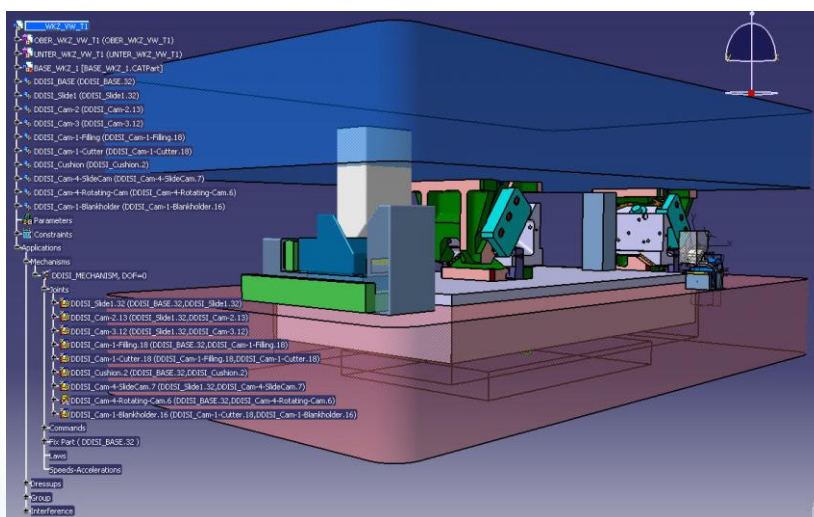


Virtual Die Tryout

- DI9 -










User Guide – V1

BPA Delivery 8 for V5R20 (V5.8)

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CATIA V5 Assembly Design

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CATIA V5 Part Design

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CATIA V5 DUM Space Analysis

Copyright © 2010, Dassault Systèmes. All rights reserved.

CATIA V5 DMU Kinematics

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Following components are used: Parts, Products, Mechanisms, Joints, Commands, Clashes, ClashResults,

1. Introduction

This document describes the user guide for the BPA **Virtual Die Tryout**.

This document is divided into the following sections:

- Virtual Die Tryout overview
- Virtual Die Tryout

1. Scope and purpose

To verify the proper function of a die model the die designer has to define the kinematics of several types of cam units and to test for inner collisions. Already the definition is difficult as cams and drivers are typically placed in different subassemblies on unequal assembly levels. To use given mechanisms like “slide curve joints” the die structure has to be rebuilt but the cam units have to be in steady contact. Another option defining curves in order to animate the motion of cam units is limited to linear cam units without links. Additionally the die designer has to group manually the collision partners or has to check a large list of interference conflicts. Animated motion may reduce the informational value.

With the BPA “Virtual Die Tryout” the user will get a couple of dedicated functions for the test of die kinematics:

- A toolbar containing special commands for die joint definition, Add existing component, die motion calculation, kinematics generation and collision detection and viewing.
- Description of joints are directly related to any subcomponent of any assembly level of a given die assembly
- User interface allows to input 2 information: the already described component and the product where it will be added.
- The generation of the mechanism and corresponding dress up is done automatically
- To change a joint in a mechanism from revolute to prismatic joint takes two mouse clicks
- It is possible to define a discontinuous contact between cam and driver
- It is possible to define springs to model the behavior of cushions
- The motion is calculated by collision detection displacing the cam due to its kinematics and spring forces.
- The collision detection reacts on any given geometrical shape
- This approach is similar to the real die behavior why it could be seen as “Virtual Die Tryout”
- The system generates automatically collision groups on top of the cam unit definition.
- It is possible to reframe on the area where collision is occurred.
- It is possible to clip the model directly at the point of Sectioning & to show the Maximum penetration length for that clash.
- Instead of highlighting and gathering conflicts stepwise, the system stores the angle values for each interference group and simulates only those steps where a collision is found.
- Inspection can be controlled with one conflict list.

This guide describes the use case of BPA DI9 and the mode of operation. Main use case is the verification of the kinematical functionality of die assemblies built as CATProducts and CATParts.

2. Definitions

Pictograms





Symbol	Usage
	Step The step symbol signals that a sequence of work operations is given.
	Information The info symbol signals background information.
	Tip The lamp symbol signals a tip that offers you practical experience to make your work easier.
	Warning: The warning symbol signals critical moments to which you should pay attention in order to avoid problems in your work process.

Table 1 - Pictograms

3. Prerequisite for Virtual Die Tryout usage

Following Modules are prerequisites for the usage of the DI9 BPA

- CATIA V5 Part Design
 - CATIA V5 Assembly Design
 - CATIA V5 DMU Space Analysis
 - CATIA V5 DMU Kinematics
- The assembly structure of the die assembly to be examined corresponds to its kinematical structure. All components moving together are subcomponents of the movable subassembly.



e.g.

- All components moving with PressSlide.1 are subcomponents of this assembly.
- All components moving with the Cam#2Rotor.1 subcomponents of this assembly.

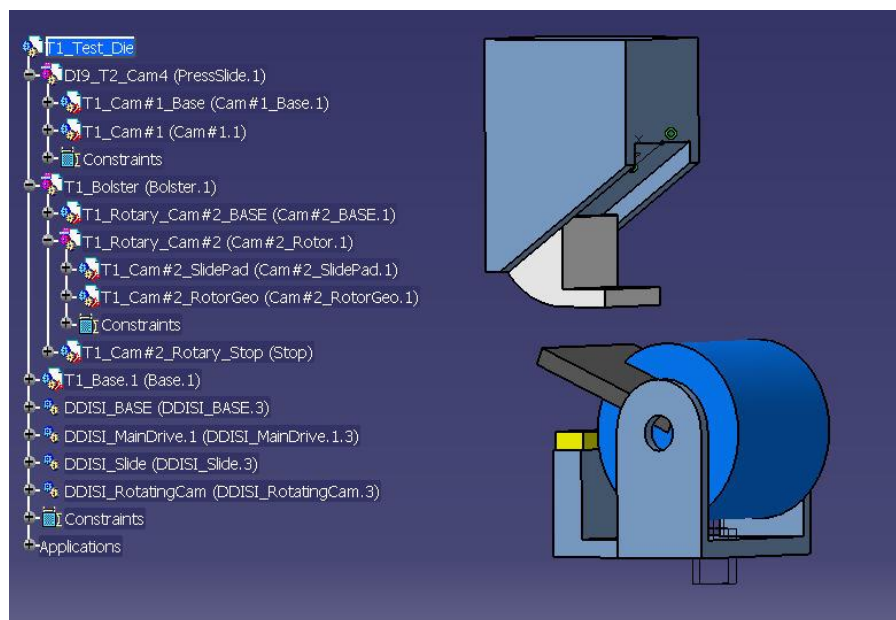


Figure 1 – Example of a suitable die structure

2. Virtual Die Tryout overview

1. Functional overview

- Description of die motion
- Add Existing Component
- Automatic kinematics generation with automatic dress up
- Automatic cam curve calculation
- Automatic inner die collision check and easy collision viewing

2. Processes and rules

Virtual Die Tryout concepts presentation

The main concept of BPA DI9 is the definition of cam units by describing the corresponding components on all levels of the die assembly.

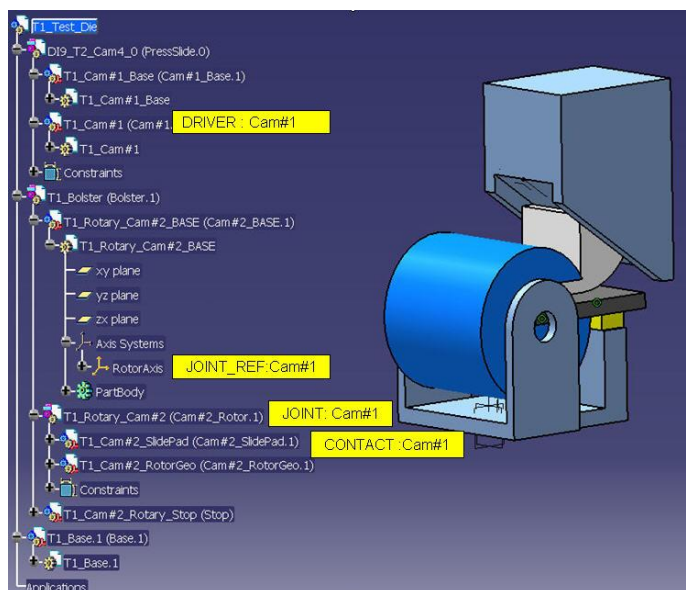


Figure 2 – Example of a suitable die structure

The main algorithm of BPA DI9 traverse the whole die structure and gathers all matching cam unit definitions and the corresponding dress up components. According to this information a new flat kinematics structure is generated and the “dress up” objects are assigned.

The cam unit information is used for the automatic cam motion calculation displacing the cam by the corresponding driver via collision and contact detection.

Also the automatic inner die collision check is based on the results of die structure traversing as all motion groups are checked against each other.

Virtual Die Tryout typical process

The typical process of BPA DI9 “Die Virtual Tryout” shows figure 3. The cam unit description is inserted into the given die structure by selecting and describing the corresponding components of a cam unit: moving component, reference system, cam contact and driver. The moving component additionally receives information about the joint type, minimum, maximum and default value and spring force.

