



**SIEMENS**

*Ingenuity for life*

# KineoWorks

## Quickly and easily compute collision-free motion with the leading path planning solution

### Benefits

- Enables high-performance automated path planning in motion simulation and control
- Guarantees continuous collision avoidance along a trajectory
- Optimizes trajectory paths
- Analyses collisions along a trajectory
- Performs collision-free robot simulation and control
- Models human interaction and accessibility
- Enables assembly/disassembly simulation
- Allows user-defined clearances
- Applications are built quickly and easily using a rich development environment
- Uses small memory footprint
- Easy to learn, use and customize
- Used with leading CAD systems

### Summary

KineoWorks™ software component from Siemens PLM Software enables you to automatically compute valid, collision-free trajectories for any kinematical system, solving problems known as path planning. KineoWorks is a valuable tool for next-generation CAD and robotics systems with advanced motion planning and control capabilities.

KineoWorks addresses all aspects of motion processes from interference detection to automated path planning – including the following situations:

**Kinematics** – KineoWorks allows you to model your system kinematics as a tree of joints. You can add custom constraints to account for special features of the system, such as closed chains or inverse kinematics.

**Trajectories** – KineoWorks enables generic motion representation using trajectory objects called paths. KineoWorks supports common motion types, such as linear and joint motion. You can also implement your own motion types for KineoWorks analysis.

### Trajectory collision analysis –

KineoWorks features an advanced algorithm for detecting collisions along a trajectory, which is both fast and exact, regardless of kinematical complexity. Performance can be further tuned by accepting small collisions of controlled depth, which can be compensated for using design tolerances.

**Path planning** – KineoWorks enables you to compute a collision-free path for any kinematical system very quickly and reliably.

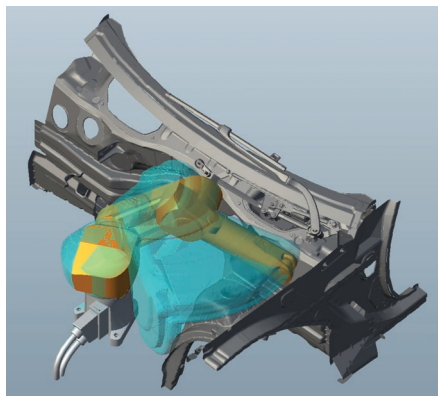
**Trajectory optimization** – KineoWorks includes algorithms you can use for optimizing collision-free trajectories. Optimization criteria include length, cycle time and energy.

**Sequence optimization** – KineoWorks provides automatic point reordering for optimizing tool paths. Travelling salesman problem (TSP) algorithms minimize the total path length through the workspace given an unordered or partially ordered list of inspection/machining positions and the tool motion type (joint or linear). An optimized tool sequence is computed while ensuring a collision-free path.

# KineoWorks

## Features

- Automates PLM assembly and disassembly studies
- Simulates human body kinematics and collisions
- Optimizes previously computed trajectories
- Programs robots online or offline
- Smooths an existing trajectory
- Implements autonomous robot navigation
- Animates interactive documentation
- Swept volume computation
- Interactive path planning with collision avoidance
- C++/C# interfaces



**Swept volumes** – KineoWorks can compute the swept volume of a part moving with a defined motion. Applications include space reservation in manikin, robotic or articulated system motion studies.

## Integrating human expertise

Magnet points and magnet paths technology provides user-guided capabilities that enable end-users to find resulting paths more efficiently. Integrating human expertise into the loop lets end-users input a draft trajectory, called a magnet path, to influence the path planner's search area or to constrain it to some regions of space. Similarly, they can interact with the software during path planning by moving magnet points that attract the search to the desired area for faster and more precise resulting paths.

Magnet technology enables end-users to combine their knowledge and the power of the software to accurately and easily solve assembly/disassembly cases. Magnet technology enables them to guide the search without worrying about collisions or other local constraints while the software does all the heavy work of avoiding obstacles.

Using any input device, you can interactively guide the simulated motion of an object while KineoWorks detects collisions and determines a close collision-free path. This approach

combines your preferred solution with automated collision avoidance to provide highly efficient motion planning.

