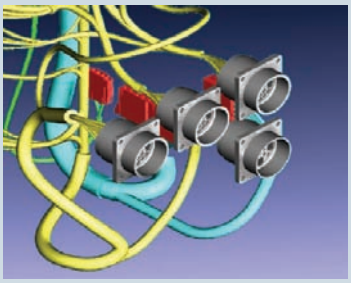
NX electrical and mechanical routing

Accelerating design of electrical and mechanical routed systems in complex assemblies

Electrical routing benefits

- Re-uses logical design – eliminates redundant data creation
- Predicts accurate wire lengths for early analysis
- Predicts accurate bundle diameters for interference checking and space allocation
- Improves quality by enforcing design standards and verifying complete connections
- Eliminates physical prototypes and rework – your harnesses fit the first time

Summary
NX™ digital product development solutions include an integrated suite of tools that facilitate the entire design process for routed systems, including wire harnesses, cables, piping, tubing, conduit and raceways. These process-specific tools reduce detailed design time, improve product quality and transfer product information seamlessly between the logical design, physical design, analysis, manufacturing and service sectors.



NX electrical routing
NX includes a fully integrated 3D electrical harness routing application that allows users to design and route harnesses in complex assemblies. Built upon the NX routing applications architecture, the electrical routing tools provide electrically smart features and functions to automate the design, modification and analysis of wire harnesses. This powerful capability imposes no limits on the number of components or wires in a design and includes a complete set of robust interfaces to electrical design technology providers. NX electrical routing enables integration with all electrical disciplines including system design, logical design, PCB design, physical design, electrical analysis, manufacturing, installation, service documentation and service delivery.

Speed to production by eliminating prototypes
The powerful design and manufacturing capabilities available in NX electrical routing enable users to produce a wire harness directly from NX product assembly models. The need to build a physical prototype before producing the wire harnesses is eliminated, significantly reducing product development time.

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NX electrical and mechanical routing

Electrical routing features

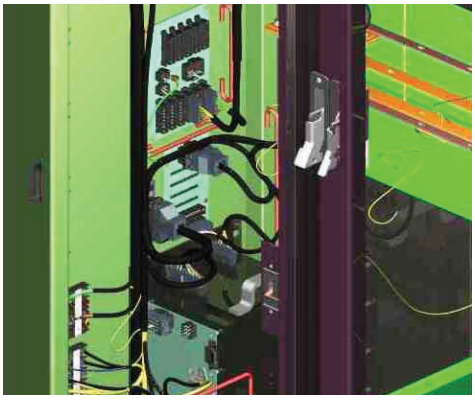
- Provides a flexible interface to logical connectivity data
- Includes connection and component creation wizard
- Provides ASCII format, XML and PLMXML Netlist support
- Supports rapid path creation between components
- Includes automatic wire routing between components with length determination
- Calculates wire bundle diameters
- Facilitate interference checking in the assembly
- Produces manufacturing documentation
- Analyzes built-in and customer-specified design rules
- Allows easy access to libraries of connectors, devices and other support hardware

Automates the entire design, analysis and manufacturing process

Intended to leverage connection information provided by logical design, NX offers tools to manage wire lists as they are imported into the 3D assembly and exported back to the logical design system. For example, a list of wires and the connections they make is imported to NX electrical routing, which then determines the lengths of the wires. The list is updated with wire lengths and can then be exported, in the same format or a different format, to a circuit analysis package.

Automatic creation of smart 3D manufacturing models

NX electrical routing goes beyond just flattening a harness – it generates a full assembly, with all electrical connectivity information intact. The result is identical to the 3D assembly, but is laid out on a single plane. Also included is the advanced capability of maintaining the relative position of each connector to the bundle as the harness is flattened.



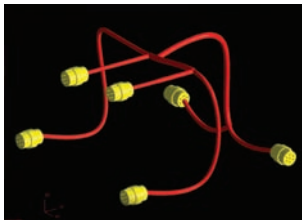
NX electrical routing reduces system development time by creating virtual prototypes of electrical wire harnesses within complex product assemblies, such as this power distribution module.

NX electrical routing generates a 2D formboard drawing, while taking the unique approach of creating a smart 3D manufacturing model.

