INCREASING THE QUALITY OF SHEET METAL EMBOSSING PROCESS FOR CAR DOOR CAISSONS MANUFACTURING

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Rezumat. *Lucrarea are ca obiectiv creşterea calităţii procesului de ambutisare a tablelor utilizate pentru confecţionarea chesoanele uşilor de automobile. Pentru obţinerea de piese fără defecte, se studiază cauza apariţiei defectelor, momentele în care apar şi condiţiile de proces care favorizează apariţia acestora. Pentru prelucrarea unor piese cu forme complexe şi neregulate sunt necesare condiţii optime pentru curgerea materialului. În situaţia în care gradul de deformare este mic, ambutisarea trebuie să se facă prin întinderea materialului şi, prin urmare, se prevăd nervuri de reţinere. Astfel, marginile semifabricatului sunt reţinute şi partea centrală a piesei va fi supusă unui proces de întindere, evitându-se astfel revenirea elastică şi asigurându-se stabilitatea formei piesei.*

Abstract. *The work aims to increase the quality of the sheet metal embossing process used for car door caissons manufacturing.In order to obtain parts without defects, the cause of the defects, the moments in which they appear and the process conditions that favor their appearance are studied. For the processing of parts with complex and irregular shapes, optimal conditions for the flow of the material are necessary. If the degree of deformation is small, the stamping must be done by stretching the material and, therefore, retaining ribs must be provided. Thus, the edges of the semi-finished product are retained and the central part of the part will be subjected to a stretching process, thus avoiding the elastic return and ensuring the stability of the shape of the part.*

Keywords: Automotive, Embossing process, Deep drawing, Quality, Caisson.

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1. Introduction

Well known, perceived quality is a game-changer in consumers' decision-making processes and is seen as one key predictor of a product's and company's success. Today, the automotive industry faces challenges not only to deliver superior manufacturing quality in order to excel in perceived quality, but also to induce a positive sensory and cognitive response from its customers [2].

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The experimental researches and the analysis were carried out within SC Matrițe Dacia SRL, Piteşti, a company that was founded in 1985 and which in 2000 was taken over by Renault. This was the launch and development point of the company, Renault being considerably involved through investments in infrastructure and labor.

In order to establish the quality of the processed elements, they are touched by painting the inner surface of the model with a thin and uniform layer of Prussian blue paint, the punch being mounted on the press table, and the negative model on the upper plate (ram). mass (depending on the type of press) until the surface of the model reaches the surface of the punch. There will be paint stains on the higher points on the surface of the punch that need to be remedied. The touching is completed when the paint is evenly distributed on the surface of the punch; in practice it is accepted that the touching surface is at least 80% uniform (Fig. 1). The touch allows the verification of the contact between the pre-made and the semi-finished product, as well as between the punch and the sheet [12].

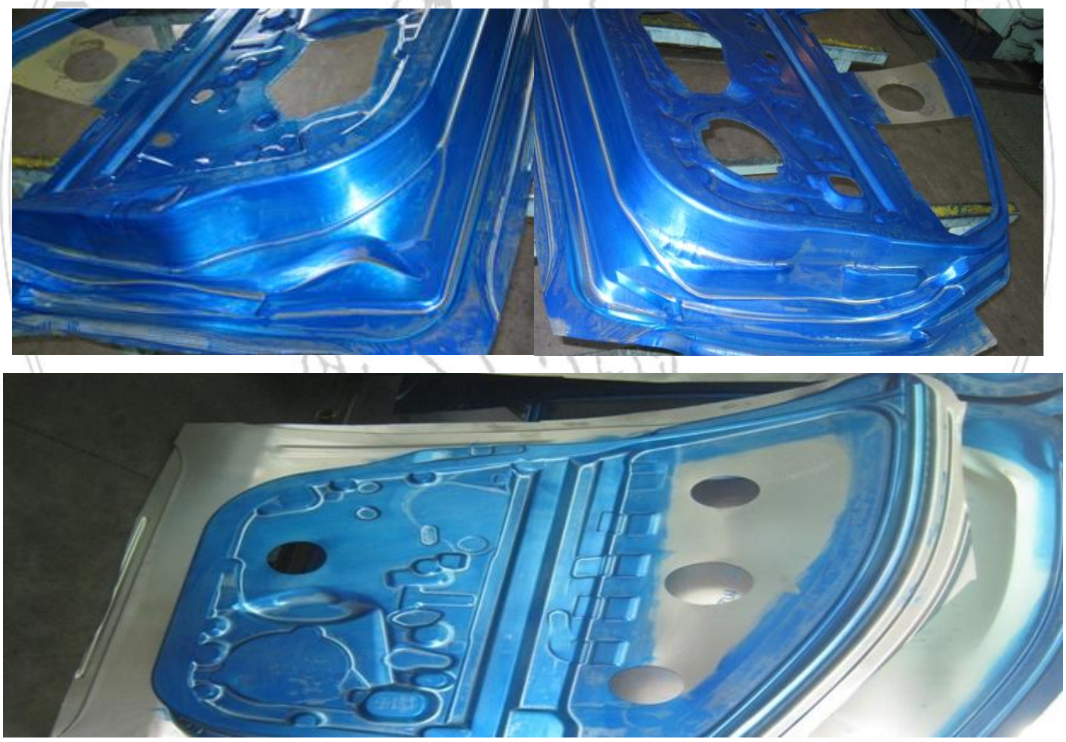

Fig. 1. Inked molds

The first defect may be the GRIP, or the deposition of material on the active parts. Its existence can be verified visually or bypalpating the active parts. To remove the grip, 800-1200 mm sandpaper was used until the surface becomes smooth and without wrinkles, after which the mold is washed.