## Openness

The KineoWorks API is fully object-oriented in which many concepts are abstracted into documented classes. This enables you to customize everything to a high degree. In addition to the standard toolbox delivered with KineoWorks, you can introduce your own constraints, metrics, motion types, etc. Advanced users, such as researchers, can re-use elementary computing blocks to design their own path planning algorithm from scratch, or customize part of KineoWorks algorithms to meet their path planning needs.

## Ease of use

Computing a collision-free path doesn't require you to tune any parameter. You simply input the start and the end motion, and the path planner does the rest. The fully object-oriented API enables you to easily describe the system and its environment in a constructive manner. The software package includes a user manual, many tutorials that run in a graphical environment and complete reference documentation of all public classes and methods.

## High performance

KineoWorks focuses on high performance for industrial applications, providing exclusive algorithms that enable you to quickly solve very constrained problems. These algorithms derive from a well-studied family of randomized algorithms, proven to be efficient even in high-dimensional spaces – enabling planning paths for very complex kinematics such as the human body. The power of Kineo™ Collision Detector software is part of KineoWorks; both work together seamlessly. KineoWorks benefits from all Kineo Collision Detector features

including high performance, robustness, low memory consumption, easy setup, openness, per-object minimum clearance and many available analysis types. If you prefer to use your own collision detector, you can plug it into KineoWorks which relies on your detector for all static collision detection tasks.

### Robot programming

A path planner is a natural tool for both offline robot programming and for autonomous systems that need to interact with their environment. Safe and efficient robot trajectories can be computed easily for handling, welding and measuring tasks. Applications include:

- **Manufacturing** – tool path and sequencing optimizations specifically designed for pick and place, spot welding, arc welding, etc.
- **Inspection** – CMM productivity is increased with automated computation of optimized sampling trajectories.
- **Cobots** – collaborative robots can react to changes in their environment by computing new paths on-the-fly.

### Virtual assembly

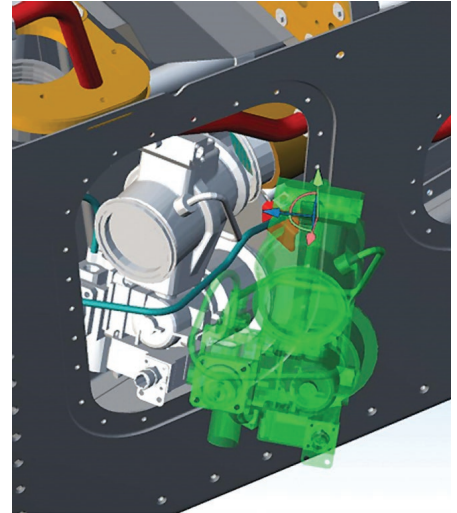
By embedding KineoWorks into your 3D CAD system, your end-users will be able to find valid, collision-free assembly and disassembly paths in one click. They can validate their designs quickly and accurately, as well as document product serviceability.

### Human accessibility and assembly simulation

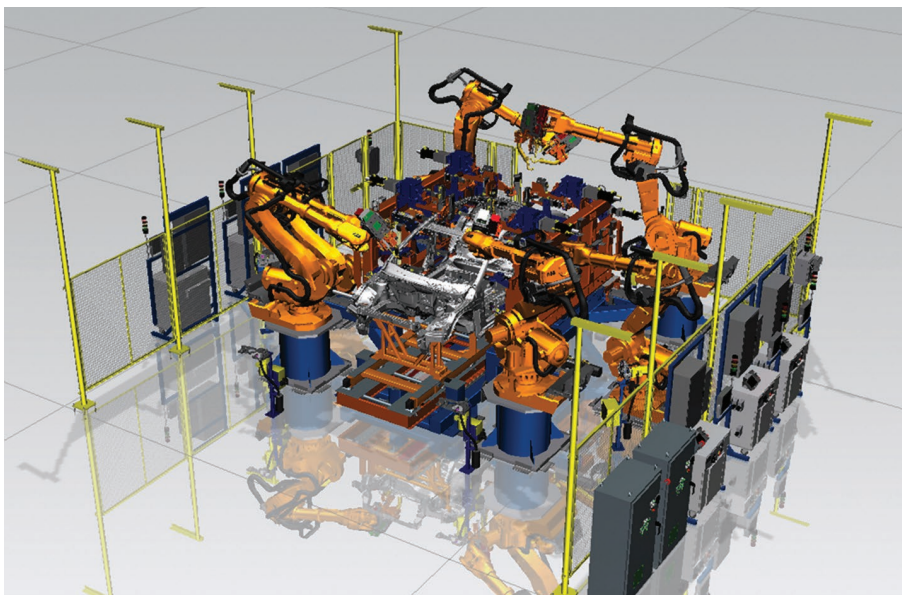
KineoWorks enables you to handle human body kinematics with more than a hundred degrees of freedom. This feature allows you to simulate the presence of the operator in assembly tasks to check feasibility, ergonomics and accessibility, as well as produce training animations and maintenance documents.

