Optimizing a cam drive with induDrive and Dynamic Designer Motion in SolidWorks

General considerations

SolidWorks places at the designer's disposal an excellent tool for 3D Design. With this system, a great number of data are made available by the program for the layout of the machines, exceeding by far the possibilities of the 2D Design. But only the corresponding tools will help you to make full use of the existing information.
With the help of the Dynamic Designer (DDM), the dynamic conduct of the design can be investigated. **InduDrive** represents a powerful program allowing a precise motion control in the DDM - to generate shock and jerk-free cam discs with drive functions, for instance, but also for other motions, like electronic drives, etc.

The motion layout must be parallel to the design: It is not sufficient to consider the movements taking place directly at the workpiece. It is also necessary to take into account all the lever linkage points, the curve contours, and the forces acting upon the cam roller (Hertzian stress), etc. A continuous circuit between the simulation results and the effect on the design is created (Fig. 1).

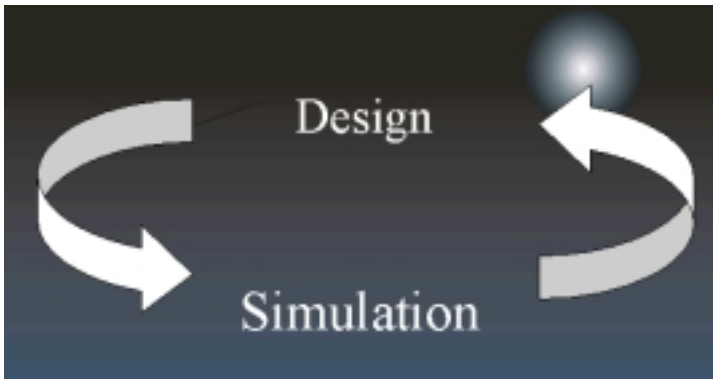
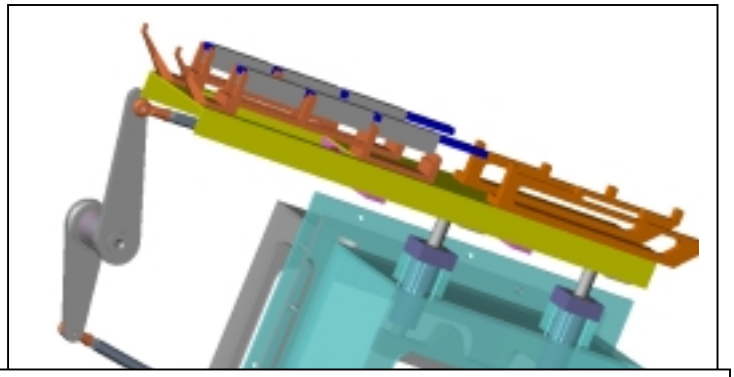


Fig. 1: Integration of design and simulation

This example will show how workpieces in a folding machine are further processed by pulse-control (see Fig. 2).



The shaping is done in three steps:

1. Determination of the motion sequence
2. Generation of the cam contour
3. Evaluation of the cam contour

These processes are explained more thoroughly below.

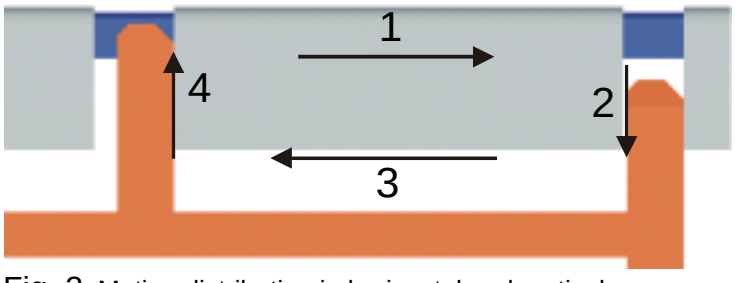


Fig. 3: Motion distribution in horizontal and vertical components

Determination of the motion sequence

The movement is split up into the following, partly overlapping motion sections (Fig. 3).

