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Influencing of Feed System for D-Ring Component Using NX-EASY Fill Advance Software

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ABSTRACT

The feed system in an injection mould tool plays a very important role as it carries molten plastic material from the machine nozzle to the edge of the component. The feed system in injection moulding is made up of sprue, runner systems and gates, which are the channels through which the molten material flow. In manufacturing of plastic parts, cycle time optimization, scrap avoidance and manual interface plays a critical role, increasing process productivity while ensuring that the product quality is not compromised. The present work focuses on the impact of an ideal feed system on melt front time and defects using NX-Easy Fill Advance software through number of trials. The new optimized feed system was tested in an injection moulding machine with a developed mould tool.

Keywords: Plastic Injection Mould Tool, NX-Easy Fill Advance, Feeding system, Defects.

1. INTRODUCTION

Plastics are at high demand in today’s world due to their numerous characteristics. Injection mould is one of most used methods of producing plastic items. A mould tool is required to be developed to create useful plastic component. This study focuses on the moulding of the D-Ring (car seat belt). In this case, a 3D model was designed using NX-11.0 software and then loaded into IGS file to asses mould flow insight. All the procedures were completed in the first stage, which include assigning the material, meshing the model and finding the optimum feed system. The traditional trial and error method is used to set the processing criteria, which is often insufficient and impractical for complicated parts. As a result, 4 trials with different feed systems were conducted to obtain the best result, and one of the outputs was found satisfactory for almost all parameters, encouraging the designer to proceed with that design and manufacturing process and procedures.

2. OBJECTIVES

- Component research and development.
- One whole shot designed and analyzed.
- Injection mould calculation and conceptual design.
- To manufacture one useful product without any flaws.

3. METHODOLOGY

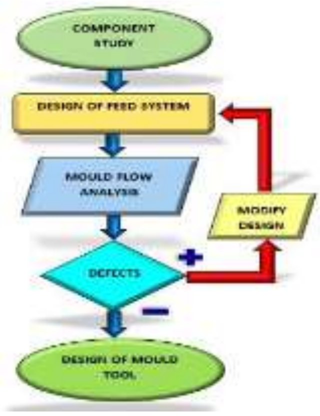

Fig 1: Flow chart of Methodology.

3.1 Component Study

Component Details

The component name is D-Ring (car seat belt). Polyoxymethylene is used as the component material. The component material is black in colour. The component volume is 24.20 cm^3. The total weight of the component is 34.12 grams. The component has a density of 1.41 grams per cubic centimeter and has a shrinkage value of 1.9-2.3 %. The melting point is 240 ℃. The component 3D model is shown in fig 2.

The D-Ring is car seat belt component which is placed in a car for safety purpose. It holds the occupant in the seat and prevents them from throwing out of the vehicle due to force and hitting the dashboard, windshield which can cause serious injuries.

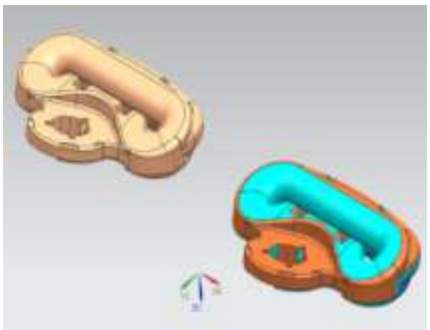

Fig. 2: Top cover strut bearing 3D model

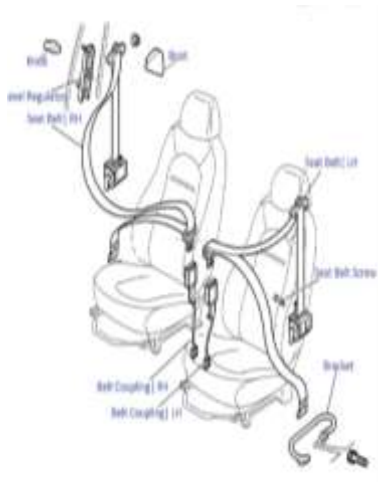

Fig. 3: Seat belt assembly in a car

3.2 Design of Feed System

- **Runner design**

Diameter of runner = $\frac{\sqrt[4]{L}\times\sqrt{w}}{3.7} = \frac{\sqrt[4]{38}\times\sqrt{68.24}}{3.7}$

- **Sprue design**

Diameter of Sprue = $D_1 = D_2 + 2L \tan A$,

Since hot sprue system is used, standard dia of **6 mm hot sprue is purchased**.