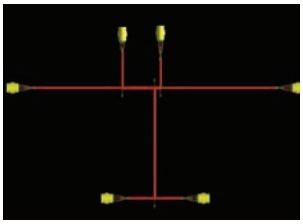
Driven by logical design

NX electrical routing integrates logical connectivity data, electrical wire information and component properties with physical harness geometry to capture the full definition of the electrical wire harness design. NX accepts logical connectivity data from a variety of sources, including schematic capture applications like NX Schematics, CIM-Team E3 Series and Mentor Graphics' LCable and CHS tool suites. This flexibility enables users to tailor NX electrical routing to their organization's electrical design processes and tools.

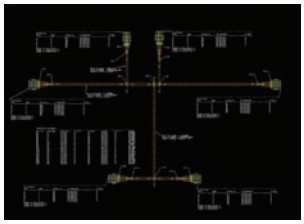
NX electrical routing adds electrical content on the fly with a Connection and Component List wizard. The wizard supports interactive creation and editing of connection and/or component list records. From/to information, stock properties and part placement can all be specified from within the wizard.



Step 1 – 3D Harness.



Step 2 – Flattened Harness remains a smart 3D assembly.



Step 3 – Formboard drawing.

Connection and component list management
The PLM XML netlist feature in NX electrical routing enables import and export of PLM XML files containing route list information, accommodating ECAD data that complies with the NX schema definition for electrical data. This format is utilized within the mechatronics framework of Teamcenter® software.

NX electrical routing also features a basic (native only) XML netlist that includes wire, cable, space reservation, logical connection and component information. This feature provides the following functionality in addition to the extension of standard netlist:

- Enhanced route list navigator to display the connections in an hierarchical fashion
- Interactive creation/deletion/modification of connections through a wizard interface
- Definition and modification of wire and cable properties
- Manual assignment of wires/cables to the logical connections
- Cable support and cable length calculations
- Modeling of splice, shields, stowed wires and dressings (overstock)
- Topology information exportable and utilized to create manufacturing reports and diagrams
- Embedded format and filter information in the XML netlist
- Flexible import formats with minimal data required during the conceptual design stage
- User-friendly display and reporting on components and connections
- All information stored as objects within the virtual prototype
- Adaptable to a wide variety of processes from the initial concept to detailed logical design
- Information needed to back annotate the logical design automatically created so a more complete analysis can be performed

Part definition, selection and placement

- Built-in capability for specifying the electrical and connectivity intelligence associated with connectors and devices. Port-to-port connections allows parts to snap into place.
- Libraries of customizable, parameterized standard connectors, devices, clips and clamps quickly defined and selected
- Automatic assignment of reference designators to components

Routing

- Specialized tools for path creation between components in crowded assemblies with full associativity
- Automatic creation of wire bundles and automatic calculation of wire length and bundle diameters
- User control of object blanking based on connectivity and option content

Design rules

- Reflecting the knowledge-driven approach of NX, design rules check and enforce standard practices to reduce production costs and assembly defects. Rules can be checked during design, on demand or in a batch for extensive analysis.
- NX is pre-loaded with extendible design rules to ensure that wire harnesses follow company design standards. Customers can add custom design rules.
- Violations – which are stored with the assembly – notify the user of problems.
- Violations can be reviewed and corrected at any time.
- Current out-of-the-box design rules are integrated into NX Check-Mate validation tools; new rules can be added.

Output to manufacturing

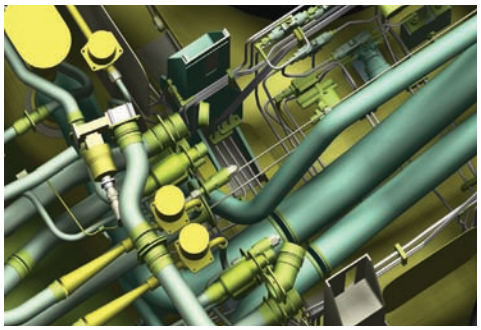
- NX readily generates output needed to communicate the harness design to a manufacturing facility. The output is a flattened model accompanied by various reports and bill of materials (BOM).
- Flattened 3D model retains electrical intelligence in a true assembly structure.
- Additional components such as tie wraps, clips and grommets, can be added to either the 3D or flattened model.
- Flattened model can be used as reference for full 3D jig design.
- Connectors can be clocked to maintain the correct relative positioning between the 3D model and the flattened model
- NX easily produces a one-to-one or scaled formboard drawing

Focused on completion of routing tasks
NX electrical routing aims at completing routing tasks in the shortest time – placing components, routing all interconnecting wires and ensuring paths avoid other equipment.

