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(54) **Title:** SHOP ORDER STATUS VISUALIZATION SYSTEM

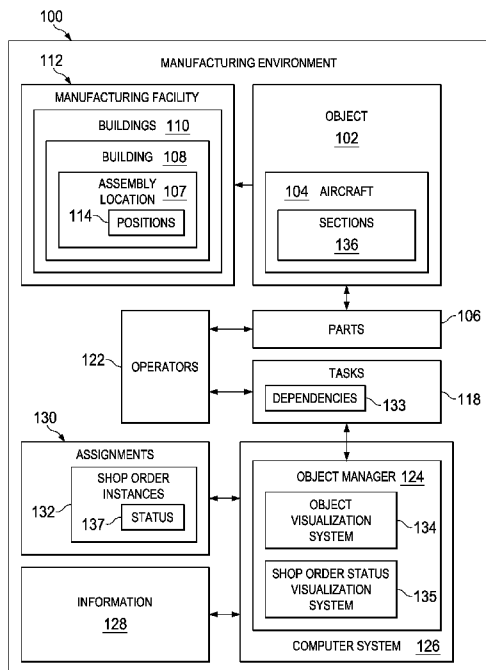


FIG. 1

(57) **Abstract:** A method and apparatus for assembling vehicles in a manufacturing environment. A model (216) of the aircraft (104) is identified. The shop order instances (132) for the aircraft (104) are identified. A status (137) of the shop order instances (132) is identified. Graphical representations (214) of parts (106) for a group of shop order instances (132) in a graphical user interface (207) are displayed on a display device. A set of graphical indicators (231) in association with the graphical representations (214) of the parts (106) displayed in the graphical user interface (207) is displayed. The set of graphical indicators (231) indicates the status (137) of the shop order instances (132).

SHOP ORDER STATUS VISUALIZATION SYSTEM**BACKGROUND INFORMATION****1. Field:**

The present disclosure relates generally to manufacturing and, in particular, to manufacturing vehicles. Still more particular, the present disclosure relates to a method and apparatus for assembling vehicles in a manufacturing environment.

2. Background:

The assembly of an aircraft is an extremely complex process. Hundreds of thousands of parts may be assembled for an aircraft.

The assembly of an aircraft may involve manufacturing different parts of the aircraft in geographically diverse locations. These different parts may then be finally assembled in a single location. For example, different portions of a fuselage of a composite aircraft may be assembled in different locations and flown to a central location where the final assembly line is located. Additionally, other parts such as engines, auxiliary power units, seats, computer systems, line replaceable units, or other components in aircraft may be shipped to this final location for assembly to form the assembled aircraft.

The assembly of the different parts involves assigning tasks to different operators. The assignment of these tasks may take the form of shop order instances. Each shop order instance may include instructions and an identification of parts for a particular assembly in the aircraft.

Operators performing the assembly of an aircraft use shop order instances to determine what tasks they will perform on a daily basis. For example, an operator may identify a task to

perform in a shop order instance. The shop order instance identifies the parts to be assembled, work instructions for assembling the parts, and a location where the assembly should be performed.

5 When an operator identifies a shop order instance assigned to that operator, the operator then identifies the different parts for assembly. Currently, the operator is unable to identify the context of other parts in the aircraft with respect to the part to be assembled. In other words, the operator is
10 not shown the location on the aircraft for the parts to be assembled. Further, the operator is also unable to view other parts that may already be located on the aircraft. In some cases, the assembly of the parts assigned to the operator may depend on the prior assembly of other parts in the aircraft.

15 Currently, the identification of the location in the shop order instance often takes the form of coordinates in aircraft. Based on these coordinates, the operator may perform research in databases and computer-aided design models to identify where the assembly should occur. This process may be more time-consuming
20 than desired. Further, it may be difficult to resolve the location information to an actual location on the plane. The increased amount of time may increase the time to assemble an aircraft more than desired. As a result, the number of aircraft that are produced during a period of time may not be as great as
25 desired or those aircraft may be assembled at a greater cost than desired.

 Therefore, it would be desirable to have a method and apparatus that takes into account at least some of the issues discussed above, as well as other possible issues.

30 This application is related to the following patent application: entitled "Object Visualization System", serial no. 13/780,109, attorney docket no. 12-1724-US-NP, filed February 28, 2013, assigned to the same assignee.

