Physna Promotes 3D Model Search and Discovery

Bridging the Virtual and Physical World

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Physna is an AI-powered geometric deep learning technology. The software uses proprietary algorithms to codify 3D models into detailed data that is understandable by software applications and powers 3D geometric search. The addition of machine-learning adds a powerful dimension as users search their product data repositories.

A New Approach to an Old Problem

What began as a question in the mind of a patent lawyer in Germany, "Is there a way to recognize 3D models?" to aid in the protection of intellectual property (IP), has blossomed into an artificial intelligence (AI)-enabled, 3D geometric search engine called Physna (physna.com).[1] The name according to Physna CEO, Mr. Paul Powers stands for "physical DNA," and offers a bridge between the digital world and the physical world. 3D search is a foundational element of the Physna solution, but it is not its raisons d'être.[2]

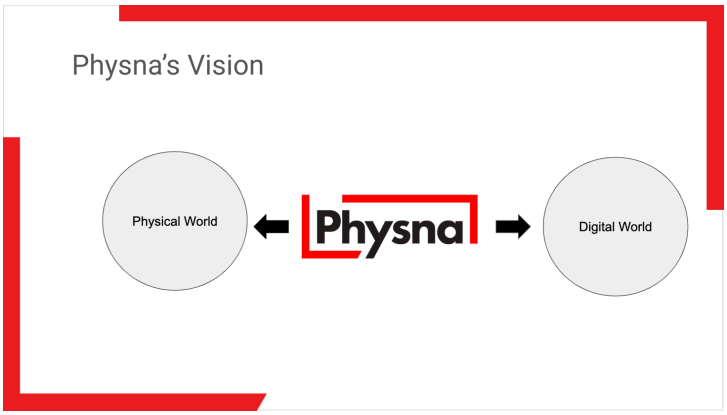


Figure 1—Physna Bridges Digital and Physical Worlds
(Courtesy of Physna)

Use Cases

The solution is valuable not only as a way of identifying 3D items that may violate IP, but in several other areas.

Examples of high-value use cases include:

- Finding previously designed items in a company's database, allowing the company to re-use those items in more product designs. This allows the company to gain more value from their investment and reduce design cost, analysis cost,

[1] See https//:www. physna.com
[2] Research for this white paper was partially supported by Physna.

testing cost, regulatory compliance cost, and other costs associated with developing a new item.

- Finding duplicate or nearly duplicate items being used across products thus identifying potential inventory and related procurement cost savings.
- Adding smart tags that allow design teams to find items more easily and avoid rework and manufacturing costs.
- Identifying parts based on their shape and seeing where the part fits into an overall assembly.
- Eliminating duplicate parts having different part numbers in multiple products thereby allowing parts consolidation and improved purchasing power.

Physna takes an approach unencumbered by common CAD model search biases—using proprietary algorithms that categorizes 3D models by locating "clusters" of specific geometry

Unlike many of the 3D search tools in the market, Physna's technology was conceived, architected, and developed by a team that was not previously involved in 3D CAD (although their staff now includes personnel knowledgeable in 3D software with development, support, and sales experience from various industries). This has allowed them to take an approach that is free of the common CAD model search bias. Using proprietary algorithms, Physna categorizes 3D models by locating "clusters" of specific geometry and the bounding box around the model. The uniqueness of this characterization allows Physna to search for exact matches, similar and alternative parts to any percentage set by the user, and more importantly find components within assemblies and identify alternate duplicate parts or similar parts that could be used to replace the component.

The AI-powered geometric deep learning technology within Physna helps deliver value to its users. In a recently published white paper by the World Economic Forum,[3] titled "Fourth Industrial Revolution Beacons of Technology and Innovation in Manufacturing,[4]" the authors state that "three technological megatrends are the principal drivers of a Fourth Industrial Revolution transformation in production: connectivity, intelligence, and flexible automation." Within the report, a McKinsey Global Institute analysis projects "a remarkable gap between companies that adopt and absorb artificial intelligence (AI) within the first five to seven years and those that follow or lag behind. The analysis suggests that AI adoption 'front runners' can anticipate a cumulative 122% cash-flow change, while 'followers' will see a significantly lower impact of only 10% cash-flow change." (See Figure 2).

