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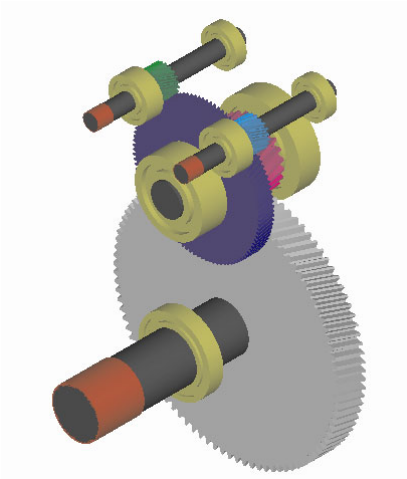
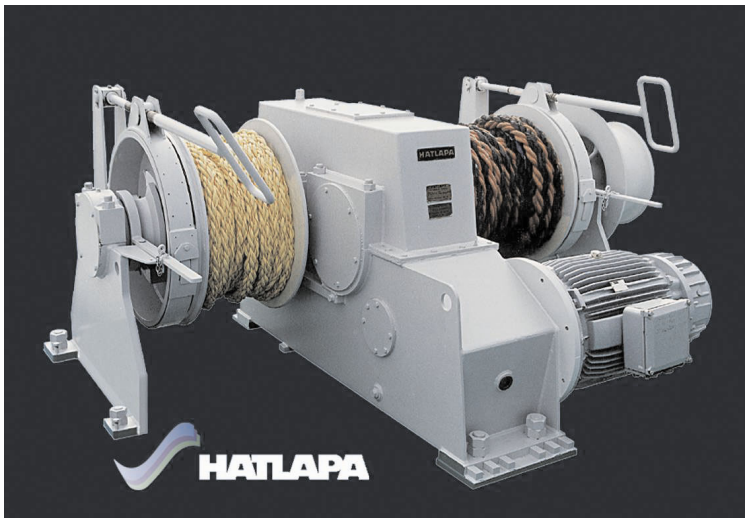
HATLAPA
MARINE EQUIPMENT

Using GPK in design

G-PK (standard package for industrial gear design) can be used in powerful way in gearbox verification and design. KISSsoft AG has made in cooperation with HATLAPA marine equipment modifications for the standard G-PK models to meet their specific requirements. G-PK makes it easy to calculate the shafts, gears and bearings with couple of mouse clicks and simultaneously all results and reports are easily created. Analysis of the gearbox becomes more efficient and faster with this tool. This will help HATLAPA not only in their accelerated product development process but also in preparing calculation reports to be submitted to the marine classification organizations.





Note that the data in this report has been modified to protect the customer interest. KISSsoft AG thanks HATLAPA for allowing us to publish this application report. See www.hatlapa.de

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G-PK - Application report

1 Customer specific models

1.1 The model

Using KISSsys, the system program for KISSsoft, HATLAPA works on a system of machine elements – modelling the complete gearbox used in their winches - instead of single elements. With KISSsys the power flow and the resulting loads on the elements (shafts, bearings, gears) of the system is calculated and the load data is available for analysis of single elements using KISSsoft automatically. The functions available in KISSsoft for dimensioning gears, shafts and other mechanical elements get much more powerful and flexible to use. When changing data on one element, the power flow is changed/recalculated and the changes in the lifetimes on other elements is visible immediately. Load spectra can be defined on a global level, several variants of a gearbox can be handled in the same model, differential gears and selector gearboxes are possible.

The time consuming iteration between different elements in the gearbox is reduced, repetitions of calculations are performed automatically and data handling mistakes are eliminated. The engineer has more time to concentrate on his important work: optimising the gearbox with respect to e.g. lifetime, noise or costs.

Furthermore, using KISSsys, both views on the gearbox (geometrical and analytical dimensioning) are handled simultaneously. In the same user interface where the strength analysis is performed, a 3D model of the gear box is available. Each step in the design and optimisation can hence checked for geometrical constraints.

A casing can be modelled using simple solids like cuboids and cylinders, to be positioned and arranged in space. Collision checks between casing and gears or shafts can be done in 3D viewer. Pre-defined views are helpful, panning, zooming and rotating is available. In case of doubt, the collision checks can be programmed in detail using data from the gears and casing (dimensions and positions). For this, KISSsys is equipped with a programming language and user interfaces with tables which can be programmed similar to Excel.

Standardised interfaces in KISSsoft (like dxf, step and iges) allow for an exchange of data (shaft, gear and bearing geometries) from KISSsys to CAD. Creation of drawings are hence much simplified. Furthermore, manufacturing parameters for gears can be printed automatically and added to manufacturing drawings.

