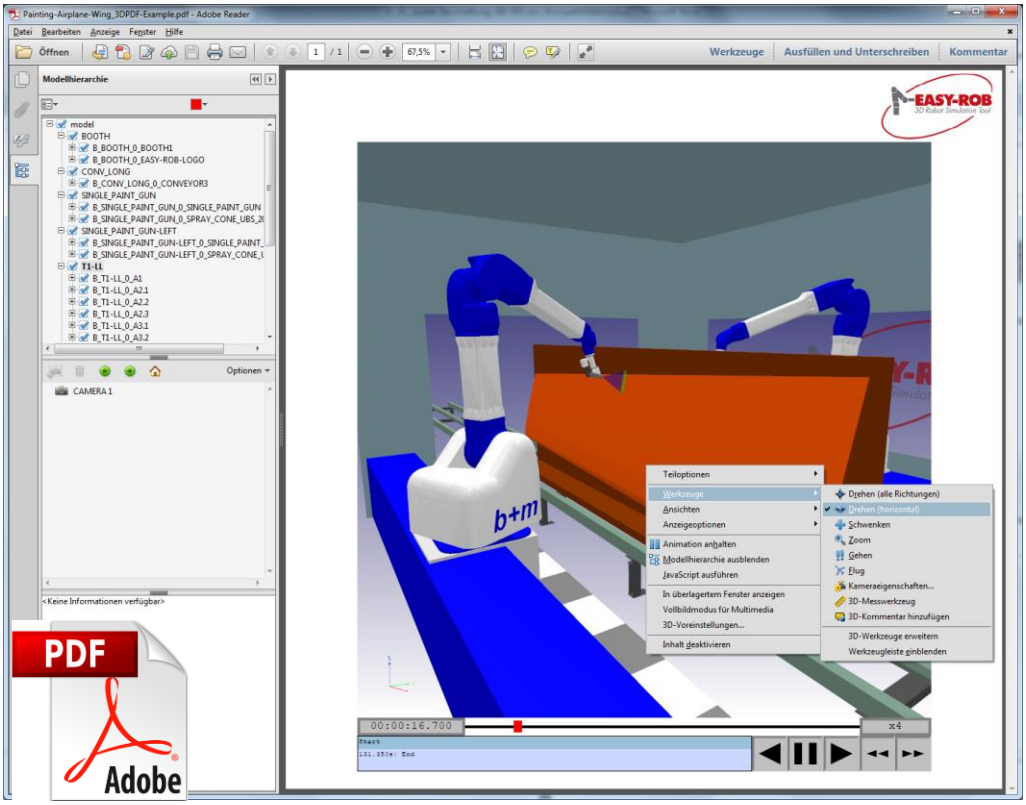
The new version

EASY-ROB™ V6.6



June 2015

Version 1.4

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EASY-ROB™

Table of contents

EASY-ROB™ V6.6 4
Adjustable transparency of EASY-ROB ™ dialogs 5
AutoRefresh Tag Attribute content 6
Cartesian Space Limits 7
Different Simulation-Views 8
External TCP with circular Interpolation 9
Optical highlighting of a device 10
Save the simulation process in 3D-PDF with animation 11
CAD2ER with individual adjustment of tessellation 13
Complete Robot Libraries 14
New kinematic Robot-types 14
New formulas for robot-damping 15
Orientation-Notation for Universal Robot 17
Advanced Post-processors 18
EASY-ROB™ Dll Multi-Program-capable 19
New ERCL-commands 20
ER_CAPI: Calculation of Jacobi-Matrix 22
ER_CAPI: Material- and Light-Attributes 23
ER_CAPI: Geometry Load Error 24
ER_CAPI: AutoPath™ 24
Robotics Simulation Kernel Multi-Thread capable 25
New EASY-ROB™-Icon 26
New example workcells in ApplicationLib 26
Contact 27
Notes 28

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EASY-ROB™ V6.6

The new version is available free of charge for all customers with a valid license key for EASY-ROB™ V6.6. For customers using older versions, it will be possible to purchase an update.

We would like to thank you for your suggestions and ideas in advance.

Thank you

Stefan Anton
EASY-ROB
3D Robot Simulation Tool

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Adjustable transparency of EASY-ROB ™ dialogs

The transparency of all EASY-ROB ™ dialogs can now be turned on and individually set. This contributes greatly to the clarity of large work cells with multiple opened dialogs.

From left to right: Transparency OFF, Transparency Medium and Transparency High

The transparency for each window can be set individually by clicking on the EASY-ROB™ icon of the opened window and selecting one of the predefined transparency values (**Transparency Low, Medium** or **High**).

Alternative: you can set an own Alpha-value between 100 (high transparency) and 255 (no transparency) under **Transparency User.**

The global presetting of transparency for all dialogues can be found in the menu bar under **View** > **Dialog Transparency Settings**. Each dialog will be opened with this selected transparency-setting.

The custom preset-value can be saved in the environment file easy-rob.env.

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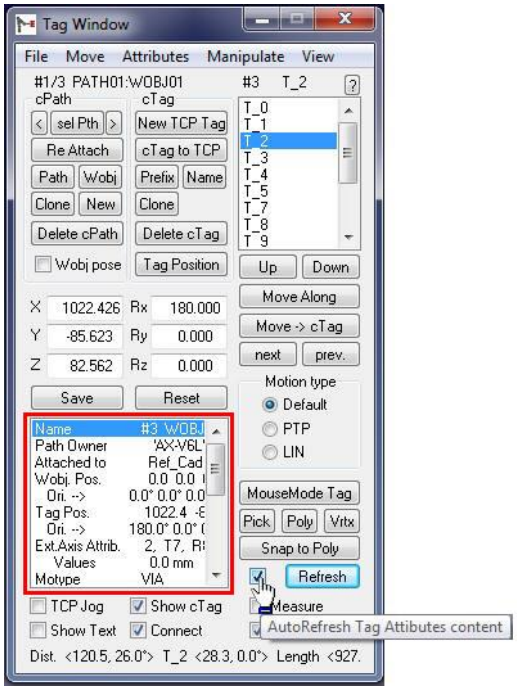
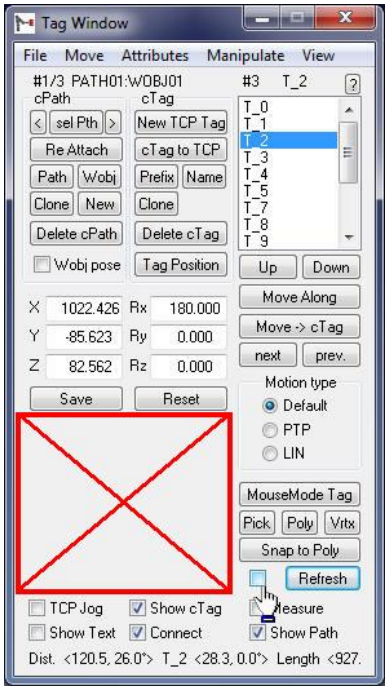
AutoRefresh Tag Attribute content

If the Tag Window is opened during a simulation, this can result in significant performance degradation, especially when a workcell has more than 1000 tagpoints.

The reason for that is the permanent refresh and display of the tag-attributes in the Tag Window. For this reason, the so-called **Auto Refresh tag attribute content-**function was introduced, that can be enabled or disabled in the Tag Window.





If the check mark under “AutoRefresh Tag Attributes content” is set, then - during simulation - the information of each tagpoint, such as Tag position will be displayed and refreshed continuously in the Tag Window.

In this case, especially workcells with a high number of tagpoints can cause performance problems.

