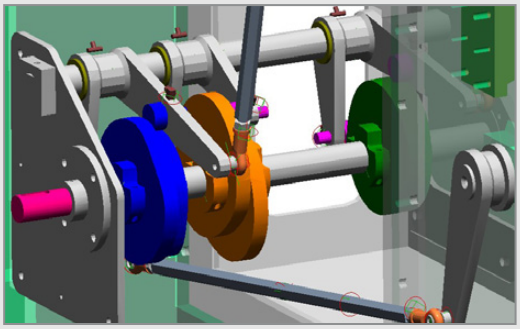
induDrive

- **Shock and jolt-free drive calculations for kinematic simulation programs**
- **Generation and evaluation of cams**

What Is induDrive?



induDrive enables kinematic simulation programs to generate shock and jolt-free motions. Easy and convenient to use and seamlessly integrable with various CAD programs, calculations with induDrive during the design process can be carried out without specialist knowledge. This way, e.g. curves and cams can be quickly designed and optimized.

Step One: Motion Synthesis

The output elements (e.g. the tools in a packaging machine) receive a theoretical drive unit that moves them exactly in the desired way. With induDrive, these movements can be predefined, optimized and passed on to the simulation program.

induDrive

- optimizing and adjusting of drives
- generating cams
- assessment of cam contours
- drive movements for controls
- integrated in SolidWorks Motion and Dynamic Designer

For this so-called motion synthesis, induDrive offers many functions, support and evaluation tools.

When the motion fulfills the requirements, the model in the kinematic tool is completed down to the cams, if this has not already been done. The center of the roller is mapped relative to the rotating cam shaft and generates a track curve (= center point path).

This curve can be read into induDrive and transferred directly to the CAD program, for instance in a drawing. From this, a cam profile is derived with an offset, which matches the motion presets exactly.

Step Two: Profile Analysis

Unfortunately, the profile generated in the motion synthesis process is not always implementable. The gradient of the cam profile may be too steep, leading to jamming or it may even intersect itself. Therefore an analysis of the profile is necessary.

First, the cam profile is examined statically and gradient as well as radius of curvature are evaluated. Then, kinematics is 'reversed' in the simulation program, meaning that the created cam profile now truly drives the system; and the forces acting on the joints are measured.

Since the weights and associated moments of inertia are known in the 3D design, e.g. the Hertzian pressure can be determined instantly from the contact forces, depending on the driving speeds.

Threshold value analyses are also possible.

induDrive

has a direct interface to the following CAD programs:

- Inventor
- Solid Edge
- SolidWorks

In all other CAD programs, curve contours can only be imported via a DXF interface

induDrive Basic

Drives can be defined in the kinematic programs. To a limited extent it is possible to input functions, however, if the complexity of the required function increases, its definition via function expressions with several case distinctions quickly becomes almost impossible and prone to errors.

Graphic Motion Design According to VDI 2143

induDrive closes this gap with a graphic function editor, which allows the user to define motion functions separately for each section in accordance with VDI 2143. All standards of this directive are supported (see chart on the right).

Boundary values are substituted (if the laws of motion allow it) with values from the following or the previous section.

An example: a linear section is fully determined by its start and end point. A following 5th degree polynomial automatically gets the gradient (speed) of the previous linear section as its beginning. This adaptation also occurs in the other direction: a polynomial preceding the linear section receives the speed of the linear section as its final speed. This guarantees the continuity of the first and second derivative.

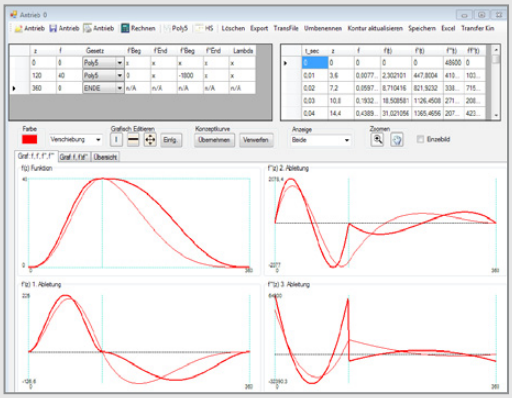
induDrive

offers the following motion standards according to VDI 2143:

- at rest
- linear
- polynomial 5th degree
- square parabola
- modified trapezoid
- modified sine
- sine-linear combination
- balanced combination
- simple sine
- inclined sine
- spline

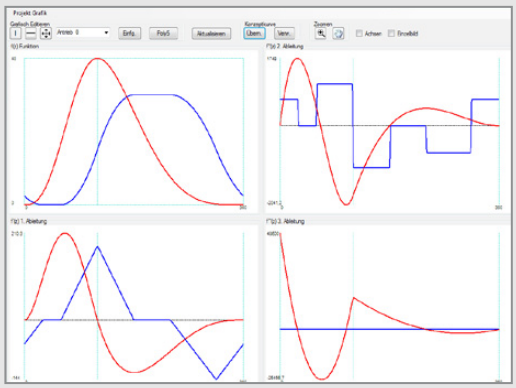
Graphic and Tabular Representation of the Motion Functions

The calculated function with its derivatives is represented in graphic as well as tabular form (the way it is transferred to the respective kinematics program). Furthermore the extremes of the function and of the derivatives are automatically determined. The curve is displayed clearly and allows easy assessment.