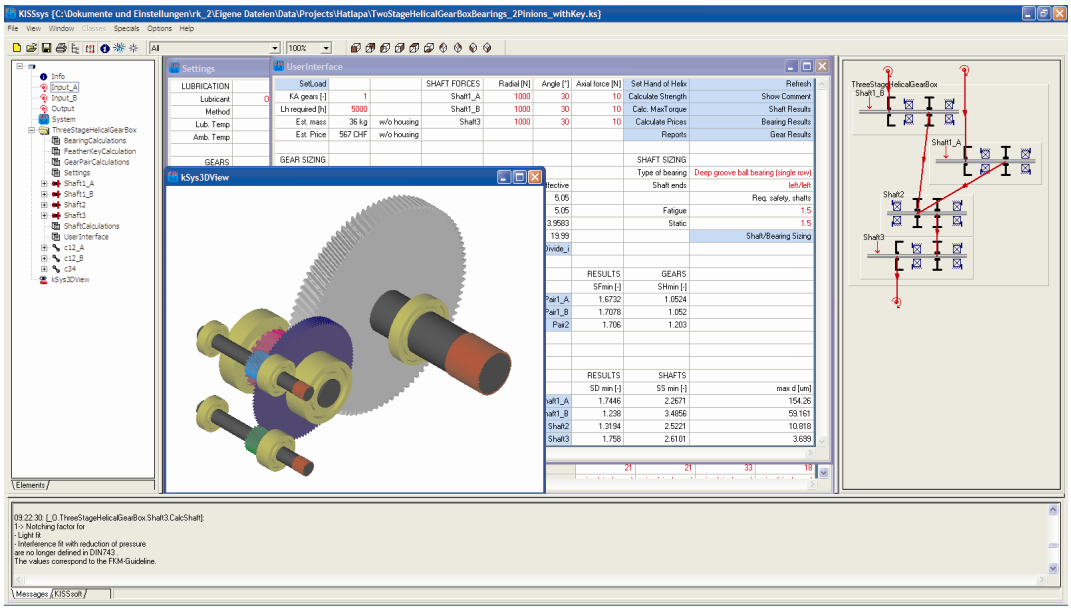


Figure 1.1-1 G-PK model of a gearbox

1.2 Model customization

Starting from the original GPK models any customization to meet customer requirement can be done. New functions can be also introduced to make special calculations or to create special reports. For HATLAPA, a second power input with a second pinion was introduced to the calculation model. For this, an existing KISSsys model (called GPK) was modified by KISSsoft AG application engineers. The customization was realized in a single day, allowing HATLAPA to start their work immediately. After completion of the model, an internet meeting was arranged to demonstrate the use of the model to HATLAPA engineers.

Figure 1.2-1 Typical deck machinery built at HATLAPA, including machinery components like gears, shafts, bearings analysed with KISSsys and KISSsoft; HATLAPA

2 Calculations

2.1 Gearbox cost estimation

The KISSsys model allows for a cost estimate even during the design phase. In the model, the costs of the gearbox (without housing) are estimated simultaneously with the calculation. In the model, HATLAPA can also introduce their production data order to improve the accuracy of the estimated costs.

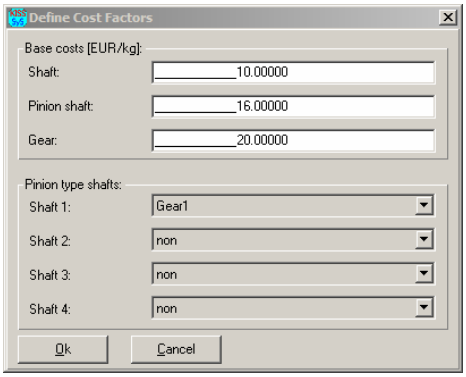


Figure 2.1-1 Settings for cost calculation

2.2 Pre sizing

The model allows for an initial, automatic sizing of the whole gearbox. Based on required lifetime, materials used and loads applied, the model will automatically propose sensible gear dimensions, bearings sizes and shaft diameter. These proposals should then be considered as a starting point for the final sizing of the individual components using the integrated KISSsoft calculation software.