SUMMARY

In one illustrative embodiment, a method for processing shop order instances for an aircraft is present. A model of the aircraft is identified. The shop order instances for the aircraft are identified. A status of the shop order instances is identified. Graphical representations of parts for a group of shop order instances in a graphical user interface are displayed on a display device. A set of graphical indicators in association with the graphical representations of the parts displayed in the graphical user interface is displayed. The set of graphical indicators indicates the status of the shop order instances.

In another illustrative embodiment, a method for identifying a status of tasks for an object is present. A model of the object is identified. Tasks for assembling parts for the object are identified. The status of the tasks is identified. Graphical representations of parts in a portion of the object are displayed using the model. A set of graphical indicators in association with the graphical representations of the parts is displayed. The set of graphical indicators indicates a status of a portion of the tasks for the parts displayed using the graphical representations.

In yet another illustrative embodiment, an aircraft management system comprises an object manager. The object manager is configured to identify a model of an aircraft. The object manager is further configured to identify shop order instances for the aircraft. The object manager is further configured to identify a status of the shop order instances. The object manager is further configured to display graphical representations for parts for a group of shop order instances in a graphical user interface on a display device. The object manager is further configured to display a set of graphical indicators in association with the graphical representations of

the parts displayed in the graphical user interface. The set of graphical indicators indicates the status of the shop order instances.

In another illustrative embodiment, a manufacturing system comprises a control system and an object manager in the control system. The control system is configured to control manufacturing equipment configured to manufacture an aircraft. The object manager is configured to identify a model of the aircraft. The object manager is further configured to identify shop order instances for the aircraft. The object manager is further configured to identify a status of the shop order instances. The object manager is further configured to display graphical representations for parts for a group of shop order instances in a graphical user interface on a display device. The object manager is further configured to display a set of graphical indicators in association with the graphical representations of the parts displayed in the graphical user interface. The set of graphical indicators indicates the status of the shop order instances.

The features and functions can be achieved independently in various embodiments of the present disclosure or may be combined in yet other embodiments in which further details can be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the illustrative embodiments are set forth in the appended claims. The illustrative embodiments, however, as well as a preferred mode of use, further objectives and features thereof, will best be understood by reference to the following detailed description of an illustrative embodiment of the present disclosure when read in conjunction with the accompanying drawings, wherein:

Figure 1 is an illustration of a block diagram of a manufacturing environment in accordance with an illustrative embodiment;

Figure 2 is an illustration of a block diagram of an object manager in accordance with an illustrative embodiment;

Figure 3 is an illustration of a block diagram of a sectional view in accordance with an illustrative embodiment;

Figure 4 is an illustration of a block diagram of a volume identifier in accordance with an illustrative embodiment;

Figure 5 is an illustration of a block diagram of a shop order instance in accordance with an illustrative embodiment;

Figure 6 is an illustration of a block diagram of a dependency structure in accordance with an illustrative embodiment;

Figure 7 is an illustration of a graph of dependencies in accordance with an illustrative embodiment;

Figure 8 is an illustration of a graphical user interface for viewing statuses of shop order instances in accordance with an illustrative embodiment;

Figure 9 is an illustration of aircraft positions in a building in accordance with an illustrative embodiment;

Figure 10 is an illustration of a graphical user interface of aircraft sections in accordance with an illustrative embodiment;

Figure 11 is an illustration of a graphical user interface of aircraft sections in accordance with an illustrative embodiment;

Figure 12 is an illustration of a window in a graphical user interface for identifying the status of shop order instances in accordance with an illustrative embodiment;

Figure 13 is an illustration of shop order instances in a graphical user interface in accordance with an illustrative embodiment;

Figure 14 is an illustration of a menu for grouping shop order instances in accordance with an illustrative embodiment;

Figure 15 is an illustration of a grouping of shop order instances in accordance with an illustrative embodiment;

5 **Figure 16** is an illustration of filtering options in accordance with an illustrative embodiment;

10 **Figure 17** is an illustration of a graphical user interface with a visual representation of the status of shop order instances in an aircraft in accordance with an illustrative embodiment;

15 **Figure 18** is an illustration of a graphical user interface with a visual representation of the status of shop order instances in an aircraft in accordance with an illustrative embodiment;

20 **Figure 19** is an illustration of a display of shop order instance information in accordance with an illustrative embodiment;

25 **Figure 20** is an illustration of a graphical user interface with a visual representation of dependencies in accordance with an illustrative embodiment;

30 **Figure 21** is an illustration of a flowchart of a process for identifying the status of tasks in accordance with an illustrative embodiment;

