

Multicriterial Design Decision Making regarding interdependent Objectives in DfX

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- The Design Process
- Support of the Design Process with Design for X
- **Visualization of Decision Problems with interdependent objectives – Idea and applications**

The Design Process

- **Planning**
 - Define Requirements and objectives (desired properties)
- **Conceptual Stage**
 - Define Functions and Function Structures
 - Find Solutions for Functions matching the requirements
 - Combine Solutions to different alternative Solution Concepts
 - Evaluation of concepts
- **Embodiment**
 - Detail Concepts
 - Evaluation
- **Detail Design**
 - Complete Design → Work out all documents



Support with Design for X

- **Planning** **What aspects have to be considered?**
 - Define Requirements and objectives (desired properties)
- **Conceptual Stage** **Guidelines, Methods, Tools**
 - Define Functions and Function Structures
 - Find Solutions for Functions matching the requirements
 - Combine Solutions to different alternative Solution Concepts
 - Evaluation of concepts
- **Embodiment** **Guidelines, Methods, Tools**
 - Detail Concepts
 - Evaluation
- **Detail Design** **Guidelines, Methods, Tools**
 - Complete Design → Work out all documents

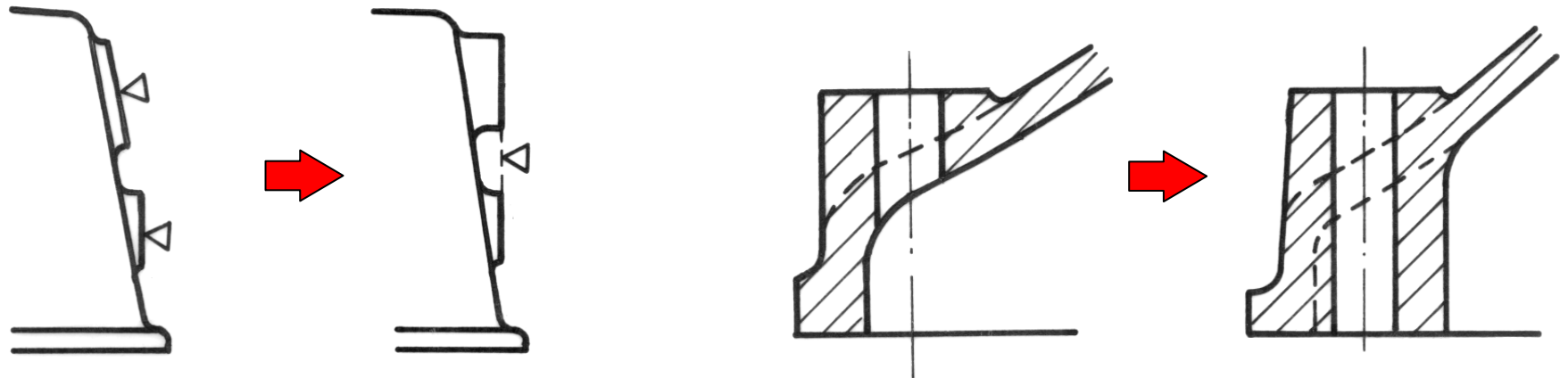
DfX Guidelines

DfX Guidelines

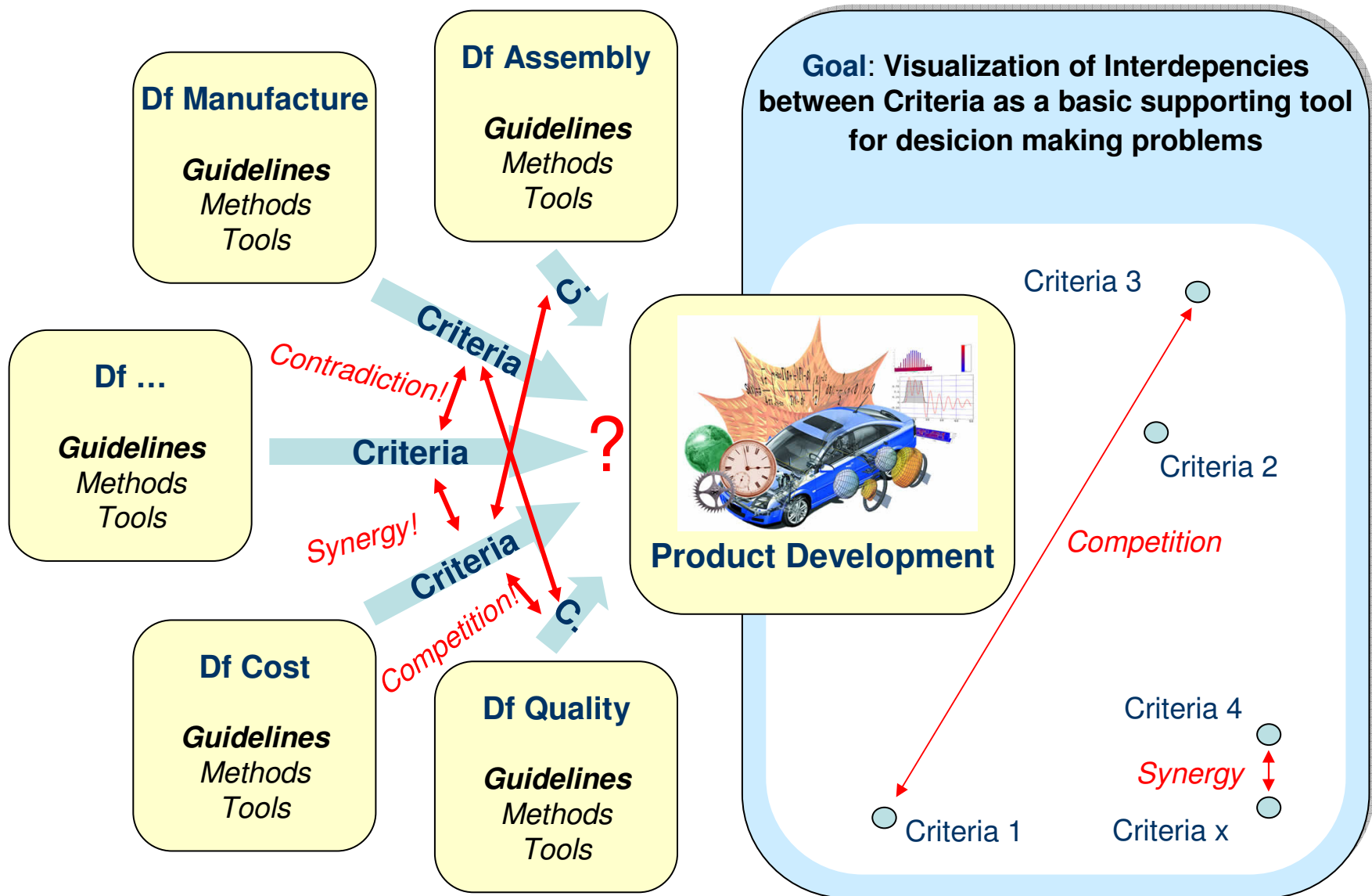
How are the product's characteristics to be defined to reach the desired property?

Example:

Design for Manufacture



Visualization of Interdependent objectives in DfX



Interdependent objectives in DfX

■ Approach

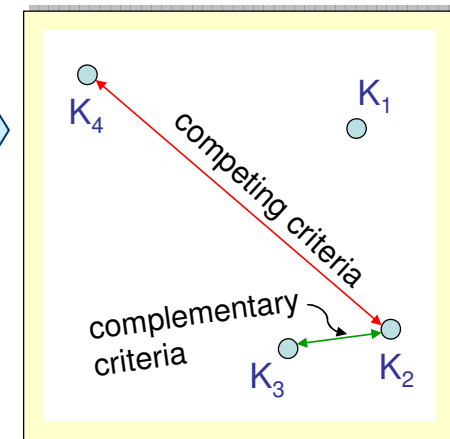
- Pairwise comparison of interdependencies between criteria by assigning a interdependency factor w in a matrix:
 - Competing Pair of criteria $\rightarrow w$ negative, $w \in [-1; -5]$
 - Complementary Pair of criteria $\rightarrow w$ positive, $w \in [1; 5]$
- Basis: Visualization Space (currently: up to 3 dimensions \rightarrow Visualization Space)
- Placing representants of the criteria (Criteria Points) in the Visualization Plane
- Calculating **distances between criteria** in such a way, that competing (complementary) Criteria Points have huge (small) distances to each other in the Visualization Plane

