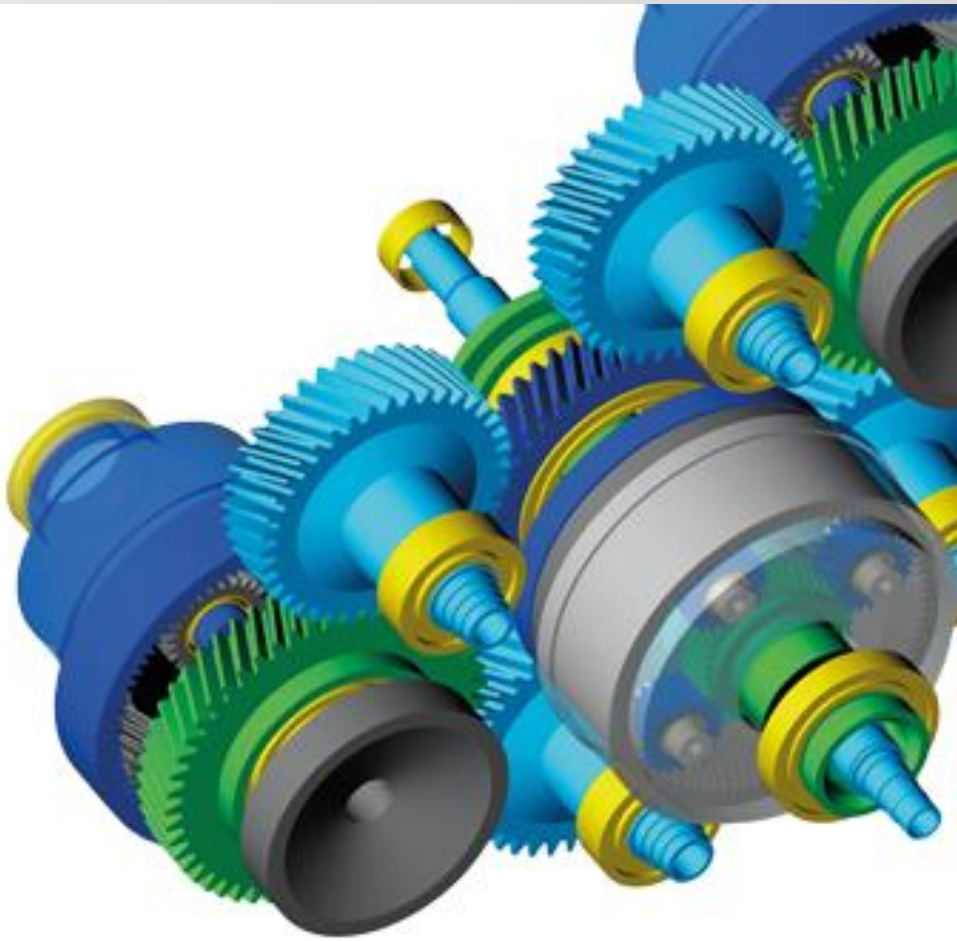
Transmission Error and Force Excitation in a Nutshell