35 **Figure 22** is an illustration of a flowchart of a process for identifying the status of shop order instances in accordance with an illustrative embodiment;

40 **Figure 23** is an illustration of a flowchart of a process for identifying information about the status of a shop order instance in accordance with an illustrative embodiment;

45 **Figure 24** is an illustration of a flowchart of a process for managing dependencies for at least one of a number of parts or a number of tasks in an aircraft in accordance with an illustrative embodiment;

Figure 25 is an illustration of a flowchart of a process for displaying graphical indicators of dependencies in accordance with an illustrative embodiment;

Figure 26 is an illustration of a block diagram of a data processing system in accordance with an illustrative embodiment;

Figure 27 is an illustration of an aircraft manufacturing and service method in accordance with an illustrative embodiment;

Figure 28 is an illustration of an aircraft in which an illustrative embodiment may be implemented;

Figure 29 is an illustration of a manufacturing system in accordance with an illustrative embodiment;

Figure 30 is an illustration of a visualization of an assembly line for an aircraft in accordance with an illustrative embodiment; and

Figure 31 is an illustration of a flowchart of a process for managing the manufacturing of an aircraft is depicted in accordance with an illustrative embodiment.

DETAILED DESCRIPTION

The illustrative embodiments recognize and take into account one or more different considerations. For example, the illustrative embodiments recognize and take into account that in performing tasks in shop order instances, some shop order instances should be completed prior to other shop order instances. The illustrative embodiments recognize and take into account that in some cases, completing one shop order instance before another may require some disassembly or rework of parts.

For example, the completion of one assembly may block installation of another assembly in the aircraft. In another case, one assembly may be attached to the second assembly, requiring the second assembly to be completed.

Further, the illustrative embodiments also recognize and take into account that the assembly of parts in the aircraft may not always be performed in a desired sequence. Additionally, a part may have an inconsistency that may be caused by an operator or the part may have been received with the inconsistency. As a result, the part may be installed and other parts also may be installed prior to identifying the inconsistency. As a result, the order of the assignment of installations may change and cause confusion to an operator installing other parts.

As another example, inspections of assembly may need to be performed before another assembly is completed. For example, installation of a second assembly may block access to the first assembly such that inspection of the first assembly may be difficult or impossible to perform. As a result, the inspection may be performed after partial or full removal of the second assembly. The second assembly is then reinstalled after the inspection.

The illustrative embodiments recognize and take into account that currently, operators may see a list of shop order instances and whether they have been completed. The illustrative embodiments recognize and take into account that an ability to see whether one assembly should be installed before the second assembly in the shop order instances is currently unavailable. As a result, removing and reinstalling assembly may occur more often than desired. This inefficiency may increase the amount of time needed to assemble an aircraft more than desired.

Thus, the illustrative embodiments provide a method and apparatus for identifying the status of instructions for assembling the object. In particular, these instructions may be for shop order instances. The illustrative embodiments may provide a visual display of the status of instructions, such as those in shop order instances.

For example, one or more illustrative embodiments may identify a model of the object. The instructions for assembling the parts for the object are identified. A status of the instructions is also identified. Parts in a portion of the object are displayed using the model for the object. A set of graphical indicators is displayed in association with the parts. The graphical indicators are configured to indicate the status of a portion of the instructions for the parts displayed.

With reference now to the figures, and in particular, with reference to **Figure 1**, an illustration of a block diagram of a manufacturing environment is depicted in accordance with an illustrative embodiment. Manufacturing environment **100** is an example of an environment in which object **102** may be assembled.

In this illustrative example, object **102** takes the form of aircraft **104**. Object **102** is completed by assembling parts **106**. A part is a group of the components. As used herein, a "group of," when used with reference items, means one or more items. For example, a group of components is one or more components.

A part may be a single component or assembly of components in these depicted examples. For example, the part may be a seat, a row of seats, an in-flight entertainment system, a duct, a system of ducts, a global positioning system receiver, an engine, an engine housing, an inlet, or other suitable types of parts.

In this illustrative example, assembling parts **106** may take place in assembly location **107** in building **108** of buildings **110** at manufacturing facility **112**. The assembly of parts **106** in building **108** may occur in positions **114** in assembly location **107** for object **102**. Each position in positions **114** is a location in building **108** in which a group of tasks **118** is performed to assemble object **102**.

In these illustrative examples, a task is a piece of work. A task may be comprised of one or more operations that are

performed by a group of operators **122** assigned to work on the assembly of object **102**.

