Drive Shaft for Heavy Duty Vehicles

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Driver Shaft

Applications

The drive shaft (also called propeller shaft or prop shaft) is a component of the drivetrain in a vehicle, with the purpose of delivering torque from the transmission to the differential, which then transmits this torque to the wheels in order to move the vehicle.The drive shaft is primarily used to transfer torque between components that are separated by a distance.

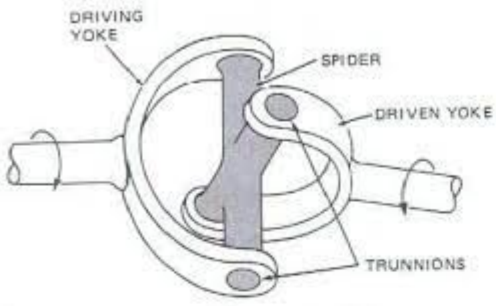
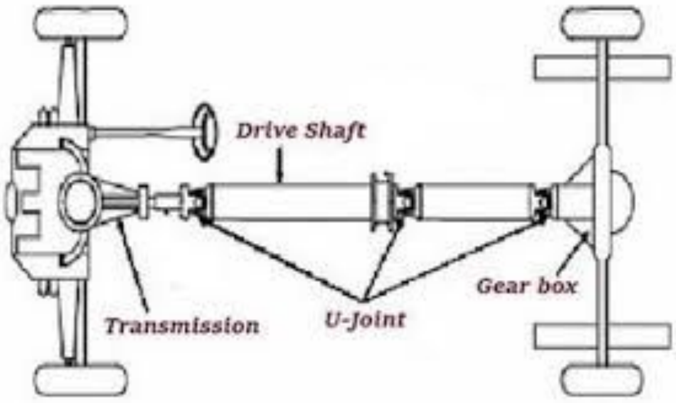


Fig 1.1:Universal coupling.



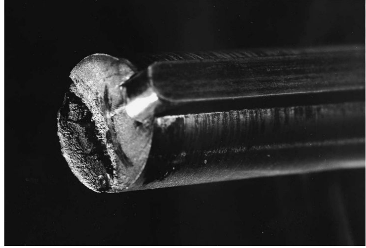
Gear Box: Attached with front wheel axis

Shaft: This metal tube is responsible for transferring torque to the drive wheels from the transmission at a constant speed.

U Joint: The U-joint, responsible for connecting the drive shaft to the differential. In some cases, it connects the drive shaft to the transmission, or even allows two drive shafts to attach to each other.

Animation : [File:Cardan-joint intermediate-shaft 3D animated.gif]

Shaft Failure



Fatigue

Due to cyclic loading in shaft.

Bending/Torsion

Due to non uniform roads, bending of shaft occur outside of certain limit.

Corrosion

In rainy season shaft came in contact of water/mud. It could occur corrosion of shaft. Also there is wearing of shaft material.

Source: [ScienceDirect]

Shape Selection

The drive shaft can be solid circular or hollow circular. Here hollow circular cross-section was chosen because:

- The hollow circular shafts are stronger in per kg weight than solid circular.
- The stress distribution in case of solid shaft is zero at the center and maximum at the outer surface while in hollow shaft stress variation is smaller. In solid shafts the material close to the center are not fully utilized.

Material Selection

Function	Shaft, delivering torque
Objective	• Minimising cost • Minimising mass
Constraints	• Should not fail under torsion ($\tau < \tau_f$) • Should not fail under fatigue loading ($\sigma < \sigma_e$) • Should not fail by bending ($\sigma < \sigma_f$) • Length of shaft
Free variables	• Cross section area • Material choice

Material Selection

$m = 2\rho L\pi rt$

Bending:

$\sigma = M/Z$

$Z = \pi r^2 t$

$M1 = \sigma_f^{1/2}/\rho$

Torsion:

$\tau = T/Q$

$Q = 2\pi r^2 t$

$M2 = S_f^{1/2}/\rho$

Fatigue Failure:

$\sigma_e = F/A$

$M3 = \sigma_e/\rho$

Design Specifications			TATA 1210
Max. Torque	625 Nm	Outer Dia	90 mm
Max. Speed of Shaft	1800 RPM	Inner Dia	72 mm
Length	2100 mm		

Material Selection

Material	**M1**	**M2**	**M3**	**Comments**
Steel SM45C	0.00253	0.00253	0.03947	Medium suited as Low in M2
SS 316	0.00179	0.00139	0.04375	Low fatigue strength
High carbon steel	0.00685	0.0053	0.1875	Medium suited as Low in M2
Al 7075	**0.00798**	**0.00647**	**0.05658**	**Best suited for torsion**
Chromoly 4130	0.00273	0.00312	0.19108	Low bending and torsion
AISI 1045	0.00293	0.00227	0.03567	Low fatigue strength

Process Selection

Objective:

1) Minimizing cost

2) Reduce Processing time

We have non-ferrous metal as raw material and circular prismatic shape.