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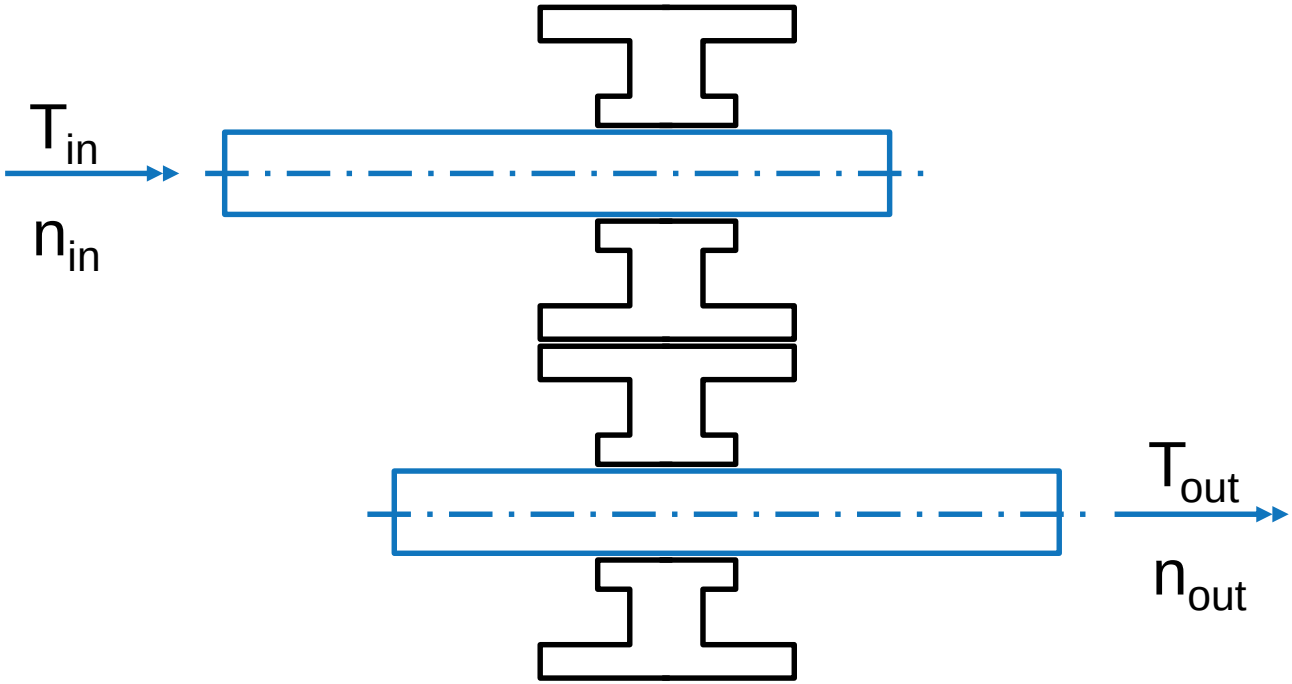
Single Stage

The situation:

We are looking at a single stage gearbox. The input torque and speed are T_{in} and n_{in}, respectively. Output torque and speed T_{out} and n_{out}.