Modifications are initially displayed in a draft curve to allow the user to examine their effects on the overall sequence. The changes can be undone, if necessary, or fully adopted. The diagrams can also be graphically edited. The segment boundaries can be moved using click & drag; new segments may be inserted. This makes modeling considerably easier.

induDrive Basic can manage several functions simultaneously in different editor windows. These functions can be visualized in a shared diagram and edited together in one window to coordinate them with each other. Data is transferred from induDrive to the kinematics program via a direct interface.

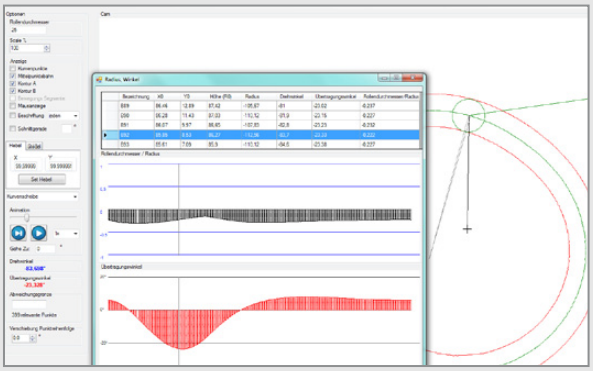


Determining Cam Profiles from Synthesis Calculations

After calculation in the kinematics tool, positions of the cam template or of the roller's center point relative to the rotating camshaft are processed by induDrive. Then the measurements are transferred directly via an API interface, for example into a drawing as spline, and the corresponding cam profile can automatically be generated or updated in the CAD system.

The cam profile can also be saved in DXF format, so it may be further edited in other programs (e.g. NC programming) that have no API interface to induDrive.

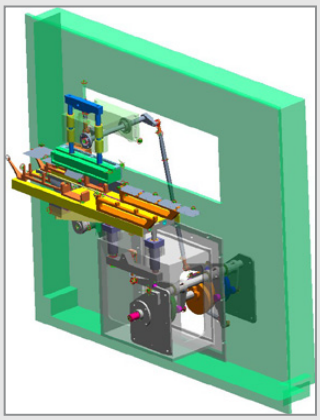
induDrive Result



After carrying out the synthesis calculations, the created cam track has to be analyzed. To do this, the point clouds transferred from the kinematics tool are converted into a cam track (only for level cams) using circular interpolation (tangentially merging circular arcs). Here too, the 'hard' cam profile can be created with an offset

The position of the joints of levers or tappets relative to the cam is automatically read in from the kinematics tool. With these values, the transmission angle between the roller and the cam profile can be determined and displayed.

Comprehensive support tools provide information about the exact position of the gradients on the cam profile and where they occur in the function. If the gradient becomes too large in areas under great stress, corrections are necessary either geometrically in the system's dimensions or in the function definition.

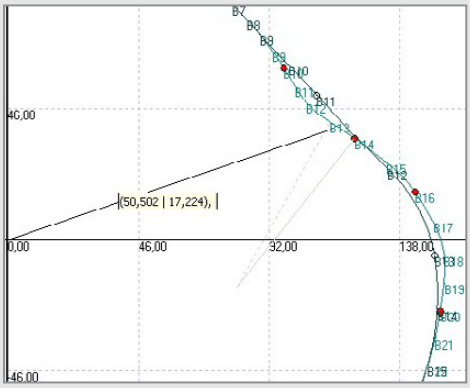


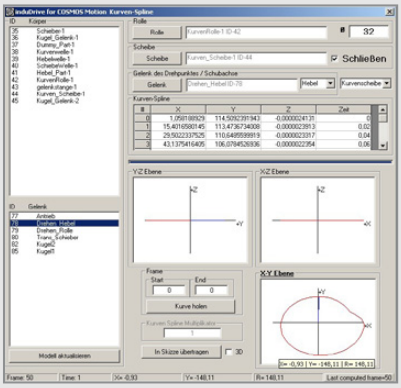
With the effective interaction of the program modules, these changes can be made in a quick, efficient and goal-oriented way.

