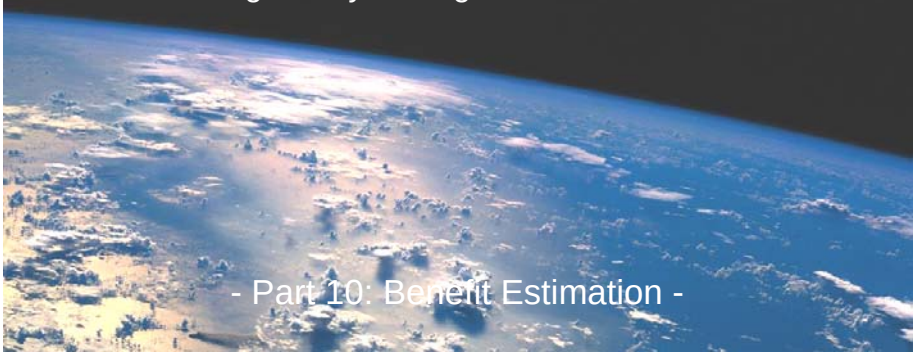
Part 10

C·O·S·T ENGINEERING™

„Design and Marketing of Rockets"

Lecture Series given by Dr.-Ing. Robert Alexander Goehlich



- Part 10: Benefit Estimation -

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General
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General
Goal of Today's Lecture

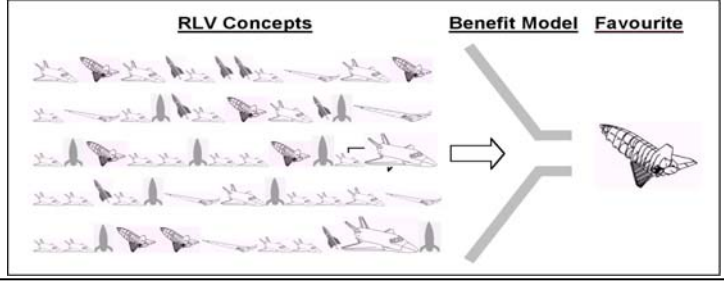
„You will learn about the necessarity of benefit estimation in order to judge space transportation systems."

Benefit Model

Main Objective

TASK
Examining performance of RLV concepts as a contribution for inexpensive space transportation leading to human presenence space.

REALIZED



Benefit Model

Different Interest Groups

Overall Benefit = „Improve the Quality of Life“

Operator/Investor	Passenger	Public/Government
		
Individual Benefit = „Profit“	Individual Benefit = „Amusement“	Individual Benefit = „Proud“

Benefit Model

Structure

- Step 1: Defining Objectives and Future Trends
- Step 2: Estimating Relative Weights
- Step 3: Selecting State Variables
- Step 4: Selecting Benefit Indicators
- Step 5: Determining Benefit Indicator Values
- Step 6: Selecting Benefit Functions
- Step 7: Calculating Benefit of each Sub Objective
- Step 8: Calculating Benefit of all Sub Objectives

Example:

1 Sub Objective out of 23

Benefit Estimation

Defining Objectives and Future Trends

Step 1 → Step 2 → Step 3 → Step 4 → Step 5 → Step 6 → Step 7 → Step 8

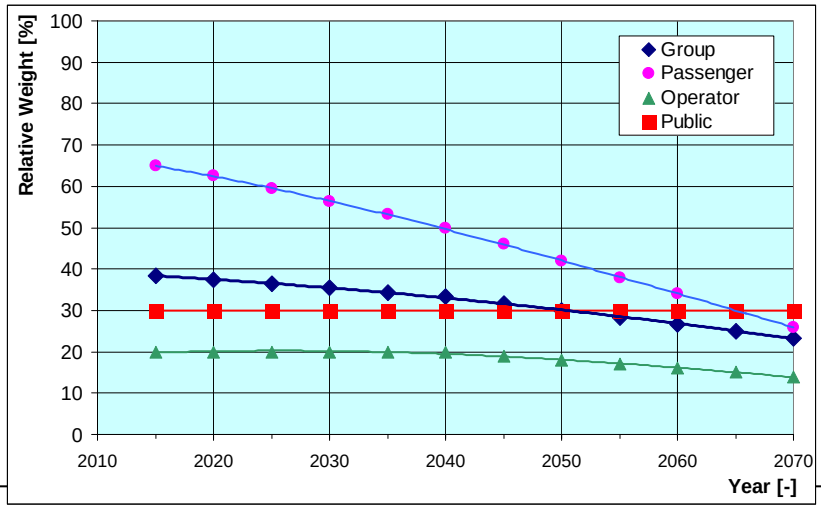
Sub Objectives	Goals for Year 2070
11 Improve mission success rate	0,999 probability of mission success
12 Reduce catastrophic failure rate	0,0001 probability of catastrophic failure
13 Improve vehicle life-cycle	1000 reuses of vehicle
14 Improve launch/landing method procedure	Comfortable and safe launch/landing
15 Improve passenger enthusiasm	Flights satisfies passenger wishes
16 Reduce number of stages	One-stage vehicle
17 Improve configuration	Clean and simple functional configuration
18 Improve propellant	Proven safe, green, and cheap propellants
19 Improve passenger comfort	No necessity of special health requirements
20 Reduce technical development risk	All subsystems are existing in-production hardware
21 Improve mission flexibility	Vehicle serves tourism market and different satellite markets
22 Improve seat capacity	100 passengers per vehicle
23 Improve profitability	Business case is financial attractive to find enough investors
24 Improve market share	Passenger ticket of a 1 day LEO trip costs $50 000
25 Improve mission duration	1 day mission with a high share of free-gravity flight
26 Reduce turn-around time	1 day
27 Simplify licensing process	Grant license after one test year
28 Enhance social standard of society	Sensitiveness in having respect for mankind and Earth
29 Reduce environmental pollution	Low emission engines
30 Enhance national self-esteem and prestige	50 % of all UN members participate in space programs
31 Provide realization of resettlement to other planets	Develop infrastructure for an extraterrestrial population of 100
32 Provide a useful employment of military sector	1 million people employed in aerospace sector
33 Provide more international cooperation	Space tourism market reaches 0,1 % of global GNP

Benefit Estimation

Estimating Relative Weights

No. 9

Step 1 → Step 2 → Step 3 → Step 4 → Step 5 → Step 6 → Step 7 → Step 8



Benefit Estimation

Selecting State Variables

No. 10

Step 1 → Step 2 → Step 3 → Step 4 → Step 5 → Step 6 → Step 7 → Step 8

State Variable	Unit	Source of Procedure
102 Degree of system health monitoring	%	external estimates
103 Number of alternative landing sites	-	external estimates
104 Degree of soft abort capability	%	external estimates
106 Degree of redundancy	%	external estimates
109 Number of reuses of cold structure	-	TRASIM model
125 Cabin volume per passenger	m^3/pax	external estimates
132 Return on Investment (ROI)	M$	TRASIM model
134 Year of positive cash flow	-	TRASIM model
144 Specific propellant consumption	Mg/pax	external estimates

Benefit Estimation

Selecting Benefit Indicators

No. 11

Step 1 → Step 2 → Step 3 → Step 4 → Step 5 → Step 6 → Step 7 → Step 8

Benefit Indicators	Quality	Remark
103 Number of alternative landing sites	0,3	For comparison, Space Shuttle can use in total 30 landing sites for emergency landing (NASA, 2002) and is assumed in this study as the maximum necessary amount of alternatives.
104 Degree of soft abort capability	0,4	Soft abort capability means that engine failure does not cause loss of control and vehicles are engines-out landing capable. Space Shuttle's soft abort capability is set to 50 % for this indicator to be comparable to other candidate vehicles. In general, winged vehicles are superior to ballistic vehicles due to their aerodynamic surfaces.
106 Degree of redundancy	0,3	Redundancy means to finish the mission successfully even if there is a malfunction of main engine, control engine, computer, pilot, etc. Quality of Space Shuttle's redundancy is set to 50 % for this indicator to be comparable to other candidate vehicles.