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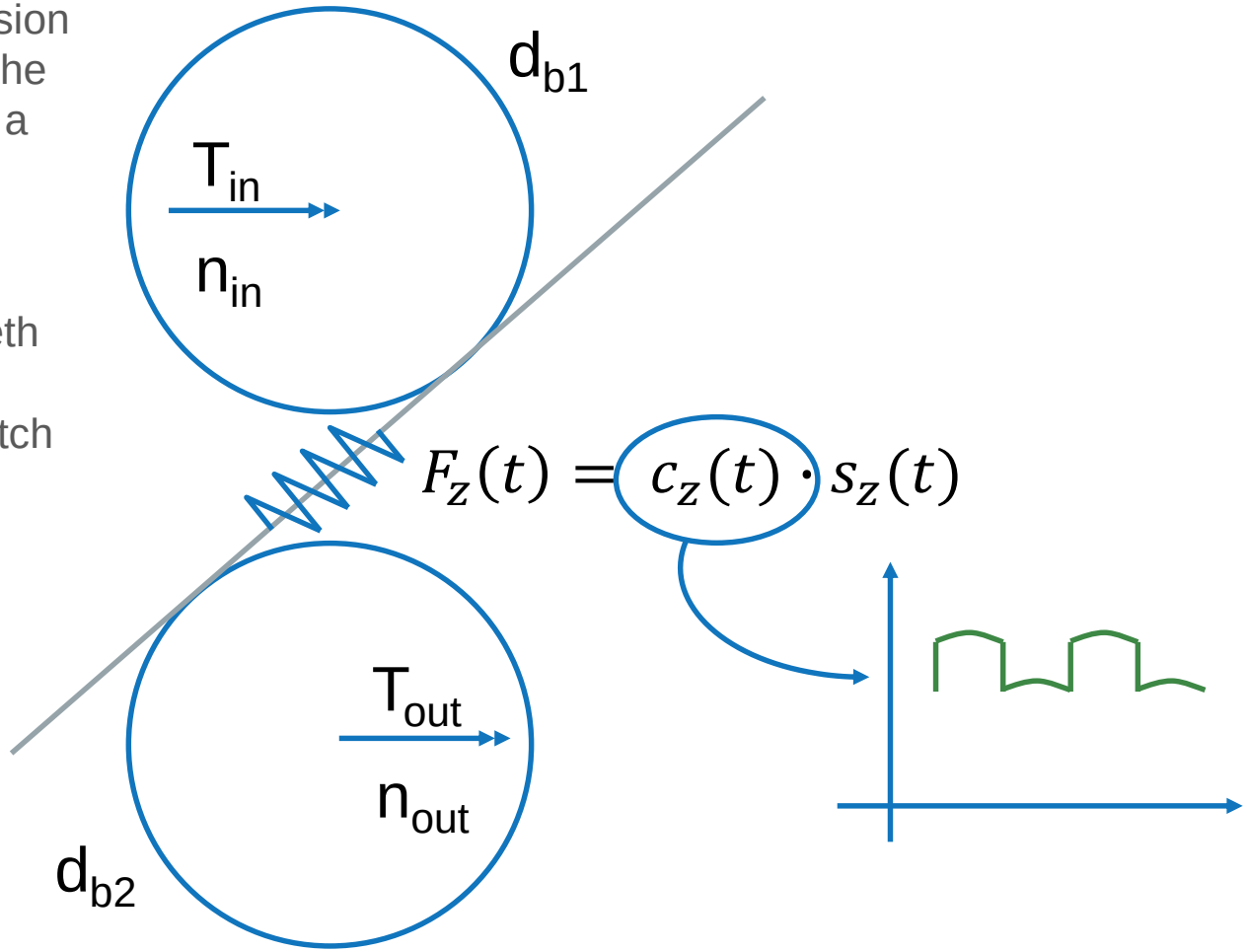
The Model

The model for the transmission error reduces the gears to the base diameter, the teeth to a spring.

The stiffness of the spring changes periodically due to the changing number of teeth in contact and the varying contact situation with the pitch as period.



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Transmission Error vs. Force Excitation

For **transmission error**, it is assumed that input speed and torque are constant, output torque is also constant, which corresponds with a constant force in the meshing. Since the stiffness of the spring is not constant, this results in a non-constant spring compression. This behavior fits to the situation, when the two gears are meshing very slowly and thus have time to move to the right position.

The model for the **excitation force** assumes the gears are running so fast that due to the inertia they can't alter the speed anymore. So the compression of the spring is constant (mean value s0 of the transmission error), which leads to a varying gear force. Some experts state that this is a more fitting model for vibrations analysis.

$$F_z(t) = c_z(t) \cdot s_z(t)$$

$$F_n = \frac{T_{in}}{r_{b1}} \qquad c_0 = \overline{c_z(t)}, \qquad s_0 = \frac{F_n}{c_0}$$

$$TE(t) = s_z(t)$$

$$FE_z(t) = c_z(t) \cdot s_0$$

	Transmission error	Force excitation
T_{in}	const	calculated
n_{in}	const	const
T_{out}	const	calculated
n_{out}	calculated	const
$F_z(t)$	const = F_n	calculated
$s_z(t)$	calculated	const = s_0