Since the update and display of attribute information of each tagpoint during a simulation run are often not of interest, it can be disabled by removing the checkmark next to the Refresh button. This results in an increase of performance.

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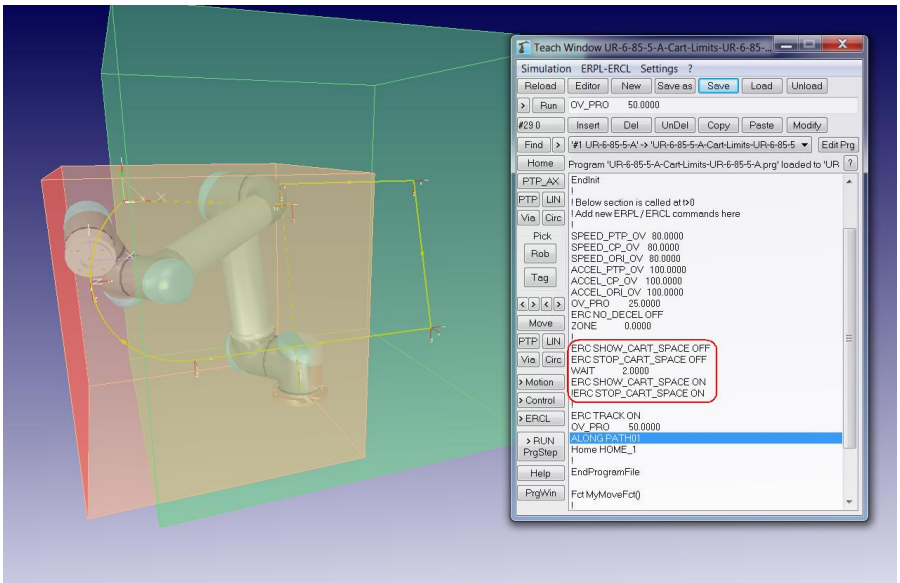
Cartesian Space Limits

In the new version, the so-called Cartesian Space Limits will be introduced. This Cartesian space - similar to the Travel ranges - with respect to the robot base is set as a limit, the robot is not allowed to exceed.



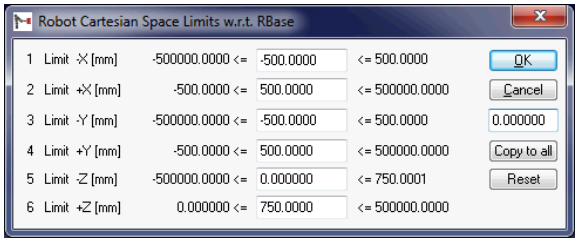
New ERCL - Commands:

```
SHOW_CART_SPACE  ON / OFF
STOP_CART_SPACE  ON / OFF

CART_LIMITS_MIN X Y Z
CART_LIMITS_MAX X Y Z
```

The green space is a user-defined area. The red space presents the current space occupied by the robot. If the permitted range is exceeded, then the surface where the exceedance occurred will turn into dark red.

You can find the Cartesian Space Limits in the Kinematics Window under Attributes.



By entering the limiting values [mm] for each coordinate direction, the Cartesian space limit will be generated.

The values are in relation to the robot base.

During the simulation, the cartesian space limits can be switched on or off by setting the corresponding ERCL command `ERC SHOW_CART_SPACE ON / OFF` in the Teach Window.

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Different Simulation-Views

In the new EASY-ROB ™ version, you have the possibility to set four (4) different simulation views for your current EASY-ROB ™ session and switch between them, using your keyboard.

Simulation-View #1

Simulation-View #2

Simulation-View #3

The current simulation view is briefly displayed in the upper left corner of the screen with a **View #1 ... #4**.

By using the Shortkey Ctrl + Tab you can switch to the next view

By using the Shortkey Ctrl + Shift + Tab you can switch to the previous view

Each simulation view can be changed as usual in cruise mode. Views can also be changed during the simulation in order to always have the best perspective on the process.

You can also select a Simulation View by using the Menu bar:
View > **Set 3D Views** > **Goto next Simulation View / Goto prev Simulation View**

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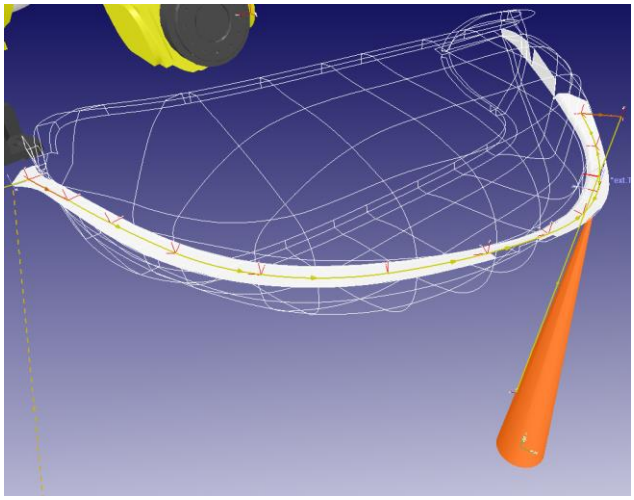
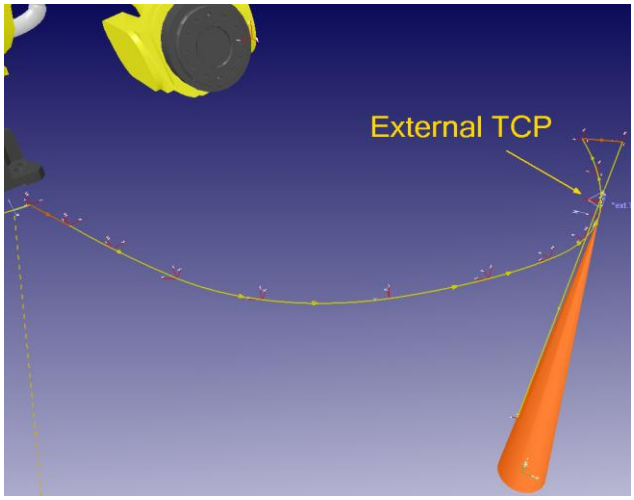
External TCP with circular Interpolation

The external TCP-functionality has been extended by the circular interpolation.

If an external TCP is defined for the robot, the robot can now guide the workpiece along the external TCP using circular interpolation.



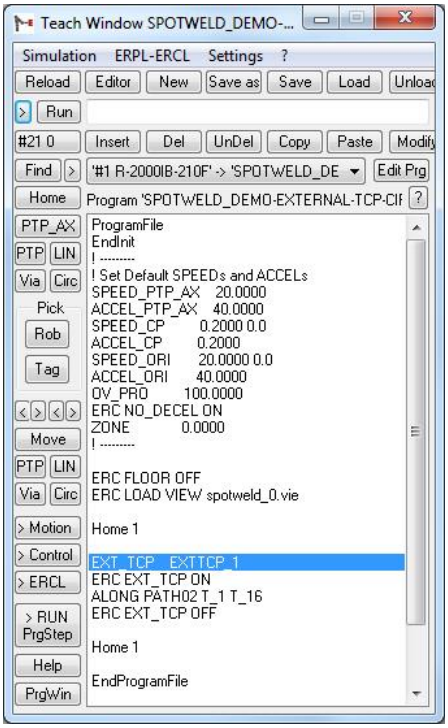


For more information please open the workcell „spotweld_demo-external-TCP-CIRC.cel“ in the directory „\ApplicationLib\SpotWelding“:

The circular interpolation is realized by the motion-types VIA and CIRC. They can be defined for each Tag point under the Tag point-attributes in the Tag Window.

