PM12500-L

Advanced Solution for Heavy Plate Fabrication

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Autodesk

Learning Objectives

- Learn how to create materials and machine data for Nesting

- Learn how to quote parts

- Learn how to bring in CAD Files into TruNest

- Learn how to create Orders

- Learn how to create nests, review nests and also verify Machine Code

Description

Thick or heavy plate manufacturing presents its own set of unique challenges. This class utilizes Autodesk® TruNest to show workflows for manufacturing heavy, thick, plates with Oxy-fuel, plasma or waterjet CNC mills. We start with importing geometry and material properties, to automated optimal nesting all the way to generating CNC code for manufacturing.

Your AU Experts

Michael Jay Spellman – As part of the recent acquisition of Magestic Systems, Mike is currently serving as Director of software Development for the Composites and Fabrication team in the Advanced Manufacturing group. Prior to his current role, Mike served as CTO of Magestic and was one of the two Original founders, were he helped Design, Develop and Architect automated Nesting, Laser Projection and AFP/ATL systems for some of the largest companies in the world such as Boeing, Lockheed Martin, GE Transportation, Airbus, covering Various industries such as Aerospace, Automotive, Heavy Equipment, and more. With a background in computer science, electrical engineering and mathematics from Polytechnic University of New York

Matt Thorn is a SQA Engineer at Autodesk. Matt received his BS in Mechanical Engineering and Mathematics from Rutgers University and Stockton University respectively after completing a five year Dual Degree program. He began his expertise in Advanced Manufacturing with Magestic Systems Inc. which was then acquired by Autodesk in July 2014. Matt has been teaching and advising companies around the world on how to optimize their nesting, laser projection, and manufacturing processes for over 2 years.

Introduction

Nesting

What is nesting? Nesting is the optimization process of trying to fit a small object or objects inside a larger one. Nesting for manufacturing involves fitting as many parts, pieces, or plies (small objects) into the given material constraints (larger objects).
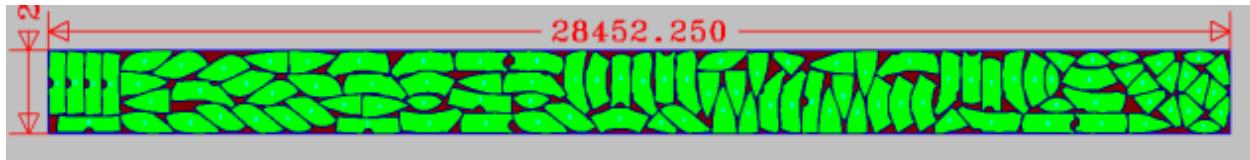
FIGURE 1: EXAMPLE OF A NEST USED IN MANUFACTURING

Why is nesting important? The nesting process drives the production of parts and assemblies on the shop floor. The nesting system knows how much material will be consumed and left over to make a product.

TruNest User Interface

Tree

The Tree serves as the main entry to every workspace within TruNest. Each node in the tree indicates how many other nodes are underneath it. Clicking a node in the tree will open that workspace. You can open multiple workspaces at a time by using the center mouse button when clicking a node in the tree. If you use a standard left click, it will replace the current workspace with the workspace chosen in the tree. Some of the nodes, like the Nests node, are automatically populated based on certain criteria within the system. The tree has a search feature that will automatically expand the nodes in the tree that match the search criteria. It also has a refresh option in case something within the configuration has changed and the tree needs to be updated.
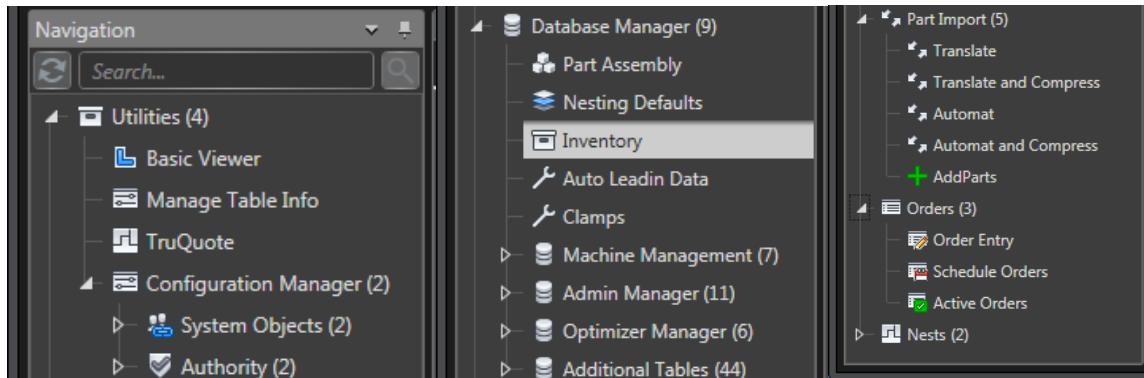

FIGURE 2: ADMIN LEVEL EXPANDED TREE (SPLIT INTO 3 PIECES)

Ribbon

The ribbon is another navigation tool within TruNest. The ribbon has more specific options to choose from that are easily accessible, rather than trying to find the correct node in the tree. One distinct difference about the ribbon is that each button opens up a separate workspace instead of overwriting the currently selected workspace.
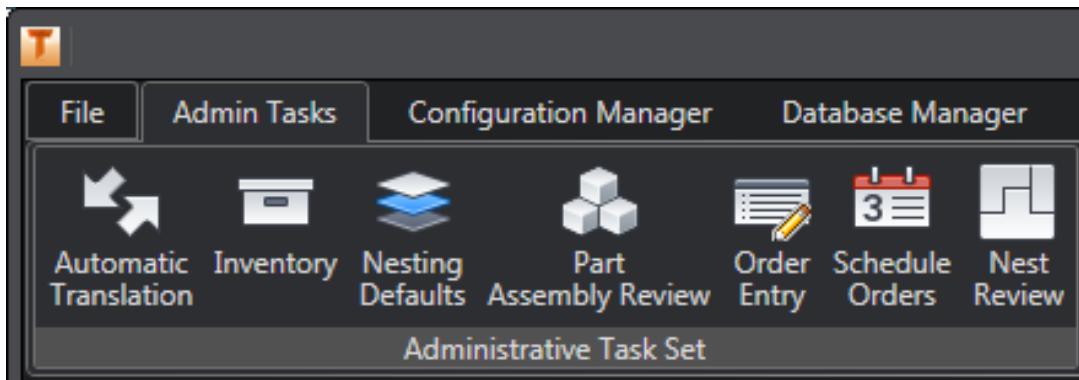
FIGURE 3: ADMIN LEVEL RIBBON TASK SET

Workspaces

Workspaces are the main action areas of the interface. There are various different types of workspaces that each serve a specific purpose in TruNest. Some serve specific purposes like the Order Entry workspace and the Schedule Orders workspace. These two workspaces are highly customized to easily allow the user to queue parts and schedule them for nesting. There are also three general types that you will see heavily used within TruNest.

Grid Workspace

The grid workspace allows the user to view a table within the TruNest database. There are several tool bar options that allow the user to copy, past, insert, and delete current records in the table. There is also support to import and export data to and from specific formats. Inside of the grid, you can also filter columns by specific criteria. This can also be used in conjunction with the grouping mechanism which groups the whole table by one or more columns. If a table has many columns that do not fit on the screen, you can also lock or freeze columns. This feature keeps important columns in view when you scroll the table. Lastly, you can resort columns to see information side by side for comparison.