2. Technological process

In order to obtain the final parts, a series of operations are necessary, the most important of which is stamping, which in this case (processing of parts with irregular shapes) requires the achievement of optimal conditions for the flow of the material [4]. If the degree of deformation is small, the stamping must be done by stretching the material and therefore retaining ribs must be inserted. Thus, the edges of the semi-finished product being retained, the central part will be subjected to a stretching process, thus avoiding the elastic return and ensuring the stability of the shape of the part [3].

3. Defects

Next I will present the defects that appear when stamping door caissons as it resulted from experimental research. For this, 3 pieces were studied, from a material marked DX54D + Z140 (a galvanized steel), with a material thickness of 0.65 mm. It analyzes the type of defects that occur, which are noted from A1 to An, the severity of the defect and its inclusion in the parameters, as well as the retouching measures [10].

Embossing technique allows strengthening properties of sheet metal materials to be specifically increased [9].

In the Renault industry, steels have a certain way of standardization, the steel from which the parts in question are made being part of a group of standardized steels DX....D, whose main characteristics are presented on the Table 1.

Table 1. The main characteristics of standardized steels

Grade	Material number	Yield Strength Re 1)MPa	Tensile strength Rm	A80 2) % minr90 3)Min	r90 3)min.
DX 51 D + Z	1.0226	-	270-*500	22	-
DX 52 D + Z	1.0350	140-300	270-420	26	-
DX 53 D + Z	1.0355	140–260	270-380	30	-
DX 54 D + Z	**1.0306**	**120–220**	**260-350**	**36**	**1,60**
DX 56 D + Z	1.0322	120–180	260-350	39	1,90
DX 57 D + Z.	1.0853	120–170	260-350	41	2,10

It is found that for caissons, the main types of defects that appear on the exterior shapes (Fig. 2, 3 and 4 and Tables 2, 3 and 4) [8]:

- volume deformations - which occur in the volume of the part on certain areas such as flattening, corrugation, impact, buckling;

- contour deformations - which occur at the outer contour of the part such as radius deformations (in the area of the radii of curved surfaces), burrs (scratches) that occur at the edges of the areas / contours of parts that have been processed by drilling / cutting / cutting.

Table 2. Exterior defects left door caisson I

Form code:			Material used: **DX54D+Z140**			
Landmark name	Left / Right	Order number	Part number	Part index	Traceability number	Material thickness
DOOR CAISSON AV G/D	Left		801113835R	H V1 1		0.65 mm

Defect code	Defect name	Defect area	IOD		1		2		3		ATLO	
			Severity	Retouch	Severity	Retouch	Severity	Retouch	Severity	Retouch	Severity	Retouch
			Verdict	min	Verdict	min	Verdict	min	Verdict	min	Verdict	min
A1	volume deformation	volume	V3U	2	V3U	0.1	OK				OK	
A2	deformed radius	radius	V3U	1	V3U	0.5	V3U	0.3			V3U	0.3
A3	degree	perforation	V3U	0.1	V3U	0.1	V3U	0.1			V3U	0.1
A4	deformed radius	radius	V3U	0.2	V3U	0.2	V3U	0.2			V3U	0.2
A5	flatten	volume	V3U	0.2	OK		V3U	0.2			V3U	0.2
A6	degree	perforation contour	V3U	0.2	V3U	0.2	V3U	0.2			V2	0.2
A7	degree	cutting contour	V3U	0.5	V3U	0.5	V3U	0.5			V3U	0.5
A8	degree	perforation	V3U	0.2	V3U	0.1	OK				OK	
A9	degree	perforation	V3U	0.1	V3U	0.1	V3U	0.1			V3U	0.1
A10	degree	perforation	V2	0.1	V2	0.2	V2	0.2			V2	0.2
A11	volume deformation	volume	V3U	0.2	V3U	0.2	V3U	0.2			V3U	0.2
A12	degree	cutting contour	V3U	0.1	V3U	0.1	V3U	0.3			V3U	0.2
A13	traceability	lack	V1	0.1	OK		OK				V1	0.1
A14	part number	lack	V1	0.1	OK		OK				V1	0.1
A15	logo	lack	V1	0.1	OK		OK				V1	0.1
		Retouched minutes (partial)	5.2		2.3		2.3		0.0		2.5	
		Retouched minutes (total)	11.2		5.9		7.4		0.0		7.9	

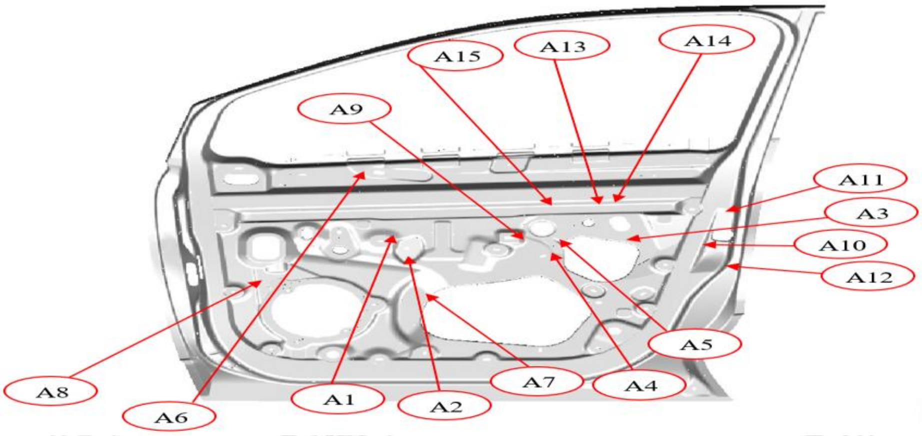

Fig. 2 Exterior defects left door caisson I

Table 3. Exterior defects left door caisson II

Form code:			Material used: **DX54D+Z140**			
Landmark name	Left / Right	Order number	Part number	Part index	Traceability number	Material thickness
DOOR CAISSON AV G/D	Left		801113835R	H V1 1		0.65 mm