Benefit Estimation

Determining Benefit Indicator Values

No. 12

Step 1 → Step 2 → Step 3 → Step 4 → Step 5 → Step 6 → Step 7 → Step 8

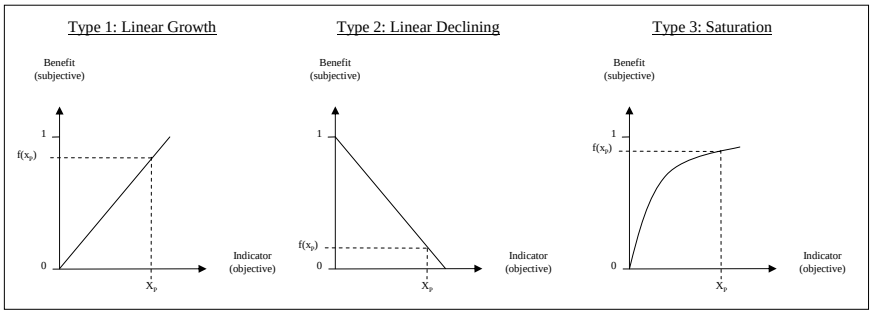
Benefit Indicators	Unit	2030	2035	2040	2045	2050	2055	2060	2065	2070
103 Number of alternative landing sites	-	0	0	1	4	8	12	16	16	16
104 Degree of soft abort capability	%	40	40	40	40	40	40	40	40	40
106 Degree of redundancy	%	90	90	95	95	100	100	100	100	100

Benefit Estimation

Selecting Benefit Functions

No. 13

Step 1 → Step 2 → Step 3 → Step 4 → Step 5 → **Step 6** → Step 7 → Step 8

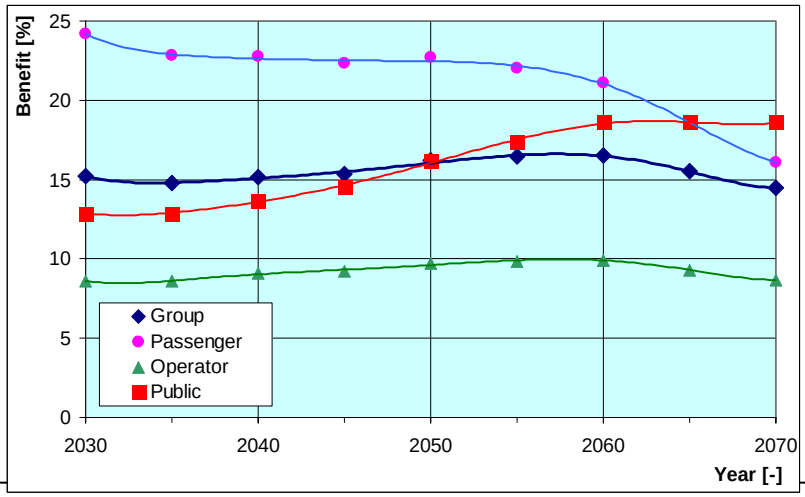


Benefit Estimation

Calculating Benefit of each Sub Objective

No. 14

Step 1 → Step 2 → Step 3 → Step 4 → Step 5 → Step 6 → **Step 7** → Step 8



Benefit Estimation

Calculating Benefit of all Sub Objectives

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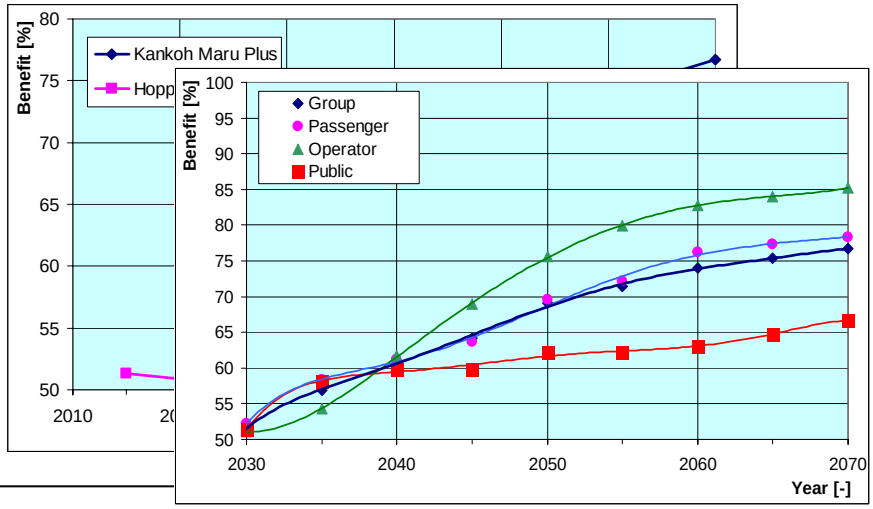

Definition

Definition of Cost Engineering (Practice)

No. 16

Case C

- *Step 10: Collect the positive and negative benefit of using rockets to either transport humans or satellites.*

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