[3] For more information on the World Economic Forum, see https://www.weforum.org/ .
[4] http://www3.weforum.org/docs/WEF_4IR_Beacons_of_Technology_and_Innovation_in_Manufacturing_report_2019.pdf

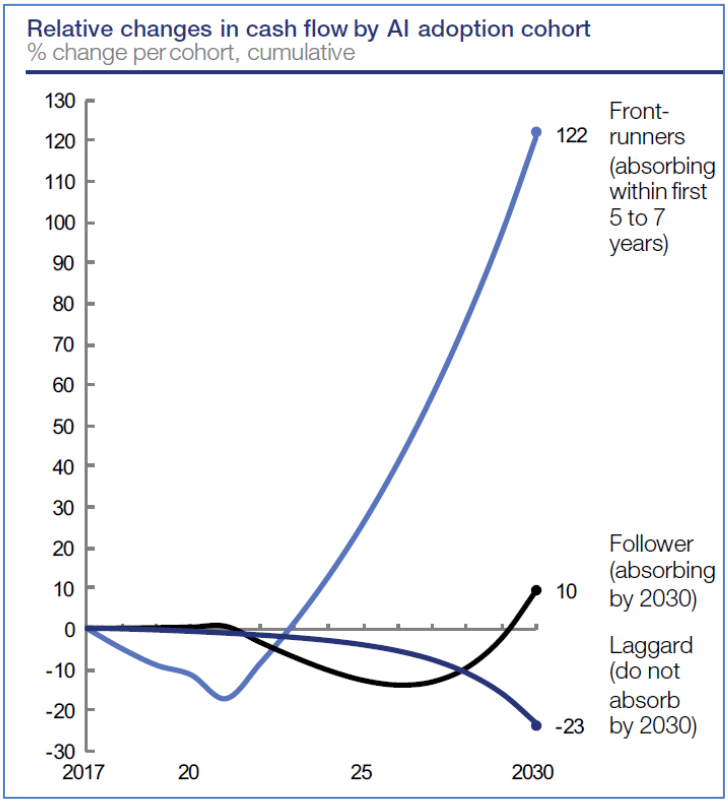


Figure 2—Relative Changes in Cash Flow by AI Adoption Cohort (% change per cohort, cumulative)
(Courtesy of World Economic Forum)

Physna, Files, and the Uploader

Files are pre-processed and loaded into the Physna server

Files are the foundational data items within Physna. A file is a 3D geometric model that has been processed and uploaded into the Physna server. The user selects a 3D model and executes the Physna Uploader which includes a software module named Holefinder that processes the model. The processing also calculates the measurement of 3D spatial bounding volumes around the model. Physna decomposes the structure of 3D models to identify differences between models and versions of the same model, including similarities, variations, flaws, and inconsistencies. In effect, Physna normalizes the data, interrogating the models to provide clear points of distinction and comparison.

Standards

In Physna the user can define anything against which they wish their models' details compared, including ANSI/ISO standards, company- or project-based standards, machine restrictions, etc. By way of example, the user can use hole diameters to find a part, see all the holes in that part, and then see if those holes match drill bit sizes on a specific drilling machine. If the user decided to use ANSI standard hole sizes, they could have that be a criterion of acceptance.

Smart Tags and AI

AI allows Physna to learn from the data it sees and refine future searches

Smart Tags are values that are attached to a File. They are used to better describe the File. Smart Tags are added, using the Identify command. Identify is a machine-learning tool that also recommends Smart Tags for Files. The user can add a Smart Tag to a File manually or by confirming Identify's artificial intelligence (AI) recommendations.

With powerful AI, Physna learns over time, and automates the prediction of more smart tags, allowing the platform to learn from the users' files and make recommendations of similar models. The power of Physna is the ability to capture more data and to make more predictions based on the data of those models. These predictions are customized to the user based on the metadata or any smart tags that they have added.

While the prediction of Smart Tags is automated in the platform, users may accept or reject a Smart Tag. Physna learns through accepted and rejected tags, becoming more efficient and accurate over time. Smart tags help with understanding the detail and specifications of the model including materials, machining processes, quality, compatibility, classifications, and what the part should cost to manufacture based on other models. These predictions are particular to each customer based on their preferences.

3D Geometric Search

Physna can search for and report partial matches to a given model

In researching commercial solutions that offer 3D geometric search capabilities, CIMdata has noted that each solution reports findings in a different visual manner. When a search is performed in Physna, the user selects an existing model of interest and performs a Match operation. Figure 3 depicts the search result from clicking "Match" on a simple bolt. Note that Physna found two identical parts. The 3rd and 4th result lines show a bolt pattern where the discovered part is inside, and a turbocharger with the bolt inside, respectively. Users can change the settings to reduce or increase the minimum match percentage to any number they want. The two percentages highlighted in Figure 3: "Pattern Match Percent" are the searched item vs. the result ("How much of this matches that?") whereas the "Reverse Match Percent" is the opposite. The Physna staff indicate that there are many cases where having both values is extremely useful. CIMdata would concur.

