

# OPTIMIZATION - SIX SIGMA OUTPUT MAXIMIZATION

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## ABSTRACT

*Maruti Suzuki India Limited (MSIL) is India's largest carmaker by both sales and production volume. It would make a fascinating case to look into upon the state of production of such a massive operation. As part of this research, we will observe and study multiple facets of the production cycle at MSIL exploring each level to ensure we have a thorough study of the process of what goes into making a myriad of components into a car.*

**Keywords:** YL8, YBA, YAD, YN4, Weld Spots, Shop to Line Times

## 1. INTRODUCTION

### Check for Weld Spots for Ertiga, S-Cross, Dzire Tour

The purpose of this task as the title suggests is to observe no. of weld spots applied to the **Front Under Body** of the respective models. The spot-welding line has 16 robots, 8 on each side.

The models assigned were given according to their factory designations. They're market names are –

YL8 – Ertiga

YAD – S-Cross

YN4 – Dzire Tour

Out of all the models being manufactured at the facility, the YN4 is the only model that has more manual work required while assembling compared to the other models.

*Checks for weld spots on Ertiga, Dzire Tour & S-Cross Front Upper Body (i)*

Robot → Followed by no. of spots	202D	606J	207L	603M	602Q	209S
<b>Ertiga</b>	27	24	26	15	32	19
<b>Dzire Tour</b>	19	27	31	19	22	6
<b>S-Cross</b>	23	24	22	18	5	21

*Checks for weld spots on Ertiga, Dzire Tour & S-Cross Front Upper Body (ii)*

Robot →	203B	205F	401T	403W	403AG	405Y	404J	406Q
<b>YL8</b>	3 Spots	12 Spots	6 Spots	8 Spots	17 Spots	17 Spots	25 Spots	33 Spots
<b>YN4</b>	NA	NA	16 Spots	9 Spots	16 Spots	17 Spots	27 Spots	20 Spots
<b>YAD</b>	4 Spots	11 Spots	16 Spots	2 Spots	14 Spots	20 Spots	24 Spots	7 Spots

Robot → Followed by no. of spots	603C	204E	606I	207G	609B	408V	601BT	206G
<b>Ertiga</b>	7	20	26	24	19	33	18	8
<b>DzireTour</b>	4	20	27	26	9	Not Applicable	Not Applicable	6
<b>S-Cross</b>	9	24	25	23	19	14	Not Applicable	7

*Checks for weld spots on Ertiga, Dzire Tour & S-Cross Front Upper Body (iii)*

Robot -> Followed by no. of spots	505J	304N	504Y	302V
Ertiga	24	20	8	7
Dzire Tour	28	18	11	18
S-Cross	26	16	3	18

*Checks for weld spots on Ertiga, Dzire Tour & S-Cross Front Upper Body (iv)*

*Checks for weld spots on Ertiga, Dzire Tour & S-Cross Front Upper Body (v)*

Robot -> Followed by no. of Spots	406Z	407AB	407AD	407AE	406AA	404I
Ertiga	36 Spots	21 Spots	20 Spots	20 Spots	35 Spots	23 Spots
Dzire Tour	36 Spots	9 Spots	38 Spots	38 Spots	37 Spots	30 Spots
S-Cross	26 Spots	13 Spots	21 Spots	23 Spots	26 Spots	24 Spots