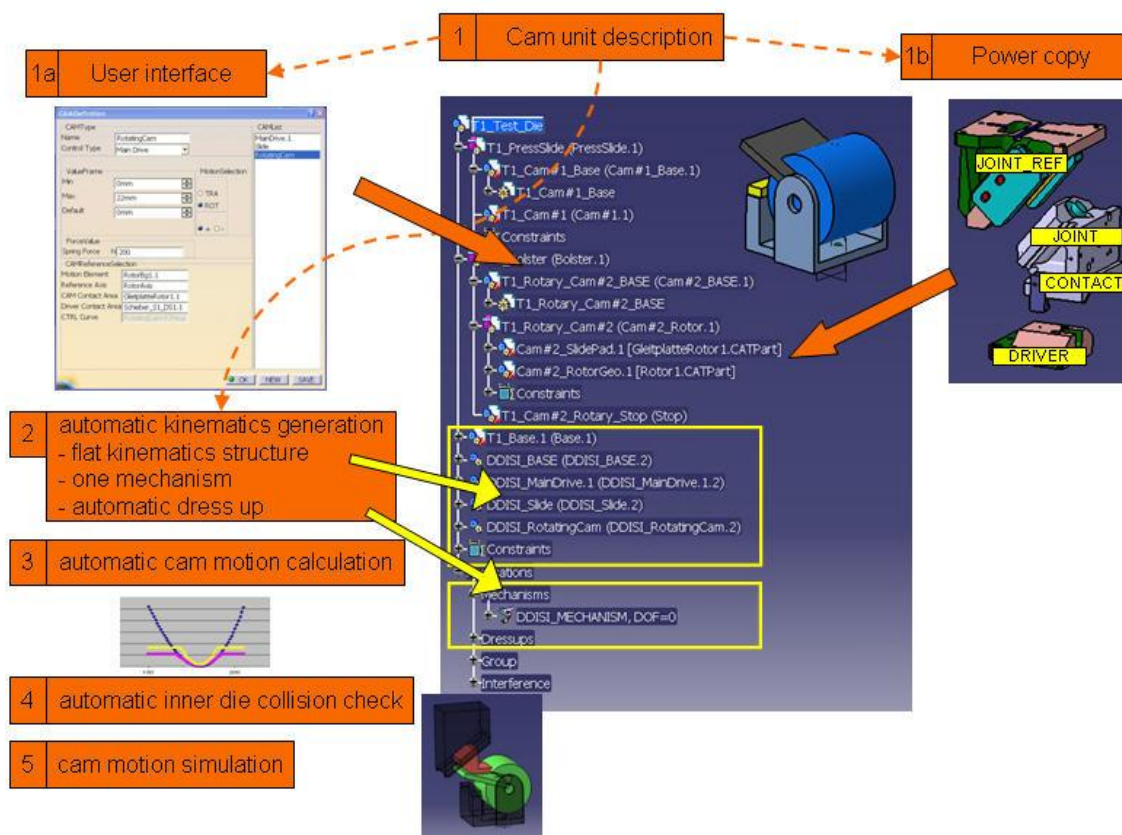


Figure 3 - Process example

The DI9 traversing algorithm gathers all matching cam unit descriptions as well as the corresponding “dress up” objects and stores it in an internal data structure. Due to that information a new flat kinematics structure is automatically generated with only one mechanism and the dress up objects are automatically assigned. After the generation of kinematics the user can check the joint with usual functions of DMU kinematics.

When all cams are moving correctly the automatic cam curve calculation to synchronize the motion of all components can be started. As a result motion curves for all moving components are stored.

These motion curves will be used to check the inner die collisions and to simulate the die motion. The collision results are viewed as one list of clashes results. By selecting a clash the corresponding partners are simulated for all curve increments being in contact or collision.

Virtual Die Tryout rules

- BPA works on Parts and Products
- The assembly structure of the given die assembly must correspond to its kinematical structure. All components moving together are subcomponents of the movable subassembly
- Components of a cam unit can be defined in different levels of the die assembly,
- “DMU kinematics” is a prerequisite for DI9.

3. Virtual Die Tryout user modes

The “Virtual Die Tryout” is using one interactive definition window for the description of die joints. Once this description is saved in the model, no changes in the assembly structure or descriptions should be carried out manually. All following functions generating kinematics, motion curves and clash results are executed without user interaction.

For the result presentation two simulation players are offered to the user - one to check the motion increments the other to visualize inner die collisions.

4. User Interface presentation

BPA User interface

Die Tryout Toolbar:

The toolbar contains dedicated commands for die joint definition, add existing component, kinematics generation, die motion calculation, die simulation, collision detection and viewing.

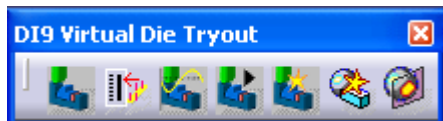


Figure 4 – Virtual Die Tryout Toolbar

1. Die joint definition
2. Add existing component
3. Cam motion calculation
4. Die simulation
5. Collision and visualization
6. Check clash
7. Sectioning

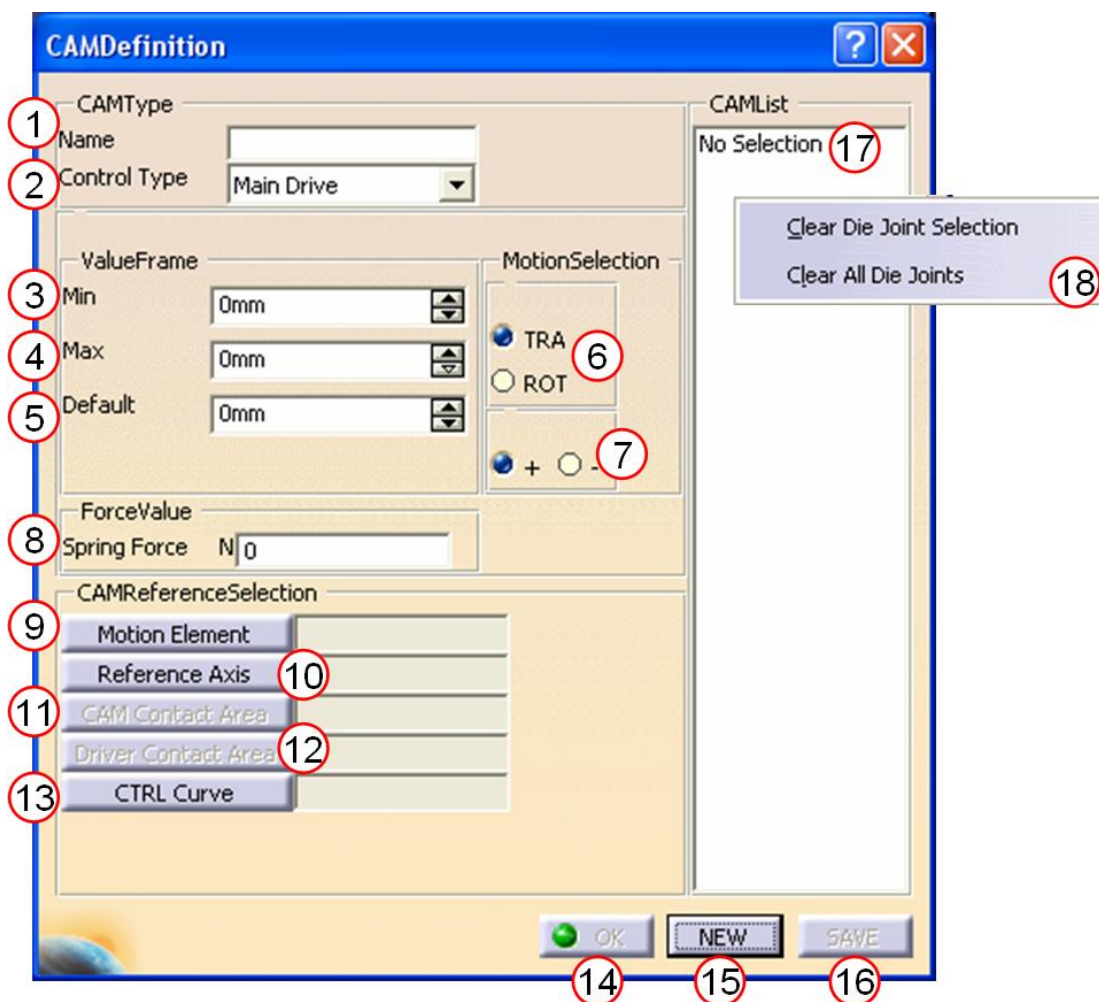


Figure 5 – Die Joint Definition Window

1. Name Input. More than two letters and a unique name
2. Selection of control type
3. Minimum value of joint
4. Maximum value of joint
5. Default value of joint
6. Selection of joint type. Prismatic joint = "TRA", revolute joint = "ROT"
7. Direction of joint axis
8. Spring force definition
9. Selection of motion element
10. Selection of reference system (coordinate system)
11. Selection of cam contact component
12. Selection of driver contact component
13. Selection of control curve file (file selection box)
14. OK - creates kinematics and closes window
15. NEW – a new die joint can be edited
16. SAVE – saves the changes made in during editing
17. Die Joint Selection – to edit a Die Joint double click the item in the list
18. Click Right Button:
 - Clear Die Joint Selection – the selected die joint will be removed
 - Clear All Die Joints will be removed.



Figure 6 – Add Existing Component Window

1. Select product to add component
2. Select component to be added
3. Browse for the component
4. OK – Adds the component in the product
5. Cancel – Does not add the component.

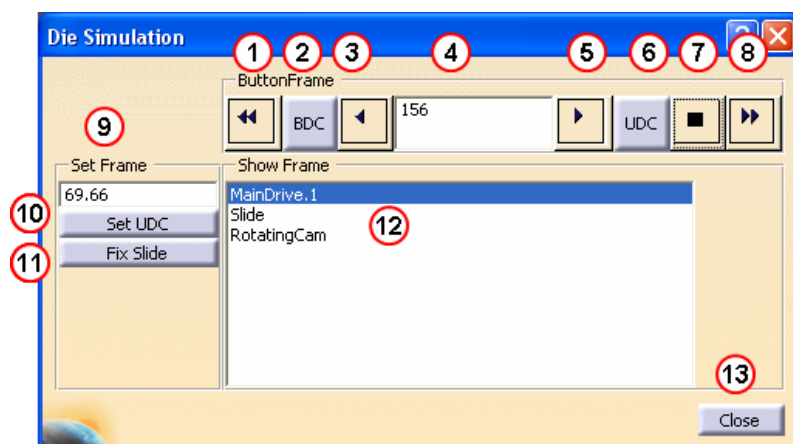


Figure 7 – Die Simulation Window

1. Run backward
2. Bottom dead center
3. Step backward
4. Current increment value
5. Step forward
6. Upper dead center

7. Stop
8. Run forward
9. Current value of selected joint
10. Set upper dead center
11. Select component as fix point in the visualization
12. Selection of joints
13. Close window