### Ease of integration

KineoWorks is a software component that has been carefully designed with OEMs and system integrators in mind. Its portable architecture enables flexible integration with existing software systems. New software applications based on KineoWorks are easy to build using our complementary developer toolkit, KineoWorks™ Interact.



Assembly/disassembly studies.



### KineoWorks Interact

KineoWorks Interact is a rich CAD and robotics GUI toolkit that enables the rapid development of 3D software applications that benefit from Kineo motion planning, collision detection and flexible cable simulation technologies. It is used in-house by OEMs and niche market software developers to maximize and expedite return-on-investment for their digital manufacturing solutions.

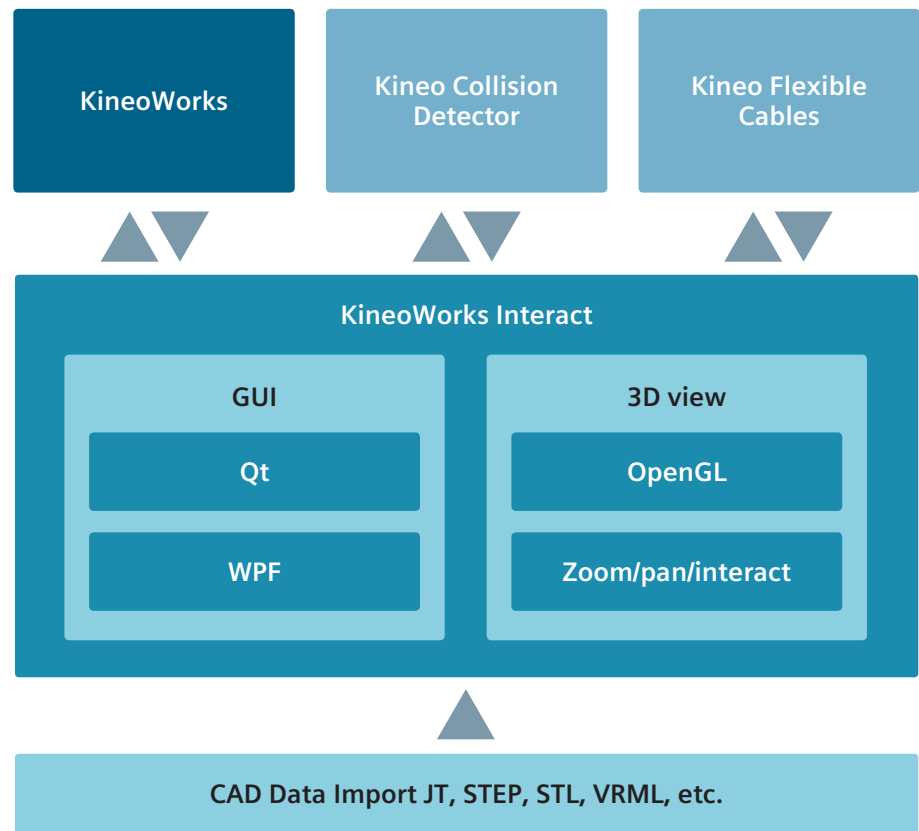
Users can easily develop and run customized and proprietary modules through standard C++/C# application programming interfaces (APIs).

#### Key features

- Graphical User Interface development (Qt, WPF interfaces)
- Rich 3D visualization
  - OpenGL rendering of the KineoWorks data model
  - Extensions available for rendering custom data types and for adding custom behaviors
- Mouse navigation and interaction with the model
- 3D geometry importers for JT, STL, VRML, STEP and IGES
- Support of copy/paste, undo/redo
- Support for unicode and localization
- Graphical edition of KineoWorks objects

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