In the illustrative examples, object manager **124** may be used to manage the assembly of object **102**. When object **102** is aircraft **104**, object manager **124** may be part of an aircraft management system. Object manager **124** may be implemented in software, hardware, firmware, or a combination thereof. When software is used, the operations performed by object manager **124** may be implemented in program code configured to run on a processor unit. When firmware is used, the operations performed by object manager **124** may be implemented in program code and data and stored in persistent memory to run on a processor unit. When hardware is employed, the hardware may include circuits that operate to perform the operations in object manager **124**.

In the illustrative examples, the hardware may take the form of a circuit system, an integrated circuit, an application specific integrated circuit (ASIC), a programmable logic device, or some other suitable type of hardware configured to perform a number of operations. With a programmable logic device, the device is configured to perform the number of operations. The device may be reconfigured at a later time or may be permanently configured to perform the number of operations. Examples of programmable logic devices include, for example, a programmable logic array, a programmable array logic, a field programmable logic array, a field programmable gate array, or other suitable hardware devices. Additionally, the processes may be implemented in organic components integrated with inorganic components and/or may be comprised entirely of organic components excluding a human being. For example, the processes may be implemented as circuits in organic semiconductors.

As depicted, object manager **124** may be implemented in computer system **126**. Computer system **126** is one or more computers. When more than one computer is present, the computers in computer system **126** may communicate with each other

using a communications medium such as a network. Computer system **126** may be located all in the same location or in different geographic locations. For example, computer system **126** may be distributed through buildings **110** or located in building **108**. Portions of computer system **126** may even be located in another geographic location separate from manufacturing facility **112**.

In managing the assembly of object **102**, object manager **124** may manage tasks **118** and information **128** about object **102**. In the illustrative example, the management of tasks **118** may include at least one of assigning tasks **118** to operators **122**, monitoring the status of tasks **118**, organizing tasks **118**, providing information about tasks **118**, or other suitable operations. Information **128** may include, for example, the models of objects, part inventories, or other suitable information relating to object **102**.

As used herein, the phrase "at least one of," when used with a list of items, means different combinations of one or more of the listed items may be used and only one of each item in the list may be needed. For example, "at least one of item A, item B, and item C" may include, without limitation, item A or item A and item B. This example also may include item A, item B, and item C or item B and item C. The item may be a particular object, thing, or a category. In other words, at least one of means any combination of items and number of items may be used from the list but not all of the items in the list are required.

In these illustrative examples, object manager **124** may manage tasks **118** using assignments **130** in the form of shop order instances **132**. For example, object manager **124** may assign tasks through the use of shop order instances **132** to operators **122** for performance and assembling of object **102**. Additionally, the status of shop order instances **132** may be used to identify the state of assembly of object **102** by operators **122**.

Additionally, tasks **118** may have dependencies **133**. In other words, tasks **118** may be performed in a particular order. Dependencies **133** may dictate when tasks within tasks **118** should be performed relative to other tasks in tasks **118**. Dependencies
5 may also be for parts **106** in addition to or in place of tasks **118**. In this form, dependencies **133** may result in dependencies **133** for tasks **118**.

As a result, dependencies **133** may affect the manner in which assignments **130** are made as shop order instances **132**. In
10 particular, dependencies **133** may be used to determine when shop order instances **132** should be performed.

In these illustrative examples, object manager **124** may provide different functions and capabilities for assembling object **102**. For example, object manager **124** may include at
15 least one of object visualization system **134**, shop order status visualization system **135**, or other types of systems. The systems may be implemented using hardware, software, or some combination thereof.

In one illustrative example, object visualization system
20 **134** may provide a visualization of object **102** to operators **122**. In particular, operators **122** may perform queries using object visualization system **134** to view a number of sections **136** in object **102**. In particular, sections **136** may be sections that correspond to sections at manufacturing facility **112** for
25 assembly of object **102**, such as aircraft **104**.

In these illustrative examples, the manufacturing may include at least one of fabricating components for parts, assembling components to form parts, assembling parts for object **102**, or some other suitable manufacturing operation performed to
30 assemble object **102**.

For example, object manager **124** may provide visual information about all of object **102** or one or more specific sections of object **102**. This type of visualization may be especially useful when object **102** takes the form of aircraft

104. Information **128** may be used when operators **122** perform tasks **118** with respect to parts **106** to assemble aircraft **104**.