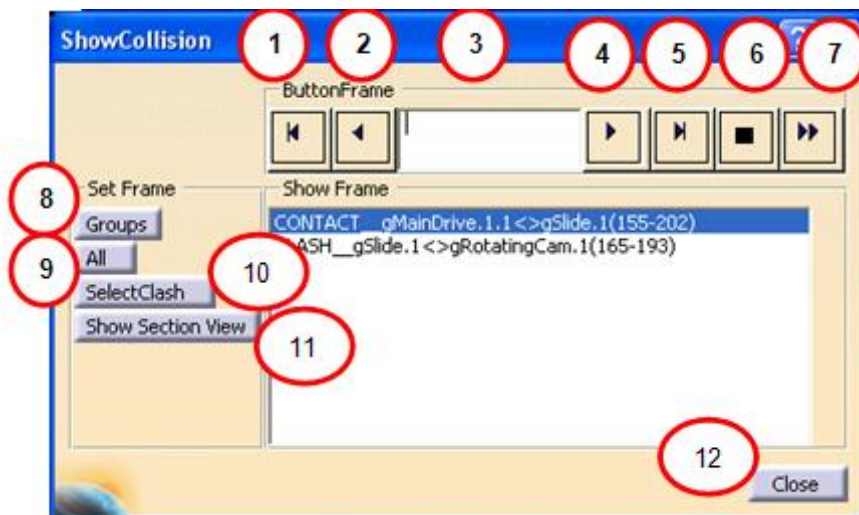


Figure 8 – Collision Show Window

1. Jump to first collision increment
2. Step backward
3. Current increment value
4. Step forward
5. Jump to last collision increment
6. Stop
7. Run forward
8. View clash pair components only
9. Visualize all components
10. Reframe on the area where collision is occurred.
11. Clips the model at the point of Sectioning, show the Maximum penetration length for that clash.
12. Close window

3. Virtual Die Tryout

1. Chapter : Describe Die Motion

Purpose

This function will allow the user to describe die motion with a dedicated user interface.

Die motion can be caused by drives or cam units or a combination of both, e.g. a die cushion can be driven by a drive but will be additionally displaced by the upper die.

Following control types are selectable:

- MAIN DRIVE : slide motion given by the press line slide curve
- DRIVE : other controlled die components, e.g. pneumatic
- DRIVE + CAM UNIT : controlled and displaced die joints like cushions
- CAM UNIT : cams displaced by drivers

Function overview

For the motion definition the user has generally to select the moving component and the reference axis of the motion. For defining kinematics

- motion type (revolute or prismatic joint) and
- axis direction,
- as well as the limits and default value of the motion

have to be defined.

In case of “Drives” the user has to select a curve file (format see appendix).

In case of “Cam Unit” the driver contact area and cam contact area have to be selected. The cam contact area is a CATPart belonging to motion element.

The Die Joint will be described with help of Die Joint Definition Window.

The user has to type in **Name** of the new die joint as well as the values for **Minimum**, **Maximum** and **Default** value of the die joint.

Die **Joint Type** is selected from an item list

Motion Type and **Motion Direction** are defined by selecting radio buttons.

The components for **Motion element**, **Reference Axis**, **Cam Contact Area** and **Driver Contact Area** have to be selected in the graphics or in the assembly tree.

Prerequisites

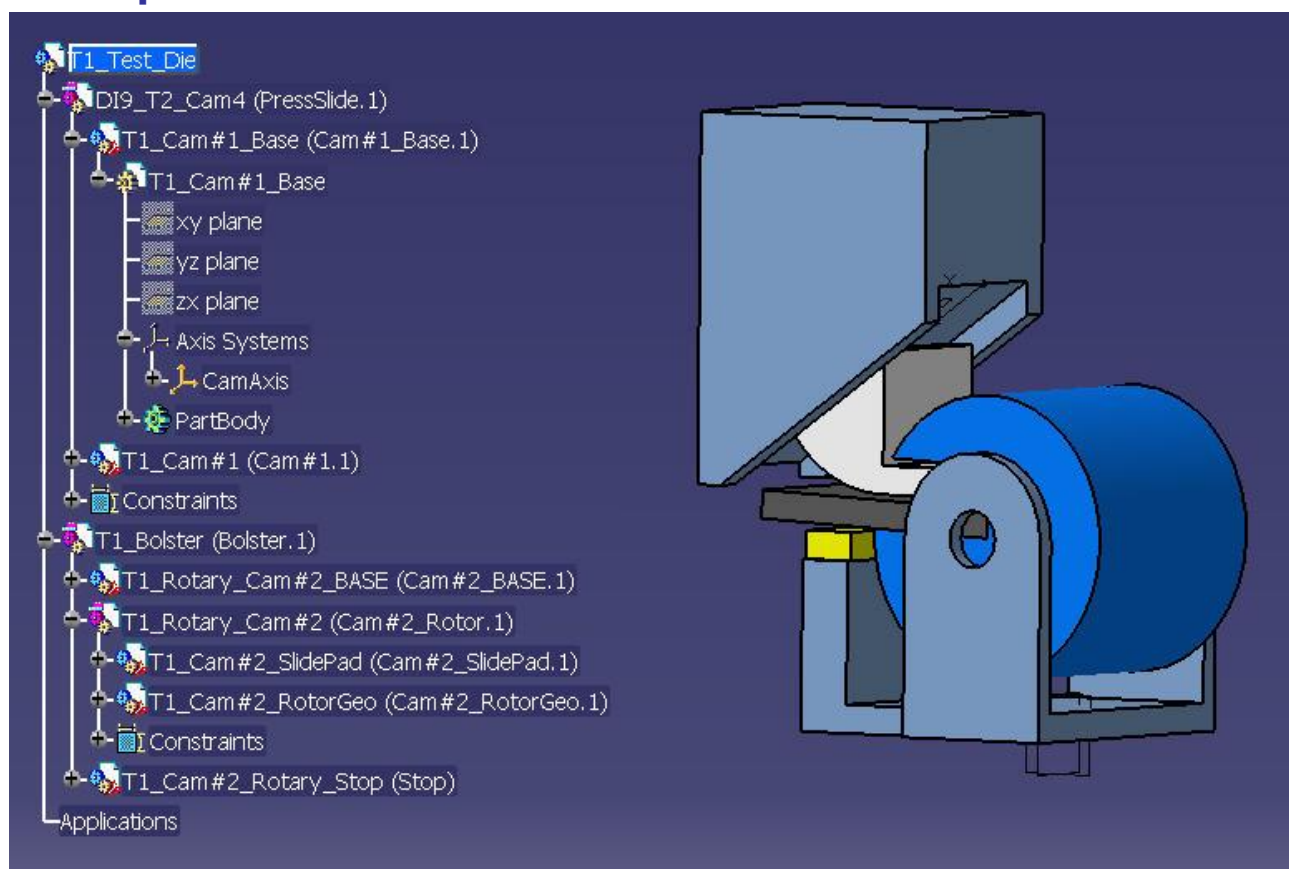


Figure 9 – Suitable Die Structure



- The assembly structure of the die assembly to be examined corresponds to its kinematical structure. All components moving together are subcomponents of the movable subassembly.
- The die should not contain any mechanisms
- The coordinate systems as reference system for the cam motion have to be already defined. (CATPart > Axis System > Definition)
- The positive direction of the z-axis of this reference system has to point towards the driver.
- The reference system must not be a subcomponent of the cam component itself.
Example in figure 3 shows the **CamAxis** as part of **Cam#1_Base**. It is no subcomponent of **Cam#1.1** and for this reason usable as reference system of **Cam#1.1**.

Function description



Describe Die Motion



Main Drive

1. Select in toolbar “Virtual Die Tryout” the “Definition” command  to launch following window

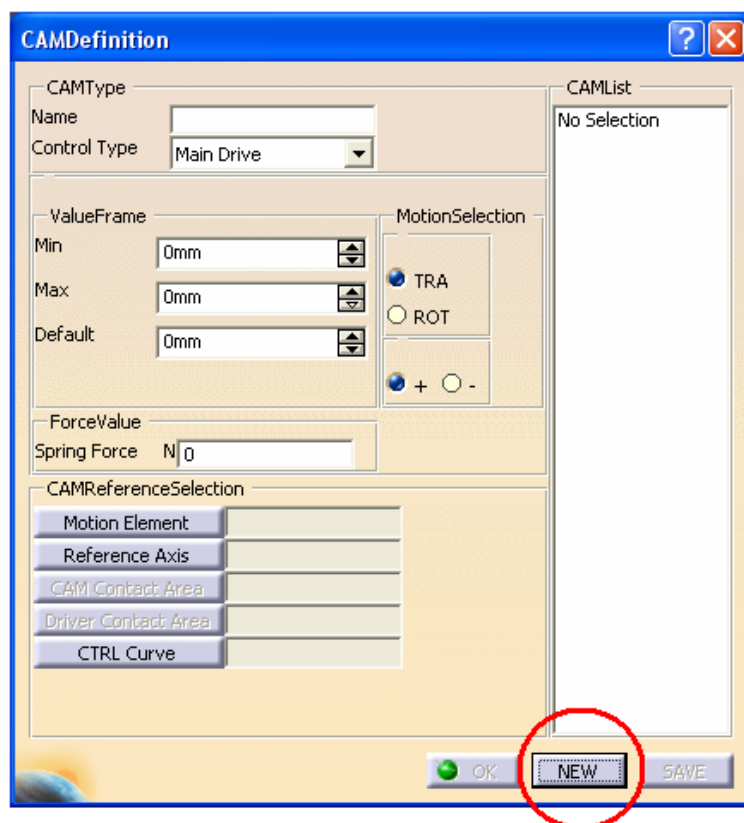


Figure 10 – New Die Joint

2. Click “NEW”

The first die joint will be automatically of control type MAIN_DRIVE, which will be the motion of the upper die. The system sets the name automatically to MainDrive.1. The Name can be changed.

