Automobile Sector

ISE 514 – Advanced Production Planning and Scheduling

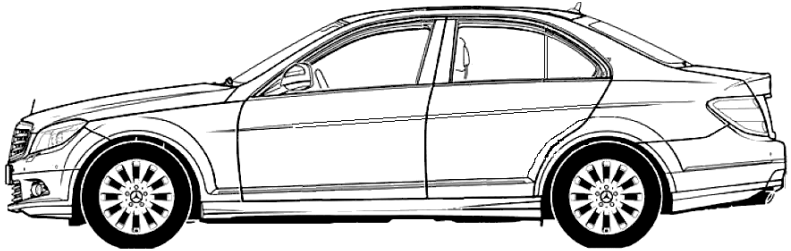
Professor: Dr. Shalini Gupta

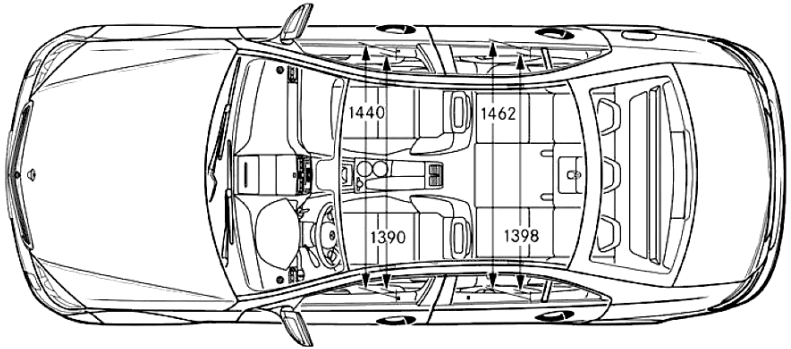
Done by

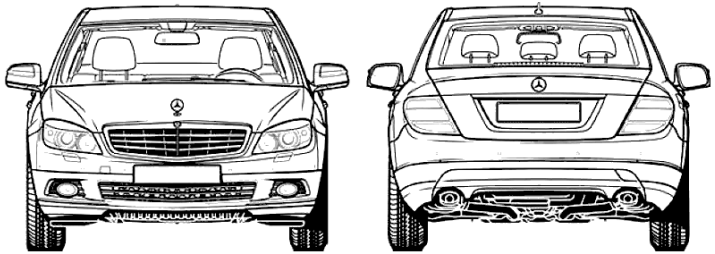
Avishek Banerji

Introduction

- Leading German car manufacturer company and is well known for its innovative, high powered and luxurious vehicles, trucks, vans and buses.
- Today, Mercedes is present in 93 locations around the world
- The iconic logo signifies that Mercedes is present in the land, air and water
- Headquartered in Germany but also manufactured in United States, France, Romania, China and South Africa.