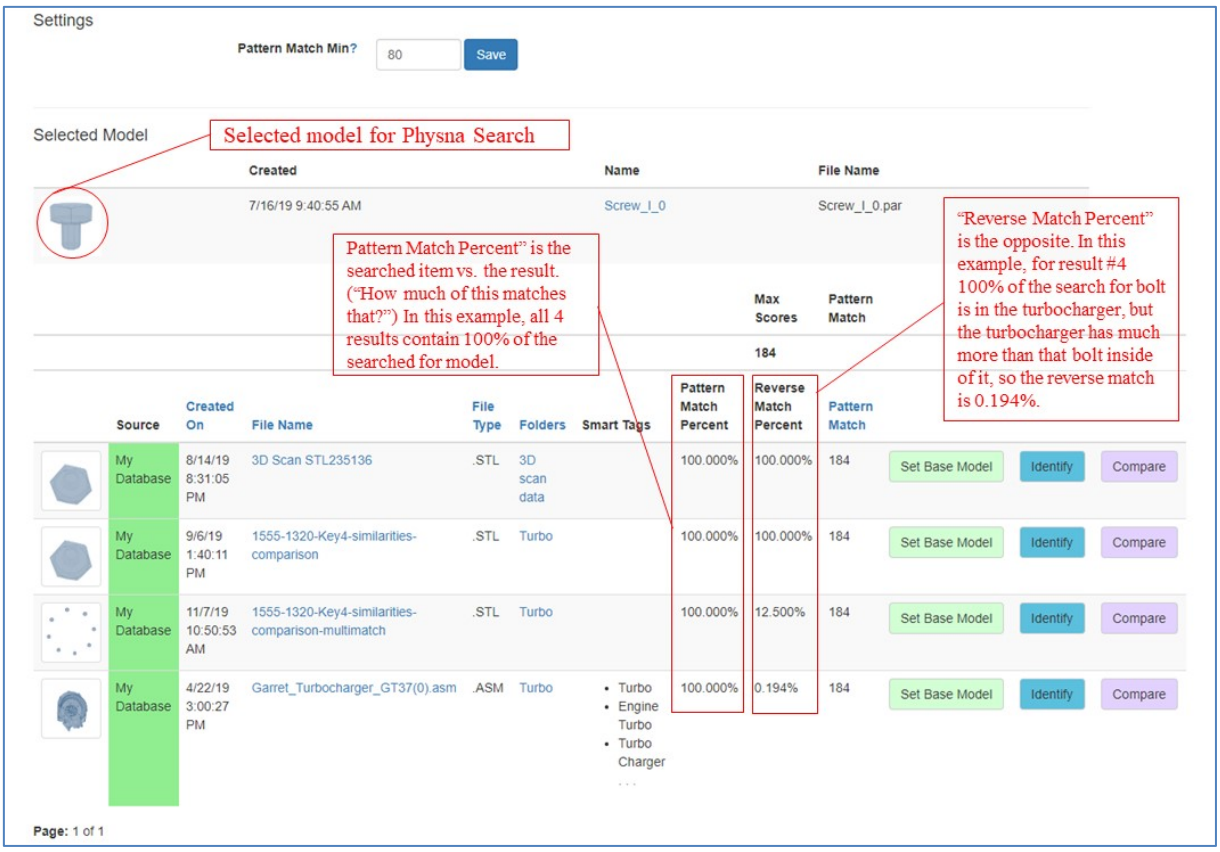
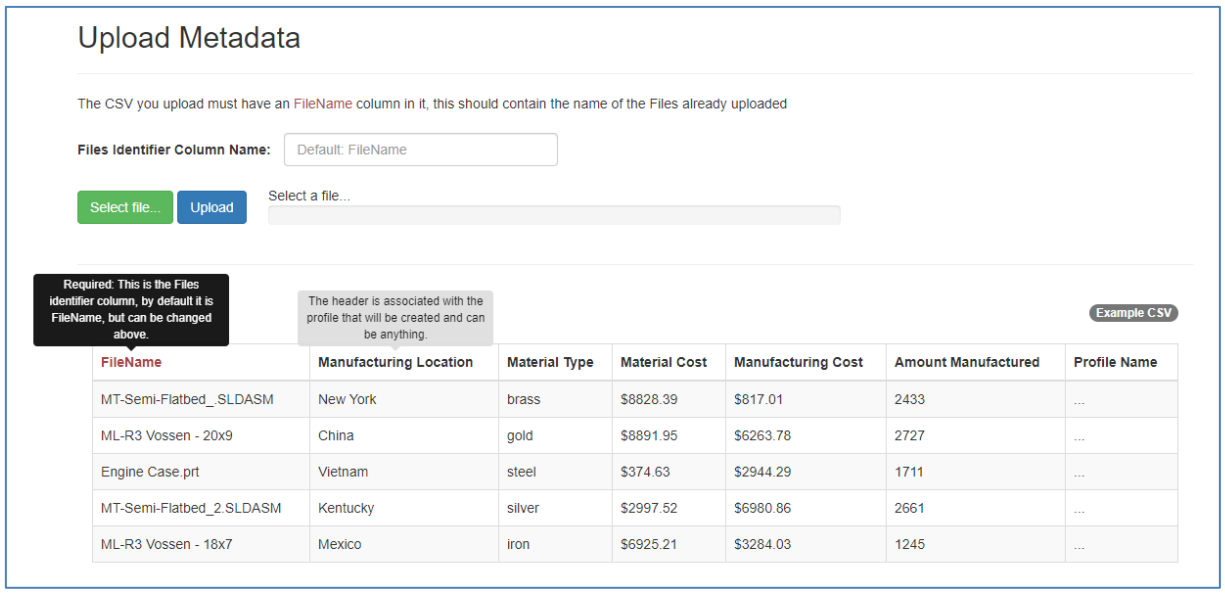


