# Material Selection – Massow

## Families:

A diagram of different types of materials

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A group of numbers and a group of numbers

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Example

Metals – Steel -1.4301

## Material Properties

Classes:

* General
* Mechanical
* Thermal
* Electrical
* Optical
* Eco-properties

A screenshot of a computer

Description automatically generated

## Choice of Material

* Dictated by the design & vice versa
* Not independent of the choice of process
* Influences costs
* Influences sustainability & ecological footprint
* Important for industrial design
  + Form, texture, haptic, colour
  + “good design works; excellent design also gives pleasure”

IMPORTANT to examine the full range of materials & not to reject option because they are unfamiliar

Over 120 000 materials available

## Material Selection Strategy

* Translation
  + Define requirements
  + Constraint equations
  + Objective equation
  + Identify free variables
  + Substitute free variables
  + Group variables
  + Material index
* Screening
* Ranking
* Documentation

## Functional names of components

1. Ties – carry tensile loads
2. Plates – load on area
3. Beams – carry bending load
4. Beams – carry bending load

Shafts – carry torque

Columns – carry compressive axial loads

A diagram of a beam

Description automatically generated

## Multiple Constraints

Analytical Method

A screenshot of a math test

Description automatically generated with medium confidence

Graphical Method

A screenshot of a diagram

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A diagram of a graph

Description automatically generated with medium confidence

## Conflicting Objectives

Trade-off Strategies

A diagram of a mass of a mass

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A diagram of a mass of a mass

Description automatically generated with medium confidence

Penalty functions

A diagram of a graph and a diagram of a graph

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A diagram of a graph and a diagram of a graph

Description automatically generated

Exchange constants

A diagram of a graph

Description automatically generated

## Material and Shape

Shape can be used to increase the mechanical efficiency of a material

Shape – refers to form of the components

Mechanical efficiency – refers to the use of as little material as possible

Best material-shape combination depends on the mode of loading!

Shape Factor

Characterizing the efficiency of material use in load cases

A text on a white background

Description automatically generated

Bending stiffness of beams

A math equations and symbols

Description automatically generated with medium confidence A mathematical equation with numbers and symbols

Description automatically generated

Elastic twisting of stafts

A mathematical equation with black letters

Description automatically generated A mathematical equations and numbers

Description automatically generated

Plastic failure at bending of beams

A math equations and numbers

Description automatically generated with medium confidence A black and white math equation

Description automatically generated

Plastic failure at twisting of shafts

A math equations and formulas

Description automatically generated with medium confidence A mathematical equation with a few letters

Description automatically generated with medium confidence

NEW ORDER

i)Define design requirements

ii)Derive equations for the constraints (where necessary): the constraint equations

**iii)Replace factors in the constraint equations that are influenced by the shape with the corresponding shape factors**

iv)Derive an equation for the objective: the objective function

v)Identify the free (unspecified) variables

vi)Substitute the free variables from the constraint equations (including shape factors) into the objective function

vii)Group the variables of the performance metric (P) into three groups: functional requirement (F), geometric parameters (G), and material properties & shape factors (M, ϕ); thus

P ≥ f1(F)∙f2(G)∙f3(M, ϕ) or

P ≤ f1(F)∙f2(G)∙f3(M, ϕ)

viii)Read off the material index including the shape factor that optimizes the performance metric