	K_1	K_2	K_3	K_4
K_1	/	w_{12}	w_{13}	w_{14}
K_2	w_{12}	/	w_{23}	w_{24}
K_3	w_{13}	w_{23}	/	w_{34}
K_4	w_{14}	w_{24}	w_{34}	/

Interdependency Matrix

**Calculation of
distances**

Multi Dimensional
Scaling
Mechanical Model



Visualization Plane

Example: Bicycle

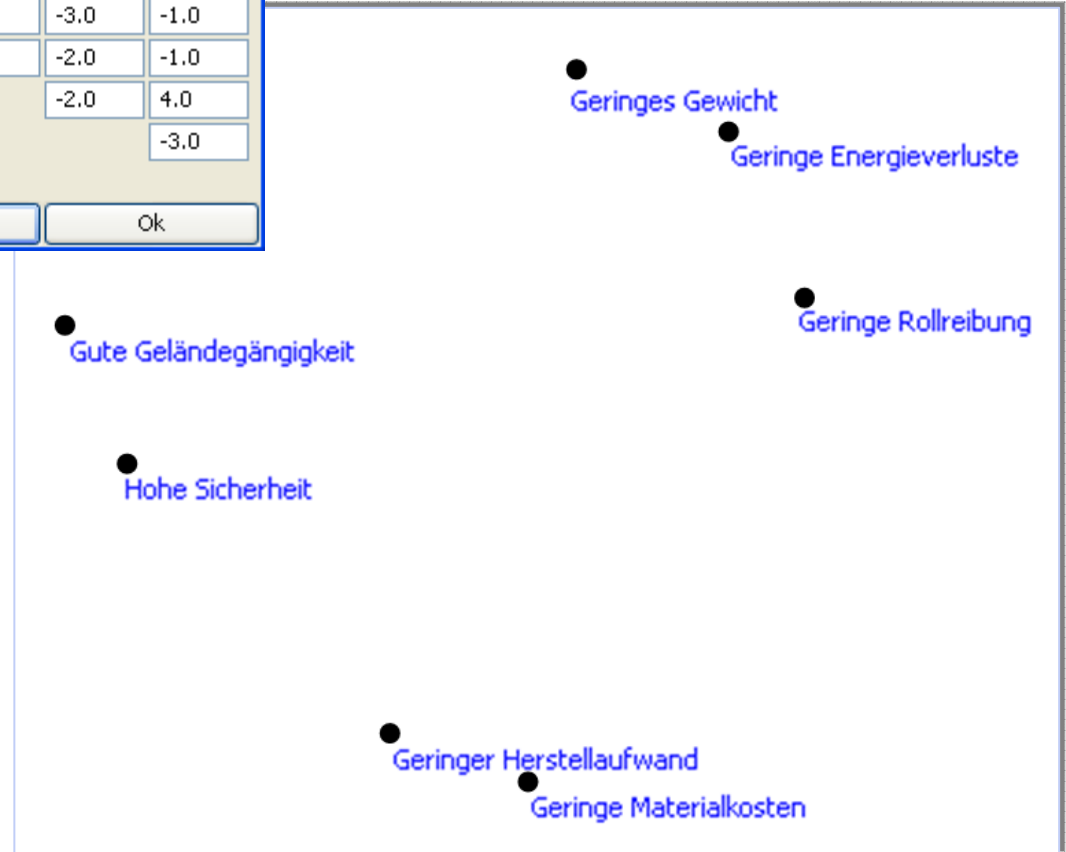
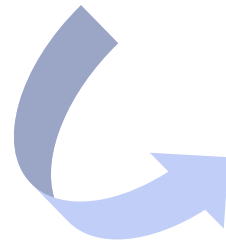
Matrizeingabe