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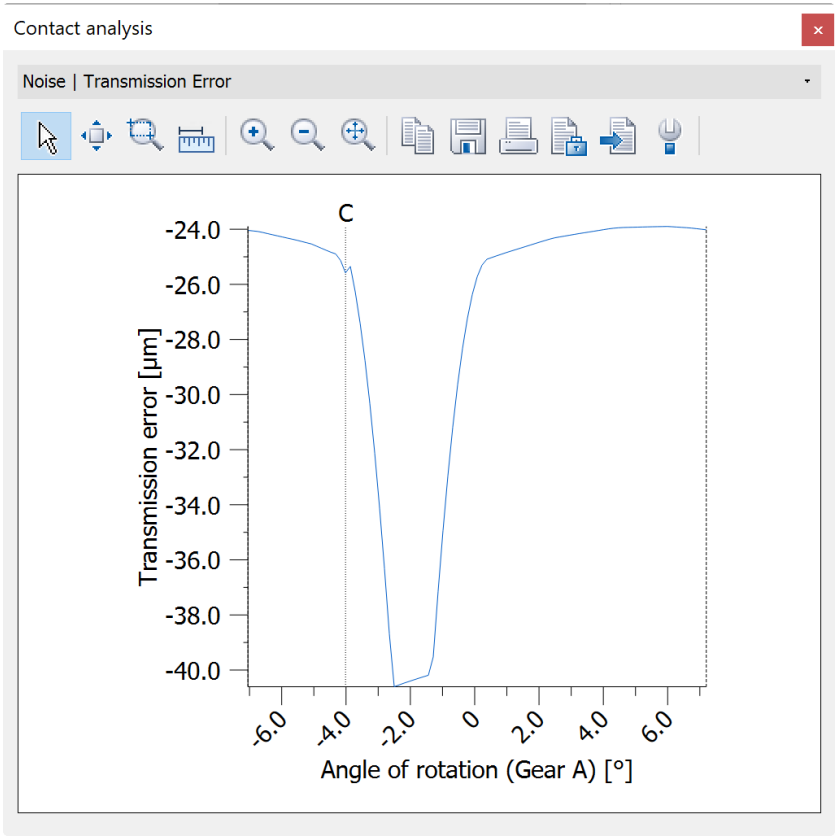
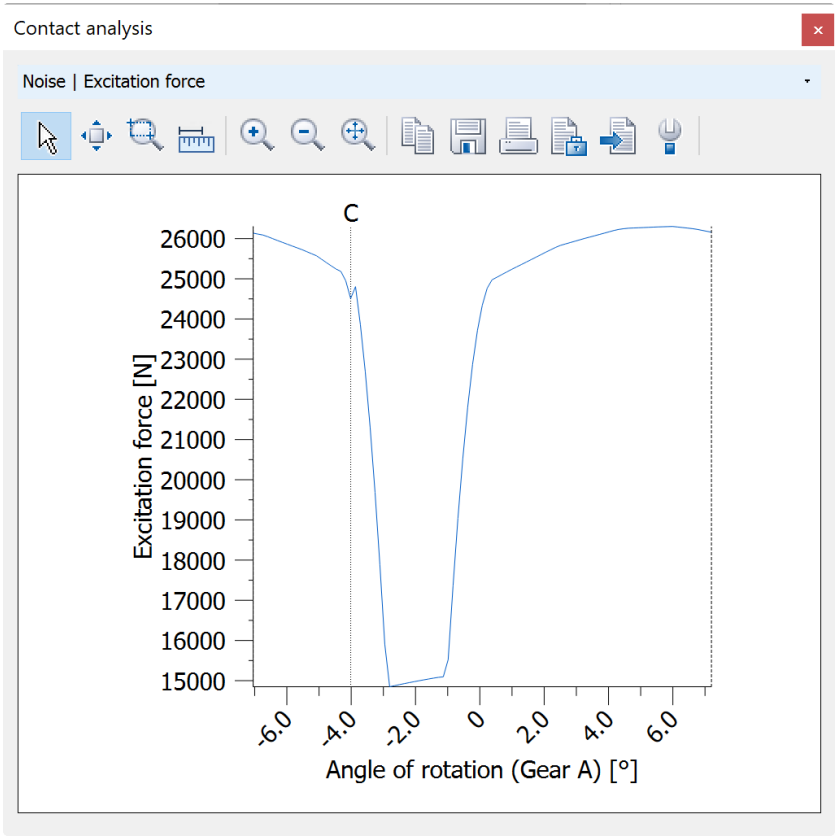
Transmission Error vs. Force Excitation

