designed in order to avoid sink marks and shrinkages. As cluster frame material is Polypropylene, it has been studied that clips walls should be 1/3 of the base wall thickness, so brackets and tabs designed follow this rule.

Fig. 7. Cluster frame with slider boundaries and directions.

Once all brackets, tabs and clips are modelled, a thickness analysis has been realized by a specific Catia module. This helps to know if thickness is constant or if it has mass concentrations, which would lead to sink marks or different time cooling zones.

Fig. 8. Cluster frame’s thickness analysis with its legend.

-ended the thickness analysis, last step to give for valid the designs consists on stress analysis. The ones that are responsible to develop it is the CAE department. In this case it has been simulated by Unigraphics of Siemens NX. Stress analysis has consisted on checking the sinking of the A surface while a force of 50N is applied. The maximum nodal displacement allowed was 1.5 mm and study showed that all inner area sinks less than 1.5mm. At the same time that force is applied, Von Misses stresses in brackets and tab’s sharp edges have been studied. Since tensile strength of polypropylene is around 70 MPa, design can be considered as valid because, programs show stresses values under the limit.

Fig. 9. Graphical representation of rigidity survey.

This last study ends with the design process, in case stresses or thickness analysis were over the limits imposed, a redesigned done by CAD modellers should be done. In order to make possible the production, moldists need the 3D file and 2D layout specifications as well, so it has been done in the same way as Idiada and Seat do.

An assembly sequence has also been represented to explain which parts are assembled before having to assemble the ones that have been designed in this project and also to show how the process and way to assemble it to the surroundings is.

Fig. 10. Final assembly of the instrument panel.

To end with this project, an economic budget has been calculated. This budget takes into account the engineering cost, giving a price of 40€/h, which includes licensing cost, make profitable hardware equipment, installations, maintenance costs and derivate costs due to worker
contracts such as social security. The total engineering cost is around 14.000€.

Mold cost is also calculated thanks to a virtual machine that takes into account the quantity of parts, material, volume, tolerance, complexity, side cores, lifters, defect rate, indirect labour costs, overhead costs, as well as profit. Having all this parameters in consideration, the indicative final price of the mold is around 252.000€.

Finally, cluster frame individual piece cost in a production of 400.000 parts, taking into account the engineering budget and the mold cost, final price is 0’665€, it means that automotive companies, if they sell a cluster frame as replacement at 50€, they have a benefit of 98%.

7. Conclusions
As a conclusion of this project, it is extracted that it has been managed to make as economical as possible adjustment, taking into account all the possible changes that could be made, resulting in a product that could be manufactured and completely functional. It has been learned how to work in the automotive industry, specifically in design process of plastic injection pieces, starting from the surface style that would be given by the customer or by a subcontractor, then giving it volume and designing clips reasoned, analyzing and studying different types of clips that exist and being aware of the limitations of molds. To verify that the design was valid, it has been worked with thickness analysis and simulation finite element stresses.

It has been learned to perform the 2D layout so that molders by using numerical control, can tool the cavity in the mold. Thanks to tools such as virtual calculation of the mold budget, it has been learned all the variables involved when giving a price to this product and how to get a final price of each piece into a commanding of a large volume as it happens in this industry.

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