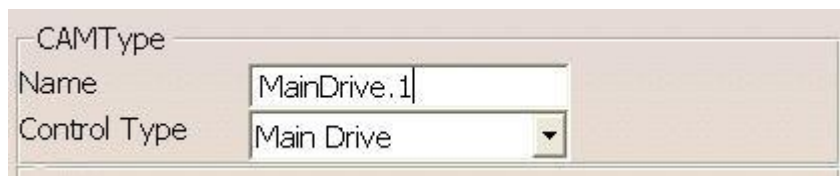


Figure 11 –Die Joint Name Input

- Next step is entering the values for the joint limits (**Min**, **Max**) and **Default** value. The **Default** value must be in between **Min** and **Max** value.



Figure 12 – Joint Kinematics Attributes

- Next step is setting of the joint parameter

To define the **Motion type** use the toggle button for TRA (prismatic) and ROT (revolute) and Toggle button **+/-** for the direction of the joint axis. Default value is “+” if the reference z-axis is pointing towards the cam driver.



The die assembly is normally modelled in closed position. In open position the joint has to reach the stop which is described as **Max** value. As the driver will push the cam into closed position the positive direction (z-axis of the reference system) will point in opening direction or towards the driver.

- Motion Element

To select an object click on the corresponding field and the cursor will displayed. Now the selection is active and the user can select the required object either in the assembly tree or in the graphics.



Selecting in the graphics only CATparts can be selected. To select superior assemblies as motion element select the component in the tree.

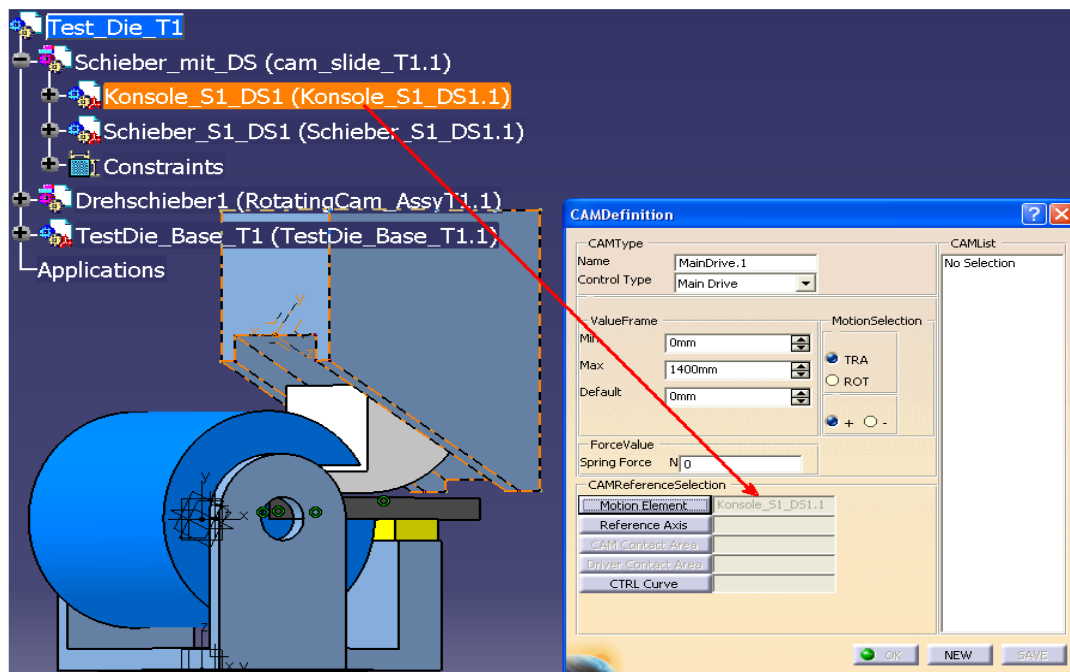


Figure 13 – Selection of Motion Element

After successful selection the name of the object is shown in this box.

6. Reference Axis

The reference axis can be selected in tree or as graphic element.



The Reference Axis must not be part structure below the motion element.



To be sure select the axis in the assembly tree. If no suitable axis is present use the according

function of the part modeller to generate a new axis.



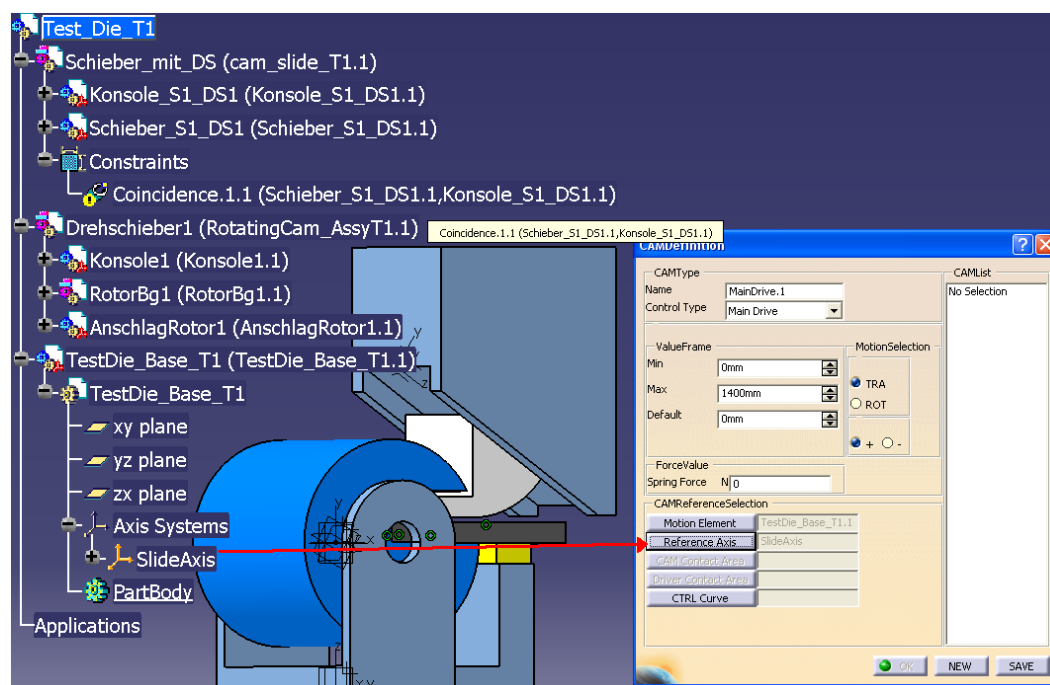


Figure 14 – Selection of Reference Axis

7. Select the curve file with motion data.

The motion curve file contains 360 time equidistant positions. This file should have the extension .KINcurve. A csv file format is used with following content::

HEADER: Size=361; AxisName=UpperDie_1; CurveName=Slide_1				
0 ;	1454.513			
1 ;	1448.49			
2 ;	1442.329			
3 ;	1436.031			
4 ;	1429.598			
5 ;	1423.033			
6 ;	1416.336			
7 ;	1409.51			
8 ;	1402.556			
9 ;	1395.477			
10 ;	1388.274			
11 ;	1380.948			
12 ;	1373.502			
13 ;	1365.937			
14 ;	1358.255			
15 ;	1350.458			

Figure 15 –Curve file format

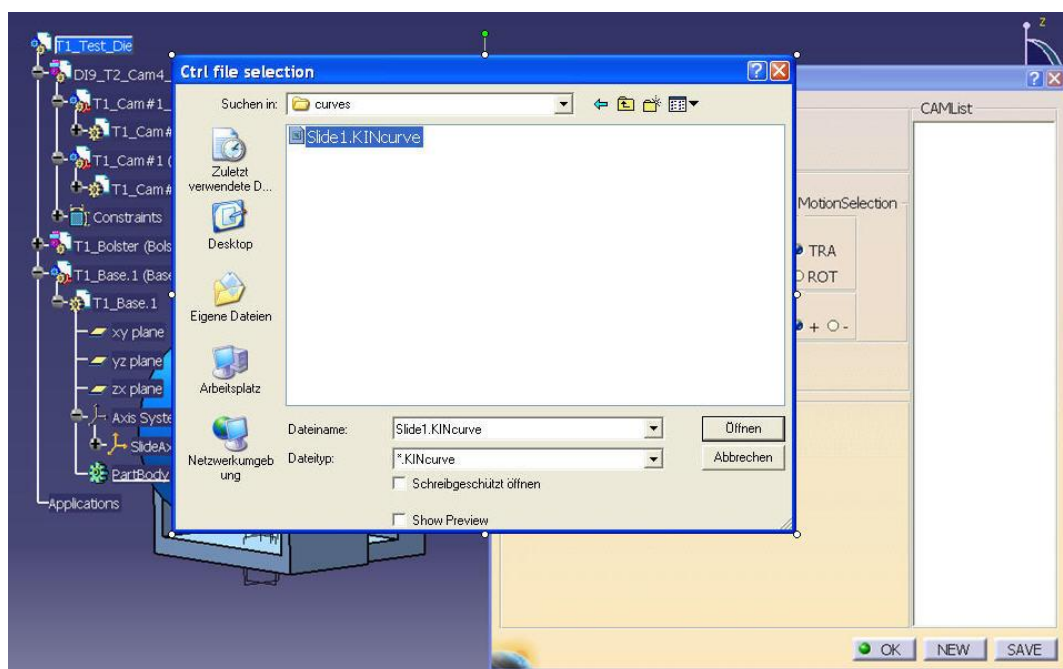


Figure 16 – File Selection Box for Die Joint Curve

Click **SAVE**

The new die joint appears in the item list of die joints.