After that the external TCP must be defined (EXT_TCP ExtTcp_1) for the robot and the work piece leading movement must be activated (ERC EXT_TCP ON).

More information to the single commands for the „external TCP“ can be found in the documentation for the EASY-ROB™ Program Language „EASY-ROB-ERPL_ENG.pdf“.



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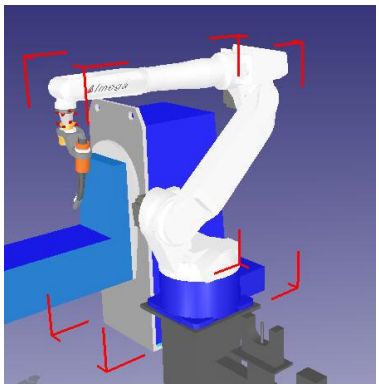
Optical highlighting of a device



The clarity of the work cell has been improved.

In the future, a currently-selected device is highlighted by a red "frame". Thus, it can be found faster and especially easier in large workcells.

Tip: A right mouse click (RMB) in Cruise Mode removes the frame.

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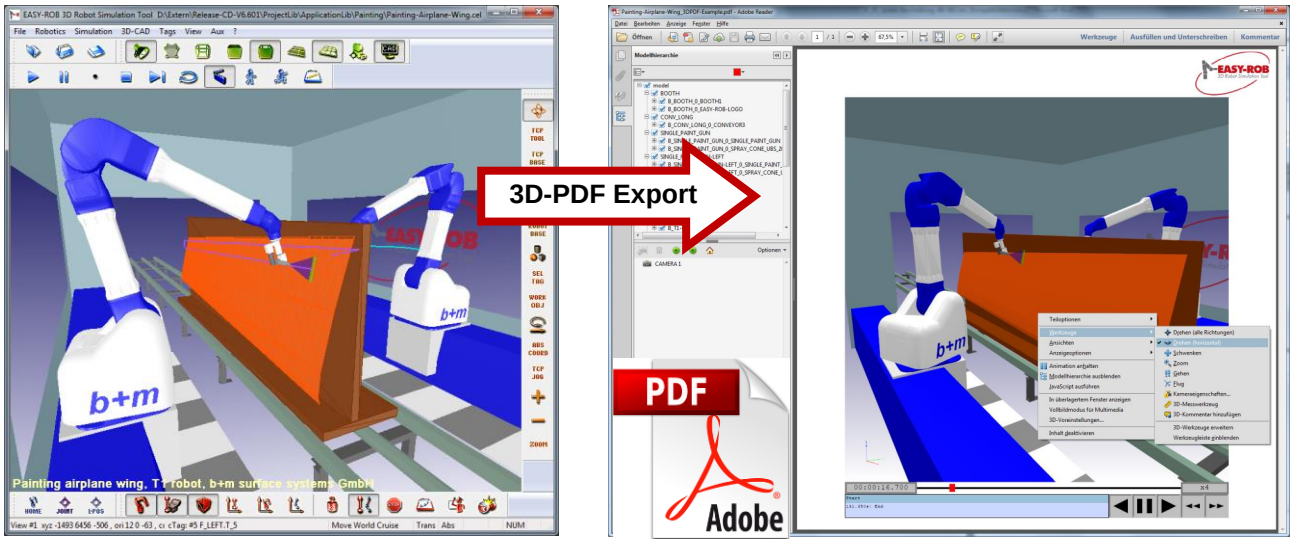
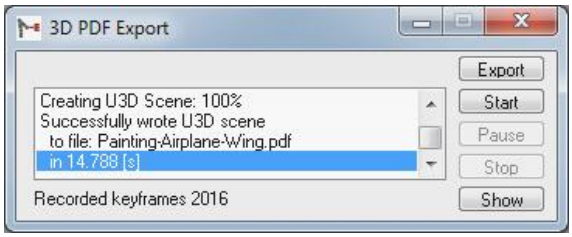
Save the simulation process in 3D-PDF with animation

With the new option EASY-ROB™ **3D-PDF-Export***) the entire simulation process with animation of a work cell can be saved as a 3D-PDF-document. Afterwards it can be opened, using the free Adobe® Reader XI and the whole simulation can be started.



Important: We recommend at least version XI (11.0.10) of Adobe® Reader.

The 3D-PDF-Export can be found under **View** > **EASY-ROB PlugIn Dlls** > **3D-PDF Export**.



3D-PDF Export dialog

- "Export" save the Scene without animation.
- Press "Start" to begin recording.
- Start the simulation . The simulation run will be recorded. The number of recorded key frames are displayed.
- Press "Stop" to finish the recording. You will be asked to enter the destination directory and the name of the PDF document.
- The 3D-PDF-document will be created.

Within the PDF document, you can rotate and zoom the recorded scene.

You can find a example 3D-PDF-document „Painting-Airplane-Wing_3DPDF-Example.pdf“ in the directory „\ApplicationLib\Painting“. This example has been exported out of the workcell „Painting-Airplane-Wing.cel“.

*) The plugin 3D PDF export must be licensed with costs

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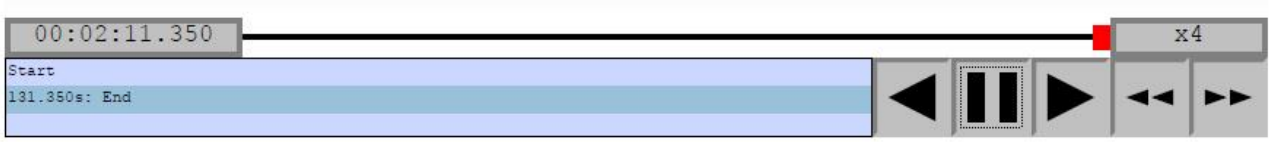
Save the simulation process in 3D-PDF with animation

In Adobe® Reader you can use the navigation bar to start, pause or stop the recorded simulation process. Fast forward and rewind (x1/64 – x64x speed) are also possible. The displayed time shows you the real process time.



Navigation bar in Adobe® Reader

The 3D-PDF-Export-functionality can also be controlled by the ERCL-commands. The following ERCL-commands can be used by the user:

ERC _3D_PDF_EXPORT SCREENSHOT [flnname]

ERC _3D_PDF_EXPORT ON / OFF [flnname]

ERC _3D_PDF_EXPORT SET_FILE flnname

ERC _3D_PDF_EXPORT SET_LABEL labelname

ERC _3D_PDF_EXPORT SET_PASSWORD passwordname

ERC _3D_PDF_EXPORT PAUSE

ERC _3D_PDF_EXPORT DEACTIVATE

A detailed description for the commands can be found under the section „New ERCL-commands“ or in the documentation for the ERPL-/ERCL-Program language **„EASY-ROB-ERPL_ENG.pdf“**

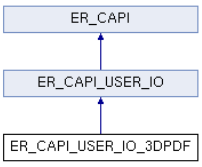
The 3D-PDF Export can also be controlled using the API methods class ER_CAPI_USER_IO_3DPDF

ER_CAPI_USER_IO_3DPDF Class Reference

Method class for 3D Pdf Export. More...

```
#include <ER_CAPI.H>
```

Inheritance diagram for ER_CAPI_USER_IO_3DPDF:



http://www.easy-rob.com/fileadmin/Userfiles/doc/er_capi/class_e_r___c_a_p_i___u_s_e_r___i_o__3_d_p_d_f.html