Figure 3—Physna Results of a Model Search
(Courtesy of Physna; Annotated by CIMdata)

Metadata Access

Physna offers users access to a model's metadata. When integrated with a product data management (PDM) or product lifecycle management (PLM) solution, Physna will automatically ingest the model's metadata stored in those solutions and sync it with the model content. When metadata is stored elsewhere, such as in an enterprise resource planning (ERP) solution, users can make it available to Physna through a simple spreadsheet. The name of the model in the spreadsheet is searched and the data in that row, and the data type defined at the top of each column, is automatically assigned to that model within Physna. Figure 4 illustrates an example of uploading metadata information for part models into Physna.

In addition to looking at object geometry, Physna can also search based on metadata



FileName	Manufacturing Location	Material Type	Material Cost	Manufacturing Cost	Amount Manufactured	Profile Name
MT-Semi-Flatbed_.SLDASM	New York	brass	$8828.39	$817.01	2433	...
ML-R3 Vossen - 20x9	China	gold	$8891.95	$6263.78	2727	...
Engine Case.prt	Vietnam	steel	$374.63	$2944.29	1711	...
MT-Semi-Flatbed_2.SLDASM	Kentucky	silver	$2997.52	$6980.86	2661	...
ML-R3 Vossen - 18x7	Mexico	iron	$6925.21	$3284.03	1245	...

Figure 4—Uploading Metadata into Physna
(Courtesy of Physna)

In addition, a user can manually input values for existing metadata types or create a new metadata type and then populate its values.

User Interface

The user interface is clean and straightforward

The user interface of Physna presents a clean, straightforward display of command buttons. When the user selects a command button from the top-level command list, the lower portion of the screen displays either a list of more detailed functions or the result of selecting the higher-level command. Users can easily understand this hierarchical command presentation as they explore 3D models within Physna.

Figure 5 depicts the user interface screen for the top level Identify function of the part file named v11010.par. It shows five lower level operations, including:

- Details
- Viewer
- Component Finder
- Feature Finder
- Metadata

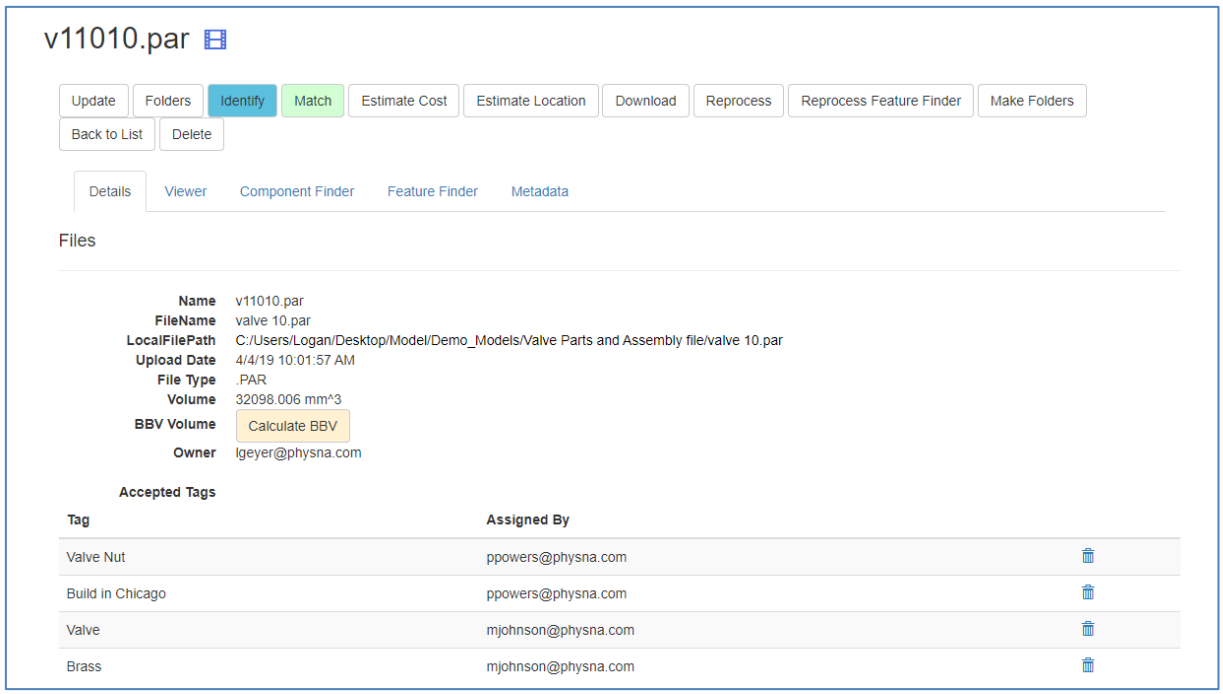


Figure 5—Top Level of User Interface
(Courtesy of Physna)

The Details selection lists information such as the file name, who uploaded it, when it was uploaded, where it came from, the model's volume, and any actions performed on it in the past such as Smart Tags and who assigned or rejected them, etc.

Physna works effectively in web browsers as well as on desktop computers

The Viewer selection (Figure) displays the model in 3D. Physna interrogates and converts the native model into a codified representation of the model. This is then used to display a 3D representation of what that model looks like. The simple user experience allows Physna to work effectively in browsers. It also allows Physna to show detailed differences and similarities between models. The differences can be saved as a new model that can be used for operations such as visualizing interference volumes or material that has not yet been removed or added in a manufacturing operation.

The Component Finder

The Component Finder selection identifies which part models fit inside an assembly or could be substituted in place of an existing part. It is agnostic to source data file type and file hierarchy data, meaning it's finding this on its own purely based on complex geometrical analyses and AI. This allows users to see options such as how models go together and where each component fits, to identify which component is ideal for a specific task. The component finder is also able to show parts within assemblies and has the ability to run complex reports on each of the components contained in an assembly.