Anzahl Kriterien: 7

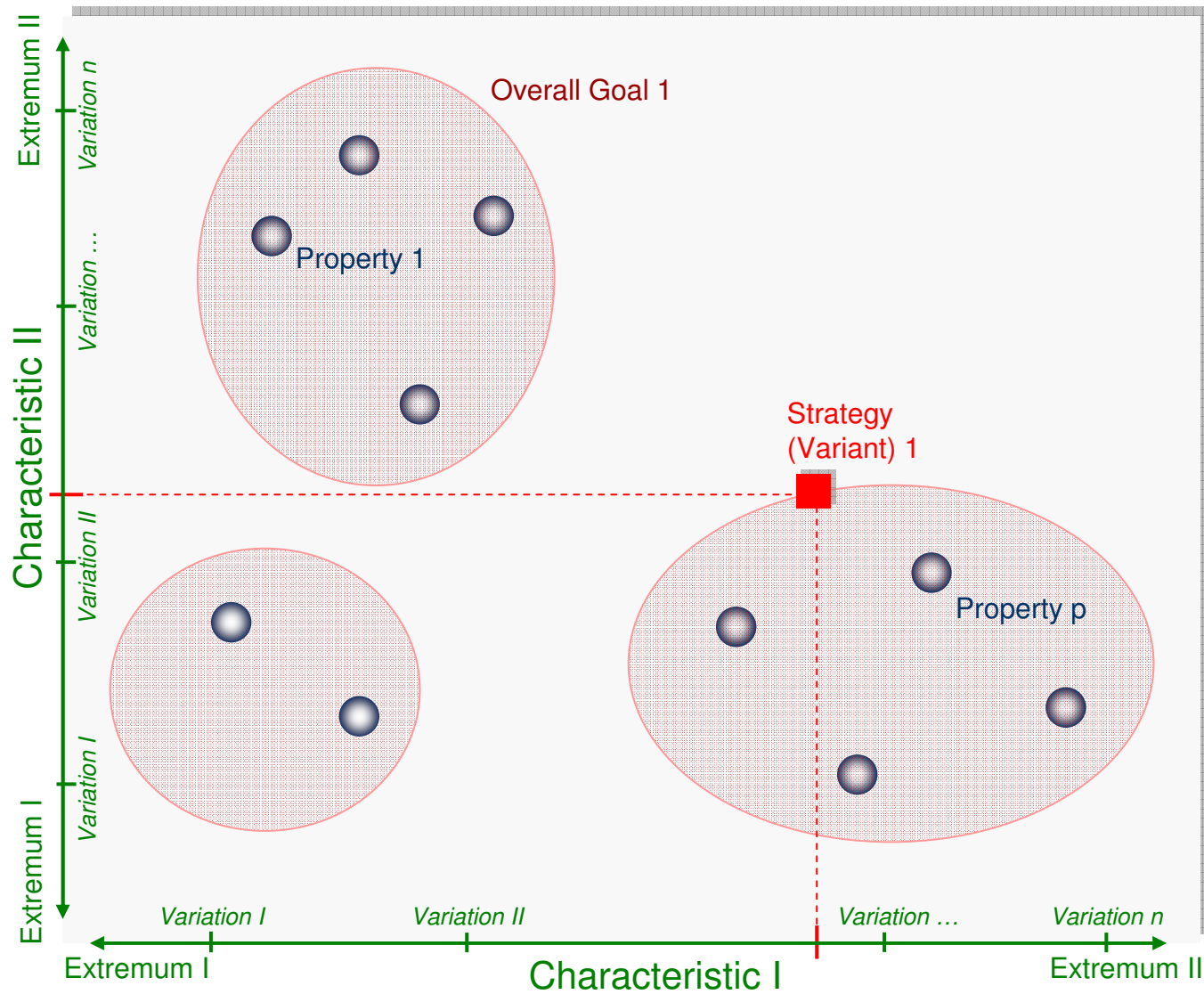
	K2	K3	K4	K5	K6	K7	
K1	Geringes Gewicht	-1.0	-4.0	-4.0	-1.0	4.0	-1.0
K2	Geringe Rollreibung		-1.0	-2.0	-3.0	5.0	-5.0
K3	Geringe Materialkosten			3.0	-2.0	-3.0	-1.0
K4	Geringer Herstattaufwand				1.0	-2.0	-1.0
K5	Hohe Sicherheit					-2.0	4.0
K6	Geringe Energieverluste						-3.0
K7	Gute Geländegängigkeit						