Viewport Workspace

The viewport workspace allows the user to view part files in 3D. In this workspace the user can fully inspect the geometry with the tools given in the tool bar. There are entity, shape, and part inspection options that bring up a contextual menu that updates based on what geometry is selected. This will give the user information about what layer, color, and line style the selected geometry is on. It will also allow the user to see information about area, perimeter, and center of gravity. There is also a measuring option for inspection purposes.

Action Workspace
The action workspace allows the user to launch specific processes based on the contents of a table. This workspace is similar to the grid workspace, but with action buttons on the right-hand side. This workspace is commonly used for nesting and part import functions.

Users, Groups, and Logins
TruNest has a user authentication system. Each user inside of TruNest has a certain amount of privileges depending on what group they are assigned to. A user in the admin group typically has access to all types of workspaces, read and write access, and user tasks. Other groups, like engineering, may only have access to user tasks like part importing and order entry. Each user and group assignment is fully customizable in regards to what the user can access, change, and see within the environment. If a user is assigned to multiple types of groups, the user can seamlessly change between the different groups using the profile dropdown menu.
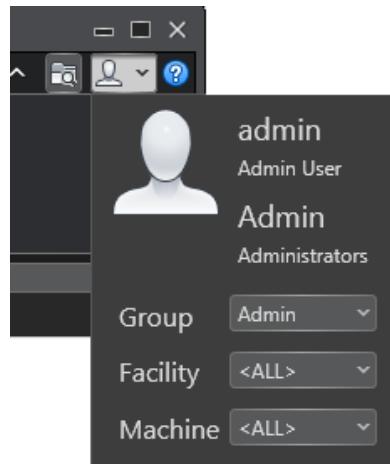
FIGURE 4: USER PROFILE MENU

Utilizing Material Data and Machine Management

Inventory Management
The Inventory management feature tracks materials, inventory IDs, remnant IDs, and other inventory information. The information you set up here automatically prefills many of the part, order, and nesting data needed to schedule and cut parts within TruNest. In Figure, the table shows the different inventory available. The material and inventory ID allows the system to track like material types of varying sizes. The remnant ID allows the system to track pieces of material that are left over from the cutting process to potentially be used again by nesting.
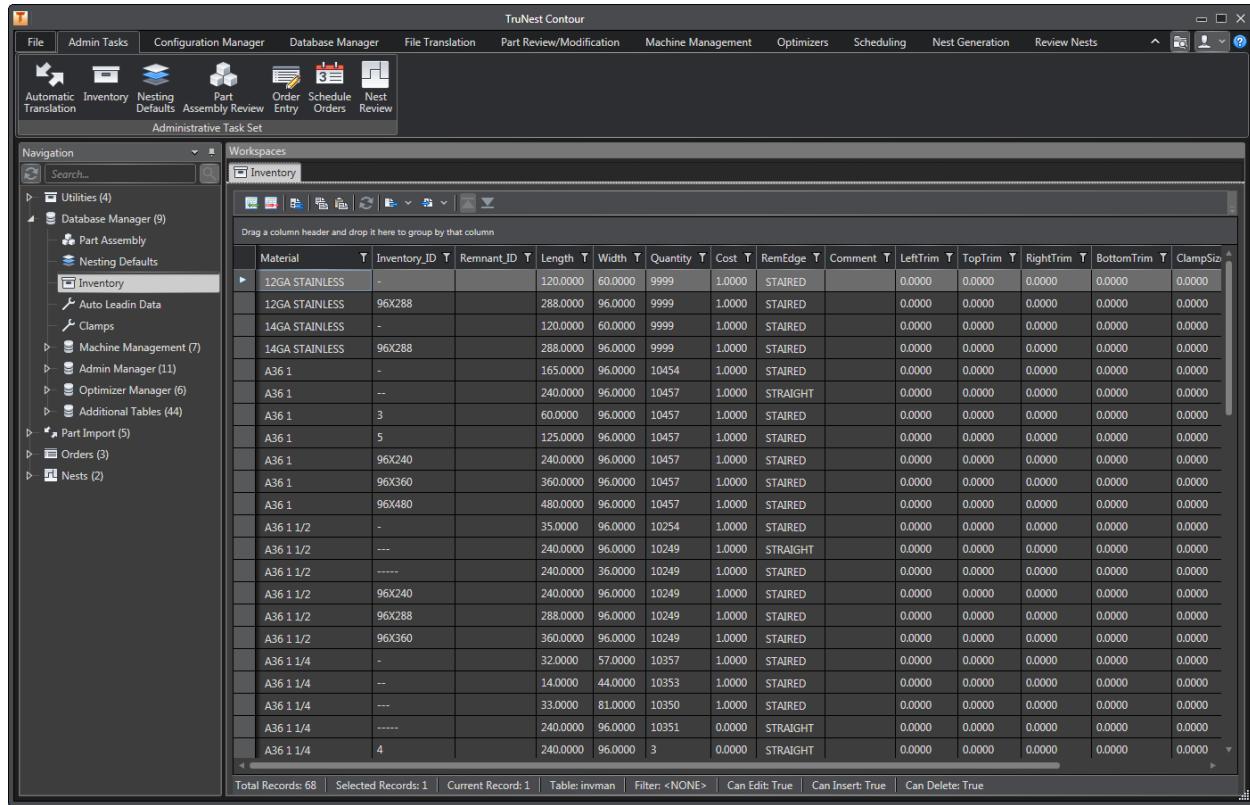
FIGURE 5: INVENTORY WORKSPACE