## 2. VITARA BREZZA SIDE BODY OUTLINE

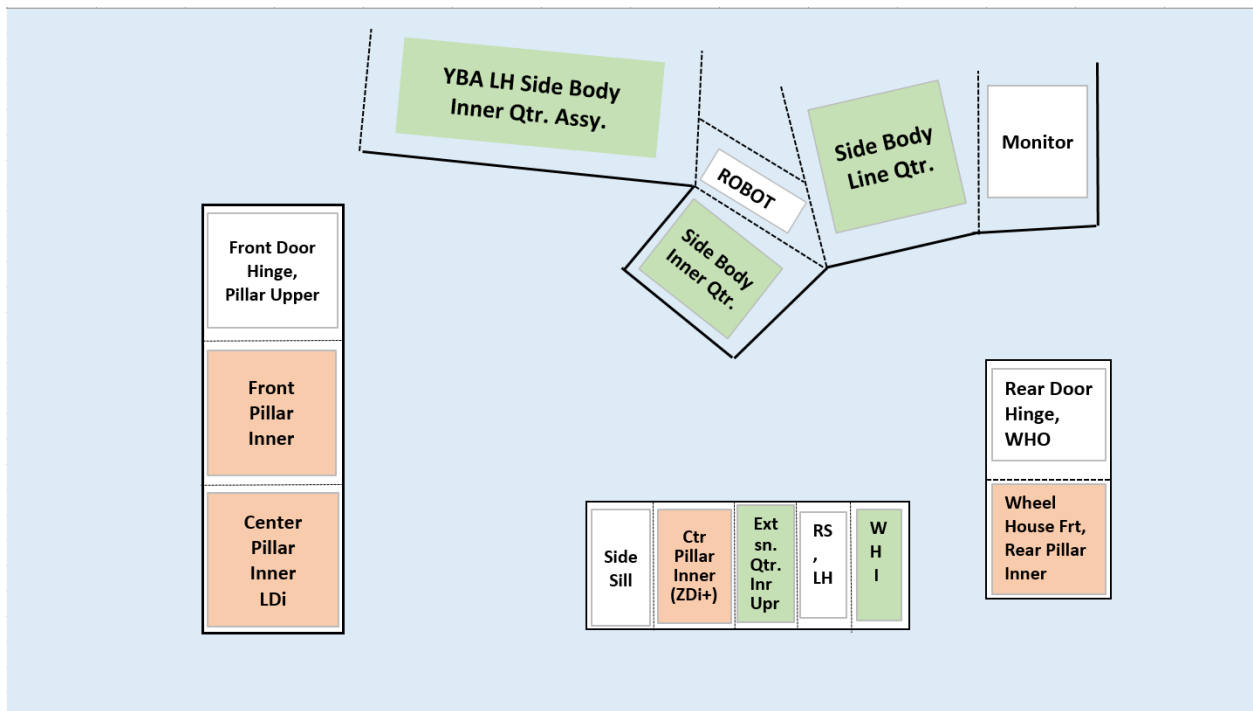
### Introduction:

The project assigned was to draw the “YBA Side Body Outline”. The YBA, known as the Vitara Brezza commercially is Maruti Suzuki’s latest vehicle in the market. Revealed at the Auto Expo 2016, the YBA has a compact SUV form made to take on the likes of Ford EcoSport, Renault Duster and Nissan Terrano. It has a 1.4 litre Diesel engine generating 84 BHP.

The Side Body line of the YBA has the issue of only one side being operated and welded upon at a given time. The other side remains unused as it is for the YRA (commercially known as the Ignis) whose launch would be in the second half of 2016.

The purpose of this project was to obtain an accurate outline of the Side Body line of the YBA including the locations of all the spares, tools and parts to be applied.

The method used here was simple. The Side Body line of the YBA was first observed and then a rough outline is drawn on paper which is then translated to Microsoft Excel. The Side Body line of the YBA consists of two part, the Right Hand side and the Left Hand side.