- **Gate design**

Diameter $d_2 = \frac{d_{2a} + d_{2b}}{2} = \frac{\mathbf{1.37+1.57}}{\mathbf{2}}$ **= 1.47 mm** where, d_{2a} = 1.37 mm, d_{2b} = 1.57 mm

Width of the gate (Wg) is calculated by, $W_g = \frac{n \times \sqrt{A}}{30} = \frac{0.65 \times \sqrt{42196.21}}{30}$ = 4.46 mm

By analysing the best feed system using trial and error method. From that analysis an optimum or best feed system was selected and mould tool was developed.

3.3 Mould Flow Analysis

It is the study of flow analysis of plastic material that aids in the evaluation of the part, parameters to produce high quality parts. Moldex3D program controls, NX Easy-Fill Analysis, Solid works, are the different flow analysis software's used to check the optimized feed system. Developers use this software to check the parameters like material, feed system design, etc.

Table 1: Input data for analysis

Material selected	POM
Supplier	DuPont
Trade name	Delrin AF
Density	1.41 g/cc
Melt Temperature	240°C
Mold Temperature	70°C
Max. Pressure	177.5 MPa
Injection Time	4.52 s

3.4 NX Easy Fill Advance Results

The mould flow simulations are run several times, and among them, best feed system is chosen for developing the tool based on gate contribution, fill time, pressure, average temperature, air traps, weld lines and other defects.

3.5 Best Feed System by using 3 trials in NX Easy Fill Advance

Trial 1

Runner: Modified Trapezoidal Gate: Submarine

Trial 2

Runner: Half Round Gate: Edge

Trial 3

Runner: Full Round Gate: Edge

Trial 1

To get optimum results, two more trials were analyzed.

Table 2: Result from Trial 1

SL. NO.	PARAMETERS	RESULTS
1	Gate contribution	Balanced flow
2	Melt front time	4.750 s
3	Pressure	50.098 MPa
4	Temperature	233.135 °C
5	Air traps	Less
6	Weld lines	Less
7	Flow rate	Good
8	Ejection	Easy