In another illustrative example, shop order status visualization system **135** may provide a visualization of status **137** of shop order instances **132**. This information may be provided visually to operators **122**. In particular, object manager **124** may function as shop order status visualization system **135** as well as provide other suitable functions in managing the assembly of object **102**.

Turning now to **Figure 2**, an illustration of a block diagram of an object manager is depicted in accordance with an illustrative embodiment. Examples of components that may be implemented in object manager **124** are shown in this figure.

As depicted, object manager **124** includes a number of different components. For example, object manager **124** includes assignment manager **202**, object visualizer **204**, inventory identifier **205**, status identifier **206**, and graphical user interface **207**. These different components and object manager **124** may be implemented using hardware, software, or some combination thereof. As used herein, a "number of" when used with reference to items means one or more items. For example, a number of different components means one or more different components.

Graphical user interface **207** is configured to provide an interface for operators **122** to interact with object manager **124**. In these illustrative examples, graphical user interface **207** may be displayed on display system **208** in interface system **209**. Display system **208** is hardware and may include one or more display devices selected from at least one of a liquid crystal display (LCD), a light emitting display (LED), an organic light emitting display (OLED), or other suitable types of display devices.

Input may be received from operators **122** through input system **210** in interface system **209**. In this illustrative

example, input system **210** is a hardware system. Input system **210** may include one or more devices. These devices may include at least one of a keyboard, a mouse, a joystick, a touchscreen panel, or other suitable types of devices.

5 In this illustrative example, assignment manager **202** is configured to manage assignments **130** in the form of shop order instances **132** in shop order database **211**. For example, assignment manager **202** may be used to assign tasks **118** to operators **122** using shop order instances **132**. Additionally,
10 assignment manager **202** also may be configured to receive information about the performance of tasks **118** assigned through shop order instances **132**. This information may be used by assignment manager **202** to generate and update status **212** for shop order instances **132**.

15 Additionally, shop order database **211** also may include dependency structures **213**. Dependency structures **213** may be used to describe dependencies **133** between at least one of parts **106** and tasks **118**. For example, a first part may need to be installed before a second part is installed. As another
20 example, a first task for installing a part may need to be performed prior to a second task for inspecting the installation of the part. Dependency structures **213** describe these relationships between at least one of parts **106** and tasks **118** for assembling object **102**.

25 Object visualizer **204** is configured to generate graphical representations **214** for parts **106**. Graphical representations **214** may be displayed on graphical user interface **207** in display system **208**. As depicted, object visualizer **204** is configured to access model database **215**. Object visualizer **204** may identify
30 model **216** from models **217** in model database **215** for object **102** and, in particular, for aircraft **104**. Model **216** is used to generate graphical representations **214** in this illustrative example.

In these illustrative examples, graphical representations **214** may be generated for sections **136** of object **102**, which may take the form of aircraft **104**. In this illustrative example, model **216** may be identified for object **102** from models **217** in model database **215**. Models **217** may take various forms. For example, without limitation, models **217** may include computer-aided design (CAD) files.

Each model in models **217** may be for a particular object. These objects may be of the same type but used for different instances. For example, models **217** may be for a particular type of aircraft but may be used for a different instance. Each model may be for a particular aircraft that is being assembled for a customer. Further, the different models may be for the same aircraft model but may have variations for different options selected by a customer. In other illustrative examples, models **217** may include models for different types of aircraft **104**.

The generation of graphical representations **214** may be based on all of model **216** or a group of volumes **218** in model **216**. These items may have different shapes. For example, volume **219** in volumes **218** may be a cube, a cuboid, a cylinder, a sphere, or some other suitable shape.

In these illustrative examples, volume **219** is for at least a portion of a part in parts **106** of object **102**. Volume **219** may be large enough to encompass the part. Volume **219** may also be larger than the part. In these illustrative examples, volume **219** may comprise an amount of space around the part for viewing the part in a graphical user interface. For example, the amount of space around the part may be for viewing the part in the graphical user interface from one or more angles. In this example, the one or more angles may be one or more angles from the point of view of an operator. In this example, the point of view of the operator may be of an operator performing a task associated with the part.

As depicted, the group of volumes **218** may be identified in model **216** using volume database **220**. Volume database **220** is a collection of information that may be used to identify which volumes in volumes **218** may be displayed as graphical
5 representations **214**. In particular, the collection of information may include volume identifiers **221**. For example, volume identifier **222** in volume identifiers **221** may define volume **219** in volumes **218**.