Nest Default Management

The Nest Default management table looks at the material from a nesting and machining perspective. It contains parameters like material thickness, separation of parts, nesting frame, and grain constraints. The nesting process uses these parameters to optimize part placement for the machine. Depending on the machine configuration, the nesting defaults vary greatly.
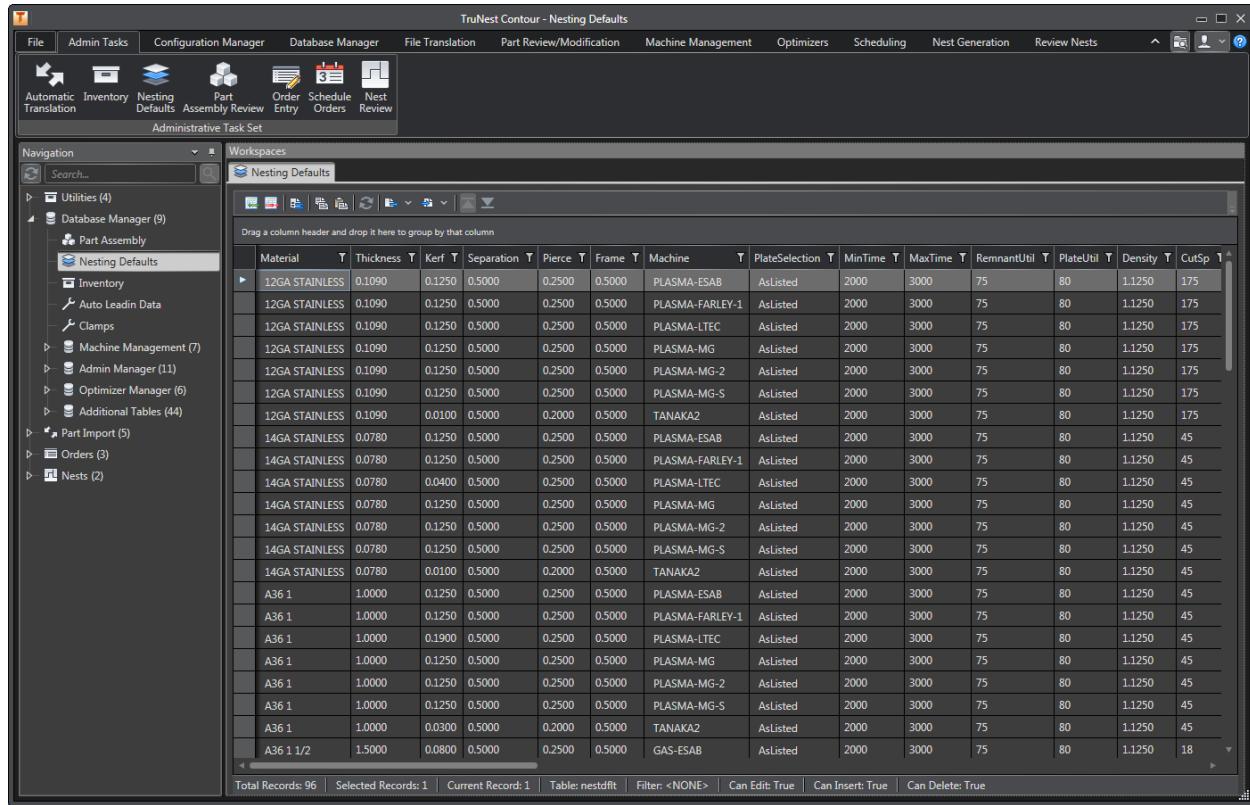
FIGURE 6: NEST DEFAULT WORKSPACE

Machine Management

Under the Machine Management node in the tree, there are various tabs that define the critical components of the machine configuration. Depending on whether you have a punch, router, laser, etc., this machine configuration will reflect the necessities in tooling information and machine settings to support that machine type.

Tool Defaults

The tool defaults table contains information about each tool in regards to the CNC process. On a punch or router machine, each punch tool or router head is going to have a unique default that defines how the tool can be used by the machine. This table defines parameters like tool priority, cut speeds, rapid speeds, and which materials each tool can be used on.

Tool Library

The tool library table contains information about the design of the tool. It defines parameters like tool size, tool wear, machine range, and tooling pre-stations. This information allows the post processor to classify which tool is best for the parts it is trying to manufacture.

Machine Settings

The machine settings table associates the tools defined in the library to a specific station on the machine. It also allows the user to define the range of the tool and any potential offsets the tool may have.

Machine Info

The machine info table describes the characteristics of the machine to the nesting system. An important parameter in this table is the workable area of the machine. This area defines the maximum length and width of material that can be processed by that machine.

FIGURE 7: MACHINE MANAGEMENT WORKSPACES (MACHINE SETTINGS SHOWN)

Importing Designs

Translating Data

CAD data is one of the primary resources for the nesting system. Depending on the CAD system, the data be as minimal as a single geometry defining the part periphery or can be as complex as containing information about geometry, part name, material, assembly structure and even tooling information. This "input data" can even be legacy nest files or machine code. TruNest handles all of these different

data type through its universal translator. All of the functions of importing CAD data into TruNest can be found in the Part Import section of the tree.
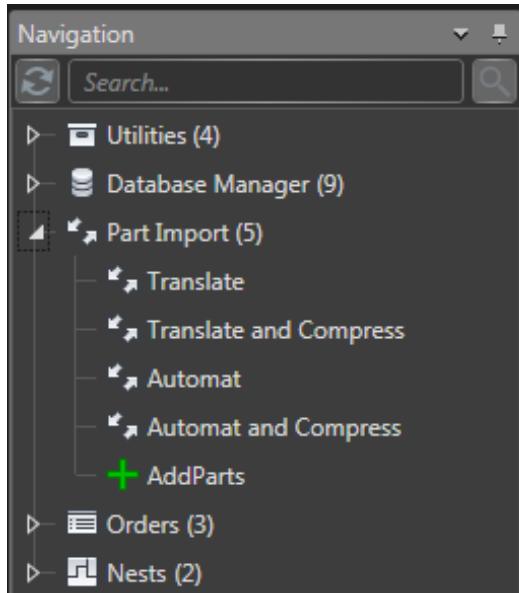
FIGURE 8: TRUNEST TREE WITH PART IMPORT NODE EXPANDED

As you can see in **Figure 2**, there are a few different ways to import part information. The first option is Translate. Clicking Translate opens the Translate workspace where part files can be added into the window. Once they are added via one of the Select Files options, they will show up in the workspace table. The different options for selecting files indicate to TruNest where to put the results of the translation. The files will either end up in the base of the parts folder, one sub-directory level within the parts folder (Level 1), or two sub-directories within the parts folder (Level 2).
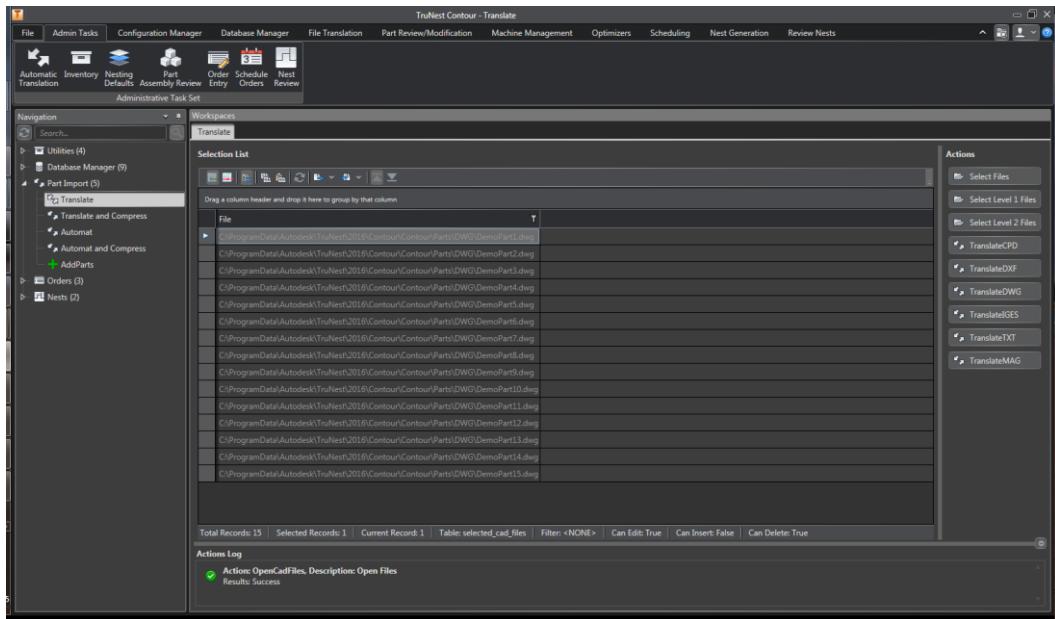
FIGURE 9: TRUNEST WITH MULTIPLE CAD FILES SELECTED IN THE TRANSLATE WORKSPACE