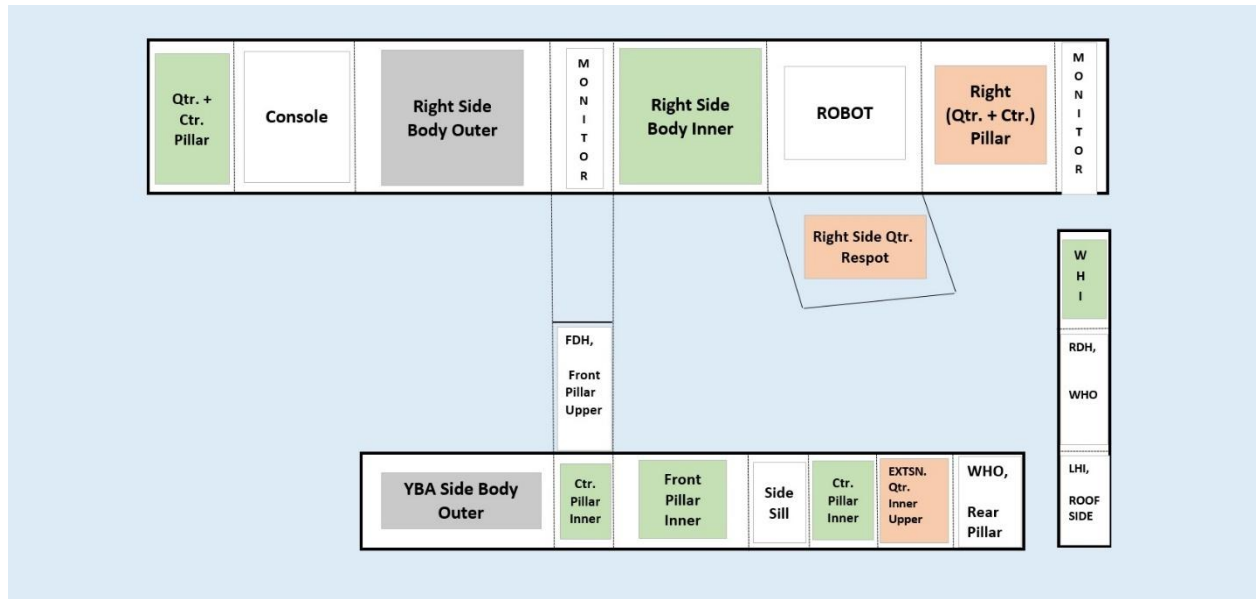
*Figure 3.1 YBA Left Side Body Outline*

Key -

- WHI - Wheel Housing Inner
- WHO - Wheel Housing Outer
- LH - Lamp Housing
- RS - Roof Side
- Extns. - Extension

**Quarter Component**

**Inner Component**



*Figure 3.2 YBA Right Side Body Outline*

Key –

WHI – Wheel Housing Inner

RDH - Rear Door Hinge

WHO - Wheel Housing Outer

FDH - Front Door Hinge

LHI - Lamp Housing Inner

**Quarter Component**

**Inner Component**

### 3. SHELF TO LINE TIMES FOR YBA SIDE BODY

#### Introduction:

This project was a continuation of 3.2 i.e. the YBA side body outline. The purpose of this project was to note down the time taken for the assembly staff member to take the part off the shelf and mount it on the line.

The approach for this was rather simple. The staff member on the line was observed and the time taken by him to get a part from the shelf to the line was observed and noted through means of a stop watch.

**Table 3.6 Vitara Brezza Shelf to Line times Left Side Body (i)**

Name of Part→	Rear Door Hinge	Wheel Housing Outer	Rear Pillar Inner	Wheel Housing Front	Wheel Housing Inner	Roof Side	Front Door Hinge	Front Pillar Upper
Time Taken	13 seconds	16 seconds	16 seconds	16 seconds	11 seconds	18 seconds	15 seconds	14 seconds

**Table 3.7 Vitara Brezza Shelf to Line times Left Side Body (ii)**

Name of Part→	Center Pillar (Z)	Side Sill	Ctr. Pillar (L)	Fr. Pillar Inr.
Time Taken	13 seconds	14 sec	12 sec	12 sec

**Table 3.8 Vitara Brezza Shelf to Line times for Right Side Body (i)**

Name of Part→	Wheel Housing Inner	Rear Door Hinge	Wheel Housing Outer	Lamp Housing Inner	Rear Pillar	Roof Side	Side Body Outer	Center Pillar
Time Taken	9 seconds	17 seconds	10 seconds	14 seconds	16 seconds	15 seconds	31 seconds	7 seconds

**Table 3.9 Vitara Brezza Shelf to Line times for Right Side Body (ii)**

Name of Part→	Front Pillar Inner	Side Sill	Front Door Hinge	Front Pillar Upper
Time Taken	27 seconds	28 seconds	20 seconds	14 seconds

#### 4. SHOP TO LINE TIMES FOR YBA, YE3, YL8 AND YAD

##### **Introduction:**

The purpose of this task was to observe the total time taken for a component of the body of a specific model to be transferred from storage area to the production line. The calculation includes time taken to load the part, time travelled (2x) back and forth from press shop to the production line and time taken to unload the component once arrived at the production line.

Every individual component that comes from the press shop is mounted on a pallet and then sent to storage and is retrieved as per requirement.

These components vary according to area of fitting, they may include –

- Doors – Inner and Outer, Left and Right.
- Side Body – Inner and outer, Left and Right
- Hood – Inner and Outer
- Back Door – Inner and Outer
- Roof
- Rear Floor
- Main Floor

These components may be of multiple kinds depending on variant of the vehicle. For e.g. VXi&ZXi have different door panels, back door panels, etc.