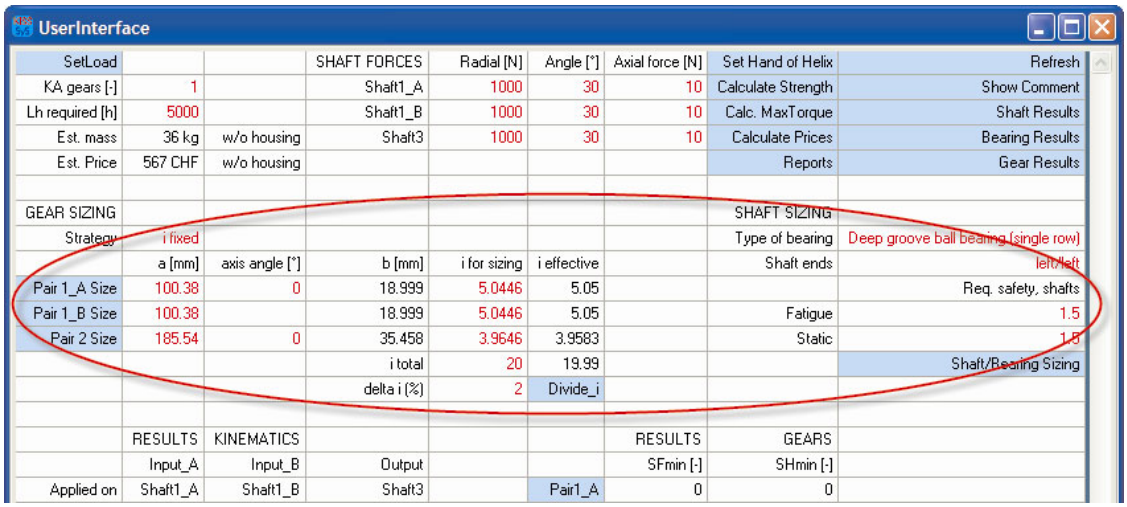
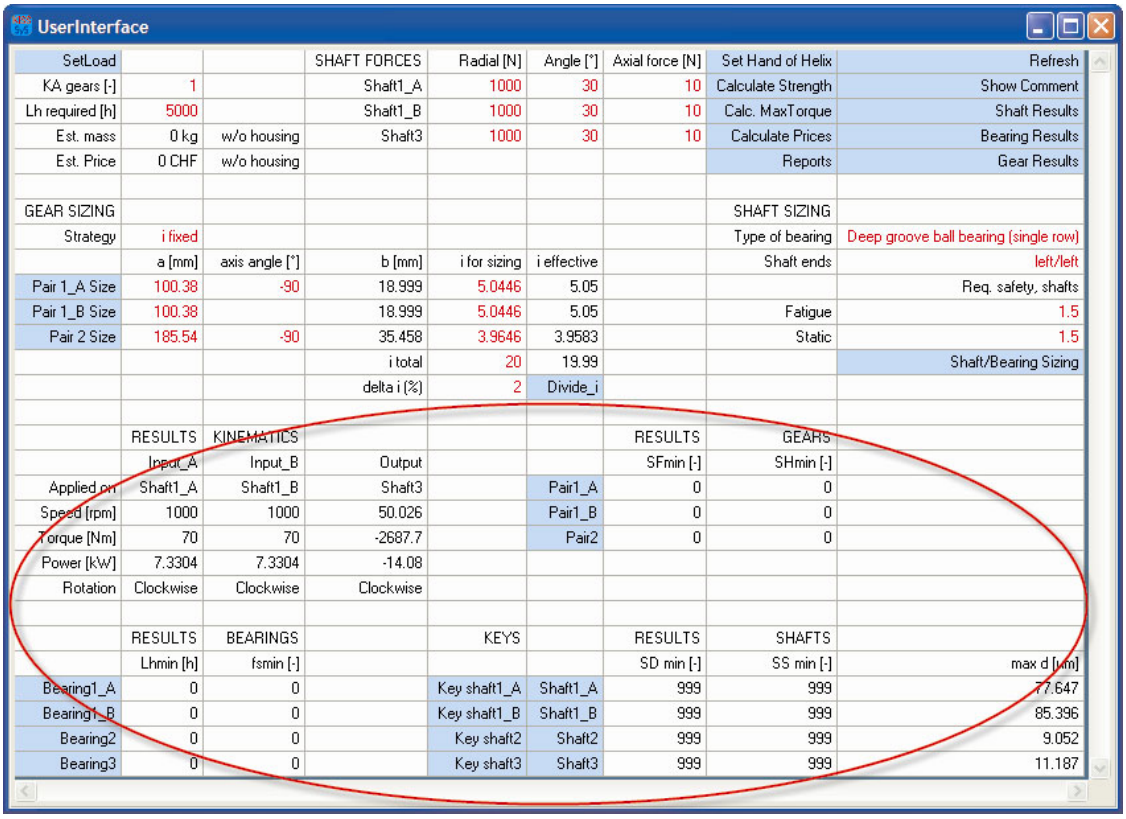