In these illustrative examples, an identification of volume
10 **219** may be made using sectional view **223** from sectional views **224** in sectional view database **225**. Sectional views **224** may include sectional views of the different objects. For example, sectional view **223** may correspond to model **216**. An operator may select the group of volumes **218** using sectional view **223**
15 displayed on graphical user interface **207** in this particular example.

As depicted, sectional views **224** in sectional view database **225** may provide views of sections **136** for object **102**. In the illustrative examples, sections **136** correspond to sections as
20 manufactured for assembly of object **102**. In particular, sections **136** may correspond to sections as manufactured for assembly of aircraft **104**.

Further, sectional views **224** may include different levels of detail. For example, sectional views **224** may include a
25 hierarchy of levels in which the lower levels have more detail about aircraft **104** than higher levels in the hierarchy. In some illustrative examples, a selection of a sectional view in sectional views **224** may result in another sectional view being displayed. In other illustrative examples, a selection made in
30 a sectional view may result in graphical representations **214** being generated from model **216** and displayed on graphical user interface **207**. In this manner, an operator may visually query aircraft **104** through the different sectional views in sectional views **224**.

As a result, operator interaction generating user input with sectional view **223** displayed in graphical user interface **207** may be used to identify volumes **218** in model **216**. The user input may be used to identify volume identifier **222** from volume identifiers **221**. Volume identifier **222** may point to volume **219** in model **216**.

In these illustrative examples, object visualizer **204** may generate queries using volume identifiers **221** to obtain information from model **216** in model database **215**. In particular, information may be data about volume **219** in model **216** for aircraft **104**.

As depicted, object visualizer **204** also may be configured to generate graphical representations **214** for states **226** of object **102**. In these illustrative examples, states **226** may be used for object **102** in the form of aircraft **104**. In other words, aircraft **104** may have different parts in parts **106** that are installed at different states within states **226**. In the illustrative examples, states **226** may take the form of condition of assembly **227** for object **102**.

For example, states **226** may be based on positions **114** of aircraft **104** within assembly location **107** in building **108**. In these illustrative examples, states **226** may be selected from at least one of planned states **228** or actual states **229**.

Aircraft **104** may have different planned states in planned states **228** in different positions in positions **114**. In this illustrative example, a planned state in planned states **228** includes the parts that are expected to be installed at a particular position in positions **114**. In other words, these parts may or may not have been installed at that position.

In these illustrative examples, the planned state may be based on the past position, current position, or the future position of aircraft **104** in positions **114**. In other words, graphical representations **214** may be generated for any position that is present for planned states **228** for aircraft **104**.

As depicted, an actual state in actual states **229** includes parts **106** that have actually been installed in aircraft **104**. In other words, a particular state may have a selected number of parts that are installed at that state. The actual state in
5 actual states **229** may be based on at least one of a past position or the current position of aircraft **104**. In other words, graphical representations **214** may be generated for parts **106** actually installed at a prior point in time. This prior point in time may be selected by an operator. In this manner,
10 an operator may view tasks **118** performed to install parts **106** at some prior point in time.

Additionally, the actual state may be the current state of aircraft **104**. In other words, graphical representations **214** may be generated for parts **106** that have been installed at the
15 current point in time. In this manner, graphical representations **214** may be used to visualize parts **106** that are currently present in aircraft **104**.

In these illustrative examples, the identification of parts that have already been installed or parts installed in prior
20 points in time may be identified using shop order instances **132**. In particular, shop order instances **132** may indicate whether or what parts in parts **106** have been installed.

Model database **215** is a database of models for objects. In these illustrative examples, these models may be, for example,
25 computer-aided design models (CAD). Of course, any type of model that may provide information about the three-dimensional geometries of objects may be used. Additionally, these models may also include other information about materials, instruction assemblies, or other suitable types of information.

As depicted, inventory identifier **205** is configured to
30 access inventory database **230**. Inventory database **230** contains information about parts. Inventory database **230** may include information about whether parts are in stock, when parts will be

delivered, the number of parts available, or other suitable types of information.

As depicted, status identifier **206** is configured to provide a visualization of the status for one or more of shop order instances **132**. In this illustrative example, status identifier **206** is configured to provide an operator a graphical front end through graphical user interface **207** to identify the status of a shop order instance in a specific location of object **102**, such as aircraft **104**. This information may be identified without the operator knowing the coordinates of the particular location.