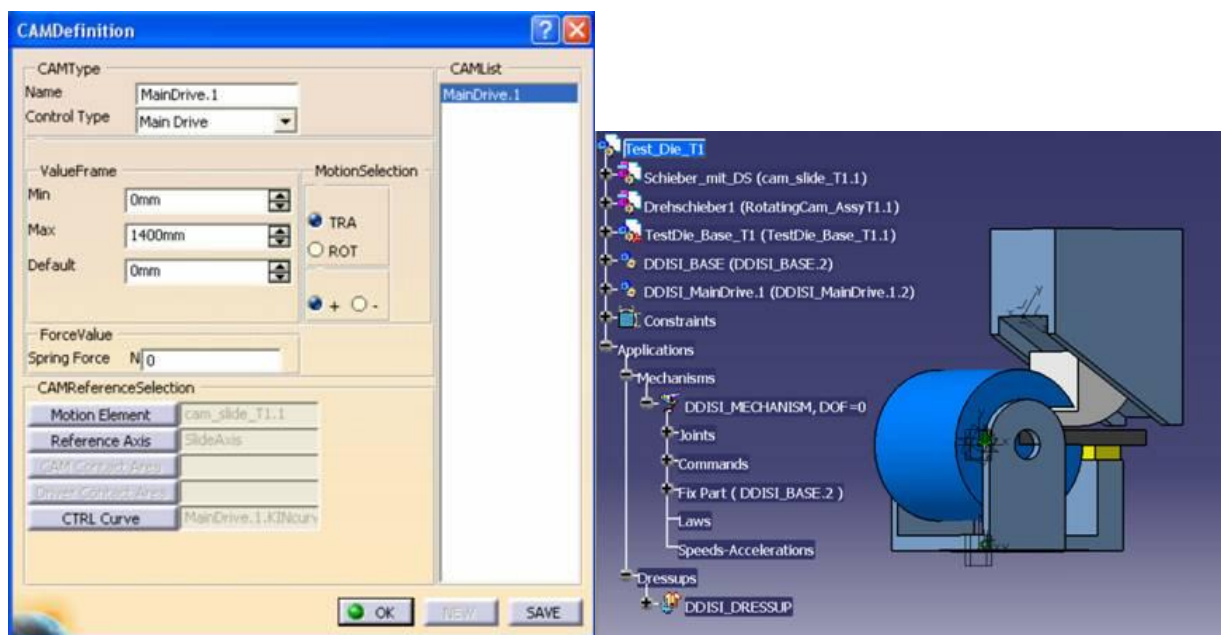


Figure 17 – Save Die Joint

8. Click OK

According to description a **DDISI_BASE** and **DDISI_MainDrive.1** CATPart will be added and a mechanism will be generated.



Cam Unit

1. To define a **Cam Unit** click **NEW** and define

- **Name** and
- **Die Joint Type**, in this case **CAM UNIT**,
- **Motion Values** and **Motion Type** as well as
- **Motion Element** and **Reference Axis**

in same manner as shown for the **Main Drive**.

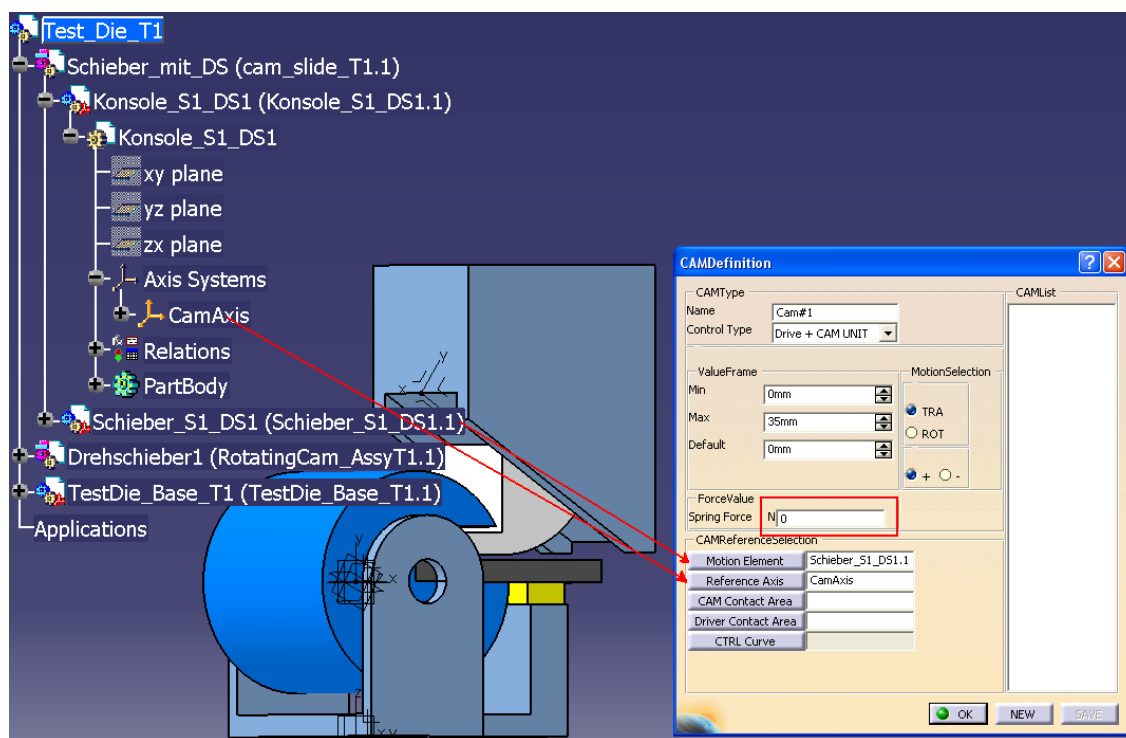


Figure 18 – Assigning Motion Element and Reference Axis

2. Additional to this description the Cam **Contact Area** and the **Driver Contact Area** have to be selected. These two contact areas are component which have to be selected in the assembly tree or graphics.



For fast motion calculation only the touching components should be selected.



If there is more than one touching part they should be combined in subassembly which will be then the contact area.

3. One important point for **Cam Units** is the definition of a spring force value. This value is used for the motion calculation to check which Cam will be moved first.



Figure 19 – Input of Spring Force



Rotating Cam Unit

1. To define a **Rotating Cam Unit** click **NEW** and follow the procedure under **Cam Unit**
2. In this case the radio button for ROT for a revolute Joint Type has to be selected

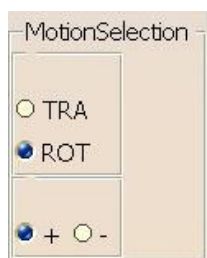


Figure 20 – Kinematics Type and Axis Direction

3. This example shows also the **Cam Contact Area** as sub component of the **Motion Element**.

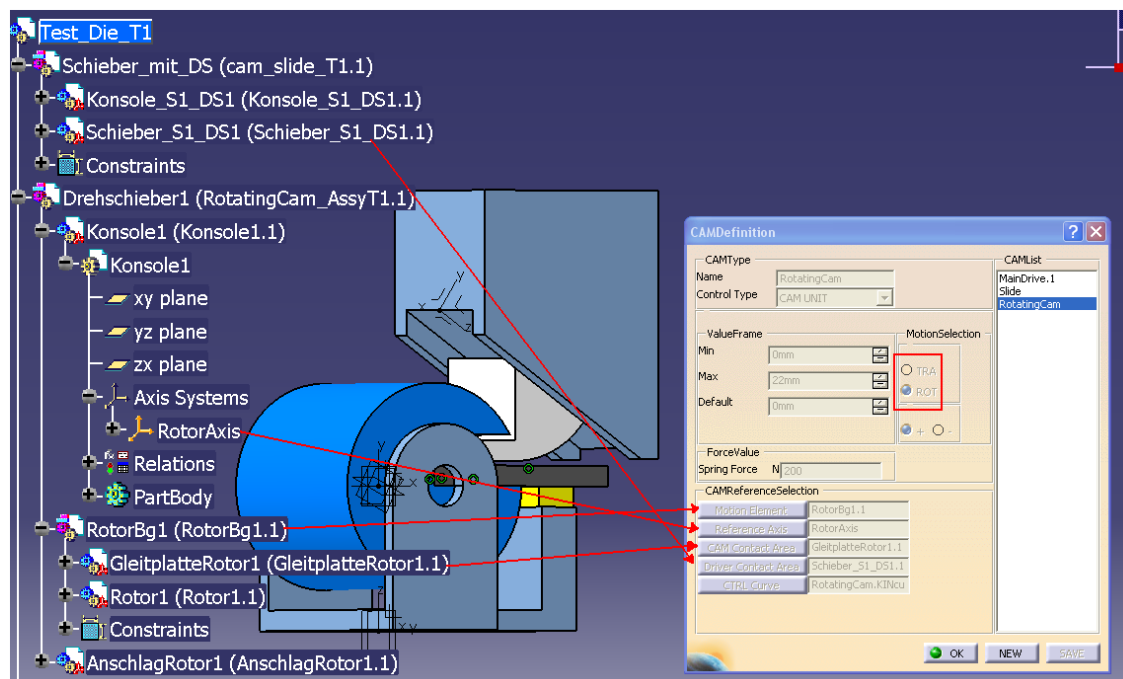


Figure 21 – Cam Drive Definition

Expected Results

1. After clicking the OK button the description will be used again to regenerate the kinematics structure, additional CATparts will generated - DDISI_Slide.1 and DDISI_RotatingCam.1.

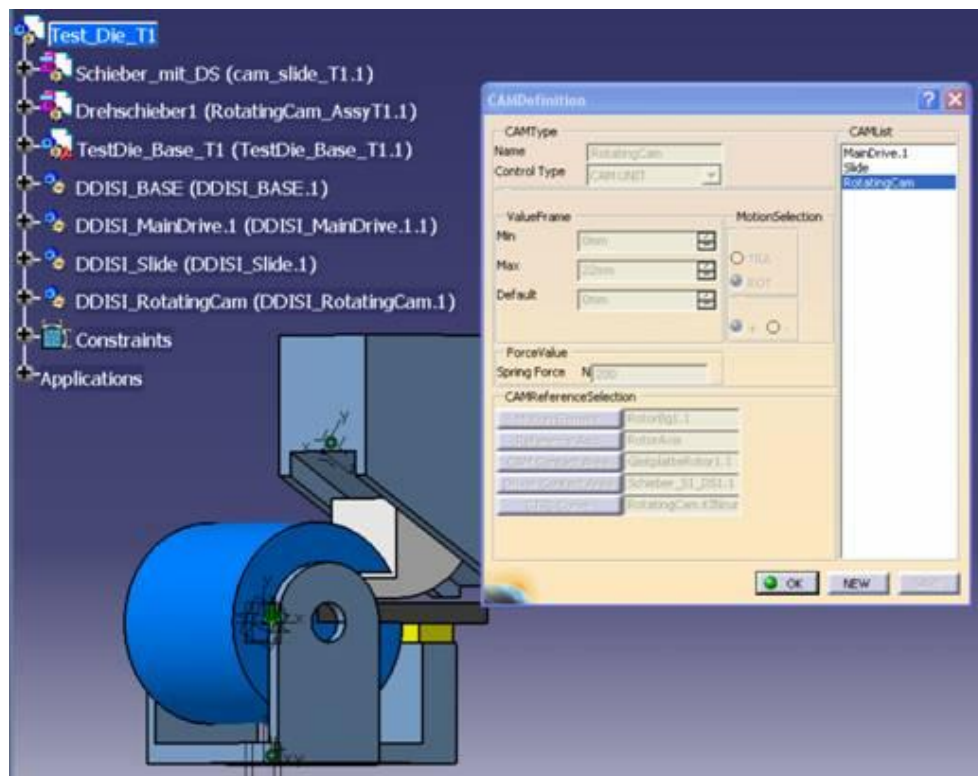


Figure 22 – Expected Results after Closing Die Joint Definition Window

2. Chapter : Add Existing Component

Purpose

To input 2 information's:

1. The already described component
2. The product where it will be added.

Function overview

The command will use the input information to create a new instance of the already described component in the product and change the description information in order to avoid the description collisions.