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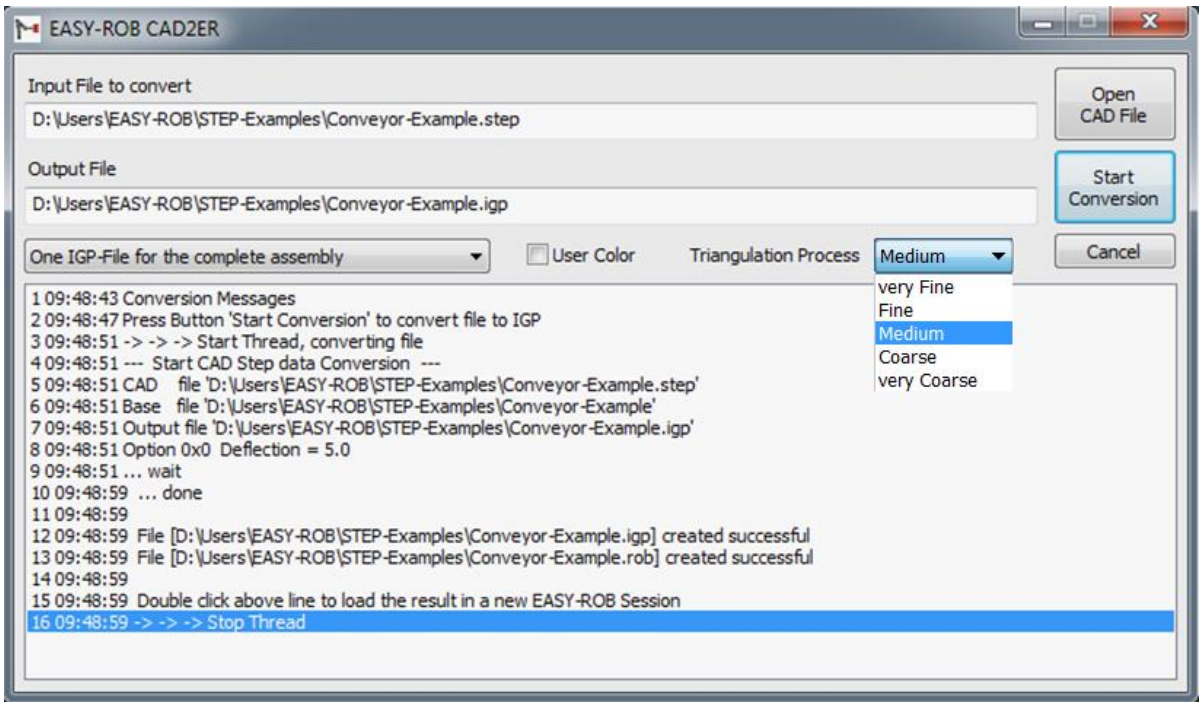
CAD2ER with individual adjustment of tessellation



The new CAD2ER converter is available as a 64-bit version now, which is especially beneficial for large files. With EASY-ROB™ CAD2ER you are able to import the neutral **STEP- (AP203, AP214), IGES-** and **VRMLII,97-** data formats and to convert them to EASY-ROB™ **IGP**.

Also new: the imported CAD-geometries can be adjusted. The tessellation can be adjusted individually, which is helpful – especially for detailed and “large” geometries – to reach adequate simulation speeds. You can choose between the detail-levels **very fine, Fine, Medium, Coarse** and **very Coarse**, which can be found under **Triangulation Process.**

Coarse – 23.337 polygones

Normal – 35.692 polygones

Fine – 67.470 polygones

When importing assemblies, device files are created automatically at the same time. Finally single components can be individually disabled or deleted.

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Complete Robot Libraries

EASY-ROB™ provides complete libraries for the integration of all major types of robots in the market. These include ABB, b+m, Comau, Denso, Eisenmann, Fanuc, Guedel, igm, Kawasaki, KUKA, Mitsubishi, Motoman, OTC-Daihen, Reis, Stäubli, Tricept, Unimation and Universal Robots.

Additional robots, machines, tools and handling systems can easily and quickly be reconstructed virtually inside the EASY-ROB™ application

The robot libraries of ABB, KUKA, Comau, Fanuc, Motoman and Staubli are almost completely and permanently maintained. These also include positioners and external axes.

Actually more than 900 robots of different manufacturers are available.

For further information see:

http://www.easy-rob.com/en/product/extensions/robot-libraries.html

New kinematic Robot-types

The new models from the KUKA LBR iiwa-series and Palletizer of the Comau Smart5 PAL-series are now available.

KUKA LBR iiwa

Comau Smart5 PAL

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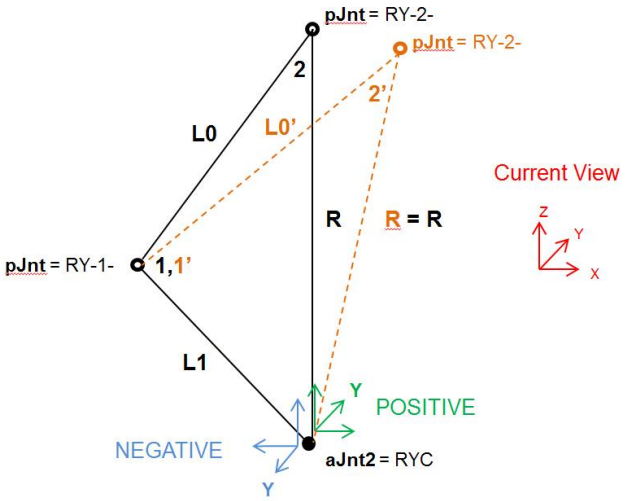
New formulas for robot-damping

In the future, the kinematic modeling of robots with damping and leveling compounds is simplified such as the ABB IRB 7600-500-255.rob. For that reason we have developed some formulas which have to be selected - depending on the kinematic model - and supplemented with parameters. This results in a correct movement of the corresponding passive "damping-axis" depending on the active robot axes.



In general, the starting position of the robot and the resulting kinematic wire model must be considered.

The general JNTDAMP_TRI – function is:

pJnt_i = JNTDAMP_TRI
(L0, L1, R, position, aJ2_ori, pjnt_idx)

The following parameters have to be defined and entered into the JNTDAMP_TRI-function:

L0 = Distance pJnt RY-1- to pJnt RY-2- [mm]
L1 = Distance aJnt2 RYC to pJnt RY-1- [mm]
R = Distance aJnt2 to RYC pJnt RY-2- [mm]

position – Position of pJnt RY-2- to aJnt2 RYC
Values: [DAMP_BELOW, DAMP_ABOVE] with
DAMP_BELOW = 0: below aJnt2
DAMP_ABOVE = 1: above aJnt2

aJ2_ori – Orientation of y-axis (Rotation-axis) of aJnt2 RYC depending on starting position (Current View)
Values: [POSITIVE, NEGATIVE] with
POSITIVE = 1: in pos. direction
NEGATIVE = -1: in neg. direction

pjnt_idx - index or number of calculated passive joint, result value
Values: [1..2] with
1 = Function returns angle change of the angle between L0 and L1 from
2 = Function returns angle change of the angle between L0 and R from

The formula with its parameters, belonging to the according passive axis can be entered in the Kinematics Window under **Kinematics** > **2 – Passive Joints > passive Joint ()** > **5 – Math. Jnt dependency**