93

Locations worldwide

172,425

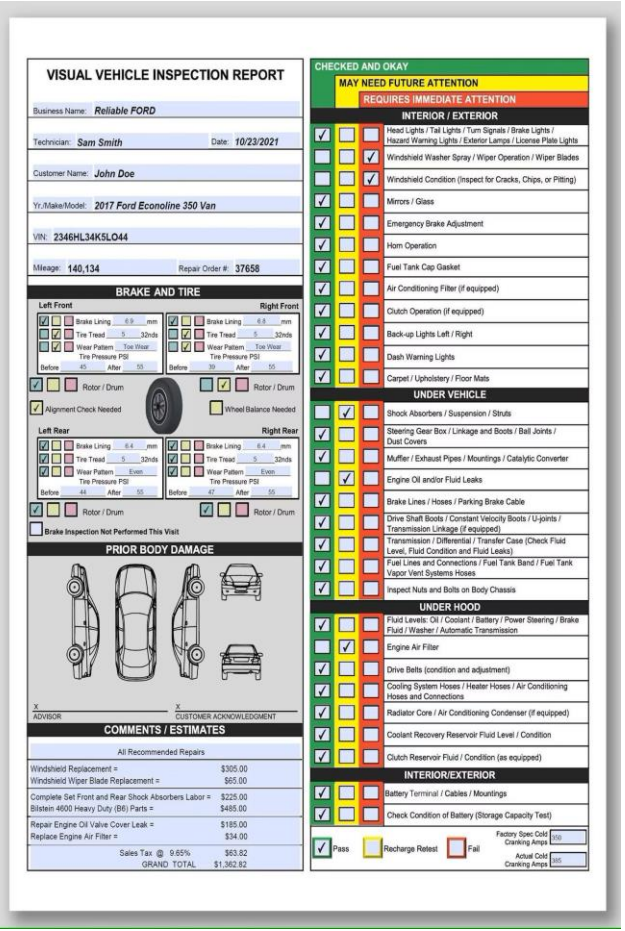
Employees in Mercedes Benz Worldwide

~3%

Market share worldwide

Background

- Mercedes was invented by Carl Benz in 1886. It made its start with a petrol powered vehicle that had only 3 wheels and was called the “Motorwagen”. At the time the company was named Benz & Co.
- Later in 1926, Carl Benz, Gottlieb Daimler, Wilhelm Maybach and Emil Jellinek merged together to form – Mercedes Benz, after Emil Jellinek’s daughter whose name was Mercedes.
- This was the first work that was patented in the company. Today, Mercedes Benz has a total of 30090 patents globally.



VISUAL VEHICLE INSPECTION REPORT

Business Name: Reliable FORD

Technician: Sam Smith Date: 10/23/2021

Customer Name: John Doe

Yr./Make/Model: 2017 Ford Econoline 350 Van

VIN: 2346HL34K5LO44

Mileage: 140,134 Repair Order #: 37658

BRAKE AND TIRE

Left Front | Right Front

Brake Lining 6.9 mm | Brake Lining 6.8 mm
Tire Tread 5 32nds | Tire Tread 5 32nds
Wear Pattern Toe Wear | Wear Pattern Toe Wear
Tire Pressure PSI
Before 45 After 55 | Before 39 After 55

Rotor / Drum | Rotor / Drum
Alignment Check Needed | Wheel Balance Needed

Left Rear | Right Rear

Brake Lining 6.4 mm | Brake Lining 6.4 mm
Tire Tread 5 32nds | Tire Tread 5 32nds
Wear Pattern Even | Wear Pattern Even
Tire Pressure PSI
Before 44 After 55 | Before 47 After 55

Rotor / Drum | Rotor / Drum

Brake Inspection Not Performed This Visit

PRIOR BODY DAMAGE

X ADVISOR X CUSTOMER ACKNOWLEDGMENT

COMMENTS / ESTIMATES

All Recommended Repairs

Windshield Replacement =	$305.00
Windshield Wiper Blade Replacement =	$65.00
Complete Set Front and Rear Shock Absorbers Labor =	$225.00
Bilstein 4600 Heavy Duty (B6) Parts =	$485.00
Repair Engine Oil Valve Cover Leak =	$185.00
Replace Engine Air Filter =	$34.00
Sales Tax @ 9.65%	$63.82
GRAND TOTAL	$1,362.82

CHECKED AND OKAY
MAY NEED FUTURE ATTENTION
REQUIRES IMMEDIATE ATTENTION

INTERIOR / EXTERIOR
- Head Lights / Tail Lights / Turn Signals / Brake Lights / Hazard Warning Lights / Exterior Lamps / License Plate Lights
- Windshield Washer Spray / Wiper Operation / Wiper Blades
- Windshield Condition (Inspect for Cracks, Chips, or Pitting)
- Mirrors / Glass
- Emergency Brake Adjustment
- Horn Operation
- Fuel Tank Cap Gasket
- Air Conditioning Filter (if equipped)
- Clutch Operation (if equipped)
- Back-up Lights Left / Right
- Dash Warning Lights
- Carpet / Upholstery / Floor Mats