After selection of the files is completed, the Translate options are now enabled. Depending on the data you're bringing into TruNest, you can select the appropriate option for the universal translator. Once the translation is complete the results are displayed in the graphical workspace. There are other options available to import part data. The node labeled Translate and Compress will apply compression settings on the geometry to reduce the amount of unnecessary points contained in the original geometry.
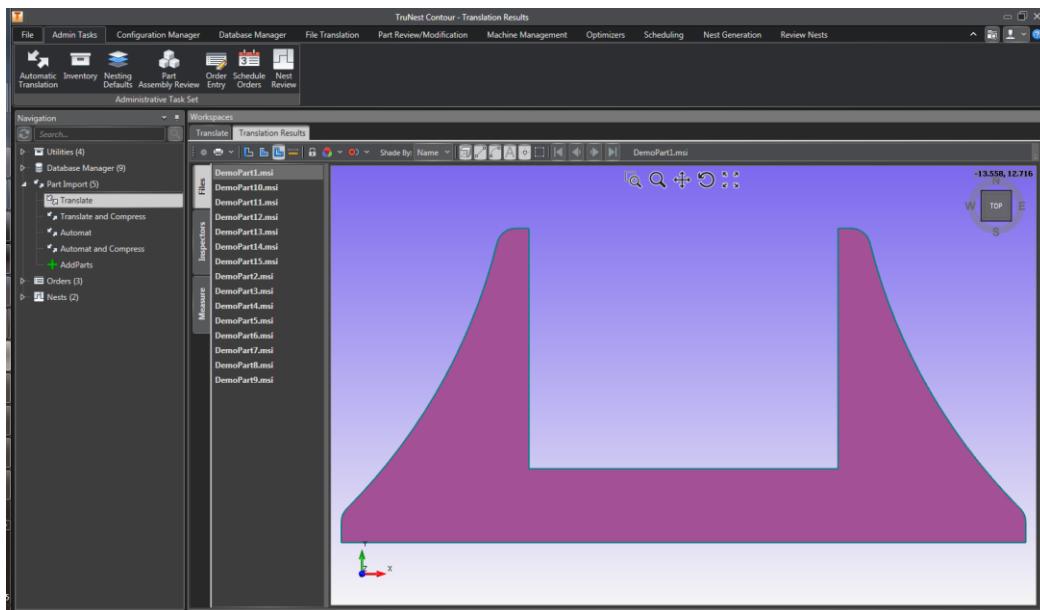
FIGURE 10: TRANSLATION RESULTS WORKSPACE

Adding Parts

The node labeled Add Parts is the next step in TruNest to go from original CAD data to nesting data. The Add Parts workspace allows the user to customize how the part data is inserting as nesting data. At this point in the process, the user can control what assembly and subassembly each part belongs to, what material is associated to the part, what machine that part is allowed to be manufactured on, and what nesting constraints will be applied to the part. In the Add Parts workspace we have the same Select Files option. This button will open up the same Windows Explorer dialog before, but it will open up to the location of where the results of the translation are stored. The files selected via the Windows Explorer dialog will be inserted into the Add Parts table upon clicking Open.
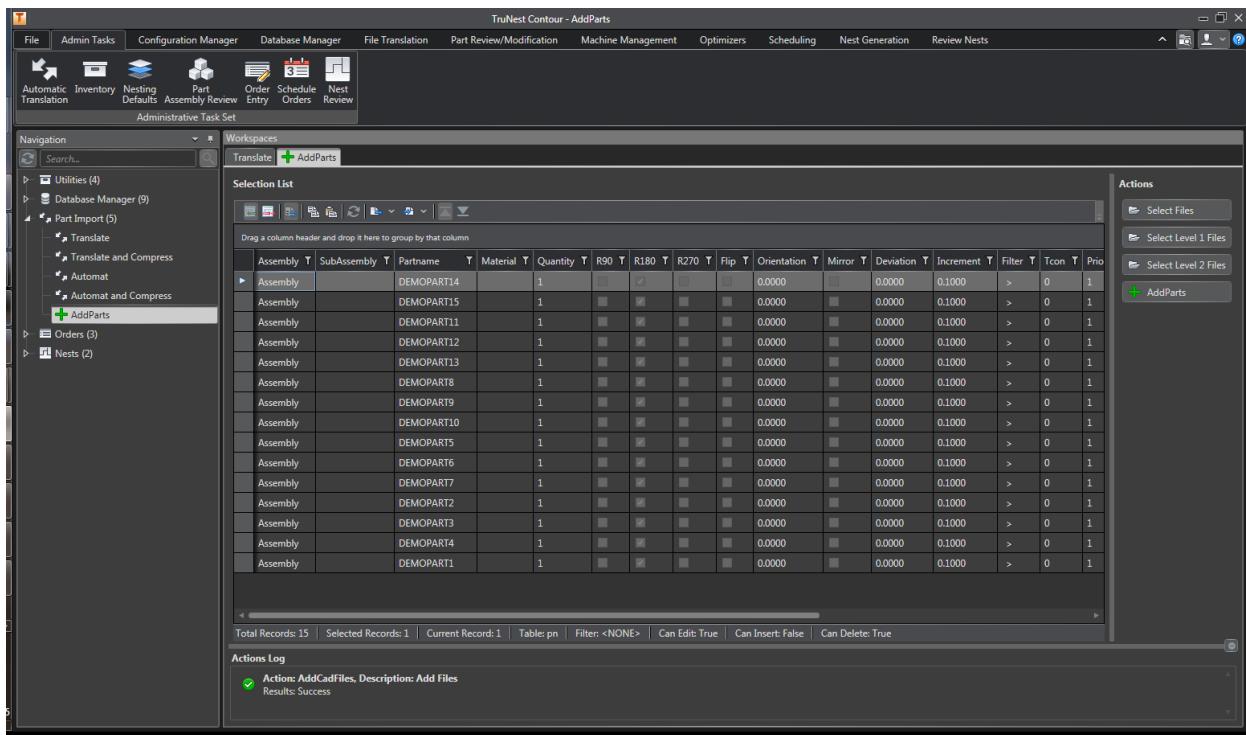
FIGURE 11: ADD PARTS WORKSPACE AFTER IMPORTING TRANSLATED FILES

Once the table appears, the user can begin editing the data about each part. This is a workspace where the Insert, Delete, Copy and Paste function in the tool bar are heavily used. After all edits have been made, selecting the Add Parts button will insert this information into the TruNest Part Assembly. The Part Assembly is a library of all the available part and assembly data ready to be used for nesting.