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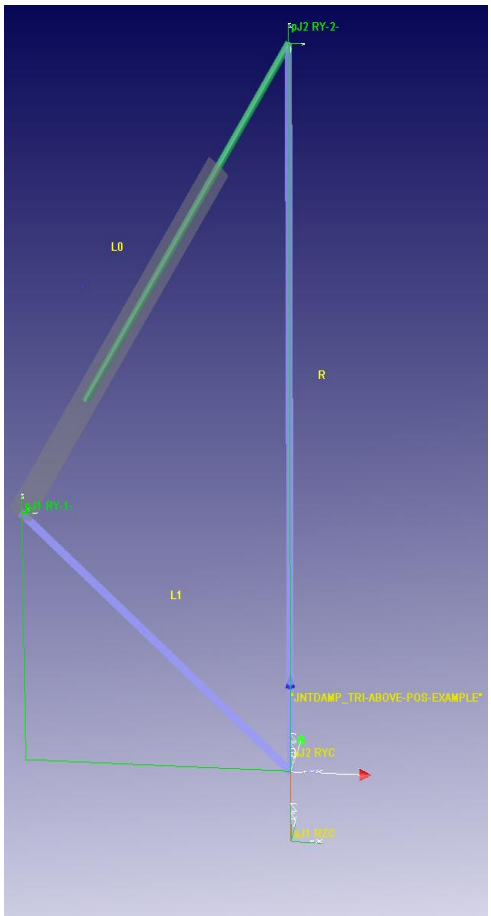
New formulas for robot-damping

Example for the function „JNTDAMP_TRI“:



JNTDAMP_TRI-Funktion Example

pJnt_i = JntDampTri (L0,L1,R, position, aJnt_ori, pJnt_idx)

First all the relevant lengths in EASY-ROB are measured:

L0 = 400.000 mm, **L1** = 300.000 mm, **R** = 500.000 mm

Subsequently, the position of the passive axle PJ2 RY-2 against aJnt2 must be determined:

pJ2 RY-2- lies above aJ2 RYC and the appropriate parameter is **position** = DAMP_ABOVE

Considering the aJ2 coordinate system, we see that the y-axis shows away from the viewer (in positive direction).

aJnt_ori = POSITIVE

The now given parameters can be added to the JNTDAMP_TRI function, which can be inserted for the appropriate passive joint in the Kinematics Window under **Kinematics** > **2 – Passive Joints** > **passive Joint ()** > **5 – Math. Jnt dependency**:

For pJ1 RY-1- :

=L0=400;R=500;L1=300;
JNTDAMP_TRI (L0,L1,R,DAMP_ABOVE, POSITIVE,**1**)

For pJ2 RY-2-:

= *JNTDAMP_TRI (L0,L1,R,DAMP_ABOVE,POSITIVE,**2**)*

If aJ2 is moving, then pJ1 and pJ2 will change accordingly to the angle calculated by the JNTDAMP_TRI-function.

Example:

The joint aJ2 is moved by +10°, dof(2)*DEG=10.000°

The JNTDAMP_TRI-function calculates the following values out of the given parameters:

pJ1 = 9.42° und pJ2 = - 0.58°

Please check out the following examples for more information: „JNTDAMP_TRI-ABOVE-NEG-Example.rob“, „JNTDAMP_TRI-ABOVE-POS-Example.rob“, „JNTDAMP_TRI-BELOW-NEG-Example.rob“ and „JNTDAMP_TRI-BELOW-POS-Example.rob“. They can be found under „Tutorial/Functional“.

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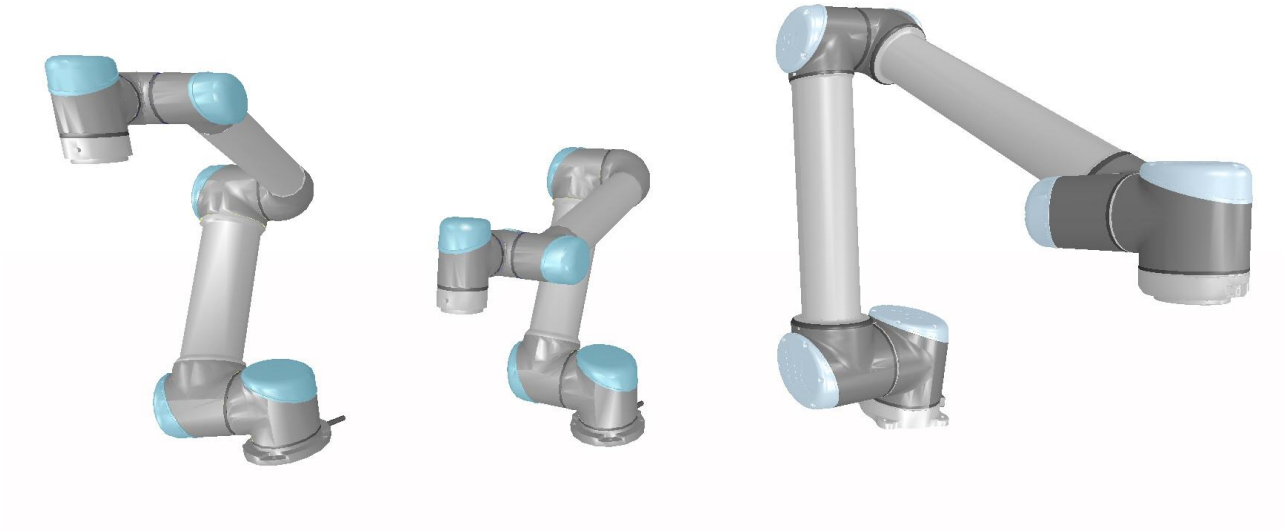
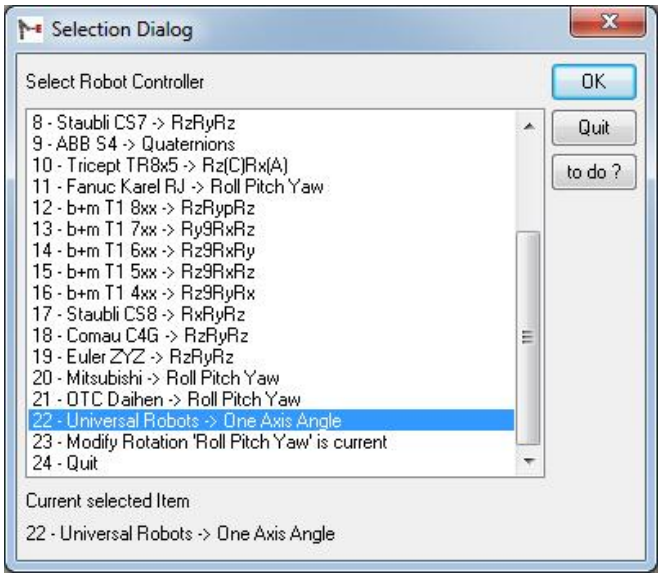
Orientation-Notation for Universal Robot

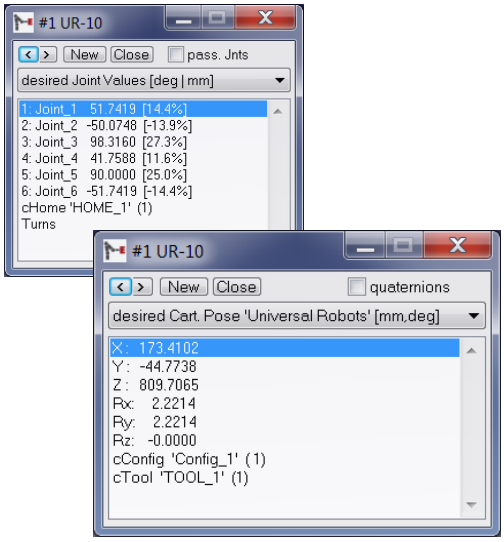
The Orientation-Notation „One axis angle“ for Universal Robot-robots has been added.