Defect code	Defect name	Defect area	IOD		1		2		3		ATLO	
			Severity Verdict	Retouch min	Severity Verdict	Retouch min	Severity Verdict	Retouch min	Severity Verdict	Retouch min	Severity Verdict	Retouch min
A16	degree	perforation	V3U	0.3	V2	0.1	V2	0.3			V3U	0.2
A17	degree	perforation	V3U	0.1	V3U	0.1	V3U	0.1			V3U	0.1
A18	degree	perforation	V3U	0.5	V2	0.1	V3U	0.5			V3U	0.5
A19	degree	perforation	V3U	0.2	V2	0.2	V3U	0.2			V3U	0.2
A20	degree	cutting contour	V3U	0.1	V3U	0.3	V3U	0.3			V3U	0.5
A21	degree	perforation	V3U	0.2	V2	0.2	V2	0.2			V2	0.2
A22	deformation	volume	V3U	0.2	V3U	0.2	OK				OK	
A23	degree	window contour	V3U	0.1	V3U	0.1	V3U	0.1			V3U	0.1
A24	degree	window contour	V3U	0.1	OK		OK				OK	
A25	degree	cutting contour	V3U	0.1	V3U	0.1	V2	0.1			V3U	0.1
A26	degree	cutting contour	V3U	0.1	OK		OK				V3U	0.1
A27	crease	volume	V2	0.2	V3U	0.1	V3U	0.1			V3U	0.2
A28	degree	perforation	V3U	0.3	V2	0.3	V2	0.5			V3U	0.3
A29	degree	perforation	V3U	0.1	V3U	0.1	V3U	0.1			V3U	0.1
A30	waves	volume	V3U	0.2	V3U	0.1	V3U	0.1			V3U	0.1
		Retouched minutes (partial)	2.8		2.0		2.6		0.0		2.7	
		Retouched minutes (total)	11.2		5.9		7.4		0.0		7.9	

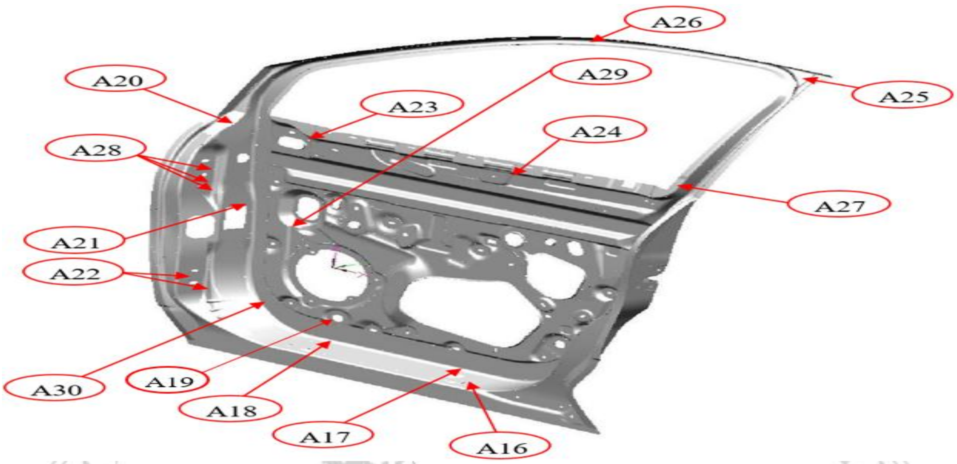

Fig. 3 Exterior defects left door caisson II

Table 4. Exterior defects left door caisson III

	Form code:		Material used: **DX54D+Z140**			
Landmark name	Left / Right	Order number	Part number	Part index	Traceability number	Material thickness
DOOR CAISSON AV G/D	Left		801113835R	H V1 1		0.65 mm

Defect code	Defect name	Defect area	IOD		1		2		3		ATLO	
			Severity Verdict	Retouch min	Severity Verdict	Retouch min	Severity Verdict	Retouch min	Severity Verdict	Retouch min	Severity Verdict	Retouch min
A31	impact	ambutures volume	V3U	0.4	OK		OK				V3U	0.2
A32	degree	perforation	V3U	0.2	V3U	0.2	V3U	0.5			V3U	0.5
A33	waves	volume	V3U	2	V3U	0.2	OK				OK	
A34	waves	volume	V3U	0.2	OK		OK				V3U	0.2
A35	waves	volume	V3U	0.2	OK		OK				OK	
A36	waves	volume	V3U	0.2	V3U	0.2	OK				OK	
A37	degree	window contour			V2	0.1	V2	0.1			OK	
A38	degree	perforation			V3U	0.1	V3U	0.1			V3U	0.1
A39	degree	perforation			V3U	0.1	OK				V3U	0.1
A40	degree	cutting contour			V3U	0.1	V3U	0.1			V3U	0.1
A41	degree	cutting contour			V3U	0.2	V3U	0.2			V3U	0.1
A42	degree	perforation			V2	0.1	V2	0.2			V3U	0.2
A43	degree	perforation			V3U	0.1	OK				V3U	0.2
A44	flatten	volume			V3U	0.2	V3U	0.5			V3U	0.2
A45	degree	perforation					V3U	0.1			V3U	0.1
		Retouched minutes (partial)	3.2		1.6		1.8		0.0		2.0	
		Retouched minutes (total)	11.2		5.9		7.4		0.0		7.9	