Automatic Translation

There are two more available options under the Part Import node; Automat and Automat and Compress. These two options merge the Translate and Add Parts steps into one. That means that with one click, TruNest is able to translate the CAD data and automatically insert assembly information,

material information, and nesting constraints into the Part Assembly for each part and each assembly. However, certain file formats do not carry all of the required information to construct the Part Assembly. For these cases, TruNest allows the user to manually define these characteristics in the first step so that they will be carried over.
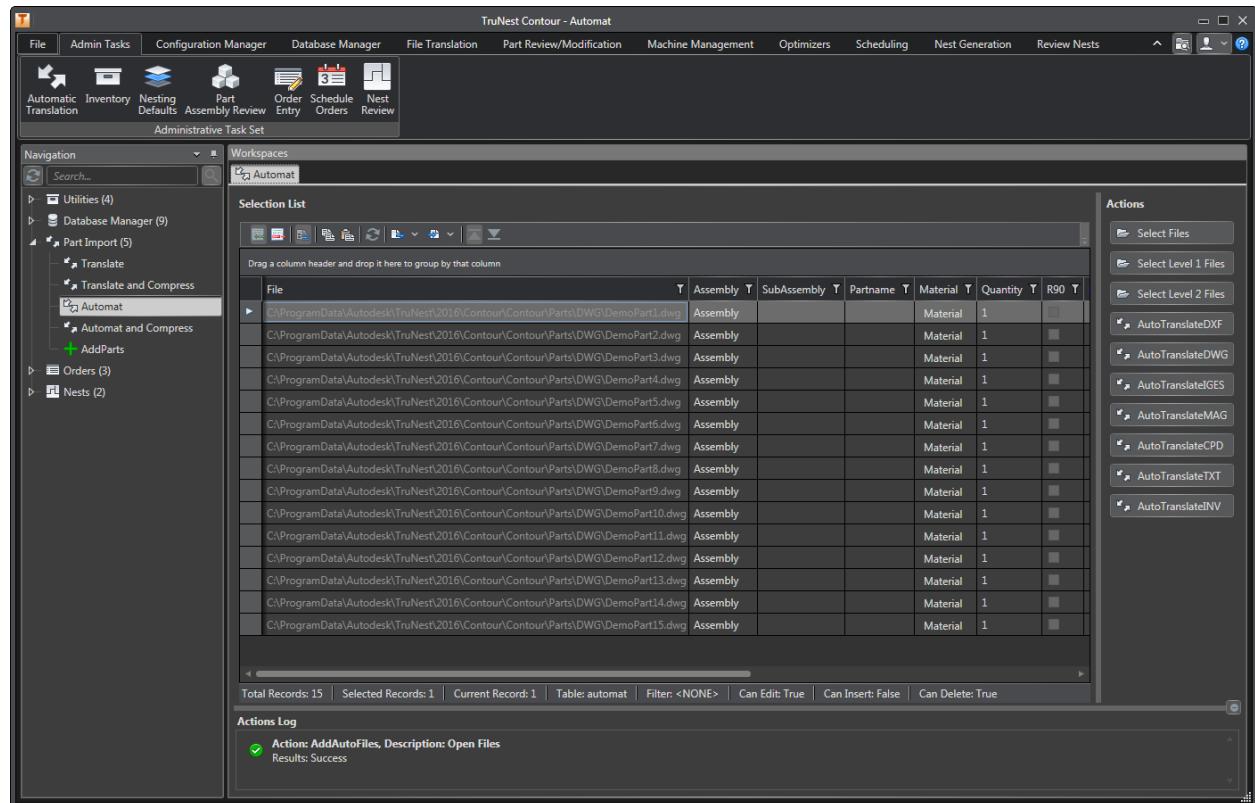
FIGURE 12: AUTOMAT WORKSPACE WITH IMPORTED FILES

Supported CAD Formats

TruNest supports native data from many various CAD platforms. It will import Inventor Part and Assembly files, Solidworks Assembly files, NX part files and FiberSim data and CATIA CPD and DXF files. It also supports universal CAD types like DXF, DWG, and IGES. TruNest can even read in machine code and legacy nest files in various formats. Having an easy translation process of CAD data closes the gap between design and manufacturing.

Performing an Optimal Nesting Process

Part Assembly Review

The first step in an optimal nesting process is reviewing the part assembly. The part assembly table contains information about the assembly-part relationship, material association, and various nesting

constraints. TruNest provides a split viewport and grid workspace to verify part information and geometry information in the same step. By selecting a record in the table, you can scroll through the records using arrows keys and the display will automatically update based on the record that is currently selected.
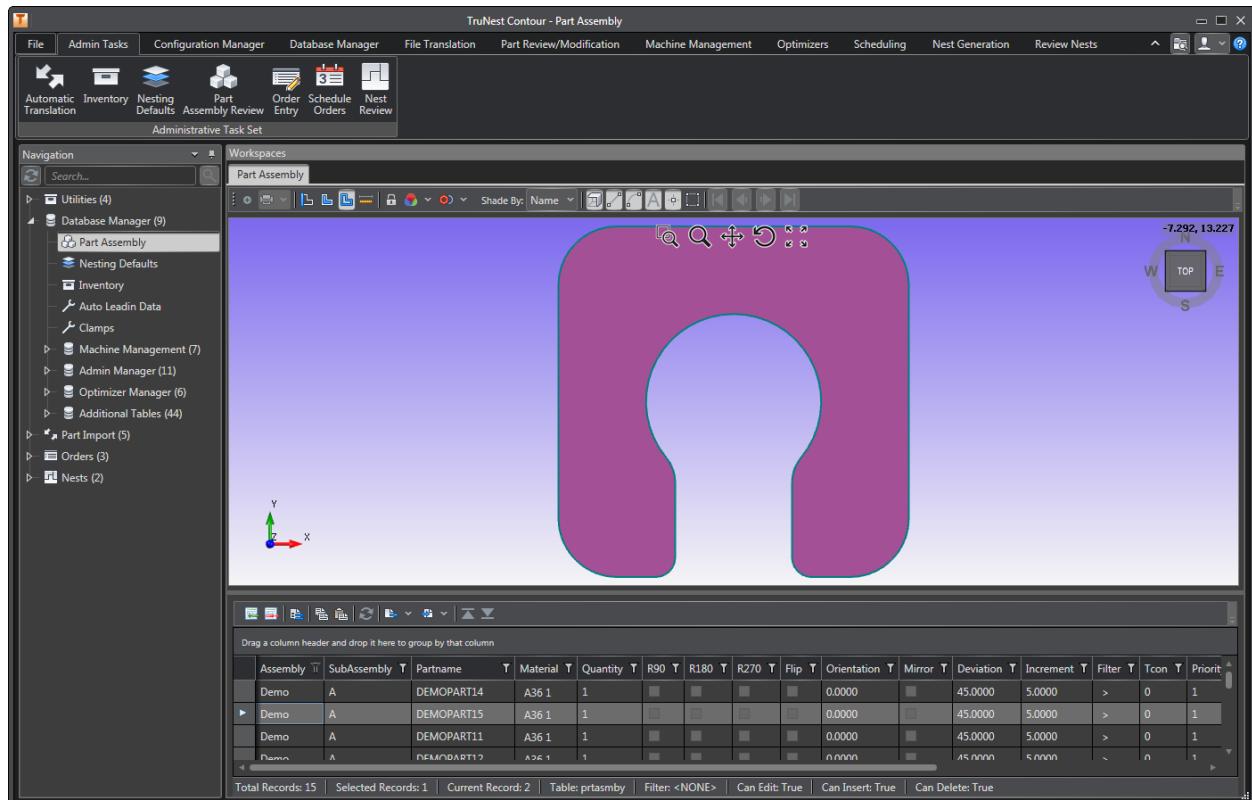
Order Entry