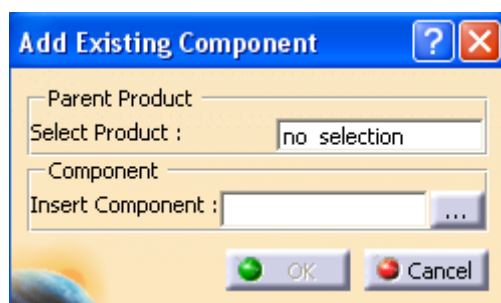


Figure 23 – Add Existing Component Window



Currently, Die designers can automatically add existing components which already have the correct DI9 description.

Currently, when adding such kind of component Die designers must change the description by hand in order to avoid name collisions.

With this command, the component is added and its description is modified automatically, simply by numbering properly the component in the description.

3. Chapter : Die Motion Calculation

Purpose

The “Die Motion Calculation” is processed automatically. A definition of a calculation sequence is not necessary. Spring forces defined for the cam units are considered during the calculation. The motion of all die components is synchronized to the **Main Drive** motion curve. During calculation the motion is visualized.



The duration of the calculation depends on the number of cam units defined in the model as well as on the geometry selected as contact areas.



The cam drive calculation has to be launched every time the user has changed the die joint definition.

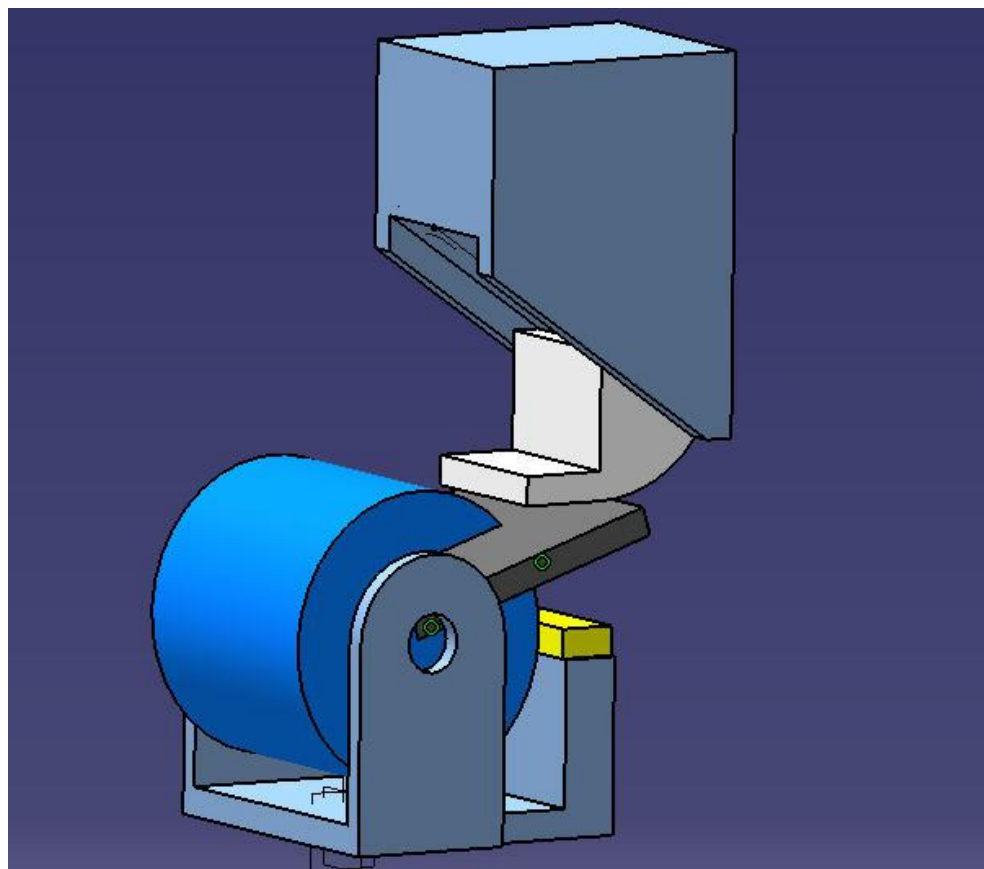


Figure 24 – Displacement Calculation of Cam Drives

4. Chapter : Die Motion Simulation

Purpose

With “Die Motion Simulation” the calculated Motion can be visualized.

Function overview

For the visualization of die motion a player is offered which contains command to run forward and backward or to go stepwise. The current stroke angle of the motion is shown is displayed in a field which can be also used as input field for a specific stroke angle. The window contains also a list of all die joints. After the selection of one die joint die motion values will be shown a second field. Two additional buttons allow jumping directly to the bottom dead center (BDC) or to the upper dead center (UDC). To visualize only the portion of motion where the cams are engaged it is possible to adjust the value of the UDC.

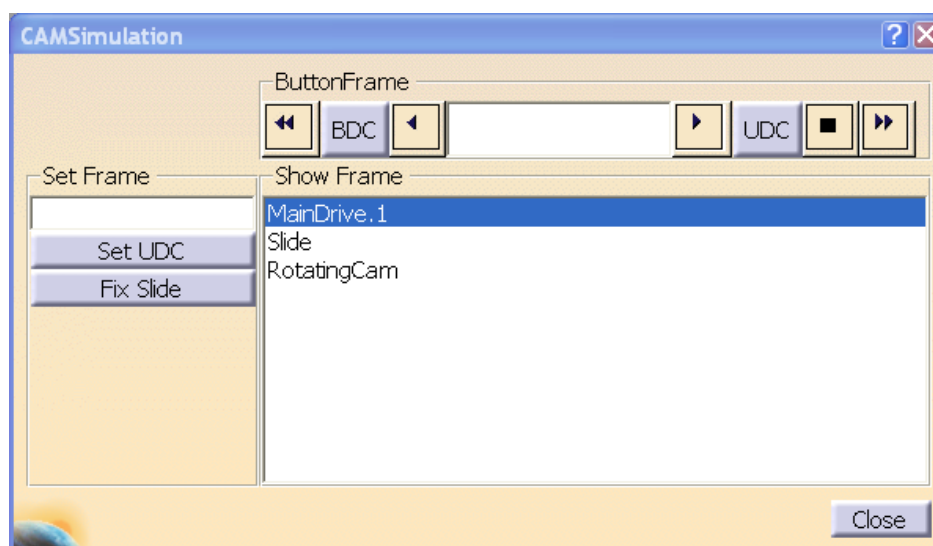


Figure 25 – Die Simulation Window

With the “Fix Slide” button it is possible to switch the fixed point of the motion from the main drive base to main drive itself which normally represents the slide motion.

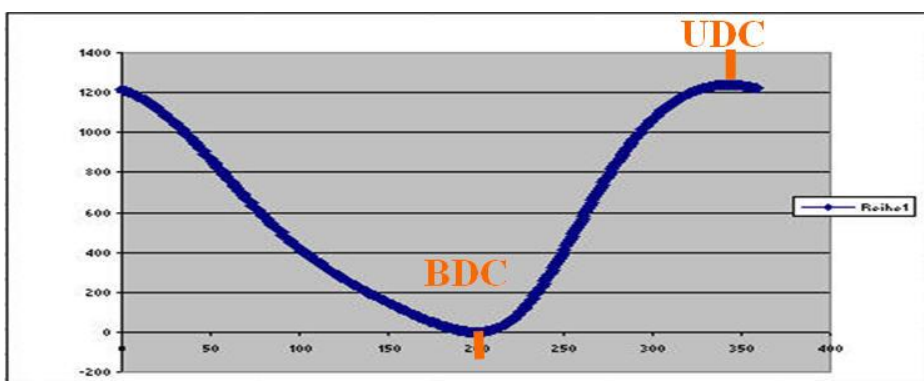


Figure 26 –UDC and BDC

5. Chapter: Calculate and Show Clash, contact & Clearance

Purpose

This command is used to calculate the inner die clashes, contacts & clearances between various die joints. The calculation is performed as “clash, contact & clearance between two selections” where every joint with its components is calculated against all other joints. All increments of detected clashes, contacts & clearances of one pair of groups are gathered. These increments will be visualized during the simulation.

Expected Results

The dialog window has a user interface Interference type wherein the user can input two Interference type:

1. Contact+Clash (calculation for contacts & clashes in the die joints) or
2. Contact+Clash+Clearance (calculation for contacts, clashes & clearances in the die joints)
(User can give the clearance value in the editor field)



When calculation has found contacts\clashes & clearances the “Show Collision” window is displayed and a list of clashes, contacts & clearances is available in an item selection list.