Abbrechen Ok

Interdependency Matrix

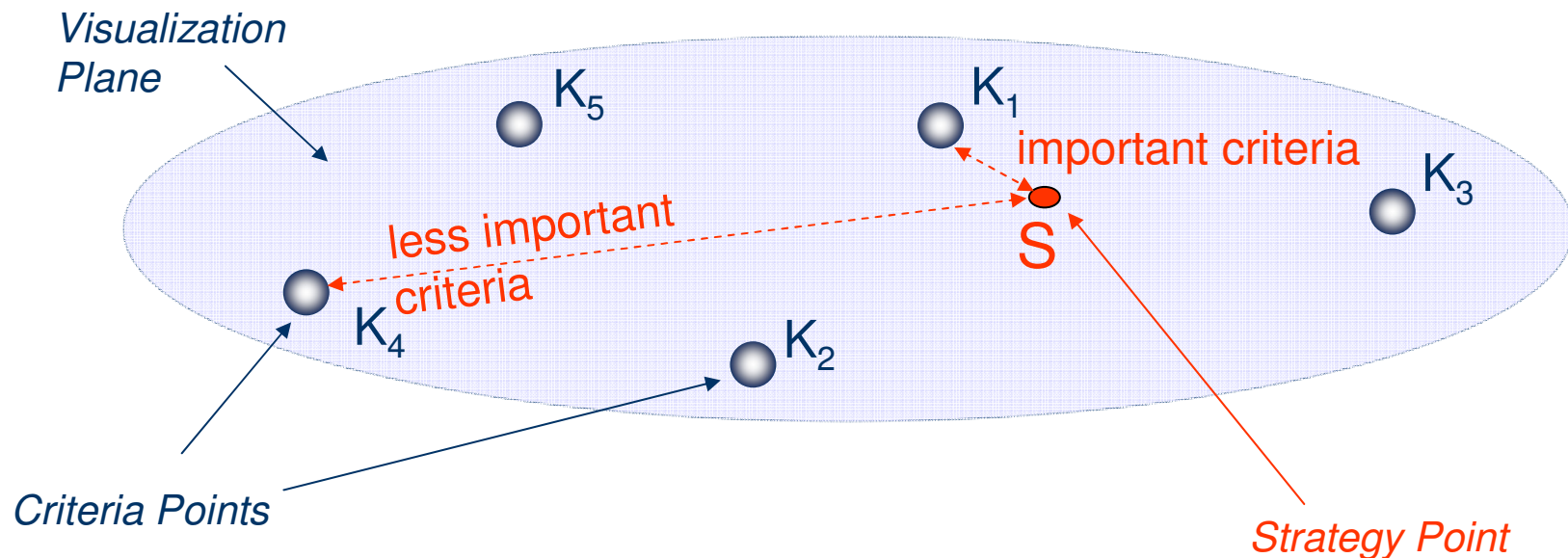


Interpretation of the Visualization



Interdependent objectives in DfX

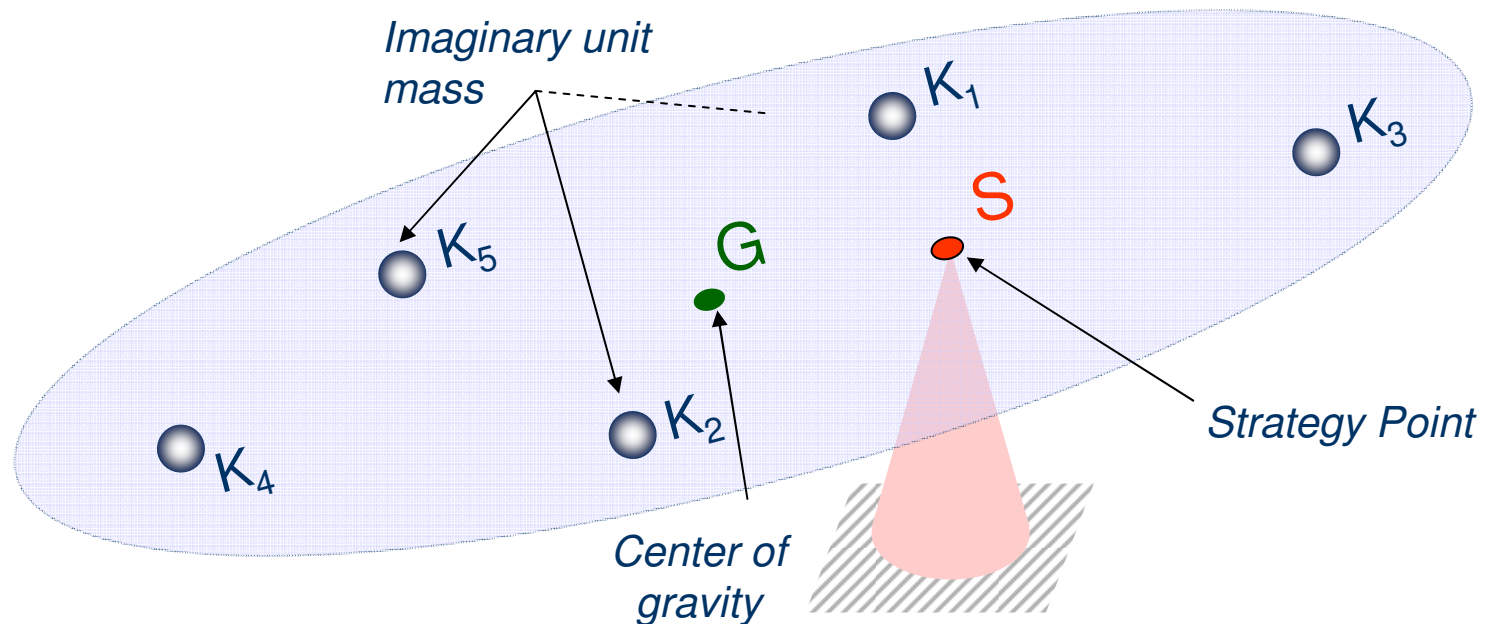
- **Application:** Tool to calculate weighting factors considering interdependencies
 - The developer has to choose a point (Strategy Point) in the Visualization Plane in such a way, that important criteria have a small distance, whereas less important criteria (automatically) have a bigger distance to that Strategy Point.