The Order Entry node in the tree is a dedicated workspace to queueing orders. This custom workspaces allows the user to enter in the exact parts, assemblies, and subassemblies that are necessary for the particular job they are trying to fulfill. As you type in the assembly, subassembly, or part name you would like to order, TruNest begins actively filtering on your selection making it easy to select the correct information. After filtering on the selection of parts you want to order, clicking add orders in the Order Details window will populate the queue at the bottom of the workspace for any final editing before scheduling the order.
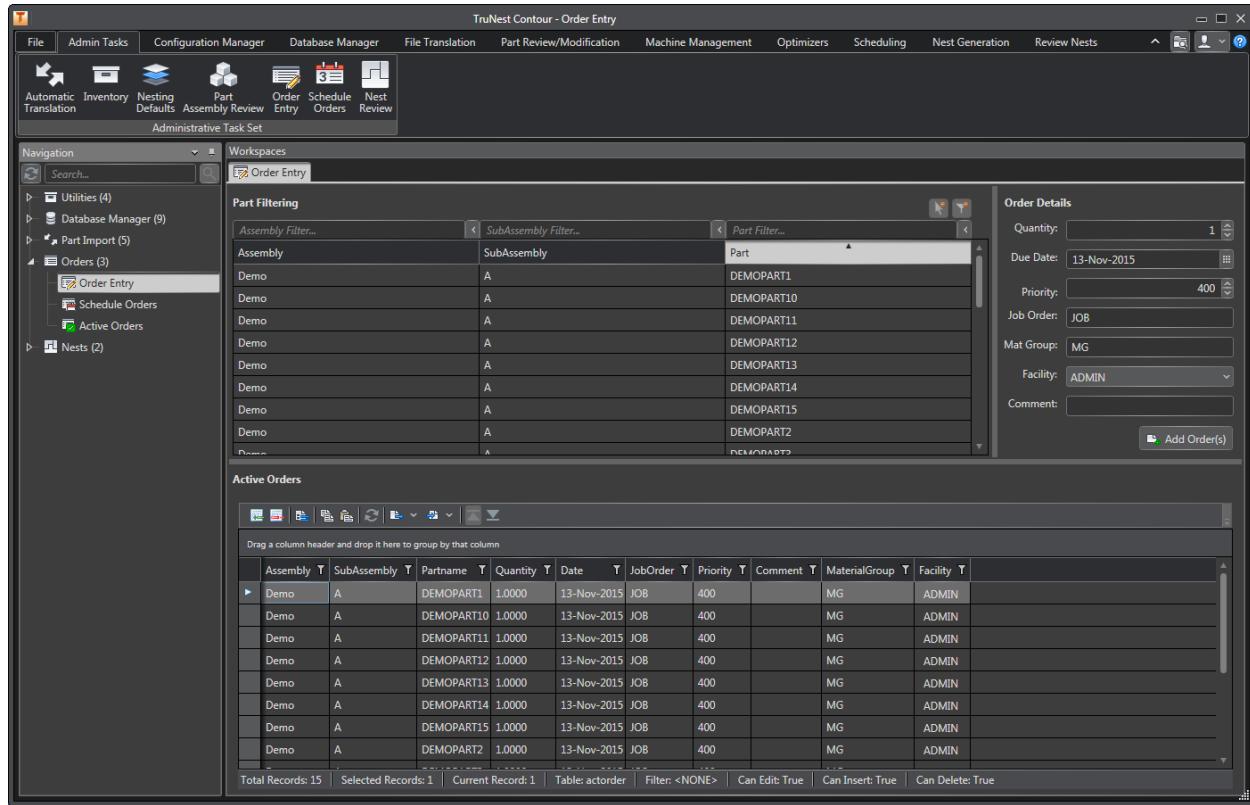
FIGURE 14: ORDER ENTRY WORKSPACE

Scheduling Orders

The schedule orders node in the tree is another dedicated workspace to provide the user with a helpful environment to start scheduling queued orders to be nested. Scheduling orders is a process in TruNest that groups all parts and assemblies of like materials and machines. This workspaces is also in charge of assigning dates for the parts to be cut by, estimating how much time it will take to machine the parts, and how much inventory will be used to nest these parts together. By providing this information the user get a sense for how much time an effort may be consumed by producing these parts. The group name and nest prefix fields inside this workspace allow the user to define the tree structure that will contain the selected orders. Once the appropriate orders are selected, the Schedule button will place these orders in a scheduled status and associate the group name and a nest id to the orders and remove them from the previous queue we constructed.
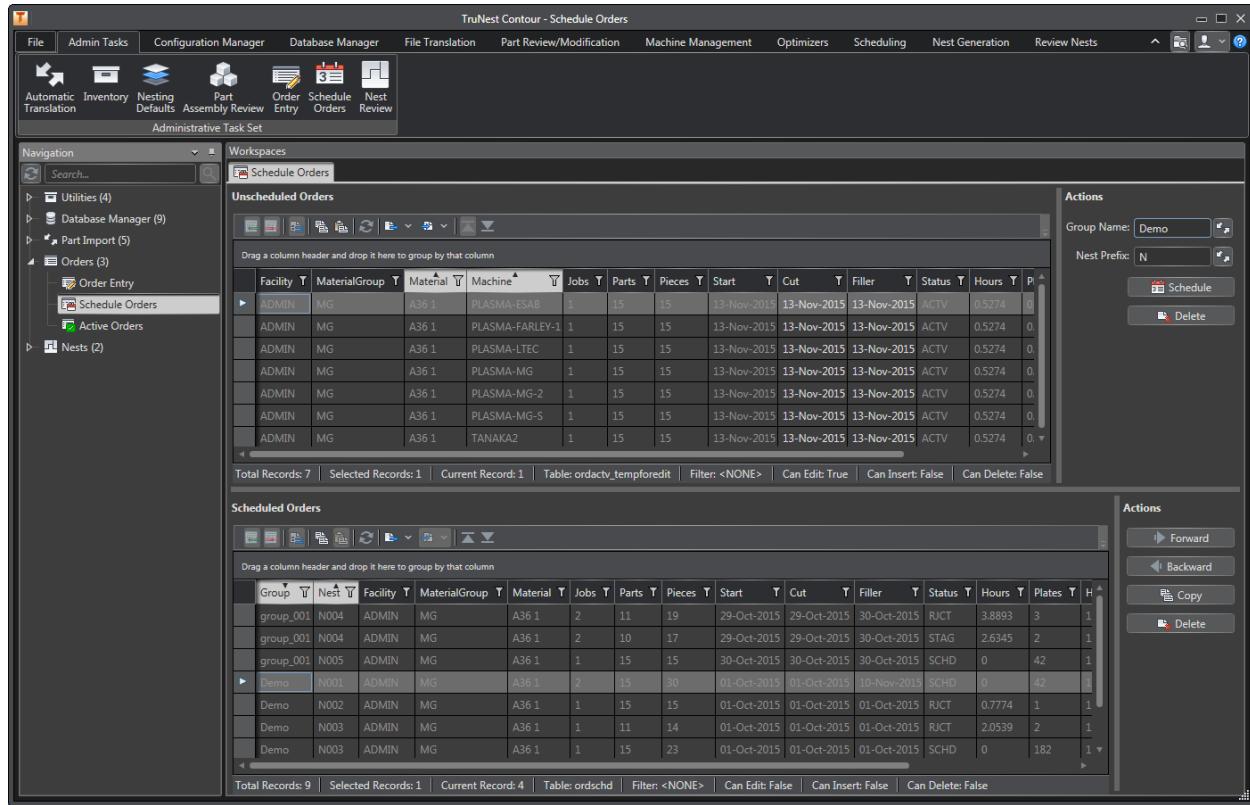
FIGURE 15: SCHEDULE ORDERS WORKSPACE