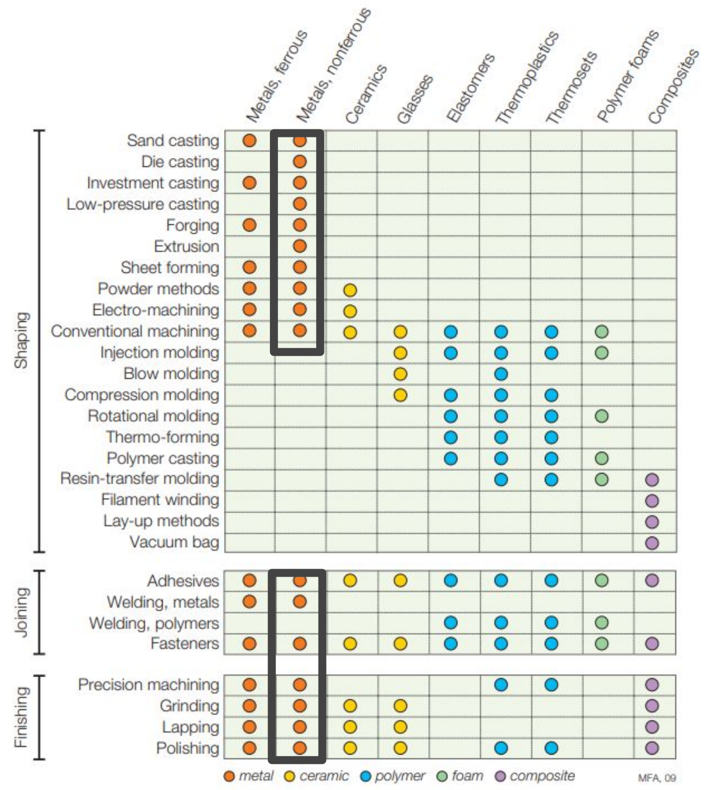


FIGURE 13.22

The process-material matrix. A colored dot indicates that the pair are compatible.

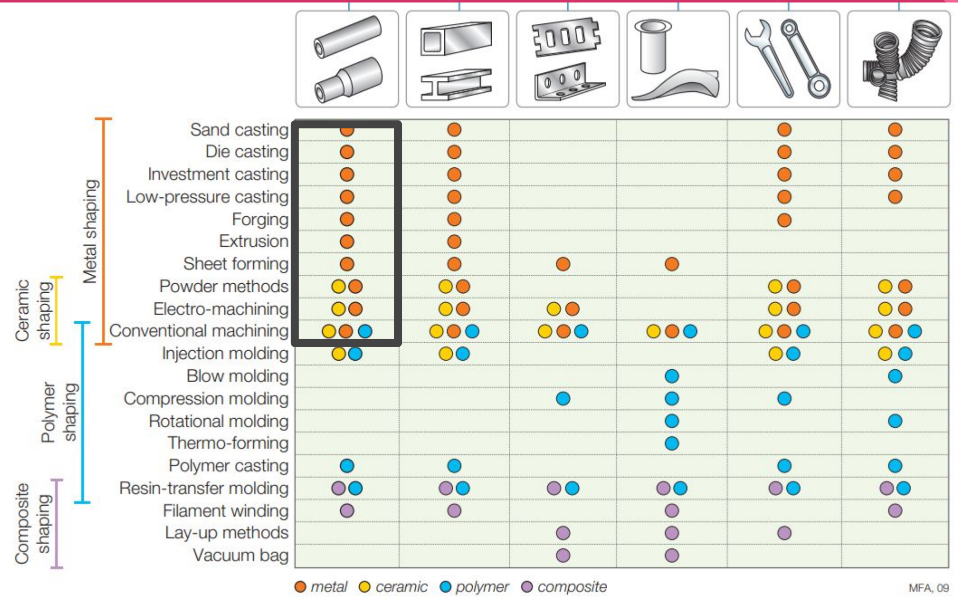


FIGURE 13.23

The process-shape matrix. Information about material compatibility is included at the extreme left.