UR-5 UR-3 UR-10

Under **Robotics** > **cRobot Motion Planner** > **Controller** you can select the notation **22 – Universal Robots -> One Axis Angle**:





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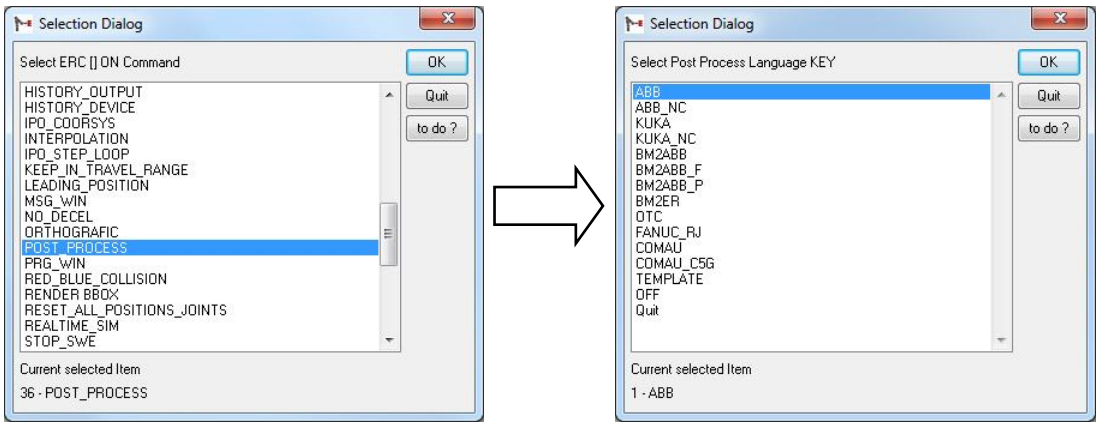
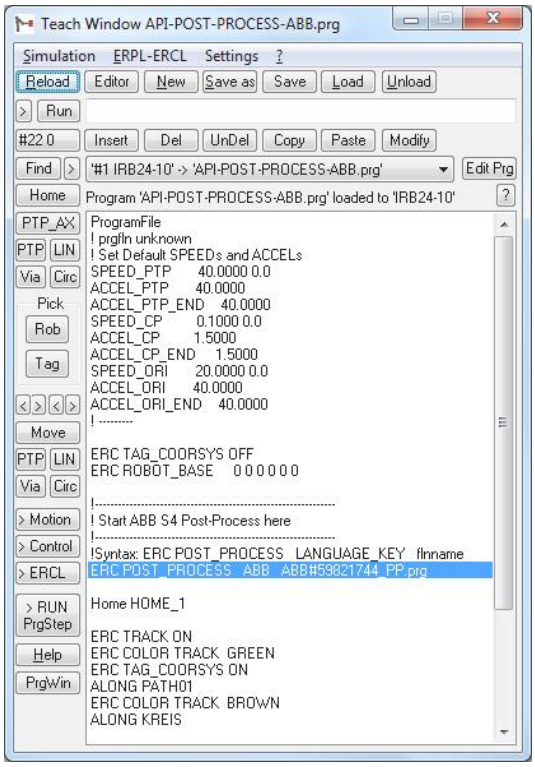
Advanced Post-processors

Also new: when setting the ERCL-command `ERC POST_PROCESS` in the Teach Window, a Selection Dialog will be opened automatically. Here you can select the desired Post Process Language (e.g. ABB, KUKA, etc).



The appropriate command line (eg for ABB post-processors) will automatically be inserted in the Teach Window:



Further information to the syntax can be found in the ERPL-documentation „EASY-ROB-ERPL_DE.pdf“.

Currently postprocessors are available for the robots of the manufacturer:

- ABB
- KUKA
- BM
- OTC
- Fanuc
- Comau

Additional user-defined Post-processors can be added via API-Post-Process.

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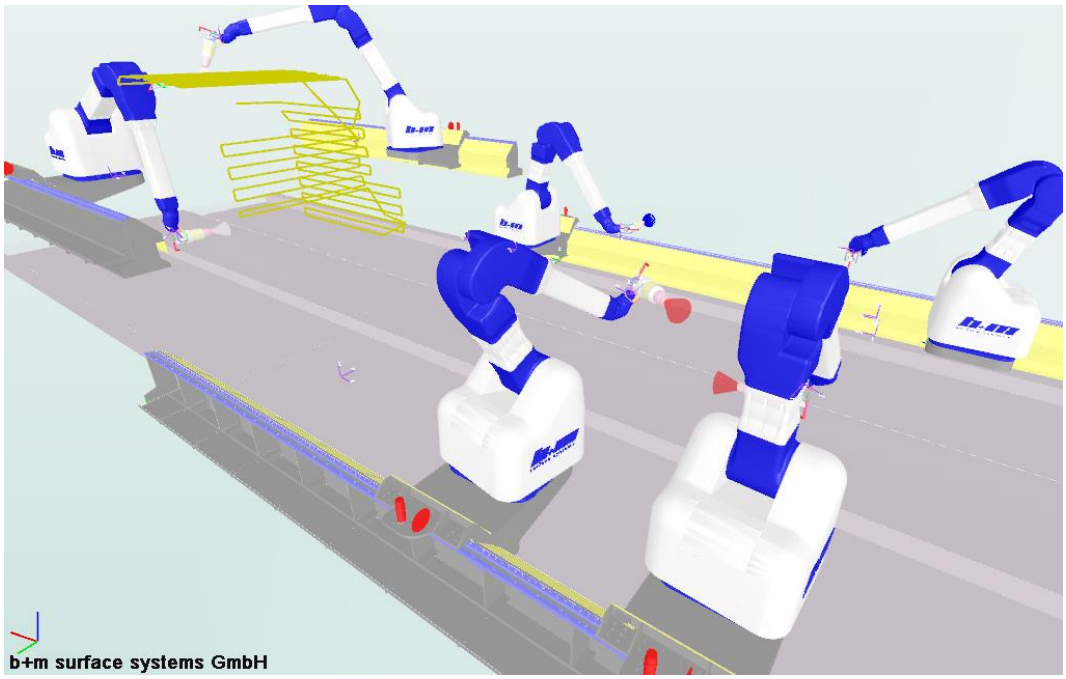
EASY-ROB™ Dll Multi-Program-capable

The EASY-ROB ™ DLL version was expanded by the Multi-Program functionality.

As with the EXE version the number of robots or kinematics in the work cell is not limited and each device can have its own loaded ERPL Program (Multi-Program). Kinematics such as gripper, positioner and conveyors can be loaded without limits, mounted to each other and simulated.
Multi-Program enables to run and simulate several robots and kinematics synchronized. The programs can "communicate" by IO-variables.

Integration example for a Multi-Program-enabled EASY-ROB ™ DLL Version:



EasyEdit™ Painting of drivers cabin, b+m surface systems GmbH

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New ERCL-commands

3D-PDF Export

ERC _3D_PDF_EXPORT SCREENSHOT [flnname]

Creates a 3D PDF document of the current scene (without animation), e.g. a still image with all angle values at the time of the command. If no [flnname] entered, the name of the workcell is taken for the 3D PDF document.

ERC _3D_PDF_EXPORT ON / OFF [flnname]

Enables / disables recording of the 3D PDF document. If no [flnname] is entered, the name of the workcell is taken for the 3D PDF document. When the recording of the 3D PDF file is stopped (OFF), the document is created automatically and saved under the specified name.

Important: If a 3D-PDF-document has been created and opened before with the Adobe® Reader, it is necessary to close it, before the recording can be finished and the document can be saved again.

ERC _3D_PDF_EXPORT SET_FILE flnname

The 3D PDF document will be created with the name specified under "flnname". Previously the _3D_PDF_EXPORT ON command must be set.