Create Nests

The Create Nests node exists for every group name under the Nests node in the tree. The group names are constructed by the user during the scheduling process. The Create Nests node in the tree opens the designated action workspace which enables the nesting functions. The options available in this workspace are regular nesting, common line nesting, part review, and manual nesting. You can also view the nesting report of any nests that have been completed using the nesting algorithms or manually. Some customized create nests workspaces have special nesting options that run additional optimization routines to further improve how the parts are handled by the machine. Clicking the Yes button will run the selected nests in the table.

TruNest provides the user with an order status that provides information on what state that order is currently in. All orders that have only been scheduled will have a status of SCHD. This lets the user know that nesting hasn't been performed on these nests. Once nested, the status can change to either STAG or RJCT which is a staged or rejected status. This status lets the user know if the nest has reached the efficiency goals setup for the material. From here, the next status is SENT which indicates that the NC code has been sent to the machine. The last status is CUT which is a final state that signifies that nest has been successfully processed by the machine.

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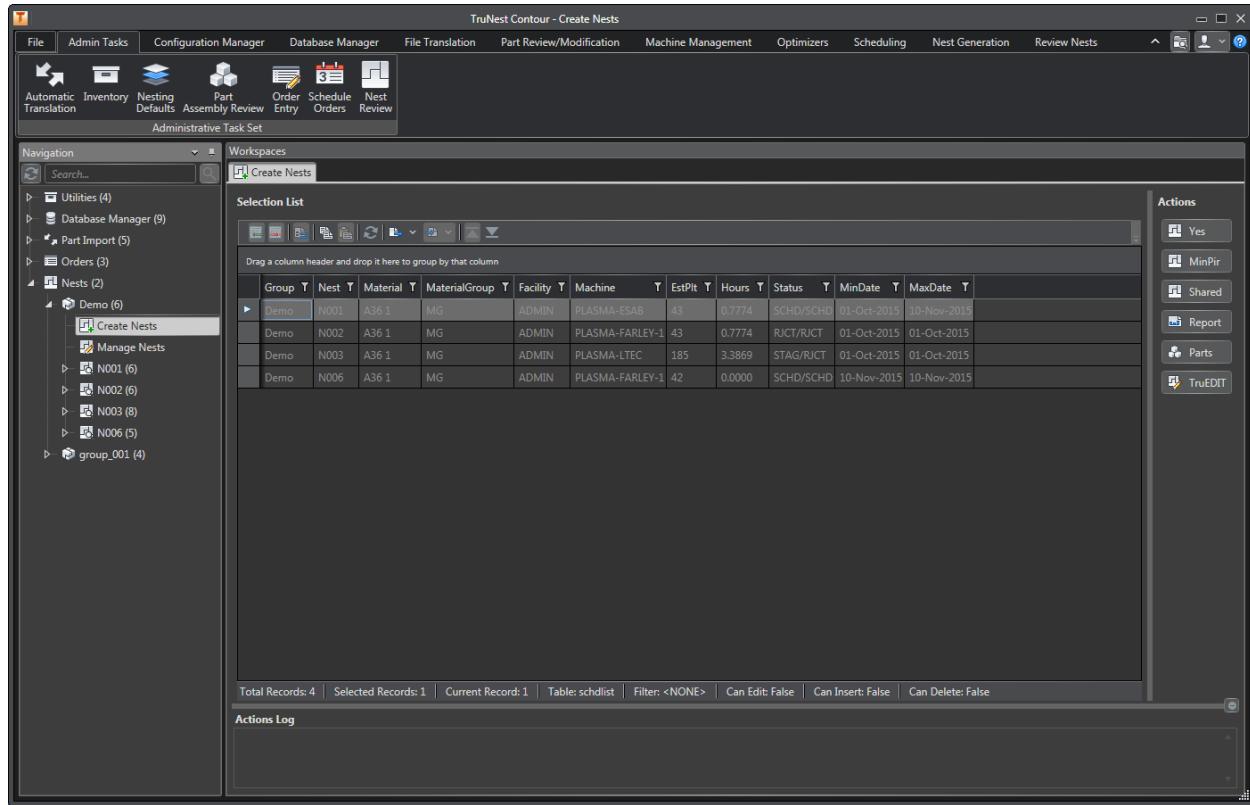
Manage Nests

The Manage Nests node also exists for every group and is located just below the Create Nests node. This workspace is only populated with records once the orders have been nested using the Create Nests node. The Manage Nests workspace is an actions workspace that executes post nesting processes. From this table populated in the grid, the user can see what status each nest is in. The user can also see how many plates, or sheets of material, were used by the nesting system to fit all the parts that were ordered. Some of the available actions in the workspace include status manipulation, post processing, and report generation. TruNest has a vast post processor library to suit the needs of the configuration. It also support generic outputs of nesting like DXF format. The back plot function is a useful tool that re-interprets the NC code into graphical form to allow the inspection of what processes will be run by the machine.
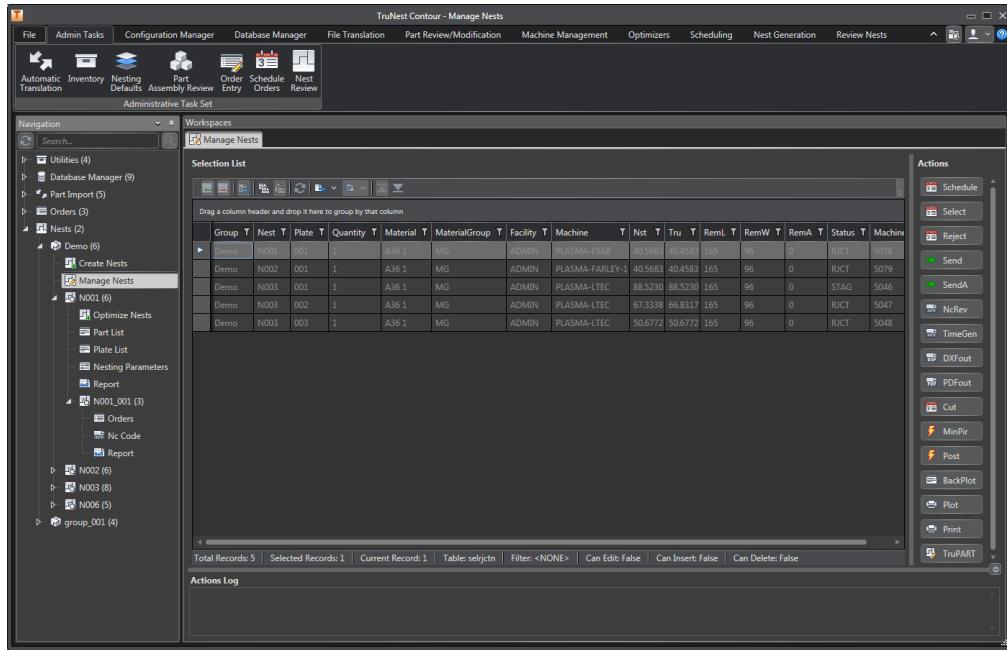
FIGURE 17: MANAGE NESTS WORKSPACE

Optimization

Optimization of nesting and post-processing allows users to go from the nesting system to the shop floor without a headache. TruNest provides many different optimization techniques that allow easy tooling and cutter optimization for the type of machine defined.