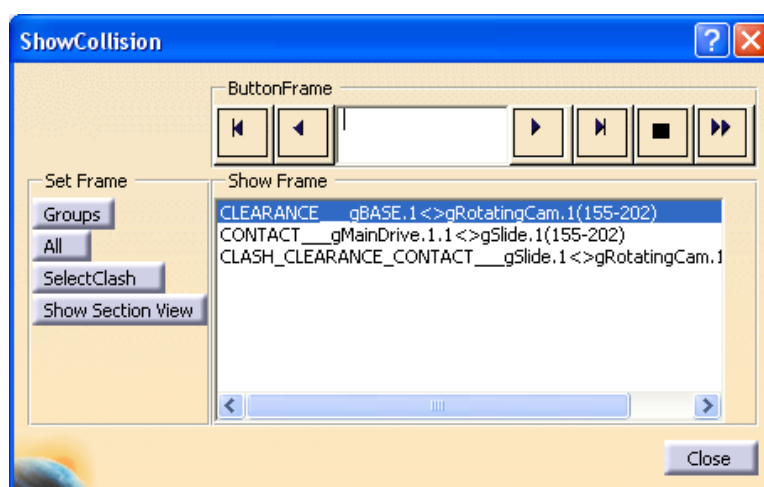


Figure 27 – Collision Show Window

1. Clash Groups selection

When a clash group is selected the two members should get different colors for better differentiation. All other groups are switched to grey and transparency.

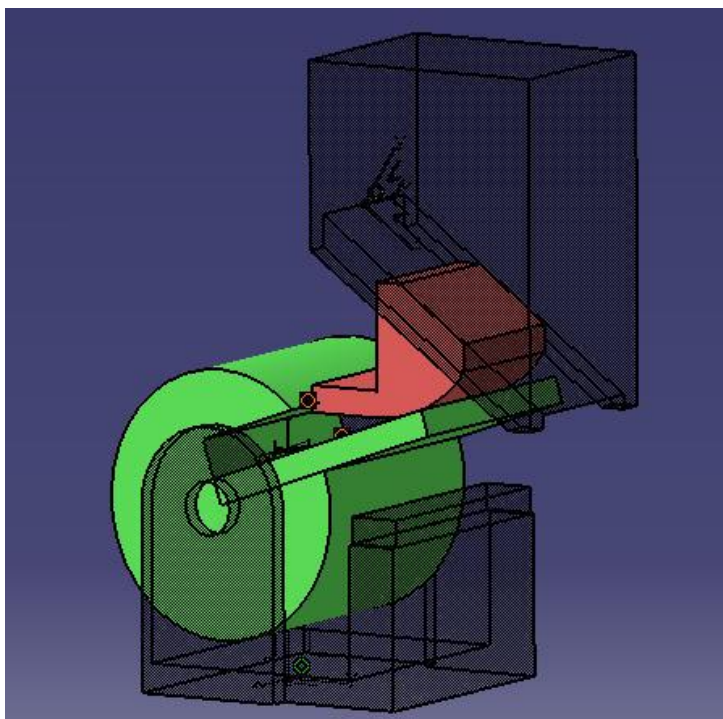


Figure 28 – Highlighting of selected “Clash Group”

2. Visualize all Groups / Visualize Clash Group only

Toggle between visualization of all groups (see above) or of selected clash group only.

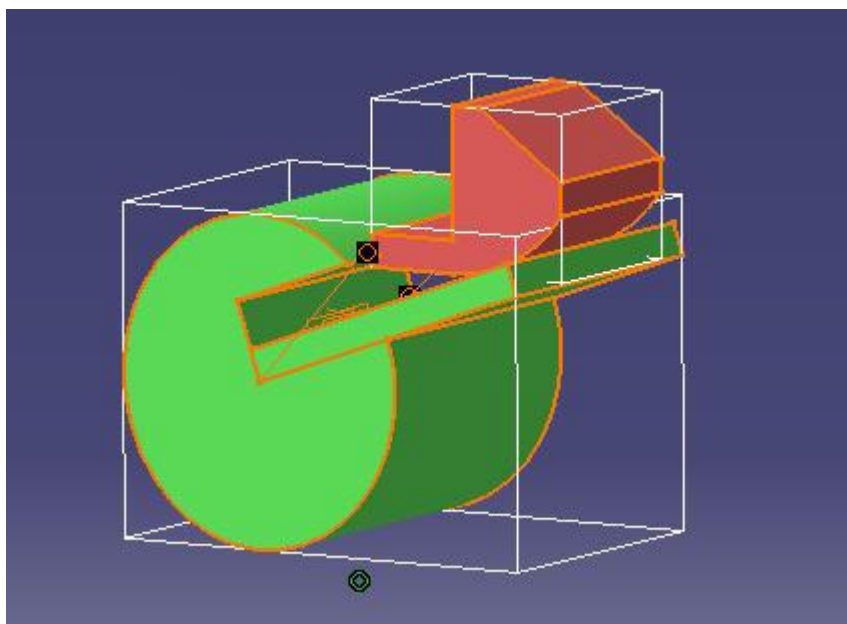


Figure 29 – Remove all components except the selected “Clash Group”

If the Clash is already been calculated and if the command is launched again than the following message is shown:

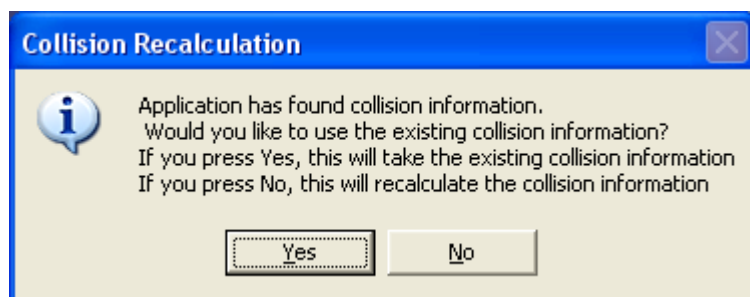


Figure 30-collision recalculation message

3. SelectClash

When a collision is selected in the DI9 Collision Window, and SelectClash push button is clicked interference is showed in main window and reframe on will be done on the area where collision is occurred.

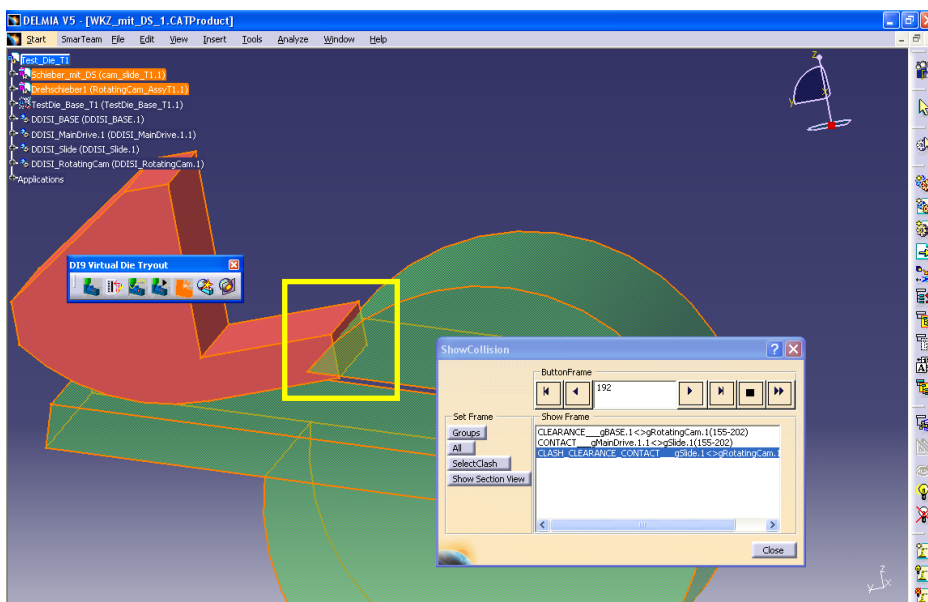


Figure 31- Reframe on the area where collision is occurred



For SelectClash to work, the user should Step forward till the clash actually occurs.

4. Show Section View

When the user clicks on the Sectioning groups and clicks on “Sectioning”, it should clip the model directly at the point of Sectioning. It will also show penetration length for the crash corresponding to the angle value

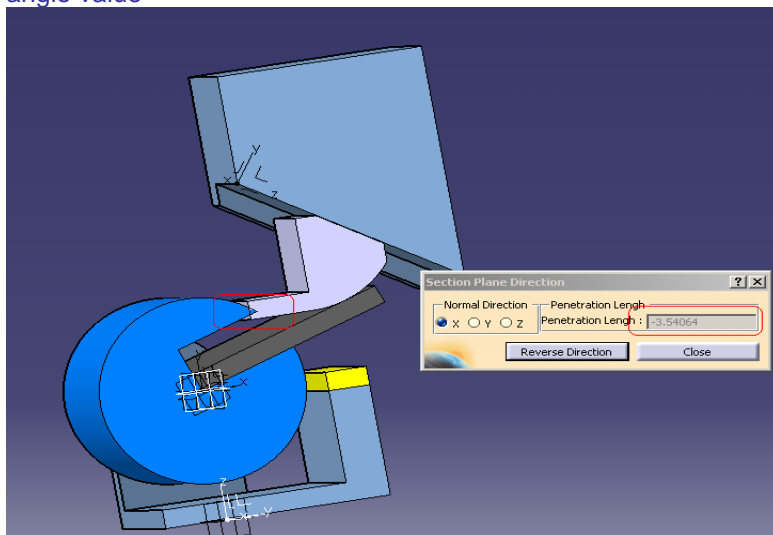


Figure 32- Penetration length of the clash is seen & the product is sectioned



On stepping forward the penetration length decreases/increases based on the movement between the colliding parts

6. Chapter: Check Clash

Purpose

This command is used to launch the “Check Clash” command from “DMU Space Analysis” workbench.

Expected Results

When we click on this icon the Check Clash window will be displayed.