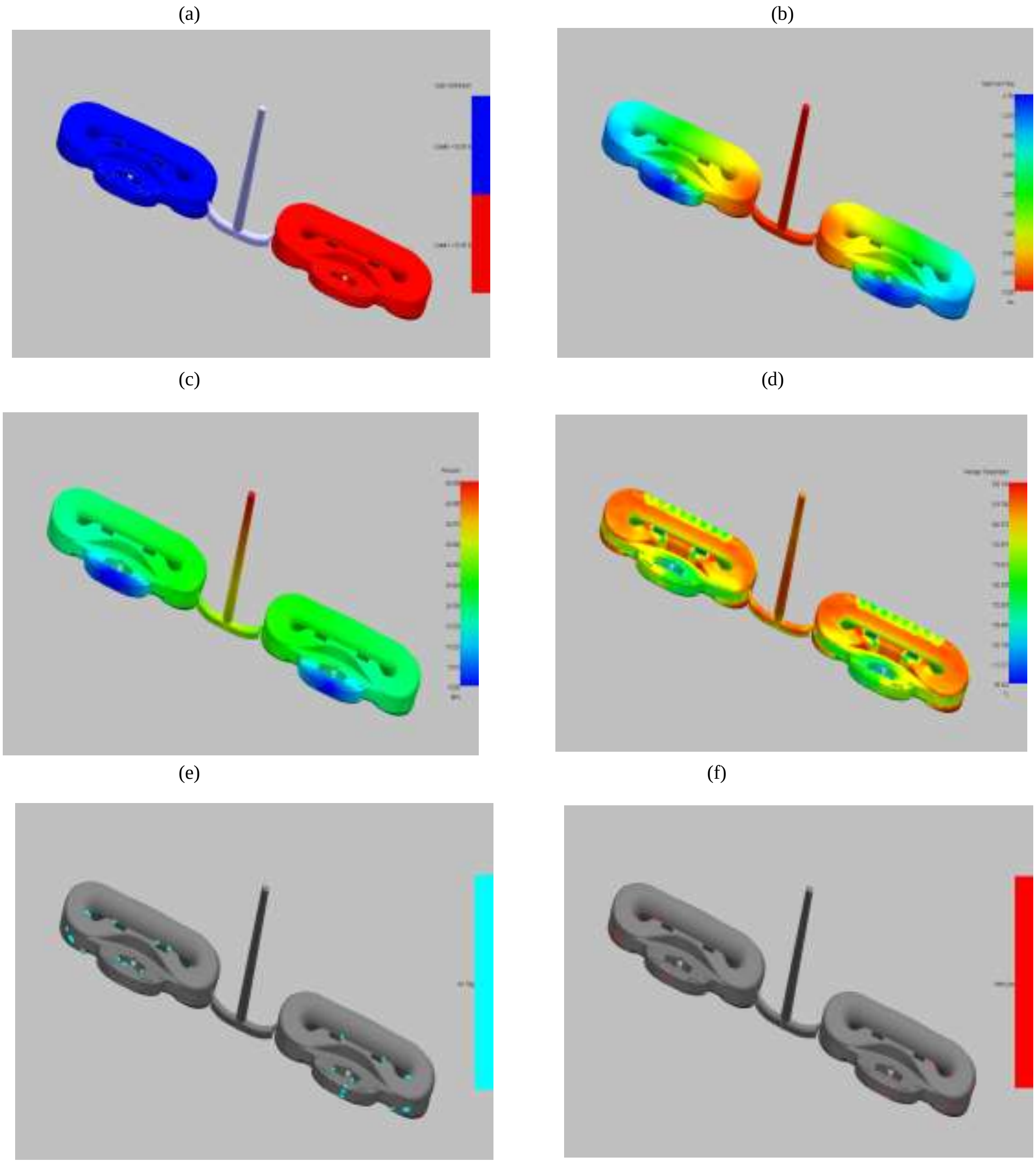

Fig 4: Flow simulation of Trial 1 a) Gate contribution, b) Melt front time, c) Pressure, d) Temperature, e) Air traps, f) Weld lines

Trial 2

Table 3: Result from Trial 2

SL.NO.	PARAMETERS	RESULTS
1	Gate contribution	Balanced flow
2	Melt front time	4.916 s
3	Pressure	44.637 MPa
4	Temperature	238.689 °C
5	Air traps	More
6	Weld lines	More
7	Flow rate	Medium
8	Ejection	Difficult