NX electrical routing helps designers create and verify wire routing and connectivity to components. It automatically connects components as defined by the netlist, calculates wire lengths and wire bundle diameters, identifies minimum bend radius violations and produces site-specific manufacturing reports and drawings. It's easy to validate the design using component usage reports, design rule checking and clearance analysis.

Mechanical routing benefits
- Eliminates need for physical measurements
- Significantly reduces time to market
- Reduces overall routing and end-user training costs

Mechanical routing features
- Accelerated path creation
- Intelligent part placement
- Parametric part selection
- Customizable part libraries
- Bills of Material automation
- Flexible application attributes



NX mechanical routing
NX provides mechanical routed system design tools and example libraries for tubing, piping, conduit and raceways. Mechanical routed system models are fully associative to NX assemblies to facilitate design changes. Automated bills of material and bend reports provide information for subsystem manufacturing. Time to market is greatly reduced by eliminating the need to take physical measurements before starting the design of the routed subsystem.

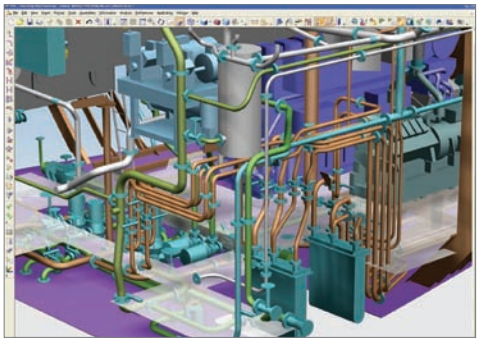
With NX mechanical routing tools, users can design 2D logical and 3D routing subsystems within 3D mechanical models. They can also automatically calculate cut lengths, produce a complete bill of material (BOM) and fabricate routing subsystems for timely installation on the first physical product.

Integrated functionality
An integrated architecture provides a seamless transition between core NX modeling tools and mechanical routing capabilities. The unified design reduces the overall cost of routing applications and end-user training and facilitates seamless interoperability between applications.

Routing systems
NX provides the common user interface and customization tools for process-specific routing capabilities. Companies can enhance NX with their own standard parts, design rules and system changes. NX mechanical routing provides the following functionality.

- NX provides XML type support in the application view file. The new XML format offers enhanced features that enable users to define disciplines and specifications that help filter part selection by general application and specific part characteristics.
- NX supports creation of a logical design for mechanical routing. The application allows 2D diagramming of mechanical systems, such as piping and tubing designs. In addition, this toolset lets you drive and compare the 3D model with the 2D diagram, to ensure consistency and aid the creation of the design.
- Run and spool creation and definition wizards assist in designing with manufacturing intent. Defining runs allows designers to permanently identify sections of piping and tubing assemblies. Through such identification, you can directly compare a 2D logical diagram to a 3D mechanical model. Users can create manufacturing instructions using run identifiers as references. After run identification and assignment, users can specify subsections called spools. NX automatically numbers the parts and stock that make up the spool to identify the items in manufacturing drawings or other product documentation.
- NX mechanical routing now supports and can determine the direction of flow. When flow direction cannot be completely determined automatically, an interface allows the designer to assign flow direction. Flow direction arrows can be displayed temporarily or placed as permanent annotations.
- NX facilitates automatic default elbow placement at corners

- Template assemblies allow designers to define families of assemblies and place them in routed subsystem designs in a single step. For example, a pump might always require a valve and two flanges. Instead of placing each component individually, they can be placed all at once with the correct assembly structure.
- General stock definitions make it possible to support many types of routing applications. Round stock can be defined for tubes, hoses, pipes, conduits. General stock cross sections can also be used for raceway, HVAC or any other type of stock including insulation. All stock can share a common path.
- Path creation tools accelerate the design of 3D paths within an assembly. Path creation drag handles and slope definitions are incorporated into the simple path toolset. Geometric path constraints can be automatically created. Users can also create complex geometric constraints to adjacent 3D geometry. They can take advantage of NX curve creation and use existing curves to define routing paths.
- Part selection from a part library mechanism supports selection based on the desired characteristics. Parts can be further filtered by discipline.