Mass = 10-20 kgs and section thickness = 9-15 mm

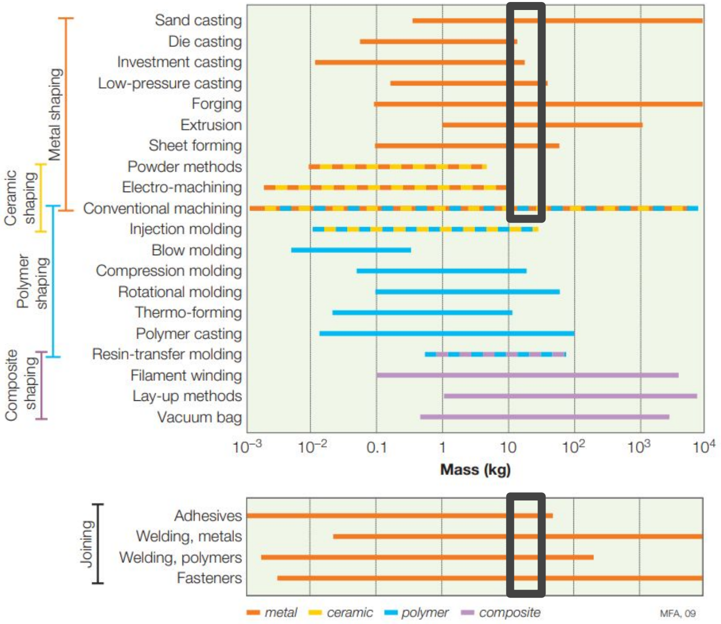


FIGURE 13.24

The process–mass-range chart. The inclusion of joining allows simple process chains to be explored.

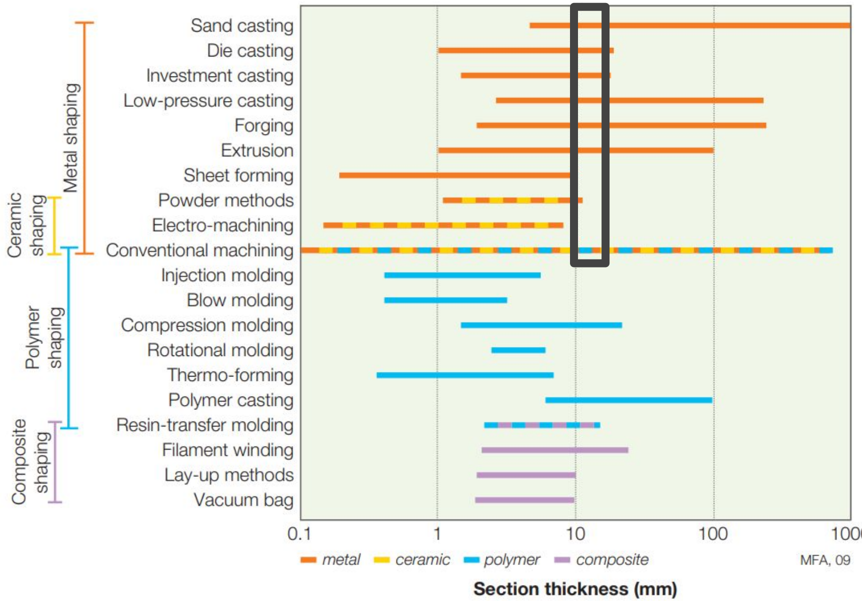


FIGURE 13.25

The process–section thickness chart.