*Choosing the Strategy Point in the Visualization Plane
= weighting the corresponding criteria collectively*

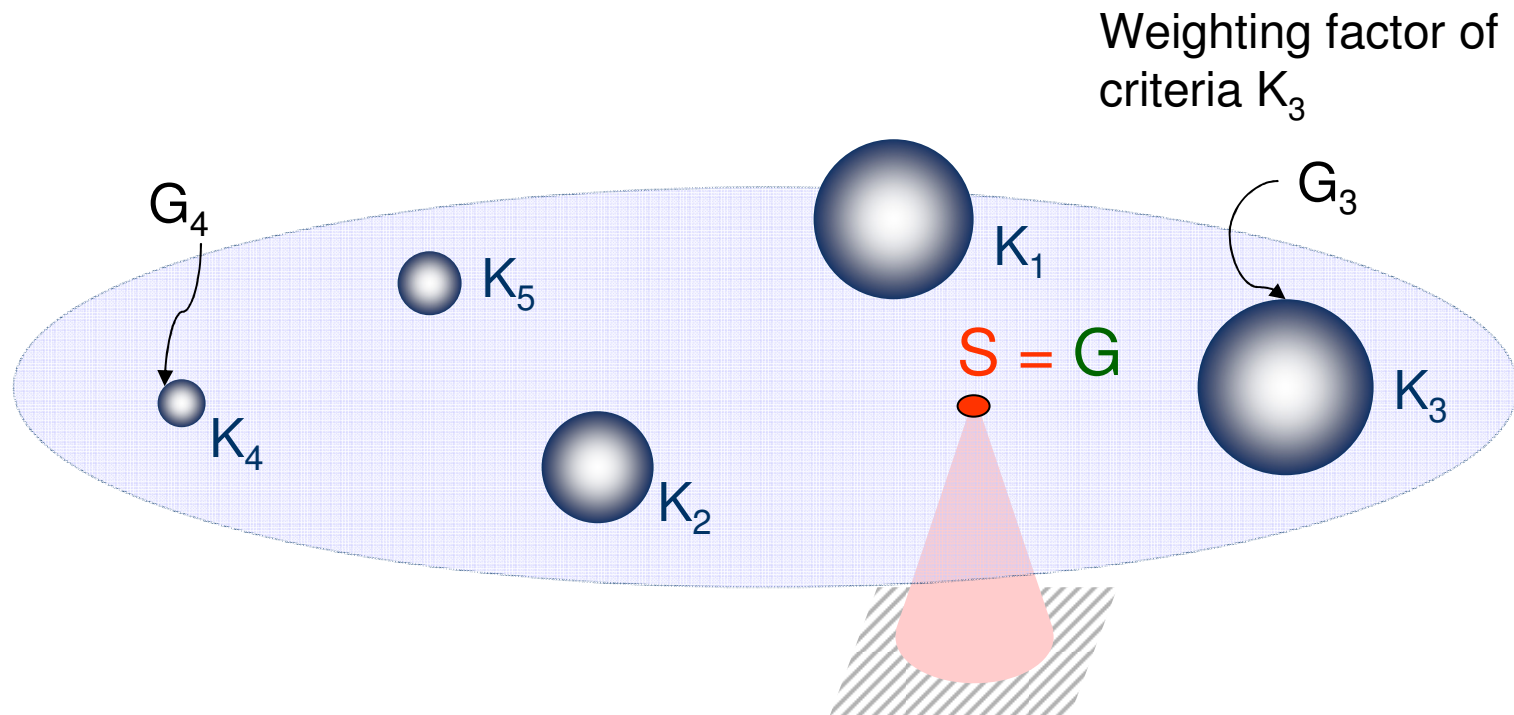
Interdependent objectives in DfX

- **Application:** Tool to calculate weighting factors considering interdependencies
 - Every Criteria point is assigned a specific mass in such a way, that the chosen Strategy Point and the center of gravity are aligned