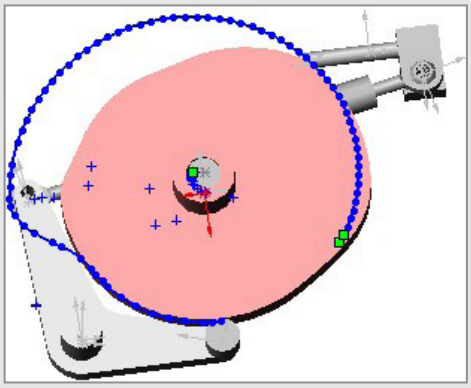
Transferring the Cam Profile in NC Systems for Production

The contour created via circular interpolation with induDrive Results can be saved as a DXF file and input directly into NC systems with a DXF interface. To make it easier to work with NC programs, the number of arcs can be reduced.

A kind of tolerance level is set for the contour (e.g. 0.01 mm). This way, many small circular arcs can be combined into a larger one, which reduces the number of points in the point cloud drastically in areas with a strong change of curvature. This makes it much easier for MC controls to process the profile.





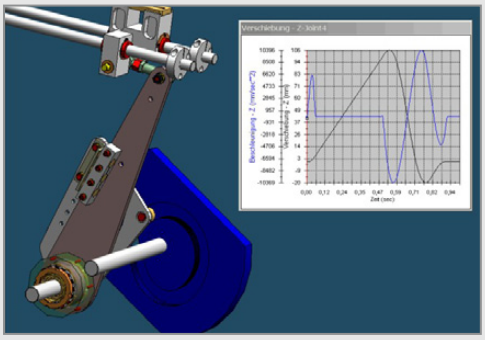


Reading Contours of Existing Cams of Older Machines: induDrive can read in point clouds from measuring machines. The profile created with circular interpolation is then transferred to the CAD system or again saved in DXF format.

Manually correcting the cam profile: Individual points in the point cloud can be moved or deleted. This is necessary if an existing profile has to be modified. The effects can be tested immediately in a simulation.

Operating Systems & Languages: induDrive works with Windows NT, 2000, and XP. It is available in German and English, and it will automatically determinate and use the language of the installed operating system.

induDrive's Advantages at a Glance



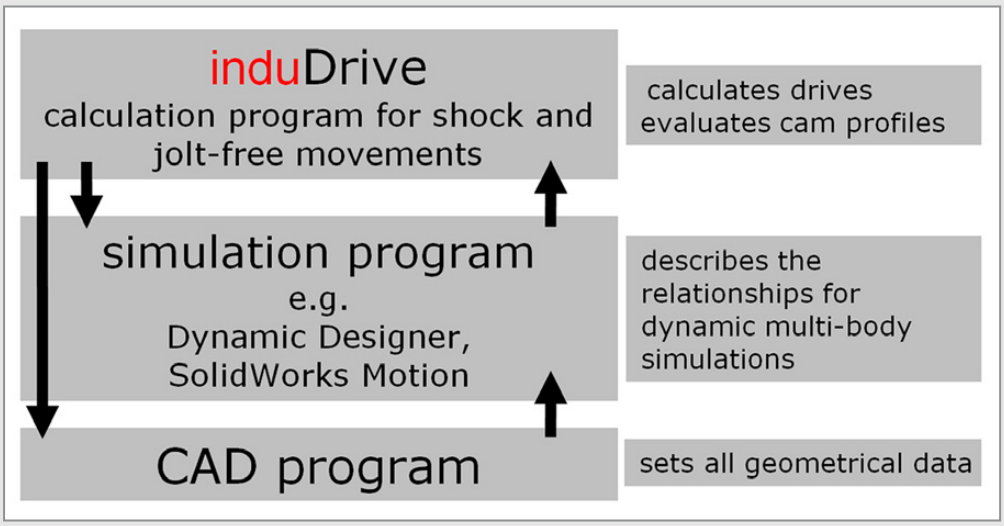
Optimized design: strain on the machine elements and noise levels are reduced through optimized motion functions with induDrive. Efficiency and lifespan of the machine increase.

Reduction of development time: dynamic testing of the system is already possible in the simulation model. Initial insights into the functionality can be gained. The produced cam geometries usually work immediately. Time-consuming and undocumented modifications of cams are avoided. The machine is operational in much less time.

Reduction of engineering effort: Manual calculations, as for the definition of the motion functions or of transmission angles, are omitted. Accelerations, etc. can be calculated without simulating the entire model. The direct data exchange eliminates many sources of error.

Reduction of assembly costs: fewer adjustments during assembly are needed due to the more accurate design.

Increase in creativity and productivity: induDrive helps in understanding complex mechanisms. Additions, improvements or alternatives to the design no longer fall victim to a lack of time.



For more information, please contact us:

induSim GmbH

Benzstr. 15
89129 Langenau
Germany

phone: +49 7345 / 929287-0
fax: +49 7345 / 929287-50
www.indusim.de
georg.zeller@indusim.de

A company of the SimPlan Group
www.simplan.de