Batch size = 1000-4000, tolerance = 0.5-1 mm

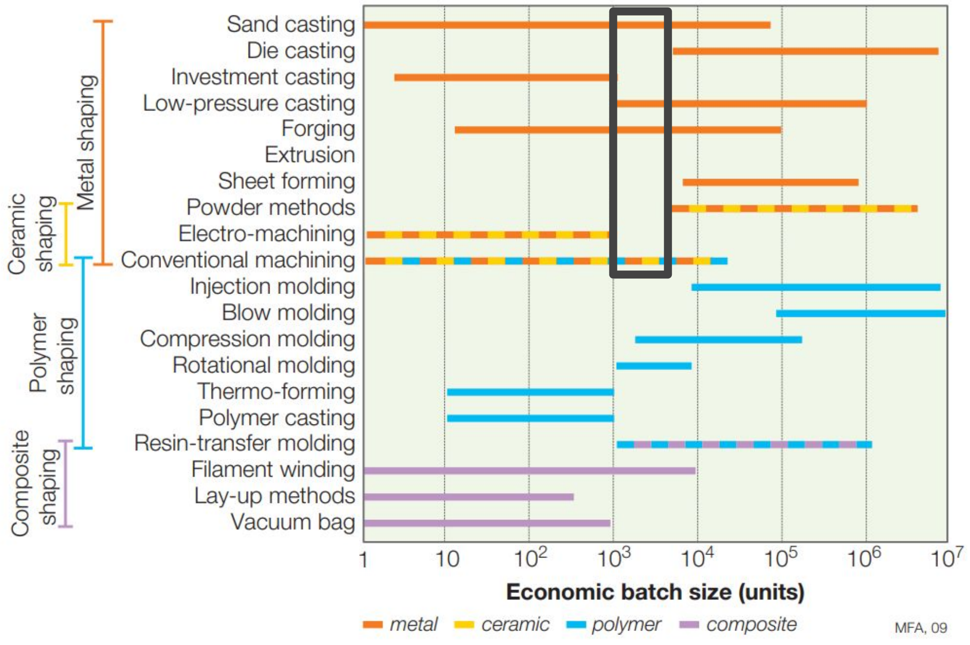


FIGURE 13.34

The economic batch size chart.

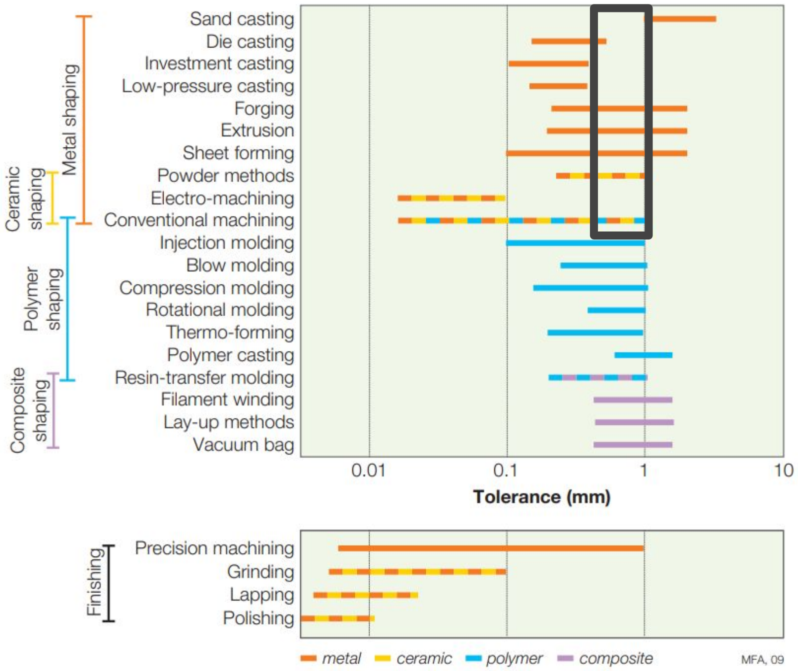


FIGURE 13.30

The process-tolerance chart. The inclusion of finishing processes allows simple process chains to be explored.

Manufacturing Process

Conventional Manufacturing:
Boring: Making hollow cylinder
Drilling: Making necessary holes for joints to assemble with other parts
Turning: Reduce diameter
Internal and external threading
Internal and external spinning and teeth cutting
Rotary Broaching

Finishing and Quality Control:
Bending
Heat treating
Electro-Polishing
Anodizing
Welding
Assembly

Conclusion

Selected Material: Aluminium 7075
Selected Process: Conventional Machining, Welding, Heat treatment
Finishing: Anodizing, Electro-polishing

References

- Design and Analysis of Drive Shaft for Heavy Duty Truck
- DESIGN AND ANALYSIS OF DRIVE SHAFT FOR HEAVY DUTY TRUCK
- Design, Failure Analysis and Optimization of a Propeller Shaft for Heavy Duty Vehicle
- Dynamic Analysis of Heavy Vehicle Medium Duty Drive Shaft Using Conventional and Composite Material
- Analysis of a vehicle wheel shaft failure
- The Material And Process Requirements For Driving Shaft Engineering Essay
- Understanding the Shaft Manufacturing Process
- Design and Manufacturing of a Composite Drive Shaft

Thank you