Interdependent objectives in DfX

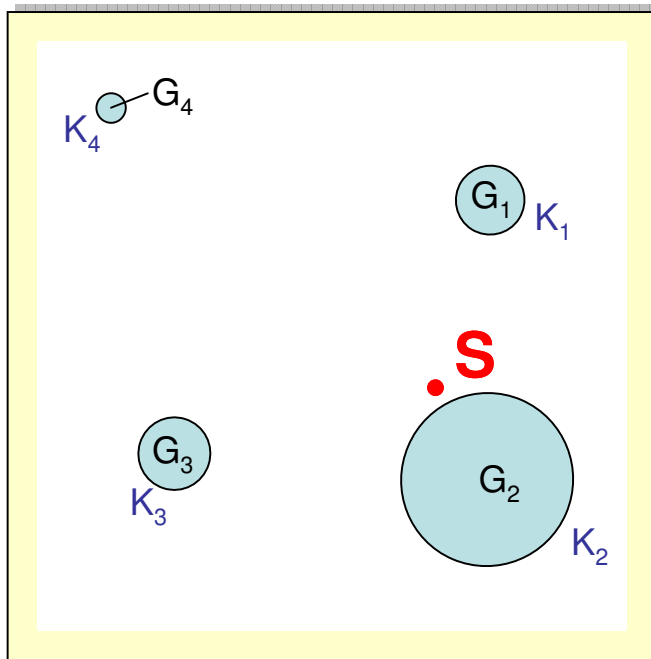
- **Application:** Tool to calculate weighting factors considering interdependencies
 - This resulting mass of a Criteria Point is identified as the weighting factor of the corresponding criteria



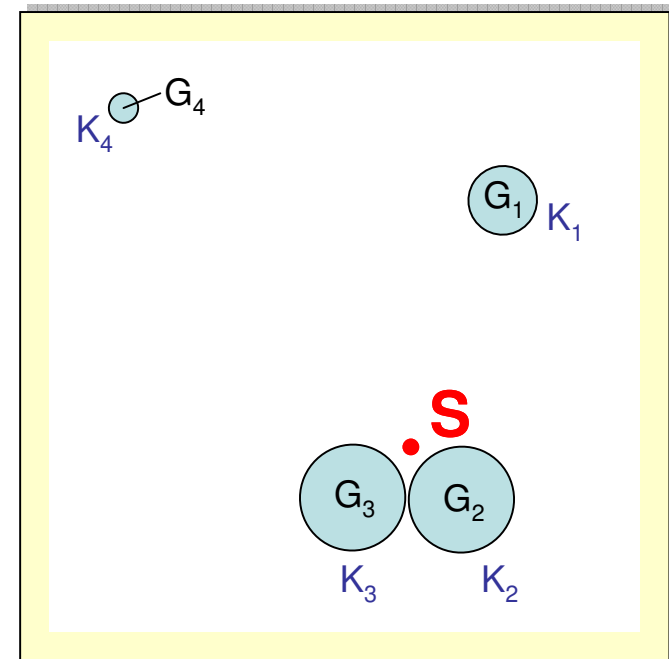
*Assigning weighting factors = Finding the **right balance** between interacting criteria!*