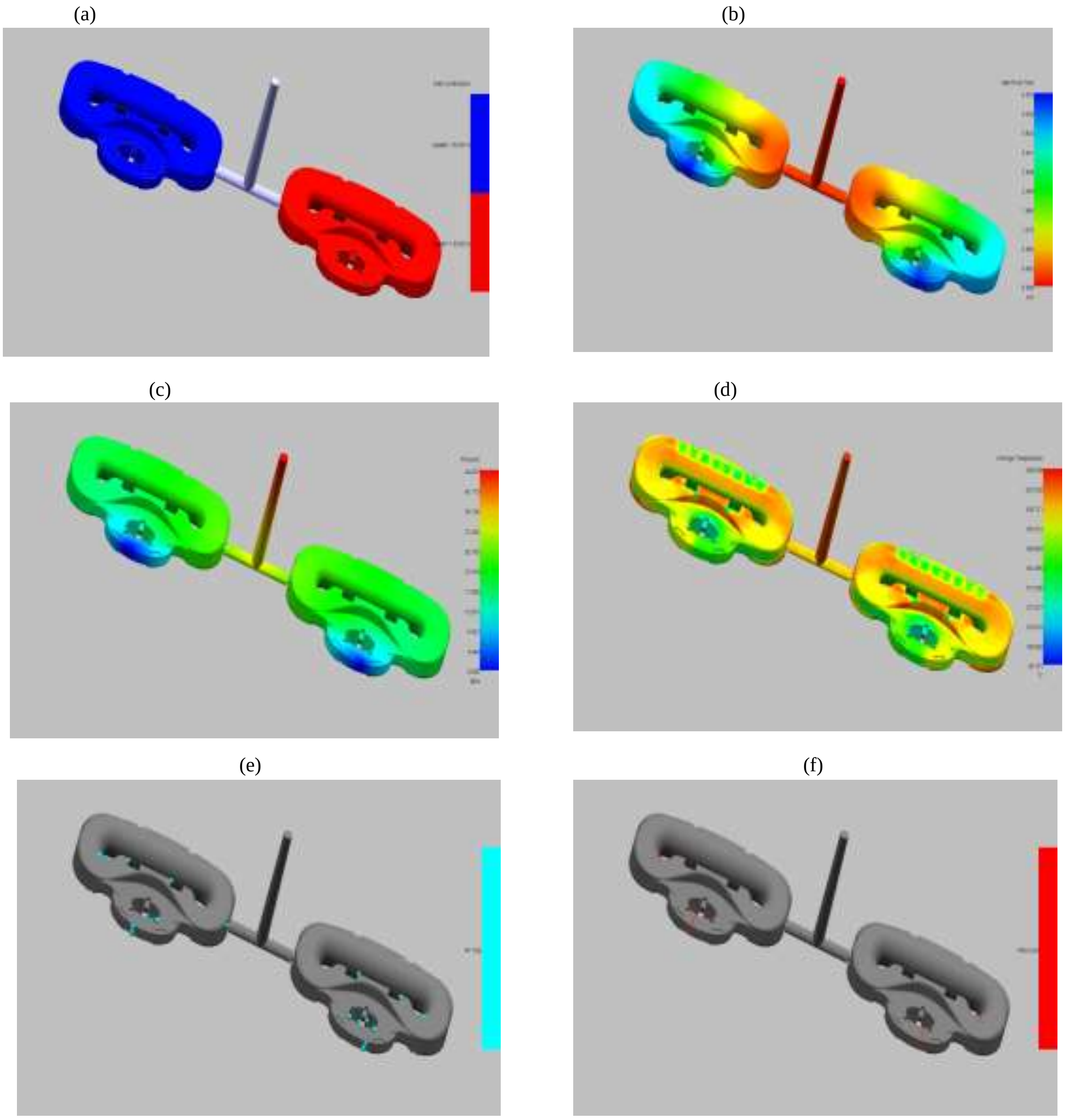

Fig 5: Flow simulation of Trial 2 a) Gate contribution, b) Melt front time, c) Pressure, d) Temperature, e) Air traps, f) Weld lines

Trial 3

Table 4: Result from Trial 3

SL.NO.	PARAMETERS	RESULTS
1	Gate contribution	Balanced flow
2	Melt front time	4.779 s
3	Pressure	39.794 MPa
4	Temperature	238.780 °C
5	Air traps	More
6	Weld lines	More
7	Flow rate	Good
8	Ejection	Medium