UNDER VEHICLE
- Shock Absorbers / Suspension / Struts
- Steering Gear Box / Linkage and Boots / Ball Joints / Dust Covers
- Muffler / Exhaust Pipes / Mountings / Catalytic Converter
- Engine Oil and/or Fluid Leaks
- Brake Lines / Hoses / Parking Brake Cable
- Drive Shaft Boots / Constant Velocity Boots / U-joints / Transmission Linkage (if equipped)
- Transmission / Differential / Transfer Case (Check Fluid Level, Fluid Condition and Fluid Leaks)
- Fuel Lines and Connections / Fuel Tank Band / Fuel Tank Vapor Vent Systems Hoses
- Inspect Nuts and Bolts on Body Chassis

UNDER HOOD
- Fluid Levels: Oil / Coolant / Battery / Power Steering / Brake Fluid / Washer / Automatic Transmission
- Engine Air Filter
- Drive Belts (condition and adjustment)
- Cooling System Hoses / Heater Hoses / Air Conditioning Hoses and Connections
- Radiator Core / Air Conditioning Condenser (if equipped)
- Coolant Recovery Reservoir Fluid Level / Condition
- Clutch Reservoir Fluid / Condition (as equipped)

INTERIOR/EXTERIOR
- Battery Terminal / Cables / Mountings
- Check Condition of Battery (Storage Capacity Test)

Pass | Recharge Retest | Fail
Factory Spec Cold Cranking Amps 550
Actual Cold Cranking Amps 585

Background

- Mercedes follows a process called “**Multi-Point Inspection”,** which is a method used for their quality checks of important components. This process includes the checks in the main control system component, fluid, tyres and breaks.

- Invests heavily in AI and machine learning. One of the future projects **“Active Research Environment for the Next Generation of Automobiles"** (ARENA2036) main focus is to build high production equipment using AI enhanced robots.

- Another project in place is **Automation and Robotics for European Sustainable Manufacturing”** (AREUS) that involves the use of green electricity to production facilities. The main aim of the project is to build automated tools for manufacturing the vehicles

Challenges

- **Issues in supply chain and operations**
- **Chip supply shortages**
- **Reduced sales**
- **Engine and wire damages**
- **Rusting**
- **Failure of electrical sensors**
- **Lack of expert technicians**

Problem Background - Vehicle Testing

Hand-made Prototypes

Vehicles needs to be tested heavily before launch. This process can invariably cost a lot of money since each prototype are hand-made. (200k – 300k) approx.

Tight Schedules

There are inflexible deadlines for ensuring the performance of each part of the vehicle. Each part must pass all the standards defined by the state/country.

Increase in Costs

One way to reduce time is to build more number of protypes, however this will increase the costs immensely