Note the differences in the duration of the single tooth contact phase.





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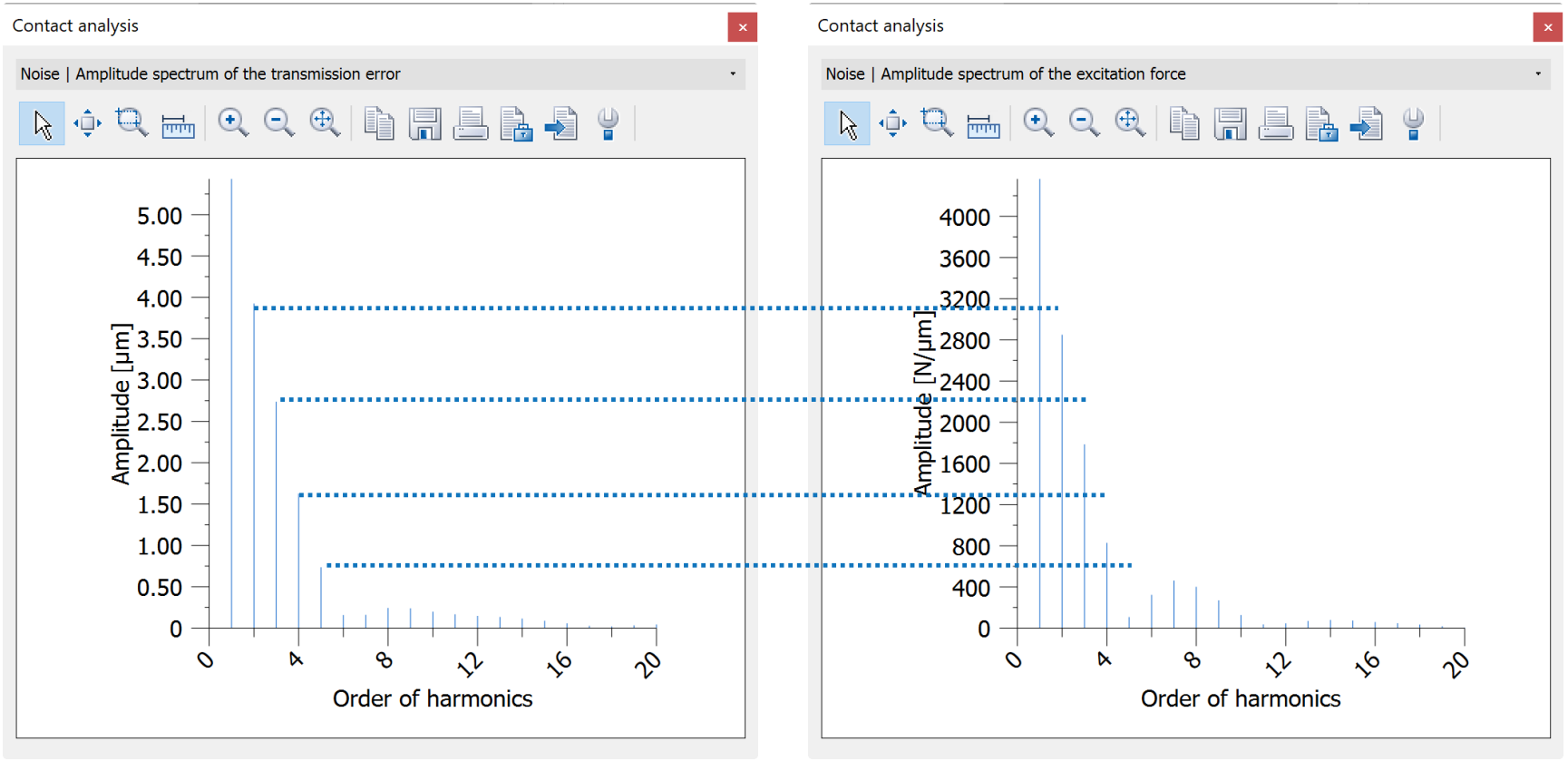
Transmission Error vs. Force Excitation