This project took a long time for completion as there were many chances of errors. The purpose of this project was to get a rough constant time that each part took to get from the press shop to the assembly line.

There were many parameters that could affect these times such as –

- Unavailability of part.
- Traffic at various points in path of travel.
- Staff incompetence or negligence.
- Wrong pallet loaded.

As a method of avoiding errors in the final report, the recorded timings for individual components were observed more than once to draw accurate conclusions.

### **Calculation**

Calculation for this part required 4 timings -

$$T = T1 + T2 + T3 + T4 \text{ (equation no. 3.1)}$$

Where,

T1 = Time taken to load

T2 = T3 = Time Travelled (back & forth)

T4 = Time taken to unload

In the final table presenting the times, T2 and T3 are represented by B and a single quantity is taken twice.

Depending on the no. of panels per pallet and total time taken, we could get a figure for how many trips would be required in total.

**Table 3.10 (i) Shop to Line times for YAD, YL8, YE3 & YBA**

Sl.No.	Model, Parts	Model	Panels/Pallet	Production volume/day	Working hours	No of trips/day	Pallet loading/ unloading (At press) A	Travel time (t) ( Press to WS2-3) B=(tX2)	Pallet loading/ unloading (At WS2-3) C	Total time/trip (A+B+C)
1	FDI R	YAD	60	110	16	2	00:35	00:50	00:25	01:50
2	FDO R	YAD	100	110	16	1	00:40	01:10	00:30	02:20
3	FDI L	YAD	60	110	16	2	00:20	00:55	00:25	01:40
4	FDO L	YAD	100	110	16	1	00:40	01:05	00:45	02:30
5	RDRI	YAD	60	110	16	2	01:25	00:50	00:45	03:00
6	RDRO	YAD	100	110	16	1	02:20	01:50	00:55	05:05
7	RDLI	YAD	60	110	16	2	01:25	00:50	00:45	03:00
8	RDLO	YAD	100	110	16	1	02:20	01:50	00:55	05:05
9	HOOD O	YAD	70	110	16	2	03:00	02:10	01:10	06:20
10	HOOD I	YAD	300	110	16	1	03:00	02:10	01:10	06:20
11	FENDER R	YAD	36	110	16	3	01:20	02:20	00:40	04:20
12	FENDER L	YAD	36	110	16	3	01:20	02:20	00:40	04:20
13	BDI	YAD	125	110	16	1	01:00	02:00	00:45	03:45
14	BDO	YAD	40	110	16	3	01:20	01:10	01:00	03:30
15	ROOF	YAD	36	110	16	3	01:30	01:10	01:25	04:05
16	SIDE R	YAD	27	110	16	4	00:40	00:35	00:25	01:40
17	SIDE L	YAD	27	110	16	4	00:40	00:35	00:25	01:40
18	Main Floor	YAD	250	110	16	0	01:15	02:30	01:10	04:55
19	RFR	YAD	60	110	16	2	01:25	02:40	01:15	05:20
20	HOOD I	YL8	500	270	16	0	01:45	01:35	00:55	04:15
21	HOOD O	YL8	70	270	16	3	02:00	01:10	00:40	03:50
22	BDI	YL8	125	270	16	2	01:50	02:00	00:50	04:40
23	BDO	YL8	40	270	16	6	01:50	02:00	00:50	04:40
24	FENDER R	YL8	34	270	16	7	01:20	03:15	01:10	05:45
25	FENDER L	YL8	34	270	16	7	01:20	03:15	01:10	05:45
26	FDRI	YL8	60	270	16	4	02:05	01:45	01:35	05:25
27	FDRO	YL8	100	270	16	3	02:15	01:25	01:30	05:10
28	FDLI	YL8	60	270	16	4	02:05	01:45	01:35	05:25
29	FDLO	YL8	100	270	16	3	02:15	01:25	01:30	05:10
30	RDRI	YL8	60	270	16	4	01:00	00:45	01:05	02:50
31	RDRO	YL8	100	270	16	3	01:25	00:40	01:15	03:20
32	RDLI	YL8	60	270	16	4	01:00	00:45	01:05	02:50
33	RDLO	YL8	100	270	16	3	01:25	00:40	01:15	03:20
34	Main Floor	YL8	200	270	16	1	02:00	01:00	01:00	04:00
35	RFR	YL8	100	270	16	3	02:00	01:00	01:00	04:00
36	Side R	YL8	27	270	16	10	02:40	00:55	00:35	04:10
37	Side L	YL8	27	270	16	10	02:40	00:55	00:35	04:10
38	ROOF	YL8	26	270	16	10	02:35	01:00	00:40	04:15