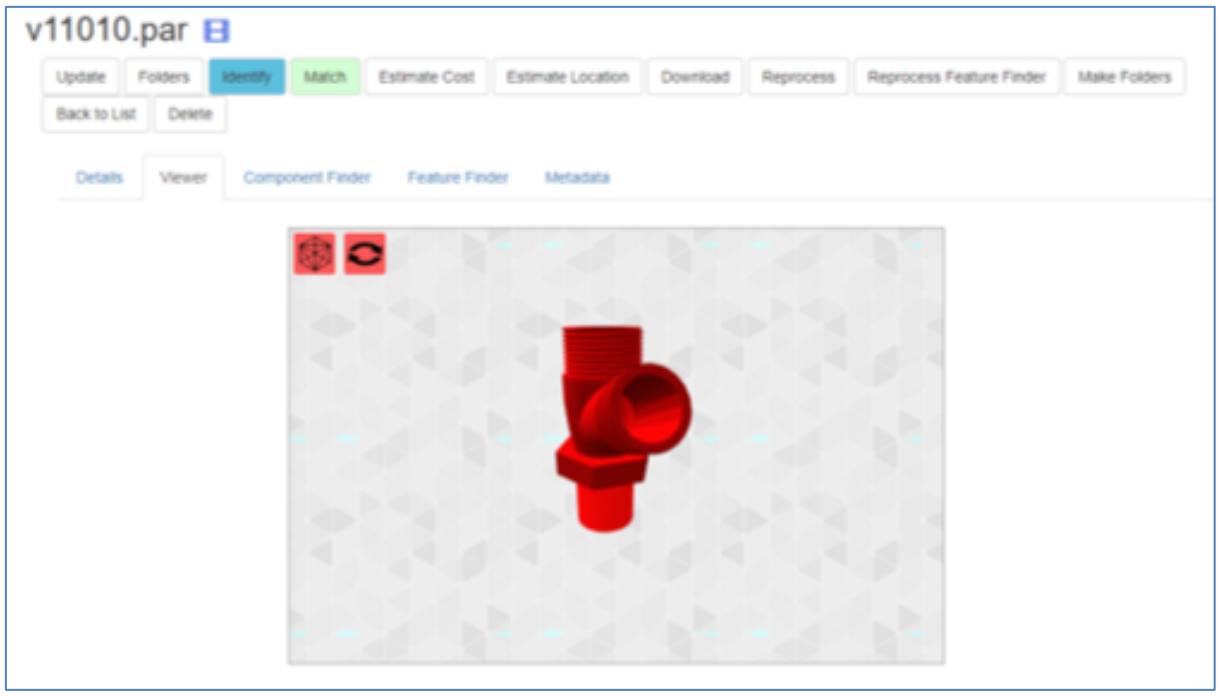


Figure 6—Physna Identify Viewer Display
(Courtesy of Physna)

Compare

3D geometry compare supports many use cases leading to potentially high benefits

Given the uniqueness of the Physna analysis and codification of 3D models, the solution offers users a powerful capability to compare models and identify differences and similarities. While commonly used to locate similar or exact matches to leverage existing models or to eliminate duplicates, Physna's Compare function has a more important aspect, that of cyber security.

According to digitalguardian.com,[5] "Cyber security refers to the body of technologies, processes, and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorized access. Cyber security may also be referred to as information technology security." Protecting product design data is a paramount concern in manufacturing companies. How can a designer guarantee that the design model they filed the day before has not been tampered with when they begin a new day's work? Often a visual inspection does not suffice because the model is too complex to easily examine. With Physna's Compare function, users can explore subtle differences between model versions. Figure depicts a solid model of an airplane wing on the left and a comparison to a similar model on the right. The user explores the "similarities" in the center image.

Note that at first glance the two models appear to be identical as noted by the central image. If the user displays the same comparison using wireframe, they see Figure . Once again, the two models appear identical.

[5] See https://digitalguardian.com/blog/what-cyber-security

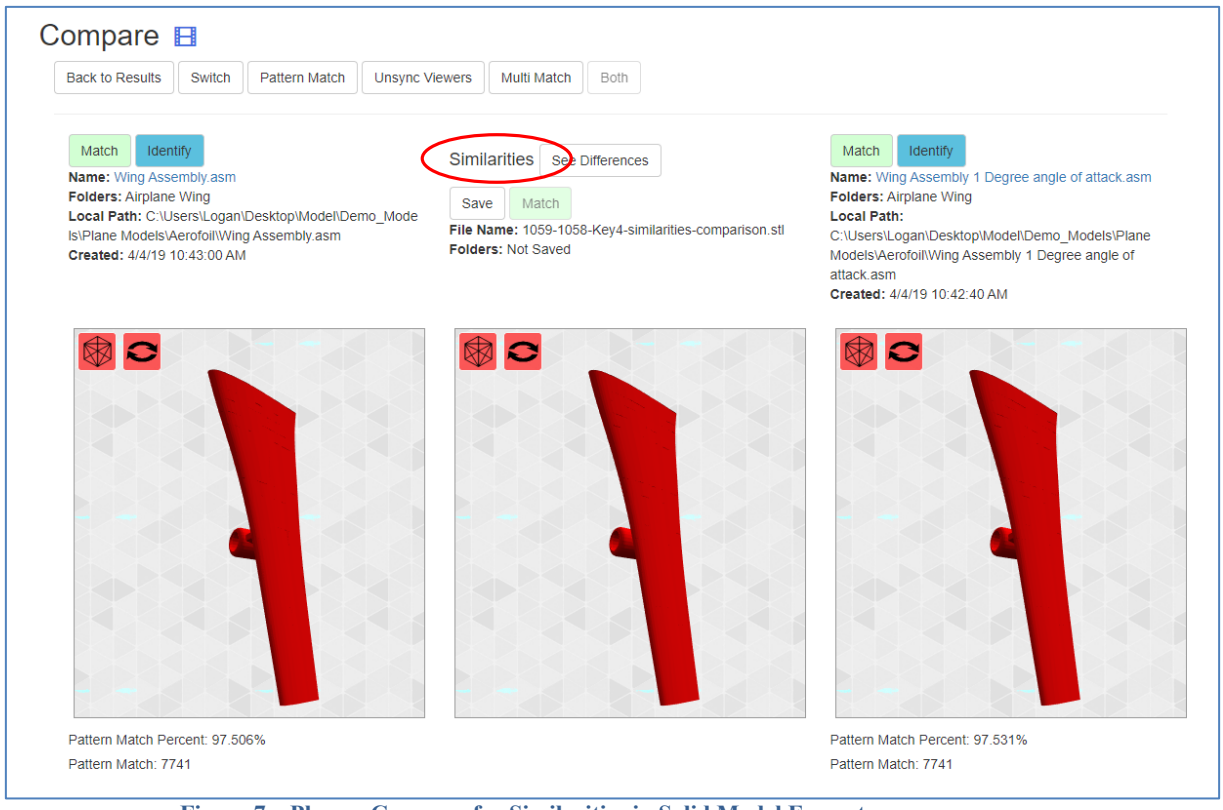


Figure 7—Physna Compare for Similarities in Solid Model Format
(Courtesy of Physna)