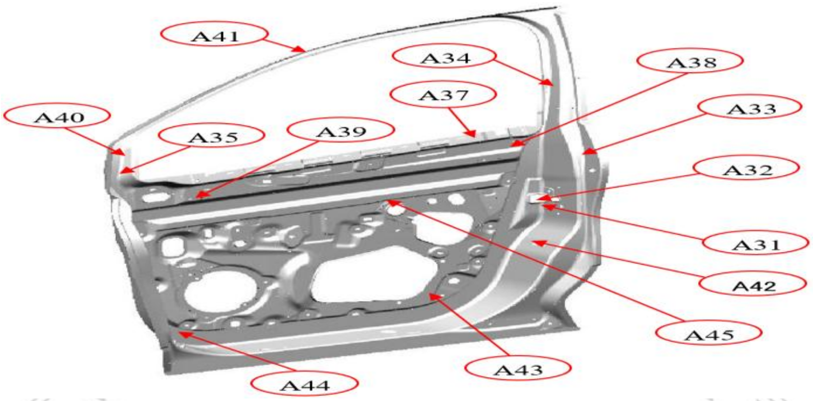

Fig. 4 Exterior defects left door caisson III

Currently, computer simulation of industrial processes is widely used because this results in very large savings when designing products and processes. This is due to the elimination of routine operations that consume a lot of time and human resources. The use of Computer Aide Design -CAD (design), Computer Aided Engineering - CAE (constructive analysis) and Computer Aided Manufacturing - CAM (simulation of industrial processes and manufacturing of SDVs) is no longer a novelty, all being approached uniformly in PDM Product Data Management [5].

Even human error in performing simulations is estimated at 3% in performing an accurate 97% simulation [6] .

For applications such as: stamping, casting, forging welding and heat treatment, virtual prototypes are built, analyzed and simulated on PC. For stamping, PAM-Stamp is generally used, which is a complete and integrated solution for stamping, taking into account all aspects: characteristics of the machine (mechanical / hydraulic press with single / double / triple action); mold characteristics, semi-finished product characteristics).

In the 3D laboratory available to SC Matrițe Dacia, measurements were made in order to establish the repeatability of the defects. For this, 5 pieces are considered marked from 1 to 5, the thickness of the material being 0.65 mm, for which measurements are made in 73 points for each piece [7].

The experimental measurements were performed with so-called 3D measuring machines MT2, the data were transferred to the GEOM program (Fig.5) [11]. The document presented below is called the Green Sheet and expresses the indicators regarding the evolution of the dimensional accuracy of the parts. The measurements are made, after which the following are studied: The average for the 5 pieces (which must be less than twice the tolerance range), the dispersion, the deviation, the lower and upper tolerances.

Fig. 5 3D measuring machine – for stamped parts

Deep drawing machines are crucial to the productive process and their availability needs to be increased [1].

In order to establish the areas on the part where corrections must be made on the geometric tool, scans of the parts are performed, which are then analyzed in detail (Fig. 6...10).

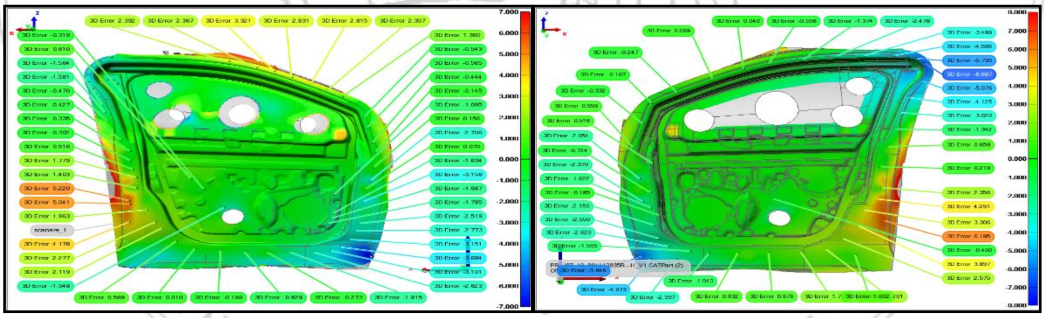

Fig. 6 Analysis of surfaces scanned by operation: right / left front door caisson – OP 10