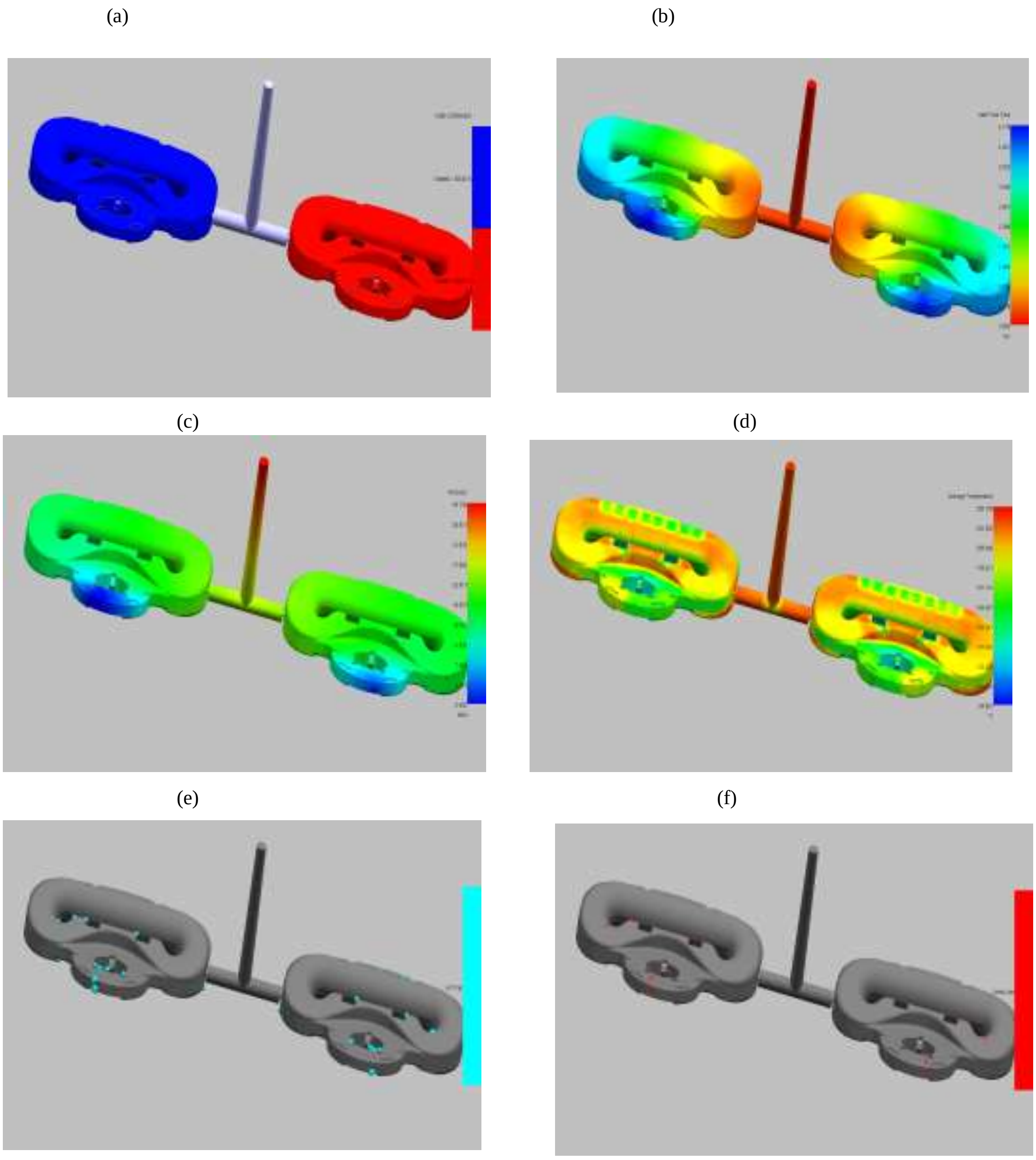

Fig 6: Flow simulation of Trial 3 a) Gate contribution, b) Melt front time, c) Pressure, d) Temperature, e) Air traps, f) Weld lines

CONCLUSIONS

The analysis for optimum feed system was determined, and flaws such as air traps weld lines were eliminated in the flow simulation by comparing the above three results. Auto de-gating was achieved, because the gate is placed in the proper location for ease of production and flaw less components. By providing air vents in core and cavity inserts at proper location air vents can be reduced. Weld lines can be reduced by change in parameters like injection pressure, barrel velocity and mould temperature. From table 5, Trial 1 with modified trapezoidal runner and submarine gate has been approved as the best feed system for further manufacturing process.

Table 5: Comparison of results from 3 Trials

Sl. No.	PARAMETERS	TRIAL 1	TRIAL 2	TRIAL 3
1	Gate contribution	Balanced Flow	Balanced Flow	Balanced Flow
2	Melt front time	4.75 s	4.91 s	4.77 s
3	Pressure	50.09 MPa	44.63 MPa	39.79 MPa
4	Temperature flow	233.13 ℃	238.68 ℃	238.78 ℃
5	Air traps	Acceptable	More	More
6	Weld lines	Less	More	More
7	Flow rate	Good	Medium	Good

8	Ejection	Easy and Automatic de-gating	Difficulty	Medium

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