**Table 3.10 (ii) Shop to Line times for YAD, YL8, YE3 & YBA**

39	Cowl Top	YE3	NA	500	16		00:35	00:25	00:25	01:25
40	Roof	YE3	NA	500	16		00:20	00:20	00:15	00:55
41	HOOD I	YE3	450	500	16	1	00:45	00:40	00:35	02:00
42	HOOD O	YE3	100	500	16	5	00:45	00:40	00:35	02:00
43	FDRI	YE3	60	500	16	8	01:55	01:00	00:55	03:50
44	FDRO	YE3	100	500	16	5	02:00	00:50	01:05	03:55
45	FDLI	YE3	60	500	16	8	01:55	01:00	00:55	03:50
46	FDLO	YE3	100	500	16	5	02:00	00:50	01:05	03:55
47	RDRI	YE3	70	500	16	7	02:00	00:55	01:15	04:10
48	RDRO	YE3	100	500	16	5	01:55	01:10	02:00	05:05
49	RDLI	YE3	70	500	16	7	02:00	00:55	01:15	04:10
50	RDLO	YE3	100	500	16	5	01:55	01:10	02:00	05:05
51	FENDER R	YE3	NA	500	16		02:15	00:50	00:45	03:50
52	FENDER L	YE3	NA	500	16		02:15	00:50	00:45	03:50
53	BDO	YE3	45	500	16	11	02:25	01:30	01:25	05:20
54	BDI	YE3	120	500	16	4	02:25	01:30	01:25	05:20
55	Main Floor	YE3	80	500	16	6	00:55	01:20	00:25	02:40
56	Qtr Inner R	YE3	150	500	16	3	01:15	00:45	00:45	02:45
57	Qtr Inner L	YE3	150	500	16	3	01:15	00:45	00:45	02:45
58	RFR	YE3	80	500	16	6	01:00	01:10	00:50	03:00
59	HOOD I	YBA		450	16		03:50	02:10	01:10	07:10
60	HOOD O	YBA		450	16		03:50	02:10	01:10	07:10
61	FDRI	YBA		450	16		02:35	01:20	01:00	04:55
62	FDRO	YBA		450	16		03:20	01:30	01:00	06:00
63	FDLI	YBA		450	16		02:35	01:20	01:00	04:55
64	FDLO	YBA		450	16		03:20	01:30	01:00	06:00
65	RDRI	YBA		450	16		02:00	02:00	00:55	05:00
66	RDRO	YBA		450	16		02:30	01:30	01:00	05:00
67	RDLI	YBA		450	16		02:00	02:00	00:55	04:45
68	RDLO	YBA		450	16		02:30	01:30	01:00	04:45
69	BDO	YBA		450	16		01:50	03:00	01:30	06:20
70	BDI	YBA		450	16		01:50	03:00	01:30	06:20
71	RFR	YBA		450	16		02:05	01:20	01:45	05:10
72	Fender R	YBA		450	16		01:00	01:00	01:00	03:00
73	Fender L	YBA		450	16		01:00	01:00	01:00	03:00

## 5. CONCLUSION AND FUTURE SCOPE

### Conclusion

This research helped me in every way in overall development of my technical as well as theoretical skills. I came to know about the very precise details of Suzuki models. I had a real exposure working with the company.

- This training period increased my skills in field of using productivity as the biggest motivation for completing a task in time i.e. getting a vehicle made in time so the company can meet the market demand.
- It taught me some basics on data collection, data processing and setting up research projects.
- It made me flexible and let me see things and think from different point of view
- Use of skills and knowledge gained in the university
- It was a learning experience for me in the professional environment
- The internship was also good to find out what my strengths and weakness are.

### **Future Scope**

I gained sufficient knowledge for figuring out how productivity can be improved in a company. In the coming years, MSIL faces a great challenge in the form of high demand of new vehicle launches. It'll need to ramp up its production accordingly. With improved staff management and an adoption of higher amount of automation in the production line will greatly improve their work quality, efficiency and what matters the most of all – Customer Satisfaction.