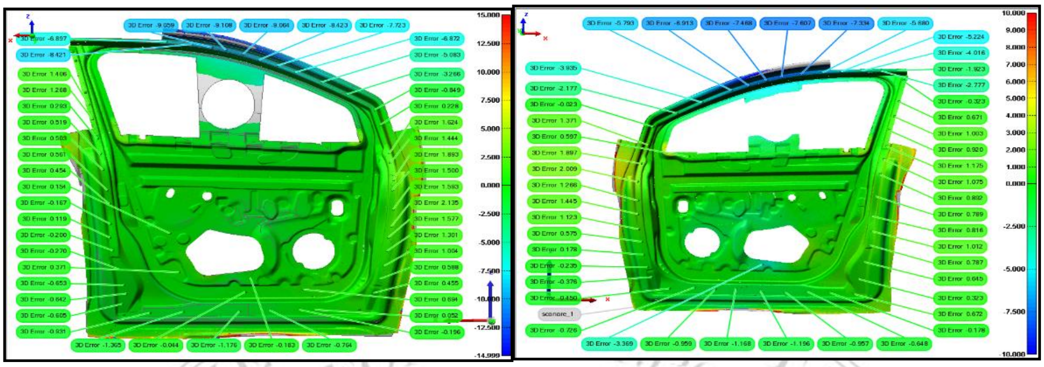

Fig. 7 Analysis of surfaces scanned by operation: right / left front door caisson – OP 20

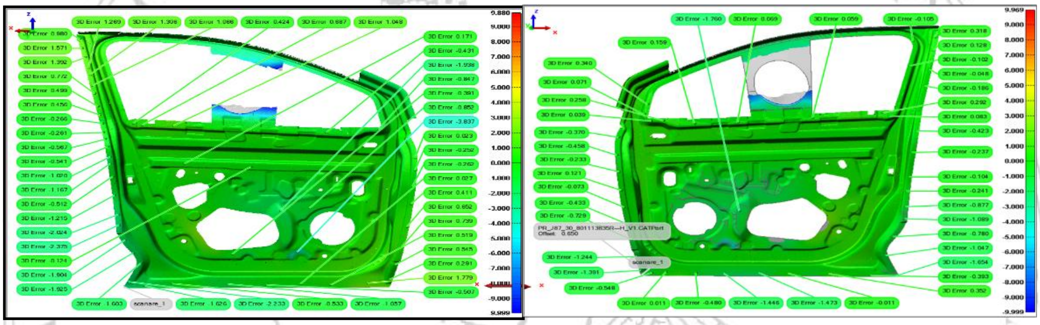

Fig. 8 Analysis of surfaces scanned by operation: right / left front door caisson – OP 30

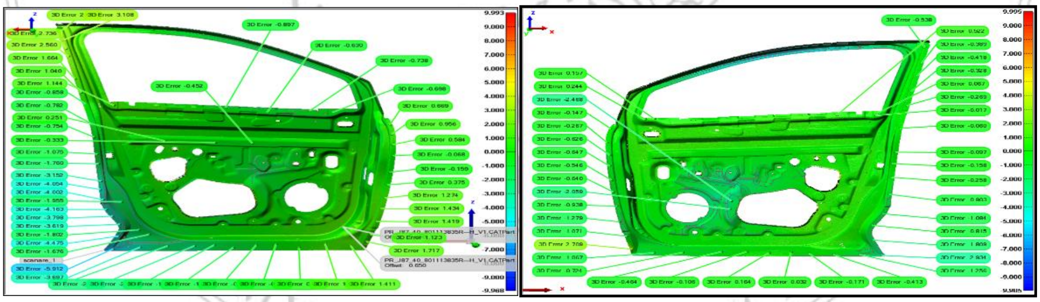

Fig. 9 Analysis of surfaces scanned by operation: right / left front door caisson – OP 40

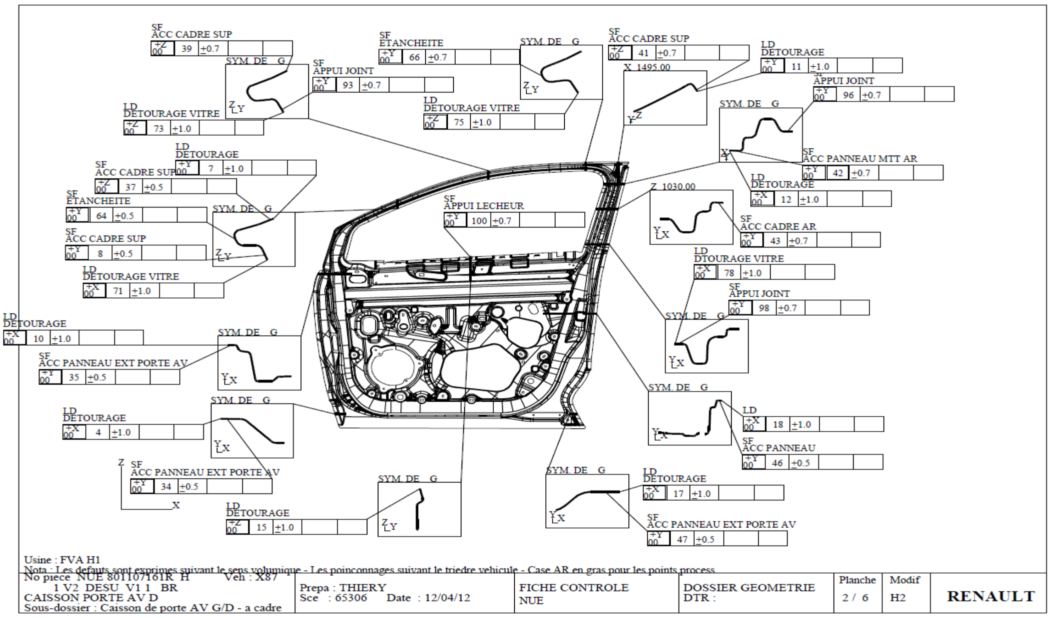

Fig. 10. Control sheet for right door caisson

RENAULT	TNC OBJECTIF	CALCUL	INDICATEURS D'AVANCEMENT DE LA GEOMETRIE DES PIECES NUES *Evolution of single part dimensional accuracy*
	0.27		
Version 2.3			