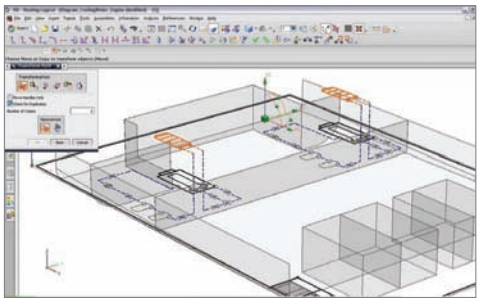


- Part placement uses intelligent algorithms that detect the way standard parts attach to the routing assembly. Typically, a part is placed by selecting a single object. NX positions the part correctly and cuts the stock back to the correct engagement. In addition, NX can determine a part by choosing characteristic values. When a destination object is selected, NX pre-filters only those parts that are appropriate for the location. This eliminates part misuse and errors.
- NX includes a custom flange placement interface that handles the details of making flange connections. This includes the selection of nuts, bolts, studs, gaskets and weld rings.
- Editing functions make it easy to change the routing assembly at any time during the design process.
- Fabrication creation helps designers decide how to best manufacture the routing system by selecting separate fabrications for drafting and assembly. This allows the user to design routing systems in the context of the entire product assembly.
- A BOM template is included that accelerates the creation of BOMs by importing a user's standard format and by including all routing parts and stock in the parts list.

Process-specific routing tools

NX mechanical routing includes example parts, design rules and system interfaces.

- *Part libraries* – NX provides an example library of parts and stock definitions. Each sample part is a fully parameterized part family. A large number of sample part specifications are also included. Companies can modify these specifications to meet the requirements of a specific industry or standard.

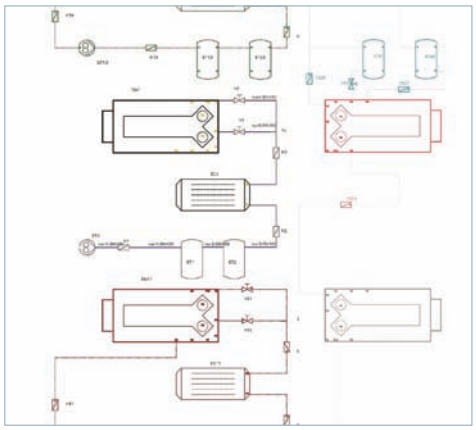


- *Design rules* – Design rules ensure that routing assemblies follow standard design practices to reduce cost and improve product quality. Design rules can be set to run concurrently, interactively or in a batch process. When a concurrent or interactive design rule is violated, the designer is warned immediately. The designer can fix the violation or enter the reason for the exception. Design rule violations are stored with the NX assembly and may be reviewed at any time.

NX mechanical routing includes the following design rules, which can be customized. Users may also create and add new design rules.

- *Minimum bend radius* – a violation is created when a bend radius is too small. Splines are also supported.
- *Minimum strength length* – a violation is created when the length of stock is too short between two bends.
- *Connection compatibility* – a violation is created when an invalid connection is made between two parts, or between stock and a part.
- *Flow direction* – NX checks flow direction characteristics on ports to ensure the orientation is correct based on the overall path flow.
- *Unique reference ID rule* – NX verifies that no two objects utilize the same reference ID characteristic.

Process support
Modeling the routing assembly is merely one step in the design and manufacturing process. Most routing applications begin with a 2D schematic that defines the logical connections between the devices within the assembly. During design, various analyses may be required. Procurement and manufacturing typically



require a BOM as well as drawings.
NX supports creation of a logical design for routing mechanical systems with 2D diagramming of mechanical systems, such as piping and tubing designs. This toolset enables designers to compare the 3D model with the 2D diagram, ensuring consistency and aiding in the creation of the design.

Routing application programming interfaces
Users may create and add custom routing functionality to the main routing toolbar.

Journaling and automation support
Users can employ journaling and automation to quickly generate source code and re-usable macros for automating and customizing tasks in NX routing.

Availability and packaging
NX electrical and mechanical routing tools are available standalone with basic prerequisites or as an add-on to any NX Mach Design solution.

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