ERC _3D_PDF_EXPORT SET_LABEL labelname

Sets a label with the text specified in "label name". The text of the label is displayed in the open 3D PDF document next to the real-time process and is used for individual identification of individual process sections. Previously the _3D_PDF_EXPORT ON command must be set.

ERC _3D_PDF_EXPORT SET_PASSWORD passwordname

This 3D PDF document will be protected with the password specified in "password name". This must be entered when the document is opened. Previously the _3D_PDF_EXPORT ON command must be set.

ERC _3D_PDF_EXPORT PAUSE

Pauses recording of the 3D PDF document. Setting the command again continues recording. Previously the _3D_PDF_EXPORT ON command must be set.

ERC _3D_PDF_EXPORT DEACTIVATE

The recording of the 3D PDF document will be canceled and the document is discarded.

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Cartesian Space Limits

Note:
Further description for the cartesian space limits can be found on page 7 of this update information.

ERC SHOW_CART_SPACE ON/OFF

Enables/Disables the visualization of the cartesian space limits, the values can be defined under attributes in the Kinematics Window. This space limit is visualized as a green space.

ERC STOP_CART_SPACE ON/OFF

Enables/ Disables the automatic stop when the cartesian space limits are exceeded.

ERC CART_LIMITS MIN

Sets the minimum limit values [m] determined for the xyz coordinate direction. By entering the maximum limit values (ERC CART_LIMITS MAX) the limited cartesian space will be created.

ERC CART_LIMITS MAX

Sets the maximum limit values [m] determined for the xyz coordinate direction. If the minimum limit values (ERC CART_LIMITS MAX) are defined the limited cartesian space will be created.

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ER_CAPI: Calculation of Jacobi-Matrix

int ER_CAPI_ROB_KIN::rob_kin_jacobian_q ()

This method calculates - depending on the axis position q - the values of the Jacobi matrix in the flange (Tip) or the TCP regarding robot base.

```
static ER_DllExport int ER_CAPI_ROB_KIN::rob_kin_jacobian_q ( float *   qn,
                                                              frame *  tTw,
                                                              float *  jac,
                                                              int      n_dofs,
                                                              float    delta_scale = 1
                                                             )
```

static

Calculation of Jacobian matrix
This method calculates, depending on robots joint location **q** , the jacobian matrix in the flange (Tip) or in Tcp w.r.t. the robots base.
If parameter `tTw` is NULL, the jacobian is in the Tip.

Remarks

For known kinematics, the jacobian is calculated analytically.
For unknown or user defined kinematics, those with mathematically joint dependencies for example, the jacobian matrix is calculated computerized.
In this case a deviation of dR=0.01deg for rotational and dx=1mm for translational joints will be taken.
Parameter `delta_scale` allows to change these values.

```
// Example:
float *q     = er_rob_kin.inq_q_solut();        // pointer to desired joint data
int num_dofs = er_rob_kin.inq_num_active_jnts(); // number of robot joints
frame *tTw = er_rob_kin.inq_tTw();      // Current Tool frame, Robot Tip (flange) to TCP

float *Jac = new float[DOF6*num_dofs];  // Jacobian (DOF6 x num_dofs)
if (Jac)
{
        float delta_scale = 0.5f; // scaling for computerized calculation of jacobian matrix

        er_rob_kin.rob_kin_jacobian_q(q,tTw,Jac,num_dofs,delta_scale); // in Tcp
        er_user_io_dialog._info_line_msg_M(0,"Jac in Tcp",Jac,DOF6,num_dofs);

        er_rob_kin.rob_kin_jacobian_q(q,NULL,Jac,num_dofs,delta_scale); // in Tip
        er_user_io_dialog._info_line_msg_M(0,"Jac in Tip",Jac,DOF6,num_dofs);
        delete Jac;
}

...
```

Parameters

[in]	**qn**	input joint values
[in]	**tTw**	tool, from Robot Tip (flange) to Tcp
[out]	**jac**	Jacobian matrix in Tip or Tcp w.r.t. Robot base
[in]	**n_dofs**	number dof
[in]	**delta_scale**	scaling for computerized calculation of jacobian matrix

Return values

0 - OK
-1 - Error

Further information:

http://www.easy-rob.com/fileadmin/Userfiles/doc/er_capi/class_e_r___c_a_p_i___r_o_b___k_i_n.html

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ER_CAPI: Material- and Light-Attributes

`float* ER_CAPI_SYS_VIEW::inq_ergl_material_light ()`

Request OpenGL material or light attributes

```
static ER_DllExport float* ER_CAPI_SYS_VIEW::inq_ergl_material_light ( int ergl_param = ERGL_UNDEF,
                                                                       int ergl_mode = ERGL_MODE_INQ
                                                                     )
```

static

Request OpenGL material or light attributes

Remarks

Parameter `ergl_param` defines the requested value

Use parameter `ergl_mode` to get the address **ERGL_MODE_INQ** or to reset **ERGL_MODE_RESET** or to transfer the attributes to OpenGL **ERGL_MODE_SET**.

```
// Example:
// Get specular RGB componentes for light source #1
float *p = er_sys_view.inq_ergl_material_light(ERGL_LIGHT_1_SPECULAR, ERGL_MODE_INQ);
// change the RED component within 0 and 1
float *v = &p[0];
*v += 0.01;
if (*v<0) v*=0;
else if (*v>1) v*=1;
// change some more attributes here .... or reset to original attributes
// er_sys_view.inq_ergl_material_light(ERGL_LIGHT_1_SPECULAR, ERGL_MODE_RESET);
// Finally, transfer modified attributes to OpenGL
er_sys_view.inq_ergl_material_light(ERGL_ALL_ATTRIBUTES, ERGL_MODE_SET);
// make a grafical update to see the results
er_sys_view.grf_update_export();
...
```

Parameters

[in] **ergl_param** is one of **ERGL_MATERIAL_AMBIENT** :: ERGL_MATERIAL_DIFFUSE to **ERGL_LIGHT_4_EMISSION**

[in] **ergl_mode** is one of **ERGL_MODE_INQ**, **ERGL_MODE_RESET** , **ERGL_MODE_SET**

Return values

pointer to requested value

Further information:

http://www.easy-rob.com/fileadmin/Userfiles/doc/er_capi/class_e_r___c_a_p_i___s_y_s___v_i_e_w.html

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ER_CAPI: Geometry Load Error

int AUX_UPDATE_IDX_LOAD_GEO_ERROR

If a device is loaded and no geometries will be found, the appropriate feedback will be shown.

const int AUX_UPDATE_IDX_LOAD_GEO_ERROR = 54

Geometry file (IGP, STL or 3DS) not found during load.

Further information:

http://www.easy-rob.com/fileadmin/Userfiles/doc/er_capi/index.html

ER_CAPI: AutoPath™

Method class to control collision-free path planning.