POURCENTAGE D'ACCEPTATION PTS SERIE		OBJECTIFS *Targets*
Mesurées	100%	100%
Moy. < 2IT	86%	100%
Disp.OK	100%	100%
Moy. OK	65%	95%
Aptitude	65%	90%

Moy . <2IT | Moy.OK Apt | Moy . <2IT — Ti-IT/2, Ti, Ts, Ts+IT/2

Dispersion — Disp.OK — Ti, Ts

Jalon / *Trial Time*	ATLO / *DIES SHIPPING*		
Désignation / *Part Name*	CAISSON PORTE AV D		
N° Pièce / *Part N°*	801107161R	Traçabilité / *Traceability*	X 32 H
Ind. DGéo/ *Change Level Dgeo*	H02	Date / *Date*	
Nb de cotes / *Total Points*	73	Véhicule / *Vehicle*	X87
Matière / *Material*	DX54D+Z140-M-B-(	Epaisseur / *Thickness*	0.65

Moyenne *Average*	Etendue *Range*	Ecart type *σ*	Ecart type Limite *σ limit*	Mesurées	Moy. < 2IT	Disp.OK	MoyOK	Aptitude	Commentaire *Comment*	Classe	Point n° *Pt N°*	T_i *LSL*	T_s *USL*	Pièce n°1 *Part N°1*	Pièce n°2 *Part N°2*	Pièce n°3 *Part N°3*	Pièce n°4 *Part N°4*	Pièce n°5 *Part N°5*	Type de cote *Type quotation*
0.03	0.05	0.02	0.53						V.G DETOURAGE	3	4	-1	1	0.006	0.06	0.046	0.014	0.025	SERIE
-1.15	0.29	0.11	0.53						V.G DETOURAGE	3	7	-1	1	-1.202	-1.318	-1.028	-1.126	-1.085	SERIE
-0.59	0.30	0.11	0.26						V.G ACC CADRE SUP	3	8	-0.5	0.5	-0.616	-0.749	-0.452	-0.603	-0.545	SERIE
-0.92	0.03	0.01	0.53						V.G DETOURAGE	3	10	-1	1	-0.93	-0.934	-0.931	-0.902	-0.918	SERIE
3.12	0.65	0.26	0.53						V.G DETOURAGE	3	11	-1	1	3.252	3.007	3.514	2.867	2.977	SERIE
-0.95	0.04	0.01	0.53						V.G DETOURAGE	3	12	-1	1	-0.962	-0.926	-0.948	-0.951	-0.957	SERIE
-0.15	0.08	0.03	0.37						V.G ACC RFT ARTICULATION	3	13	-0.7	0.7	-0.207	-0.137	-0.14	-0.131	-0.141	SERIE
-0.50	0.05	0.02	0.53						V.G DETOURAGE	3	15	-1	1	-0.523	-0.51	-0.496	-0.472	-0.483	SERIE
0.15	0.09	0.03	0.53						V.G DETOURAGE	3	17	-1	1	0.154	0.143	0.094	0.164	0.183	SERIE
-0.92	0.10	0.04	0.53						V.G	3	18	-1	1	-0.936	-0.949	-0.855	-0.906	-0.958	SERIE
-0.88	0.08	0.03	0.53						V.G DETOURAGE	3	19	-1	1	-0.889	-0.877	-0.923	-0.853	-0.839	SERIE
-0.61	0.44	0.16	0.79						V.G ANALYSE VRILLAGE	3	24	-1.5	1.5	-0.619	-0.818	-0.38	-0.657	-0.58	SERIE
2.26	0.34	0.13	0.79						V.G ANALYSE VRILLAGE	3	25	-1.5	1.5	2.338	2.087	2.43	2.179	2.285	SERIE
-0.35	0.08	0.03	0.37						V.G	3	26	-0.7	0.7	-0.39	-0.313	-0.338	-0.335	-0.366	SERIE
-0.19	0.06	0.02	0.37						V.G	3	27	-0.7	0.7	-0.212	-0.187	-0.215	-0.185	-0.16	SERIE
-0.62	0.07	0.03	0.37						V.G	3	28	-0.7	0.7	-0.594	-0.624	-0.589	-0.636	-0.659	SERIE
-1.01	0.10	0.04	0.26						V.G ACC PANNEAU EXT PORTE /	3	34	-0.5	0.5	-0.957	-1.058	-0.983	-1.015	-1.028	SERIE
0.75	0.19	0.08	0.26						V.G ACC PANNEAU EXT PORTE /	3	35	-0.5	0.5	0.778	0.776	0.861	0.669	0.686	SERIE
-0.77	0.32	0.14	0.26						V.G ACC CADRE SUP	3	37	-0.5	0.5	-0.819	-0.857	-0.934	-0.645	-0.616	SERIE
-1.21	0.28	0.13	0.37						V.G ACC CADRE SUP	3	39	-0.7	0.7	-1.303	-1.324	-1.288	-1.089	-1.04	SERIE
0.61	0.14	0.05	0.37						V.G ACC CADRE SUP	3	41	-0.7	0.7	0.624	0.615	0.677	0.534	0.595	SERIE
2.73	0.31	0.13	0.37						V.G ACC PANNEAU MTT AR	3	42	-0.7	0.7	2.825	2.553	2.862	2.656	2.77	SERIE
1.96	0.25	0.11	0.37						V.G ACC CADRE AR	3	43	-0.7	0.7	2.036	1.794	2.045	1.906	2.019	SERIE
0.15	0.11	0.04	0.26						V.G ACC PANNEAU PORTE	3	45	-0.5	0.5	0.137	0.154	0.113	0.12	0.218	SERIE
-0.11	0.36	0.15	0.26						V.G ACC PANNEAU	3	46	-0.5	0.5	-0.077	-0.01	-0.369	-0.111	-0.007	SERIE
-0.37	0.12	0.06	0.26						V.G ACC PANNEAU EXT PORTE /	3	47	-0.5	0.5	-0.362	-0.314	-0.431	-0.317	-0.433	SERIE
-0.57	0.27	0.10	0.26						V.G ETANCHEITE	3	64	-0.5	0.5	-0.622	-0.722	-0.45	-0.559	-0.514	SERIE
1.81	0.49	0.20	0.37						V.G ETANCHEITE	3	66	-0.7	0.7	1.868	1.632	2.125	1.654	1.762	SERIE
-0.23	0.21	0.09	0.53						V.G DETOURAGE VITRE	3	71	-1	1	-0.266	-0.272	-0.325	-0.153	-0.12	SERIE
0.57	0.27	0.13	0.53						V.G DETOURAGE VITRE	3	73	-1	1	0.488	0.465	0.486	0.687	0.739	SERIE
0.29	0.14	0.05	0.53						V.G DETOURAGE VITRE	3	75	-1	1	0.283	0.204	0.327	0.285	0.341	SERIE
-0.94	0.07	0.03	0.53						V.G DTOURAGE VITRE	3	78	-1	1	-0.944	-0.94	-0.927	-0.972	-0.902	SERIE