Interdependent objectives in DfX

- **Advantages** of this weighting approach
 - Conflicts of objectives can not be ignored when assigning weighting factors
 - The risk to weight intersecting aspects of complementar criteria several times is covered, since the masses (=weighting factors) of the Criteria Points are balanced around the Strategy Point

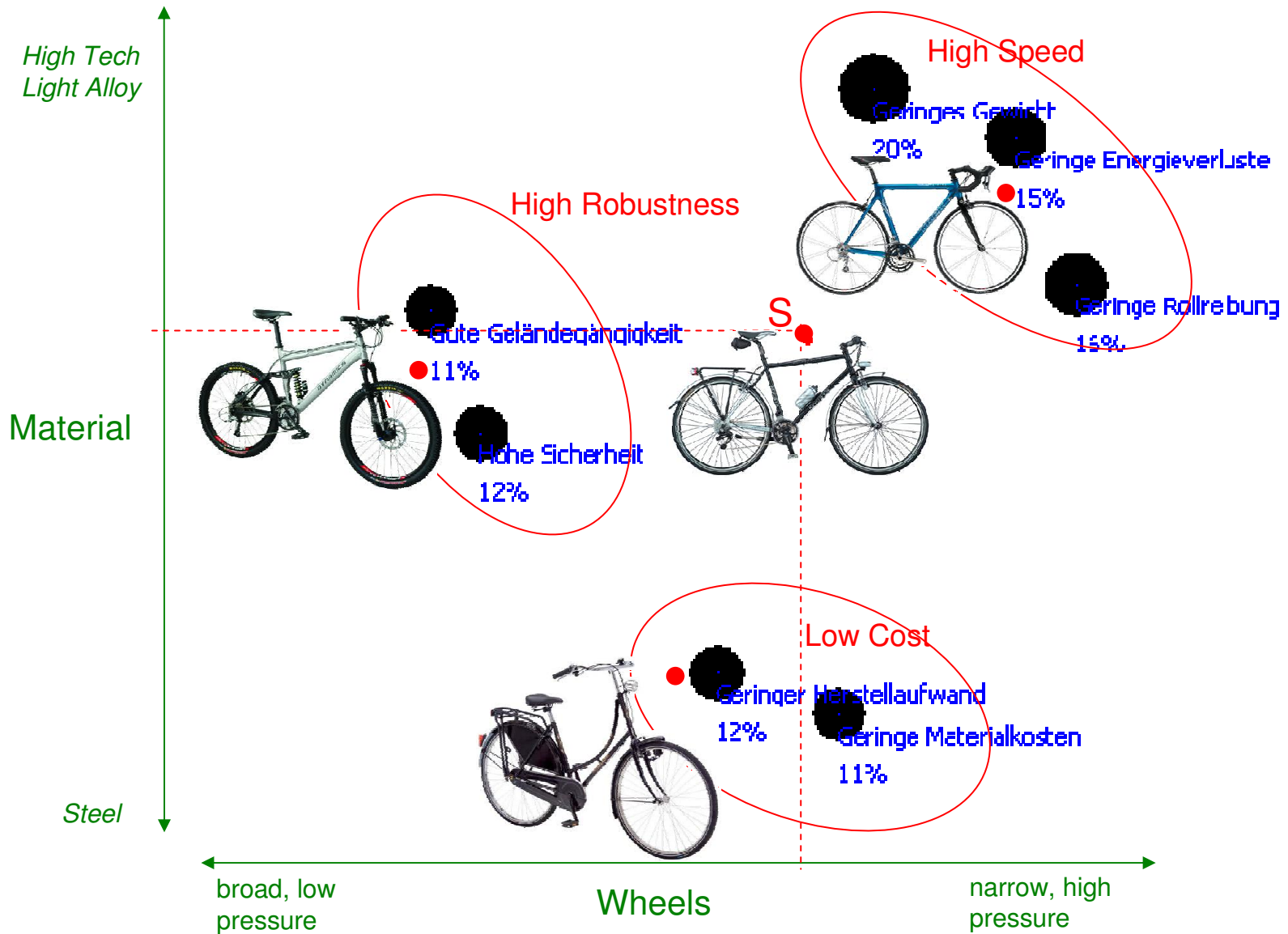


Weighting **competing** criteria



Weighting **complementary** criteria

Example: Bicycle



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