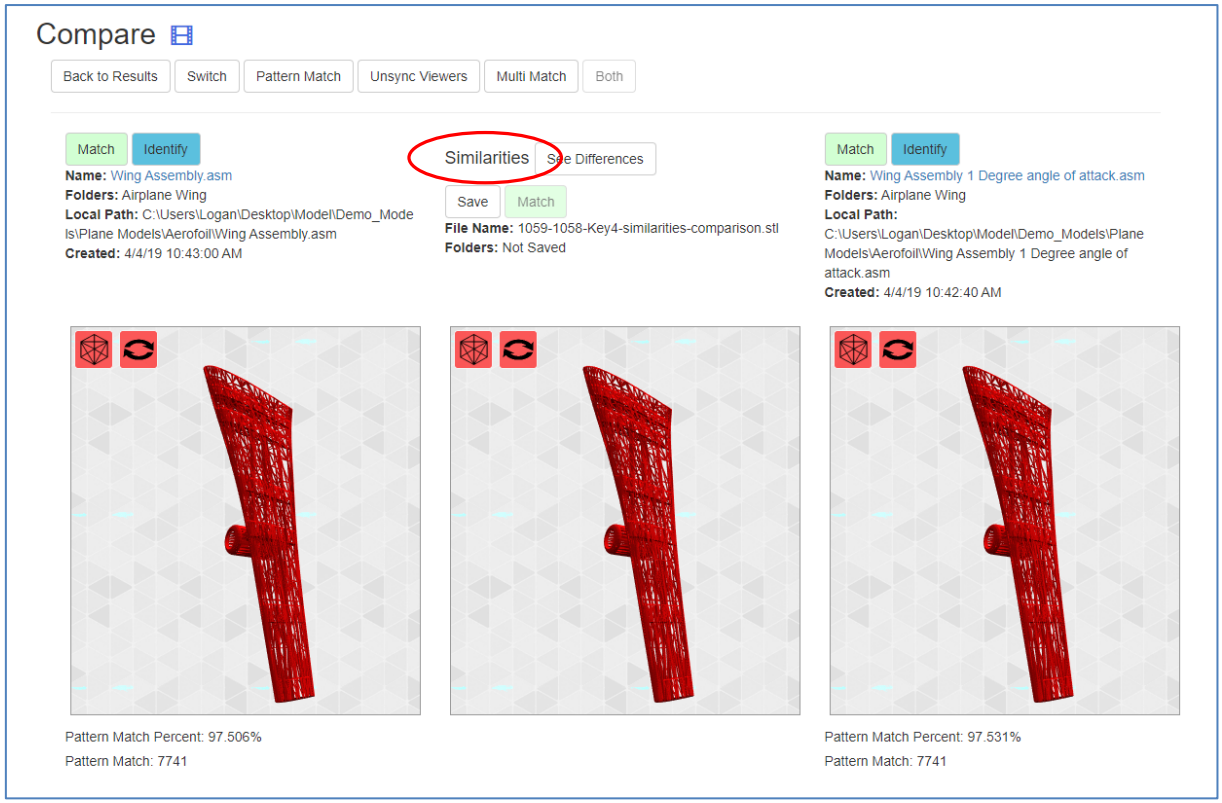


Figure 8—Physna Compare for Similarities in Wireframe Format
(Courtesy of Physna)

The telling comparison is shown in Figure where the user looks at the Differences. In the comparison, distinct disparities are seen within the interior of the wing. These variations alert the designer that changes were made to the model and highlight those changes.