In these illustrative examples, object visualizer **204** is configured to identify a model of object **102**, such as aircraft **104**. For example, object visualizer **204** may identify the model in model database **215** for object **102**.

Status identifier **206** is also configured to identify shop order instances **132** for object **102**. The identification may be made through interaction with assignment manager **202**.

In the illustrative example, status identifier **206** is also configured to identify status **212** of shop order instances **132**. This identification also may be made through assignment manager **202**.

Object visualizer **204** is configured to display graphical representations **214** of parts **106** in **Figure 1** for a group of shop order instances **132** in graphical user interface **207** on a display device in display system **208**. The generation of graphical representations **214** may be based on the identification of a group of shop order instances **132**. In other words, object visualizer **204** is configured to receive an identification of parts in the group of shop order instances **132**. The identification of these parts may be used to generate graphical representations **214**.

Further, status identifier **206** is also configured to display a set of graphical indicators **231** in association with graphical representations **214** of parts **106** displayed on

graphical user interface **207** by object visualizer **204**. As used herein, a "set of," when used with reference items, means one or more items. For example, a set of graphical indicators **231** is one or more of graphical indicators **231**.

5 In these illustrative examples, a graphical indicator in graphical indicators **231** is considered to be displayed in association with a graphical representation in graphical representations **214** when the attention of an operator viewing graphical indicators **231** is drawn to the parts. Thus, the
10 graphical indicator may be displayed as part of the graphical representation, on the graphical representation, in some proximity of the graphical representation, or in some other suitable manner that draws attention to the graphical representation.

15 The set of graphical indicators **231** displayed in association with graphical representations **214** of parts **106** may take different forms. For example, the set of graphical indicators **231** may be selected from at least one of a color, cross hatching, an icon, highlighting, animation, or other
20 suitable types of graphical indicators.

Further, the group of shop order instances **132** may be identified in a number of different ways. For example, the group of shop order instances **132** may be identified by a user input to graphical user interface **207** from an operator. For
25 example, the user input received may be a selection of the group of shop order instances **132**.

In another illustrative example, the identification of the group of shop order instances **132** may be identified from a user input selecting a group of parts **106** in object **102** in **Figure 1**.
30 The selection of the group of parts **106** may be one of a selection of the group of parts **106** from a list of parts **106** and a selection of the group of parts **106** from a display of graphical representations **214** of parts **106** in graphical user interface **207**.

Additionally, status identifier **206** may display information about a shop order instance for a part selected from graphical representations **214** of parts **106** displayed in graphical user interface **207**.

5 With this information in graphical user interface **207**, real-world operations may be performed. For example, the assembly of object **102** in **Figure 1** may be managed based on graphical representations **214** of parts **106** for shop order instances **132** and the set of graphical indicators **231** displayed
10 on graphical user interface **207**. For example, identifications of operations that should be performed may be made using this visualization. These operations may include when particular parts should be assembled, when inspections of parts assembled in object **102** should be made, or other suitable types of
15 operations.

 In **Figure 2**, different components are illustrated as being located in object manager **124**. These different components may be used as part of different systems. The systems may include at least one of object visualization system **134**, shop order
20 status visualization system **135**, and other suitable systems. A component in object manager **124** may be used in more than one system. For example, object visualizer **204** may be in both object visualization system **134** and shop order status visualization system **135**. In other words, the different
25 components illustrated in object manager **124** may be used at the same time by different systems in object manager **124**.

 Turning now to **Figure 3**, an illustration of a block diagram of a sectional view is depicted in accordance with an illustrative embodiment. An example of one implementation for
30 sectional view **223** in **Figure 2** is shown.

 As depicted, sectional view **223** includes a number of different pieces of information. For example, sectional view **223** includes sections **300** and hotspots **302**.

Sections **300** are graphical representations corresponding to sections **136** for object **102** and, in particular, aircraft **104** in **Figure 1**. In these illustrative examples, sections **300** may be located in a single image, multiple images, or some other suitable form. Graphical representations are in an exploded view in this illustrative example. Further, sections **300** are graphical representations corresponding to sections **136** manufactured for assembly of aircraft **104**.

In these illustrative examples, sections **300** may be selectable. A selection of section **304** in sections **300** having hotspot **306** results in a volume corresponding to section **304** in model **216** being displayed in this illustrative example. Hotspot **306** may be a pointer to volume identifier **222** associated with volume **219**. For example, hotspot **306** may include a universal resource locator, or some other suitable addressing convention to identify volume identifier **222** from volume identifiers **221** in volume database **220**.