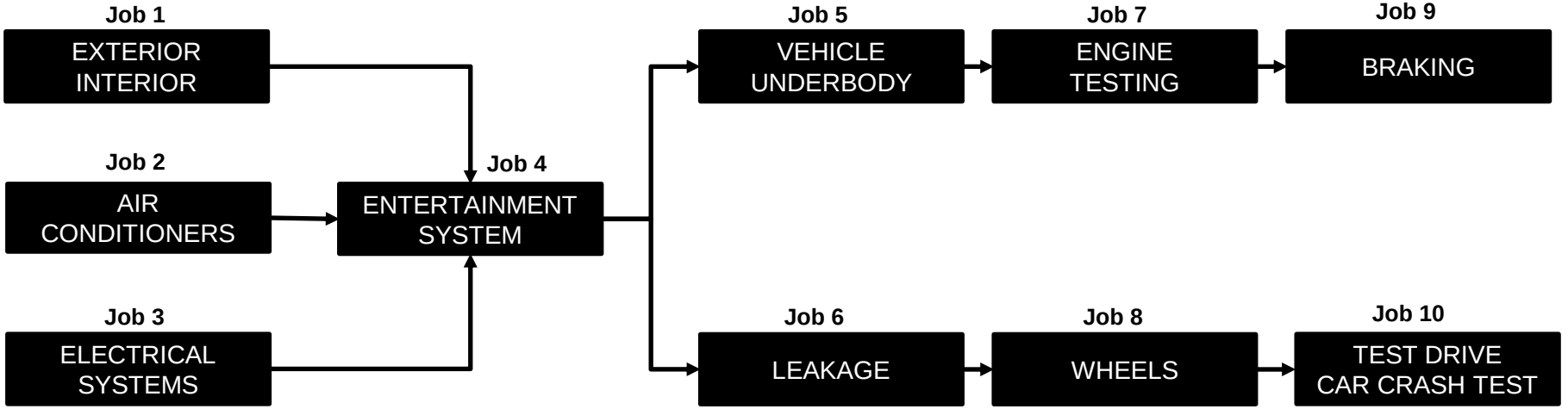
Case Study

Developed a case study to optimise the schedule of the vehicle testing using Lawler's Algorithm. There are 10 jobs, each job performs quality checks in a specific area of the vehicle. It takes about 3-6 months to manufacture a Mercedes Benz vehicle. Assuming that 80% of the time is required to assemble the vehicle and the rest 20% of the time is required for testing. This leaves us with 36 days for testing (6 months to manufacture). There are 8 cars that are being tested simultaneously in the testing bench. The objective function is to reduce the lateness in each job.

Jobs	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10
Pi	14	25	32	29	28	30	38	36	25	31
Di	18	28	26	20	30	37	35	32	35	37

Solving the above 10/1/Tmax and find the optimal schedule.

Network Diagram



*The jobs must follow the same precedence relationship

Results

Cycle 1

K = 10

τ = 14+25+32+29+28+30+38+36+25+31= 288

Pool = { J_9 , J_{10} }

Jobs	9	10
τ	288	288
Di	35	37
L	253	251

									J10

Cycle 2

K = 9

τ = 288 – (Processing time of Job 10) = 288 – 31= 257

Pool = { J_8 , J_9 }

Jobs	8	9
τ	257	257
Di	32	35
L	225	222

								J9	J10

Results

Cycle 3

K = 8
τ = 257 – (Processing time of Job 9) = 257 – 25 = 232
Pool = { J_7 ,J_8 }

Jobs	7	8
τ	232	232
Di	35	32
L	197	200

							J7	J9	J10

Cycle 4

K = 7
τ = 232 – (Processing time of Job 7) = 232 – 38 = 194
Pool = { J_5 ,J_8 }

Jobs	5	8
τ	194	194
Di	30	32
L	164	162

						J8	J7	J9	J10

Results

Cycle 5

K = 6
τ = 194 – (Processing time of Job 8) = 194 – 36 = 158
Pool = { J_5 ,J_6 }

Jobs	5	6
τ	158	158
Di	30	37
L	128	121

					J6	J8	J7	J9	J10

- Job 4 and Job 5 has a precedence already and hence the we will be following the same
- Updated processing time = 158 – (Processing time of Job 6) = 128

			J4	J5	J6	J8	J7	J9	J10

Results

Cycle 6

K = 3

τ = 128 – (Processing time of Job 4 and Job 5) =128 – (29+28)=71

Pool = { J_1 ,J_2,J_3 }

Jobs	1	2	3
τ	71	71	71
Di	18	28	26
L	53	43	45

		J2	J4	J5	J6	J8	J7	J9	J10

Cycle 7

K = 2

τ = 71 – (Processing time of Job 2) = 71 – 25 = 46

Pool = { J_1 ,J_3 }

Jobs	1	3
τ	46	46
Di	18	26
L	28	20

J1	J3	J2	J4	J5	J6	J8	J7	J9	J10

Results

Jobs	J1	J3	J2	J4	J5	J6	J8	J7	J9	J10
Pi	14	32	25	29	28	30	36	38	25	31
Ci/Fi	14	46	71	100	128	158	194	232	257	288
Di	18	26	28	20	30	37	32	35	35	37
Li	-4	20	43	80	98	121	162	197	222	251

Tardiness/Lateness = max (0, $(c_i - d_i)$)
Lateness (Li) = $c_i - d_i$

$$L_{max} = 251\ units$$

Conclusion

With the increase in the demand of production as well as increase in the costs of testing vehicle's performances, Lawler's algorithm is a very powerful tool for scheduling and finding out the tardiness/lateness. Implementation of both on going processes in Mercedes with Lawler's algorithm will prove to be more efficient and optimal. The overall time and costs can be saved that in turn will help in building the profits of the vehicle. It will help the company meet their schedule times by using the optimal schedule.

Questions?