The following functions have been copied from ER_CAPI_MOP_AUTOPATH Class to er_dvlp_ext.h:

```
EXPORT_C char* AutoPathVer(void);
EXPORT_C void* inq_AutoPathDlg_Hwnd(void);
EXPORT_C int SetDlgParameter(int ap_dlg_option, int ap_dlg_value);
EXPORT_C int GetDlgParameter(int ap_dlg_option);
EXPORT_C float* SetStartPose(void);
EXPORT_C float* SetEndPose(void);
EXPORT_C int FindPath(void);
EXPORT_C int AbortPlanning(void);
EXPORT_C int GetPlanningStatus(void);
EXPORT_C int GetNumberOfWayPoints(void);
EXPORT_C int GetWayPointDof(void);
EXPORT_C float* GetWayPoint(int idx);
EXPORT_C int ClearAllWayPoints(void);
EXPORT_C UINT* Accuracy(void);
EXPORT_C int SetAxisPriority(int axisBit, int priority);
EXPORT_C int SetAxisEnable(int axisBit, int enable);
EXPORT_C int SetParameter(int ap_option, int ap_value);
EXPORT_C int GetParameter(int ap_option);
```

Further information:

http://www.easy-rob.com/fileadmin/Userfiles/doc/er_capi/class_e_r___c_a_p_i___m_o_p___a_u_t_o_p_a_t_h.html#details

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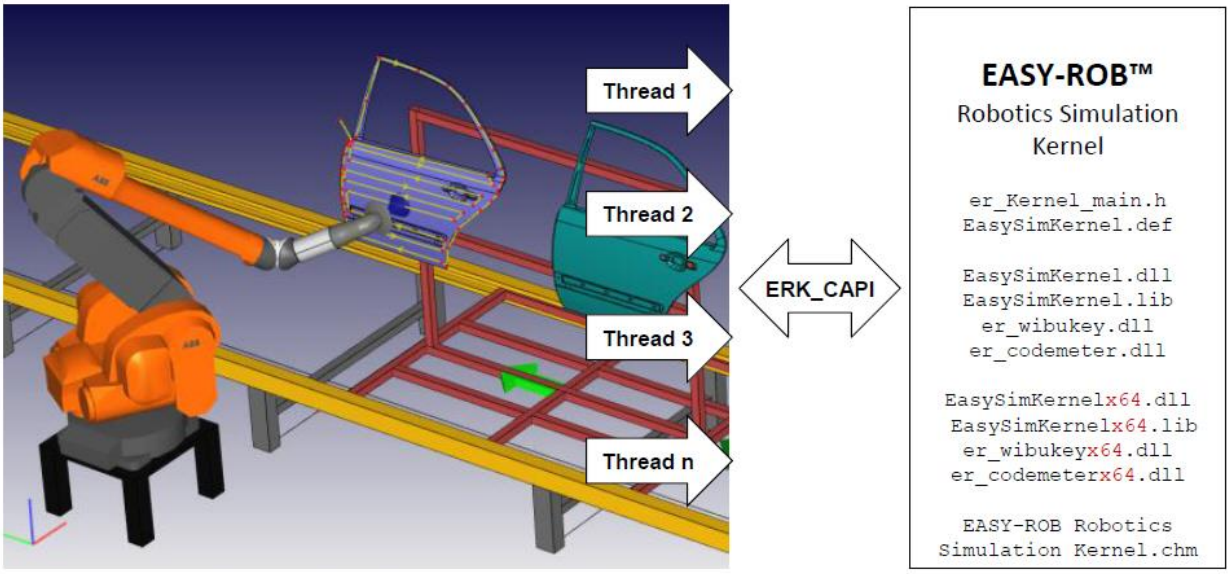
Robotics Simulation Kernel Multi-Thread capable

With the new EASY-ROB™ version the EASY-ROB Robotics Simulation Kernel (ERK) is now Multi-Thread-capable.

When calling functions from the DLL ERK by user programs, it must be ensured that a simultaneous and parallel execution of the functions is possible without interfering with each other.
A parallel execution and handling of user-specific threads is realized by Multi-Threading.
If two threads are accessing the same shared memory area, their changes will be coordinated to avoid mistakes.



OEM Application: Technology-based software with its own 3D Visualization
Parallel execution and handling of threads possible

Excerpt from the MSDN Library on thread safety in the C ++ - standard library:+-Standardbibliothek:

„If an object is being written to by one thread, then all reads and writes to that object on the same or other threads must be protected. For example, given an object A, if thread 1 is writing to A, then thread 2 must be prevented from reading from or writing to A.“

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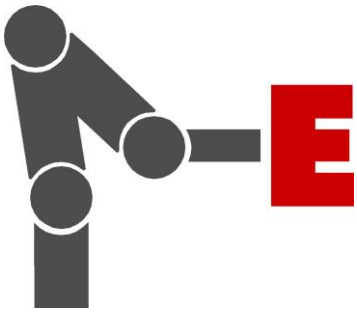
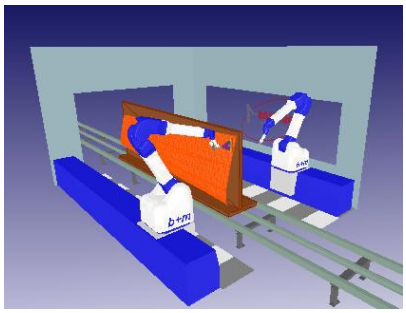
New EASY-ROB™-Icon



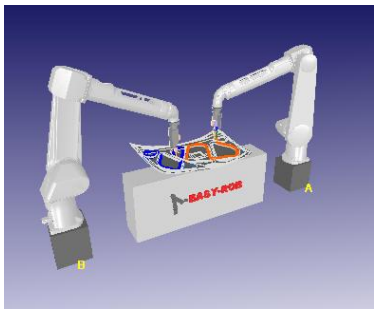
EASY-ROB™-Version 6.6 has a new icon.

New example workcells in ApplicationLib

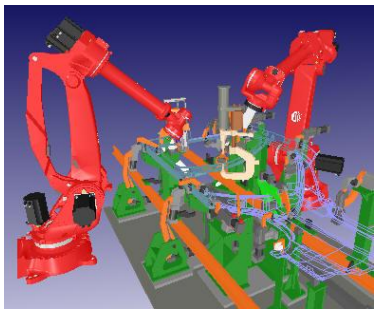
The ApplicationLib has been extended with new example workcells and some existing examples have been updated. Besides updated workcells for Spotweld- and painting-applications, new examples for applications such as dispensing, arc-welding, handling and measuring have been added.



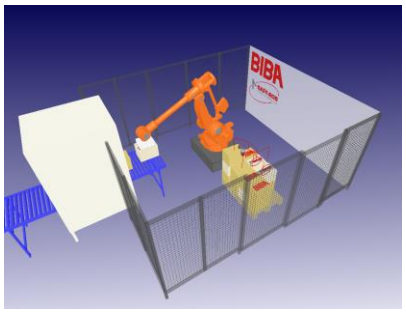
Painting-Airplane-Wing.cel



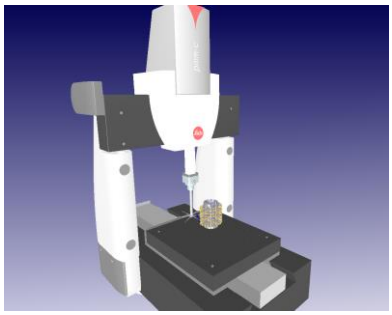
Multi-Dispensing.cel



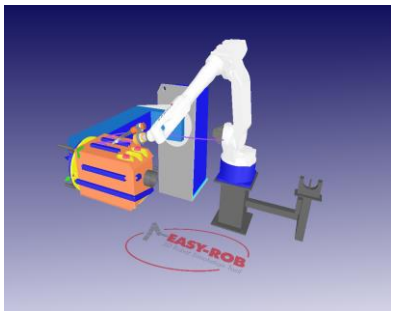
spot_weld_Comau.cel



Flystick-Depalletising.cel



Coordinate-Measuring-VMR.cel



ArcWelding-Chimney-Stove.cel

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EASY-ROB Customer area

Online available: Program Updates and Robot libraries

Web: www.easy-rob.com/en/special/customer-area

Access data:

User: customer
Password: **********

Notes

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