1. Horizontal movement to the front
2. Vertical movement downwards
3. Horizontal movement to the rear
4. Horizontal movement upwards

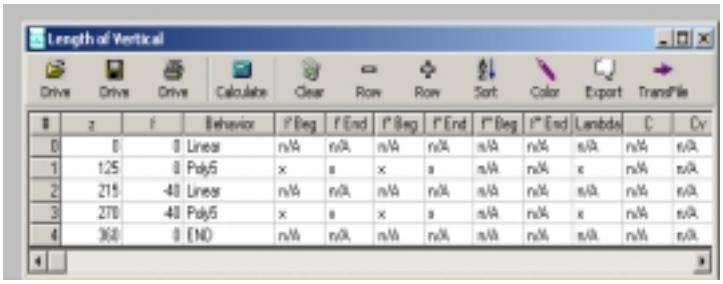


Fig. 4: Motion definition by sections in induDrive

In the DDM, a horizontal and a vertical sliding joint are defined for the rake. Any further definitions are not required at this stage. Both joints will be fitted with drives controlled by InduDrive. The drives are defined by sections. Example: The z-rates (Fig. 4) will be entered relating to 360 degrees (corresponding with one revolution of the cam disc to be generated), while the horizontal or vertical displacement paths of the rake are entered as f-rates. For displacing the path, the different shock and jerk-free laws (Poly5, modSin, modTrapeze etc.) can be entered.

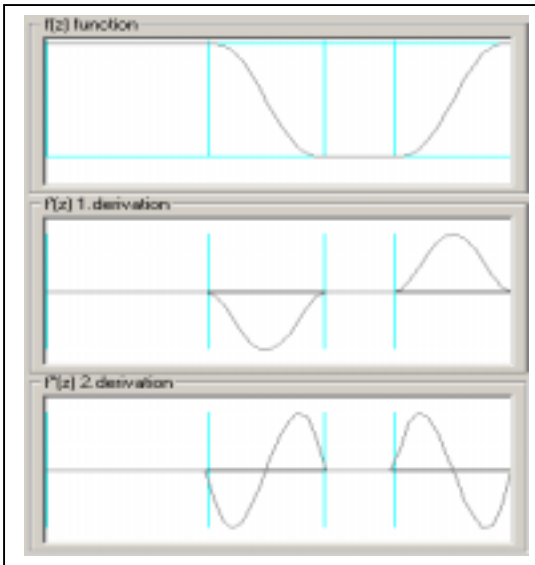


Fig. 5: Individual motion Function, Derivation

In this example, only rest-in-rest movements are required. With induDrive, however, any desired and far more complicated processes can be computed (motion in speed or reversal in resting position, etc.
With this procedure, the limiting values for the individual functional sections are computed by the program and automatically transferred to the following section. It is not necessary for the user to know the details of the mathematical functions: An extensive help function explains the working of the laws. The individual functions are graphically displayed on the screen, the rates obtained can be directly read on the graphics (fig. 5).

For this example, both drive functions are defined and viewed in a common diagram

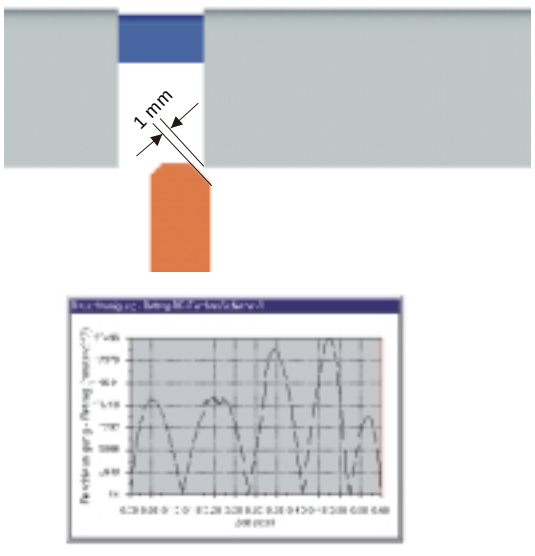


Fig. 7: Optimizing the motion equence in the

where the intended overlapping motion of the section (second derivation) can be clearly seen (Fig. 6).

Basically, any number of drives can be viewed simultaneously.

After having theoretically harmonized the drives, the computed rates are conferred onto the DDM. The simulation is started, and it is verified that the rake nowhere collides with the workpieces. As a rule, several passes will be necessary, especially with complex tasks, until in all positions a collision can be excluded and safe working is guaranteed, while the overlapping of the individual movements is still as important as possible in order to ensure a highly soft and low-vibration run.

At the same time, the true speeds and accelerations can be measured using the DDM tools (Fig. 7).