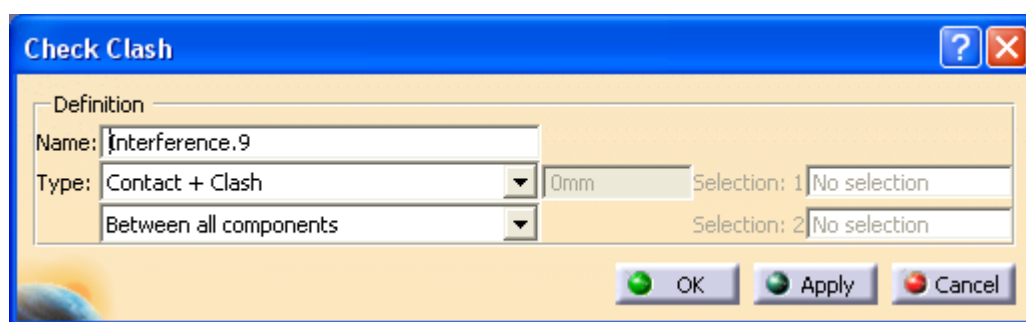


Figure 33 – check clash panel

7. Chapter: Sectioning

Purpose

This command is used to launch the “Sectioning” command from “DMU Space Analysis” workbench.

Expected Results

When we click on this icon the Sectioning window will be displayed.

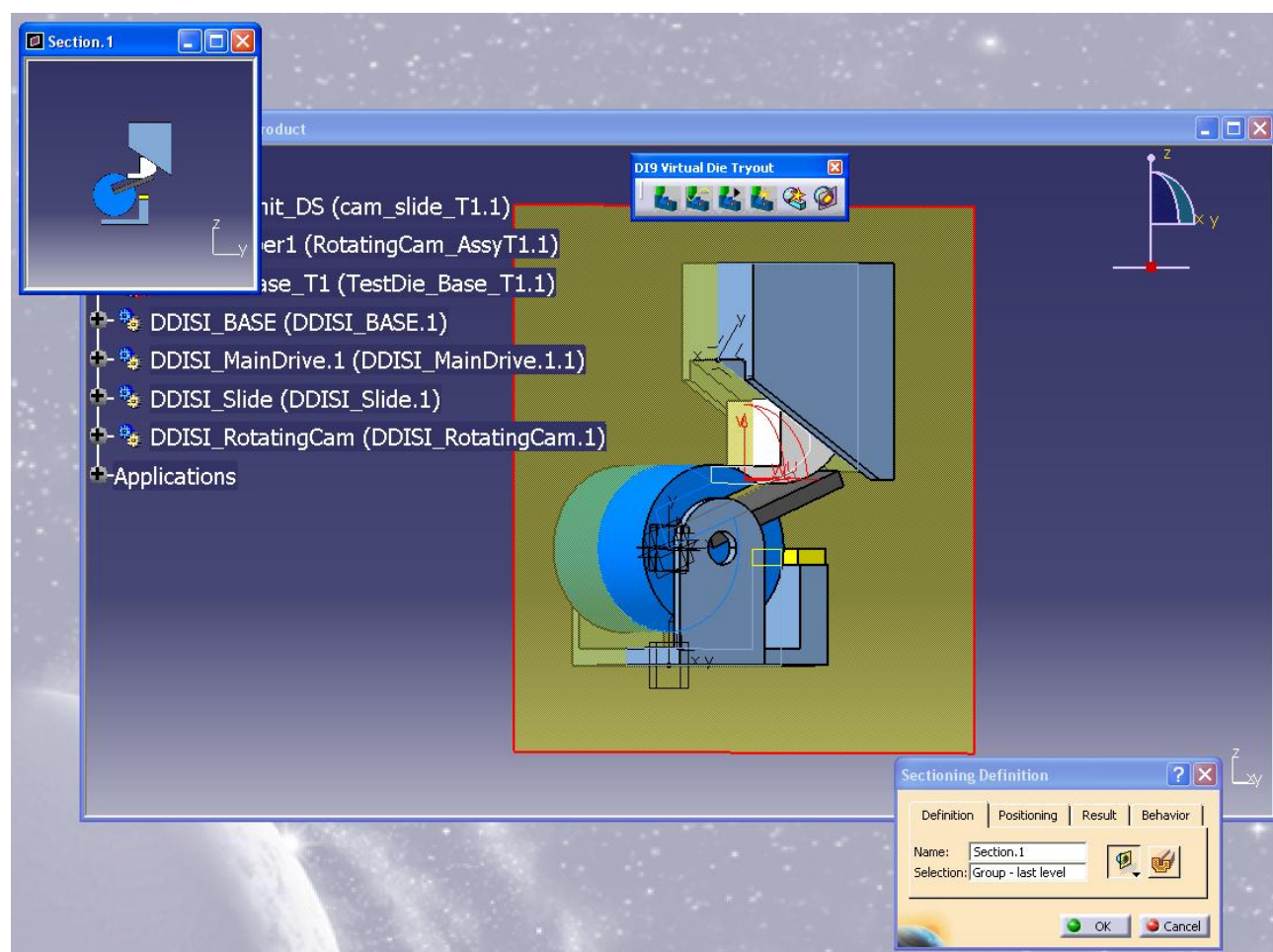


Figure 34– Sectioning window

Appendix A - BPA provided data

Sample data

As sample data an example of a rotary cam unit is provided. You will find the sample data on disk in following directory : ..\..

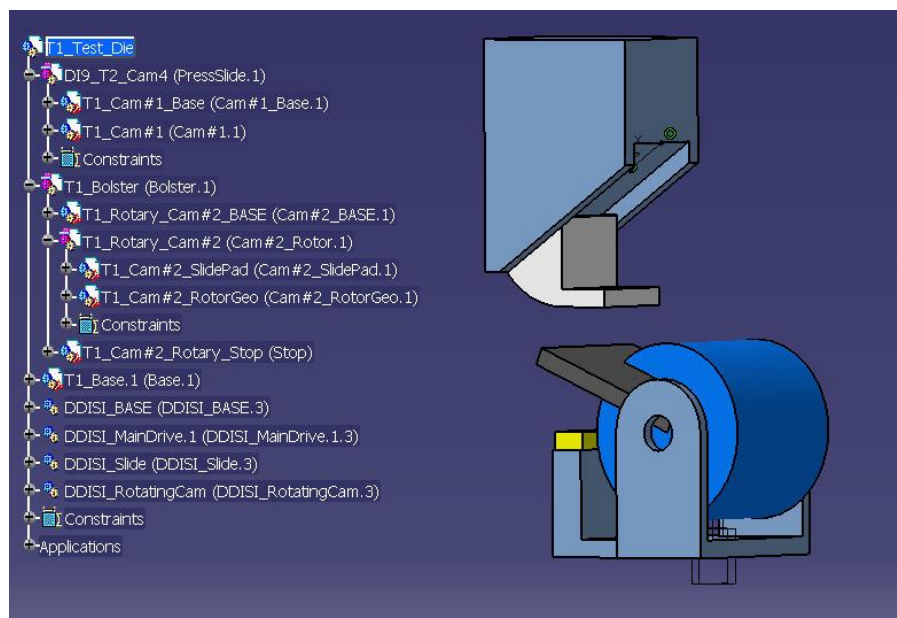
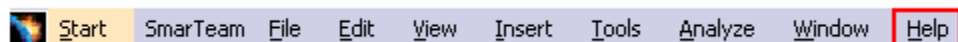


Figure 35- sample data

Help About-Virtual Die Tryout

1. Click on the help tab on the Menu Bar



2. Click on About Virtual Die Tryout

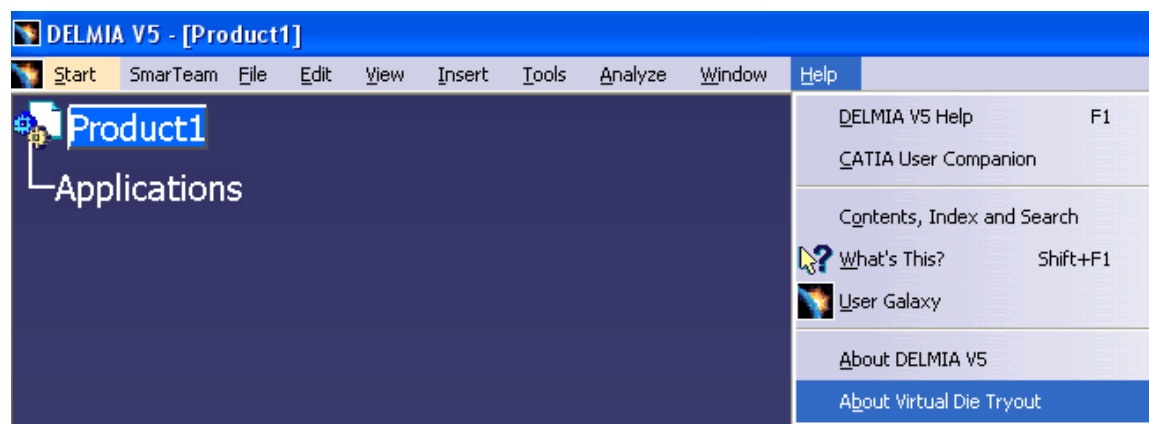


Figure 36– Help about tab

3. Help about window For Virtual Die Tryout

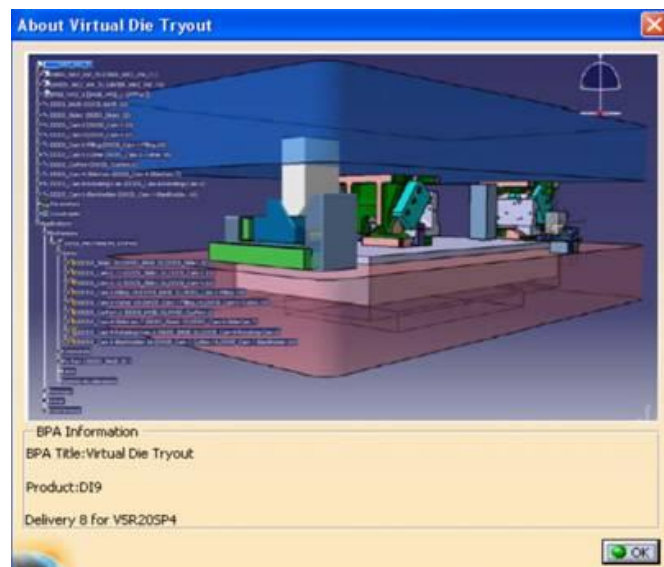


Figure 37– Help about window

Troubleshooting

Cam Unit Calculation

In case of incorrect "motion element" inputted while editing the joint, CATIA crashes when Cam Unit Calculation command is executed.