-0.61	0.13	0.05	0.37						V.G APPUI JOINT	3	93	-0.7	0.7	-0.624	-0.633	-0.539	-0.667	-0.586	SERIE
1.90	0.37	0.15	0.37						V.G APPUI JOINT	3	96	-0.7	0.7	1.971	1.746	2.111	1.783	1.895	SERIE
0.59	0.13	0.05	0.37						V.G APPUI JOINT	3	98	-0.7	0.7	0.622	0.533	0.602	0.553	0.658	SERIE
-0.47	0.27	0.11	0.37						V.G APPUI LECHEUR	3	100	-0.7	0.7	-0.452	-0.336	-0.398	-0.61	-0.555	SERIE
0.50	0.05	0.02	0.26						V.G APPUI CHARNIERE	3	110	-0.5	0.5	0.523	0.472	0.488	0.519	0.522	SERIE
0.46	0.02	0.01	0.26						V.G APPUI CHARNIERE SUP	3	111	-0.5	0.5	0.448	0.463	0.451	0.465	0.453	SERIE
0.06	0.04	0.01	0.26						X SYM. DE	3	113	-0.5	0.5	0.056	0.057	0.086	0.048	0.066	SERIE
-0.21	0.07	0.03	0.26						Z SYM. DE	3	121	-0.5	0.5	-0.245	-0.218	-0.172	-0.204	-0.212	SERIE
0.84	0.11	0.04	0.26						Y SYM. DE	3	122	-0.5	0.5	0.836	0.808	0.815	0.813	0.913	SERIE
-0.05	0.05	0.02	0.26						Z SYM. DE	3	122	-0.5	0.5	-0.069	-0.033	-0.024	-0.069	-0.068	SERIE
-0.38	0.16	0.06	0.26						V.G APPUI RAIL LEVE VITRE	3	125	-0.5	0.5	-0.463	-0.352	-0.428	-0.306	-0.369	SERIE
-0.01	0.09	0.03	0.53						V.G DETOURAGE	3	1	-1	1	0.008	-0.06	0.025	-0.025	-0.005	ANALYSE
0.49	0.06	0.02	0.53						V.G DETOURAGE	3	2	-1	1	0.53	0.482	0.494	0.475	0.485	ANALYSE
-0.41	0.11	0.04	0.53						V.G DETOURAGE	3	3	-1	1	-0.369	-0.402	-0.479	-0.398	-0.396	ANALYSE
-0.75	0.07	0.03	0.53						V.G DETOURAGE	3	5	-1	1	-0.757	-0.75	-0.785	-0.711	-0.733	ANALYSE
0.93	0.16	0.06	0.53						V.G DETOURAGE	3	6	-1	1	0.947	0.995	0.835	0.944	0.928	ANALYSE
-1.41	0.36	0.15	0.53						V.G DETOURAGE	3	9	-1	1	-1.531	-1.612	-1.252	-1.374	-1.292	ANALYSE
-0.27	0.16	0.07	0.53						V.G DETOURAGE	3	14	-1	1	-0.342	-0.249	-0.325	-0.223	-0.186	ANALYSE
-1.75	0.52	0.24	0.26						V.G ACC PANNEAU EXT PORTE /	3	31	-0.5	0.5	-1.472	-1.554	-1.756	-1.995	-1.967	ANALYSE
-1.51	0.19	0.08	0.26						V.G ACC PANNEAU EXT PORTE /	3	33	-0.5	0.5	-1.502	-1.455	-1.413	-1.601	-1.587	ANALYSE
0.78	0.05	0.02	0.26						V.G ACC RFT ARTICULATION	3	36	-0.5	0.5	0.75	0.796	0.77	0.783	0.802	ANALYSE
-0.63	0.21	0.08	0.37						V.G ACC CADRE SUP	3	40	-0.7	0.7	-0.654	-0.738	-0.609	-0.601	-0.533	ANALYSE
1.22	0.26	0.11	0.37						V.G ACC CADRE AR	3	44	-0.7	0.7	1.317	1.133	1.347	1.083	1.219	ANALYSE
0.10	0.08	0.03	0.26						V.G ETANCHEITE	3	62	-0.5	0.5	0.069	0.095	0.147	0.098	0.103	ANALYSE
0.39	0.03	0.01	0.26						V.G ETANCHEITE	3	63	-0.5	0.5	0.369	0.392	0.401	0.387	0.383	ANALYSE
-0.82	0.34	0.14	0.37						V.G ETANCHEITE	3	65	-0.7	0.7	-0.899	-1.002	-0.658	-0.792	-0.726	ANALYSE
1.83	0.25	0.11	0.37						V.G ETANCHEITE	3	67	-0.7	0.7	1.87	1.711	1.959	1.71	1.875	ANALYSE
0.06	0.08	0.03	0.26						V.G ETANCHEITE	3	68	-0.5	0.5	0.046	0.065	0.064	0.023	0.104	ANALYSE
0.22	0.32	0.15	0.26						V.G AFFL PORTE AR	3	70	-0.5	0.5	0.355	0.277	0.357	0.036	0.073	ANALYSE
-0.11	0.18	0.07	0.53						V.G DETOURAGE VITRE	3	74	-1	1	-0.133	-0.201	-0.112	-0.078	-0.021	ANALYSE
-0.77	0.17	0.07	0.53						V.G DETOURAGE VITRE	3	76	-1	1	-0.686	-0.776	-0.7	-0.825	-0.853	ANALYSE
-0.19	0.15	0.07	0.53						V.G DETOURAGE VITRE	3	77	-1	1	-0.125	-0.184	-0.131	-0.238	-0.279	ANALYSE
-0.42	0.08	0.03	0.53						V.G DETOURAGE VITRE	3	79	-1	1	-0.462	-0.383	-0.412	-0.4	-0.432	ANALYSE
-0.37	0.07	0.03	0.53						V.G DETOURAGE VITRE	3	81	-1	1	-0.398	-0.345	-0.332	-0.372	-0.378	ANALYSE
1.20	0.36	0.14	0.37						V.G ACC CADRE SUP	3	94	-0.7	0.7	1.203	1.053	1.409	1.094	1.222	ANALYSE
2.24	0.24	0.10	0.37						V.G ACC CADRE SUP	3	95	-0.7	0.7	2.362	2.122	2.24	2.161	2.329	ANALYSE
1.19	0.16	0.08	0.37						V.G ACC CADRE AR	3	97	-0.7	0.7	1.244	1.112	1.24	1.109	1.266	ANALYSE
0.22	0.29	0.11	0.37						V.G APPUI LECHEUR	3	99	-0.7	0.7	0.061	0.22	0.353	0.181	0.288	ANALYSE
-0.23	0.44	0.22	0.37						V.G APPUI LECHEUR	3	101	-0.7	0.7	-0.111	-0.072	-0.042	-0.479	-0.464	ANALYSE
0.22	0.04	0.01	0.26						V.G APPUI SERRURE	3	112	-0.5	0.5	0.213	0.216	0.246	0.22	0.21	ANALYSE
-0.15	0.09	0.03	0.26						Z SYM. DE	3	120	-0.5	0.5	-0.204	-0.146	-0.118	-0.146	-0.146	ANALYSE