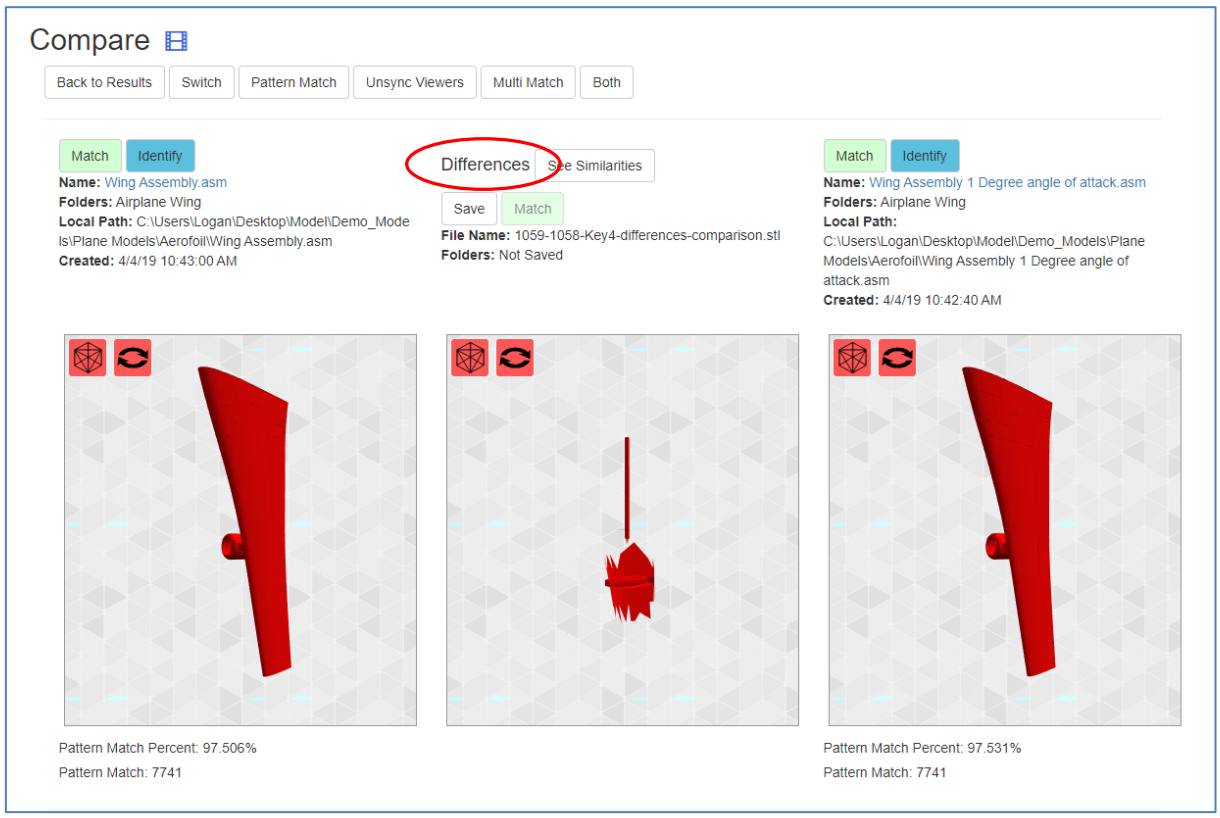


Figure 9—Physna Compare for Differences
(Courtesy of Physna)

Summary

Product designers strive for efficiency in today's competitive, fast moving market. Their productivity is slowed whenever they search for, but cannot quickly locate, an existing design. As a result, they repeatedly recreate similar designs. Eliminating duplicates and leveraging existing designs facilitates throughput and saves investments in rework and other cost associated with product development. The Physna model search solution can help designers achieve improved performance by providing the tools necessary to identify similar models and promote reuse.

Design productivity is slowed whenever product developers search for, but cannot quickly locate, an existing design

CIMdata recognizes the efforts and the ingenuity of the Physna team to deliver a highly competitive solution for design engineers and many other users of design data. Companies that wish to improve their design throughput would do well to consider Physna as part of their toolset.

About CIMdata

CIMdata, a leading independent worldwide firm, provides strategic management consulting to maximize an enterprise's ability to design and deliver innovative products and services through the application of Product Lifecycle Management (PLM) solutions. Since its founding over thirty years ago, CIMdata has delivered world-class knowledge, expertise, and best-practice methods on PLM solutions. These solutions incorporate both business processes and a wide-ranging set of PLM-enabling technologies.

CIMdata works with both industrial organizations and providers of technologies and services seeking competitive advantage in the global economy. CIMdata helps industrial organizations establish effective PLM strategies, assists in the identification of requirements and selection of PLM technologies, helps organizations optimize their operational structure and processes to implement solutions, and assists in the deployment of these solutions. For PLM solution providers, CIMdata helps define business and market strategies, delivers worldwide market information and analyses, provides education and support for internal sales and marketing teams, as well as overall support at all stages of business and product programs to make them optimally effective in their markets.

In addition to consulting, CIMdata conducts research, provides PLM-focused subscription services, and produces several commercial publications. The company also provides industry education through PLM certification programs, seminars, and conferences worldwide. CIMdata serves clients around the world from offices in North America, Europe, and Asia-Pacific.

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