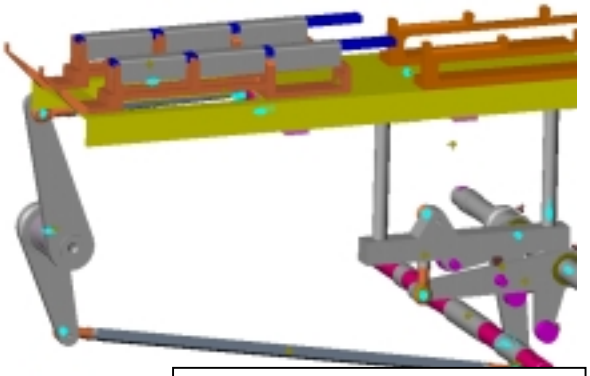


Fig.8: Extensio
levers

Generation of the cam contour

In the further course of the construction, the design from the power take-off side is completed (Fig. 8): All necessary levers and reversing points are determined and linked together in the DDM. By doing so, new simulation runs are continuously effected in order to monitor the admissible swivelling and transmission angles, and to exclude any collisions.

Finally, the cam blanks are placed on the drive shaft and rigidly tied to it in the DDM. The positions of the roller centres are recorded in the DDM. With the help of a co-ordinate transformation furnished by induDrive, the co-ordinate points x, y and z for the cam can be generated.

These points are entered in SolidWorks as spline contour in the single part of the cam disc. The disc contour is realized with the help of the spline.

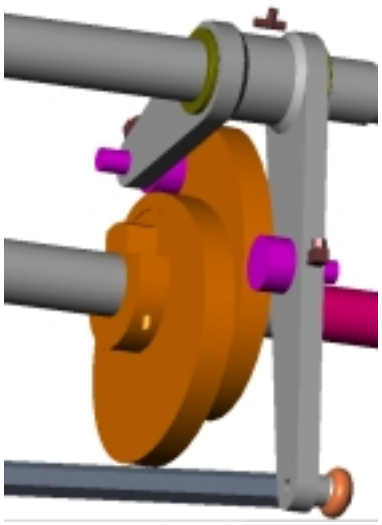


Fig. 9: Generated double cam

In this example, double cams are produced (Fig. 9) guaranteeing a forced guidance at low wear for the cam rollers.

Evaluation of the cam geometry

The evaluation is done in two steps:

1. Evaluation of the geometry:

With the help of a circular interpolation supplied by induDrive, the geometry is split up into many small circular arcs tangentially merging into one another. Apart from the possibility to directly confer these data onto NC spindle moulders, the contour radii can be read via the cam disc. This way, the maximum and minimum radius of the cam contour can be determined.
It is also of importance to check the transferring angle of the swivelling lever in order to avoid any inadmissible loads on the rollers, or even squeezing the cam. To this purpose, too, induDrive supplies an analysis.

2. The evaluation of the kinematics:

At this stage, the drives generated by induDrive are cancelled and the rollers directly connected to the cam disc (contact joint in the DDM): The kinematics are now operating in the correct direction. Since all masses and moments of inertia are known to the system, the forces occurring in all the joints can be measured. Furthermore, a final check of the motion sequence can be undertaken, this time with the real contour in the model. The stress on the cam roller as well as the necessary driving power and torque can be found with dynamical rates. The Hertzian stress can be determined. Effects of springs and absorbers onto the system (in order to put relief on rollers and joints, for instant) can be tested.

Summary

The extension of the Dynamic Designer by the induDrive program for the layout of shock and jerk-free motions offers very comfortable possibilities for generating and optimizing cam contours fast and safely in SolidWorks already during the design stage.

The motion laws are directly entered into the actors. Via the linked levers, the kinematics up to the rollers are completed. From the track of the roller centre in relation to the revolving cam, the contour is generated in SolidWorks. Subsequently, the dynamical behaviour of the machine is checked by producing the motion via the generated cam contours.

Where to buy

InduDrive is compatible with all versions of Dynamic Designer, and with ADAMS. You can obtain induDrive from your local Dynamic Designer dealer, directly at MDI, or at

InduSIM GmbH	Phone	8226 / 94 07 04
St. Ulrichstrasse 6	Fax	8226 / 94 07 06
D-89346 Bibertal / Germany		www.indusim.de