Fig. 11. Obtained results – piece T01

For example, point 4 is considered, at perforation, for the 5 pieces (-0.258, -0.251, -0.317, -0.16, -0.235), the average in this case being zero. The tolerance field is 0.12mm, the effective deviation is 0.06mm, the limit deviation is 0.53mm, Ti = -1, Ts = 1, the dimensioning type will be in series (Fig. 11).

Errors were found in the following points:

7,8,9,11,12,24,25,31,33,37,39,40,41,42,43,44,46,47,64,65,67,70,73,76,93, 94,95,96,99,100,101 and 121.

The points:

4,8,10,11,12,15,17,18,34,35,37,39,41,42,43,46,47,64,66,71,73,75,78,93,96,98 are described in the Control Sheet presented above, for each point specifying the axis of the measuring surface, the point, the tolerance, in the next two boxes the average (obtained from the measurements on 5 pieces) and the tolerance field will be entered.

It was observed that the points considered in this case and which are of interest are the tightness, the perforation of the area for making the glass, the outer panel of the door, and the upper frame of the door.

CONCLUSIONS

1. For caissons the main types of defects that occur are:
- volume deformations - which appear in the volume of the piece on certain areas (flattening, waves, impact, buckling, crease)
- contour deformations - which occur at the outer contour of the part (radius deformations, degree, scratches that occur in processes such as perforation, cutting contour.

2. In order to eliminate the defects, the stamped surfaces are scanned and analyzed on the operation: stamping, trimming, perforation, calibration in order to locate the errors and establish the areas on the part for which corrections must be made on the geometric tool.

3. The Green Sheet is drawn up, making sure that at each milestone the geometry of the piece is improved compared to the previous targets. The IOD parameter is taken into account, respectively the first part milestone obtained on the tools.

4. The process must be repeated during the course of the industrial process so as to ensure defect-free stamping by a controlled process.

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