Figure 2.2-1 Create a first estimation of the whole gearbox in minutes

2.3 Results

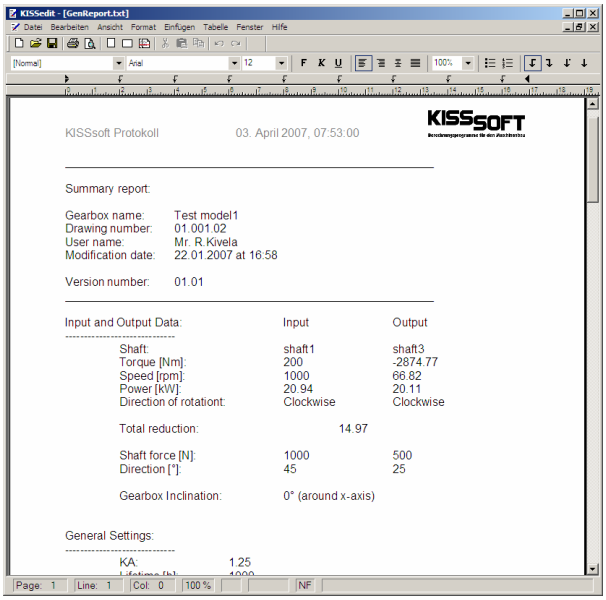
In a single table, the most relevant results are shown as a summary. The kinematic situation is described (speeds, torques, power, sense of rotation) for information. Safety factors for each gear mesh, the static and fatigue shaft strength and bearing lifetime is shown. This allows HATLAPA engineers to see instantly whether their design will fulfill their customer requirements.



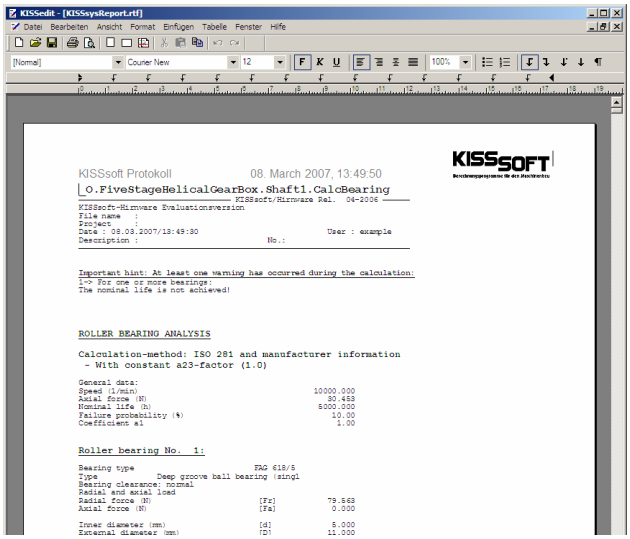
SetLoad			SHAFT FORCES	Radial [N]	Angle [°]	Axial force [N]	Set Hand of Helix	Refresh
KA gears [-]	1		Shaft1_A	1000	30	10	Calculate Strength	Show Comment
Lh required [h]	5000		Shaft1_B	1000	30	10	Calc. MaxTorque	Shaft Results
Est. mass	0 kg	w/o housing	Shaft3	1000	30	10	Calculate Prices	Bearing Results
Est. Price	0 CHF	w/o housing					Reports	Gear Results
GEAR SIZING							SHAFT SIZING	
Strategy	i fixed						Type of bearing	Deep groove ball bearing (single row)
	a [mm]	axis angle [°]	b [mm]	i for sizing	i effective		Shaft ends	left/left
Pair 1_A Size	100.38	-90	18.999	5.0446	5.05			Req. safety, shafts
Pair 1_B Size	100.38		18.999	5.0446	5.05		Fatigue	1.5
Pair 2 Size	185.54	-90	35.458	3.9646	3.9583		Static	1.5
			i total	20	19.99			Shaft/Bearing Sizing
			delta i (%)	2	Divide_i			
	RESULTS	KINEMATICS				RESULTS	GEARS	
	Input_A	Input_B	Output			SFmin [-]	SHmin [-]	
Applied on	Shaft1_A	Shaft1_B	Shaft3		Pair1_A	0	0	
Speed [rpm]	1000	1000	50.026		Pair1_B	0	0	
Torque [Nm]	70	70	-2687.7		Pair2	0	0	
Power [kW]	7.3304	7.3304	-14.08					
Rotation	Clockwise	Clockwise	Clockwise					
	RESULTS	BEARINGS		KEYS		RESULTS	SHAFTS	
	Lhmin [h]	fsmin [-]				SD min [-]	SS min [-]	max d [mm]
Bearing1_A	0	0		Key shaft1_A	Shaft1_A	999	999	77.647
Bearing1_B	0	0		Key shaft1_B	Shaft1_B	999	999	85.396
Bearing2	0	0		Key shaft2	Shaft2	999	999	9.052
Bearing3	0	0		Key shaft3	Shaft3	999	999	11.187