In the amplitude spectrum, the difference in shape manifests in the 2nd to 9th harmonics.



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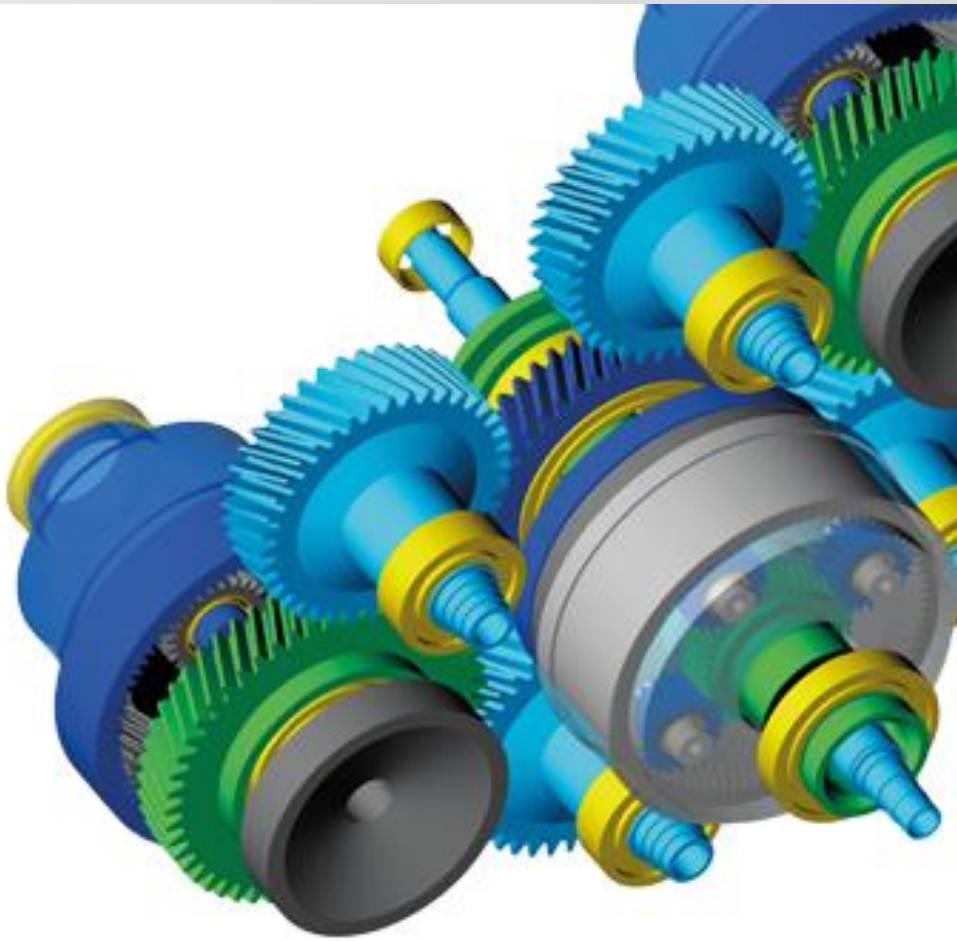
Thank you for your attention!



Sharing Knowledge

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