FIGURE 18: OPTIMIZATION TABLES (AUTOMATIC TABBING SHOWN)

Automatic Tabbing

Automatic Tabbing is an optimization routine that places tabs of varying types around the nested parts in order to hold the parts to the material skeleton as they are being processed by the machine. Some of the types of tabs are skin tabs which are a very thin tab that breaks very easily and hold down tabs which are tabs that are bigger in order to make sure the part doesn't break free from the skeleton without a secondary process to remove the tabs. Tabbing is commonly used on punch presses, routers, laser cutters, and water jet machine tools.

Automatic Riveting

Automatic Rivets is an optimization tool that places ideal rivets locations within the nest. The rivets locations are used by the machine tool, typically a routing machine, tool allow multiple sheets of material to be stacked together. A drill tool is used at each rivet location to pierce through all of the sheets of material in order for the machine tool operator to place a rivet in that location. The rivets prevent the different sheets of material from sliding out of places when cutting the parts.

Sheet Cutting

Sheet Cutting is an optimization routine that instructs the machine tool to cut the nest skeleton (material left over after parts are cut) into smaller pieces that are easy to handle by the machine tool operators. This is especially useful when cutting large sheets of material or thick (heavy plate) materials.

Minimum Piercing Logic

Minimum Pierce logic is a routine that optimizes the cutting path of the machine so that it minimizes the amount of times the machine needs to perform a pierce cycle. A pierce cycle is when the cutting machine piercing though a portion of the material in order to be able to cut a part. This cycle takes more time than standard cutting of the parts and also uses a larger footprint on the material than the kerf of the cutting tool. Minimizing the number of pierces of the material during the cutting process allows more throughput of nests and more material savings. Pierce cycles are standard processes for gas and plasma cutting machines.

Head Down Logic

Head Down logic is a routine that optimizes the cutting path of the machine to keep the head or tool cutting material as much as possible. This routine optimizes the cutting path and off-part motion of the machine from part to part.

Bridge Cutting

Bridge cutting is a routine that inserts a special bridge between parts. This optimization technique joins contours of parts into one so that the machine tool can cut multiple parts with the same path.

Chain Cutting

Chain cutting is a routine that optimizes the first and last segment of parts in order to optimize the cutting path of the machine. This routine is used for parts that do not have any internal contours.
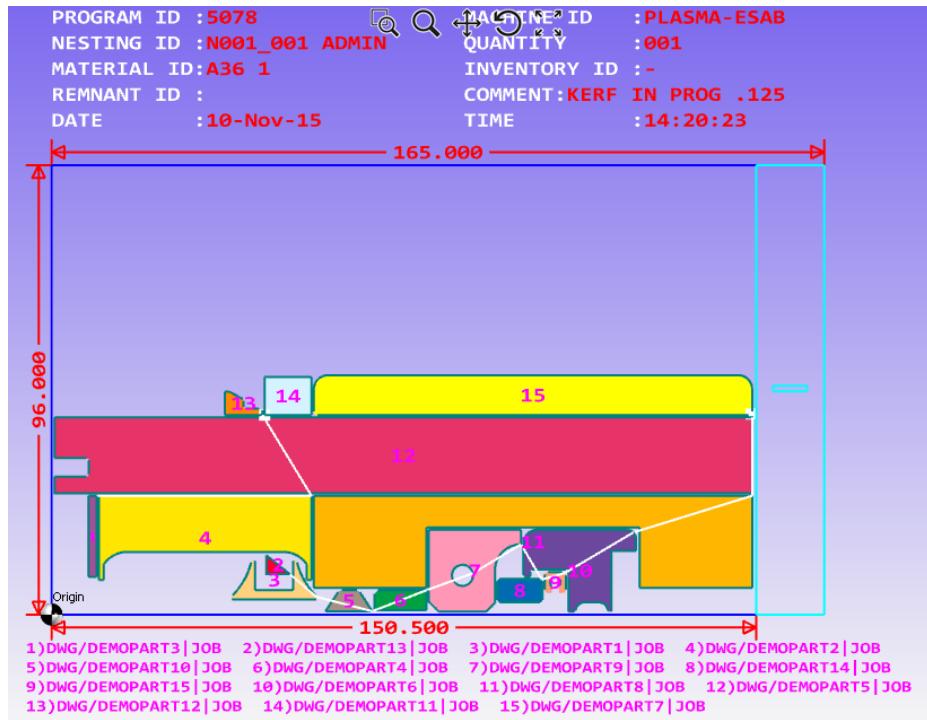
FIGURE 19: NEST WITH HEAD DOWN OPTIMIZATION PERFORMED

Special Features

TruQuote

TruQuote is a special feature within the TruNest interface that provides a very specific type of nesting. TruQuote is a feature developed to nest single parts as efficiently as possible within the specified material constraints. This is very useful when nesting to produce progressive part dies. This system will also generate a quote based on cost information to produce the die that is generated by the software. TruQuote can also produce dies with multiple parts, but the speed at which the die is calculated is significantly increased as more parts are added.

Vault Add-in

Autodesk Vault is a product where you can organize all your files and keep them in one location for easy access. All file versions are retained, so you never misplace or replace past versions. The vault stores each version of a file, along with all the files dependencies, giving you a living history of the project as you work on it. The vault also stores file properties for rapid searching and retrieving. TruNest uses Vault as an add-in to retrieve part and assembly files locally to import the information into the nesting system. TruNest does not need to update revisions or checkout parts because it only uses a read-only copy of the file.

ODBC Connectivity

TruNest supports access to either a standalone database in the standalone version or access to a master SQL Server database or Oracle Server database in the enterprise version. The enterprise version connects to the master databases through an ODBC (online database connection). An enterprise version

allows a customer to use multi-user, simultaneous access into TruNest. This is highly effective for companies with multiple levels of users that need to access information in the system at the same time.

Highly Configurable

TruNest is a highly customizable product. Each user and user type can be customized to serve a specific function. TruNest provides functionality to customize read/write access of information, tree and ribbon structure and icons, user and group privileges, and even interface themes. These customizations provide an optimized workflow and interface friendliness.

Summary

Autodesk TruNest is a product that provides an end to end solution for nesting. On the front end, TruNest interfaces with PLM systems and ERP/MRP systems to optimize input data and scheduling of job orders. On the back end, TruNest optimizes machine processes and integration completing the entire workflow from the front office to manufacturing within the same product.