Figure 2.3-1 Most important results seen immediately in one table

For submitting analysis reports e.g. to classification societies, HATLAPA is using the integrated reporting functions. KISSsys frees them from this boring chore; they may choose between a summary (e. g. for your customers, or as a cover page for the project file) and a complete report. The latter, documents in extenso all the calculations, making sure that they can document their work quickly, accurately and in a comprehensive way.



Summary report, about 2 Pages



Complete report, up to100 Pages

Figure 2.3-2 Reports for the results easily available

2.4 Calculations

The calculations are based on accepted standards. In the solution created for HATLAPA, the following standards are applied. The calculations are all performed in KISSsoft which is controlled by KISSsys.

Machine element	Standard, strength calculation	Remarks
Helical gears	DIN3990	ISO6336, VDI2737, AGMA2001 can also be used
Shafts	DIN743	FKM or Hänchen&Decker can also be used
Bearings	ISO281	Using load capacity numbers, with our without aDIN factors
Keys	DIN6892	

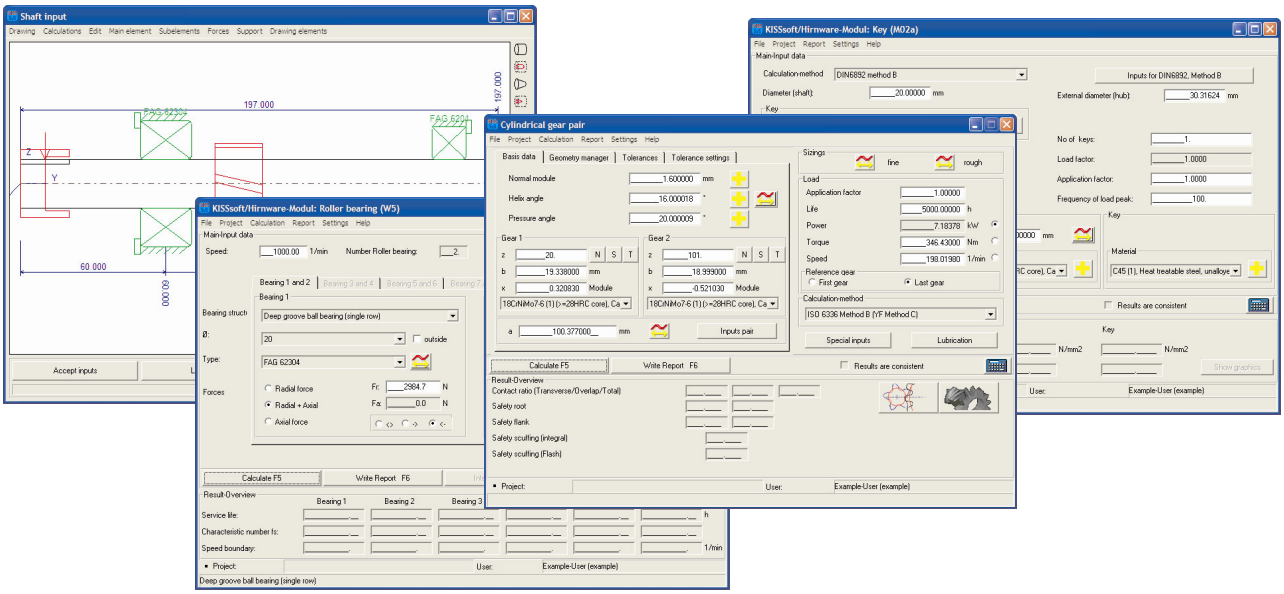


Figure 2.4-1 Access to the single components to adjust the data for the shafts, keys, bearings and gears.

Figure 2.4-2 Final machinery with gearbox enclosed on right side of winch