Turning now to **Figure 4**, an illustration of a block diagram of a volume identifier is depicted in accordance with an illustrative embodiment. In this illustrative example, one implementation for volume identifier **222** in **Figure 2** is shown.

Volume identifier **222** includes a number of components. As depicted, volume identifier **222** includes identifier **400** and volume descriptor **402**.

Identifier **400** distinguishes volume identifier **222** from others of volume identifiers **221** that may be present in volume database **220**. Identifier **400** may take various forms. For example, identifier **400** may be a word, a phrase, a number, an alphanumeric string, or some other suitable form.

Volume descriptor **402** describes the volume in model **216**. For example, volume descriptor **402** may take the form of coordinates **406**. Coordinates **406** are in the coordinate system used by model **216** in this example. For example, coordinates **406** may be three coordinates that may be used to define a polygon, a

cube, or a cuboid. Of course, other information may be present in volume descriptor **402** other than coordinates **406**. For example, volume descriptor **402** may include a single coordinate and a radius used to define volume **219** in a form of a sphere.

5 In still other illustrative examples, a single coordinate may be present with pre-selected offsets that define volume **219** as a cube or some other shape.

In some illustrative examples, the volume identifier may also include point of view **408**. Point of view **408** may define
10 the view of the volume displayed to an operator when graphical representations **214** are displayed on graphical user interface. For example, point of view **408** may include coordinates **410** of the point of view using the coordinate system for the volume.

With reference now to **Figure 5**, an illustration of a block
15 diagram of a shop order instance is depicted in accordance with an illustrative embodiment. As depicted, shop order instance **500** is an example of a shop order instance from shop order instances **132** in **Figure 1**.

As depicted, shop order instance **500** may include a number
20 of different parts. Shop order instance **500** includes identifier **502**, classification **503**, description **504**, task **505**, assigned operators **506**, part identifier **508**, location **510**, instructions **512**, and status **518**.

As depicted, identifier **502** may be used to uniquely
25 identify a task in tasks **118** in **Figure 1**. Identifier **502** may be an alphanumeric identifier, a number, or some other suitable type of identifier.

In the illustrative example, classification **503** is used to classify the shop order instance. This classification may be
30 based on the type of task to be performed. For example, the classifications may include seat installation, wiring, line replaceable unit installation, or other suitable types of classifications. The classification may be descriptive or may take the form of an identifier or other type of code.

Description **504** provides a description of task **505**. This description may be a short description to provide the operator information about task **505**. The description may be several words or a single sentence in some illustrative examples.

5 Task **505** identifies the work to be performed. For example, task **505** may be to install a part, assemble parts, perform an inspection, or some other suitable piece of work.

Assigned operators **506** identifies a group of operators that may be assigned to perform task **505**. In some cases, an operator
10 may not yet be assigned to perform task **505** for shop order instance **500**.

In this illustrative example, part identifier **508** identifies a part assembled in object **102** using shop order instance **500**. In this illustrative example, part identifier **508**
15 is a part number for the part. For example, part identifier **508** may be a serial number, a combination of a serial number and vendor identifier, or some other suitable type of identification that uniquely identifies a particular part from other parts even if those parts are the same type.

20 In the illustrative examples, part identifier **508** may be used to generate the graphical representation of the parts identified. For example, part identifier **508** may be used to locate the information in a model needed to generate the graphical representation of the part for display.

25 Location **510** identifies the location where task **505** is to be performed. This location may be in coordinates for object **102** or some other coordinate system.

Instructions **512** are a group of instructions for performing task **505**. In particular, the group of instructions may be for
30 assembling a group of parts. These instructions may be step-by-step instructions, guidance, or other suitable types of instructions. These instructions may provide guidance for assembling parts, inspecting parts, or other suitable operations that may be performed for task **505**. Instructions **512** also may

include plans for the location in which task **505** is to be performed.

As depicted, status **518** provides information about the performance of task **505** for shop order instance **500**. In this illustrative example, the status may indicate that work is to be performed, has been completed, is in progress, is unassigned, has been planned, is on hold, is ready, has been canceled, or some other suitable status for shop order instance **500**. The status may be indicated using text, codes, symbols, or other suitable mechanisms. Additionally, if status **518** indicates that the work to be performed has been completed, status **518** also may include a date and time of when work for performing task **505** occurred.

With reference now to **Figure 6**, an illustration of a block diagram of a dependency structure is depicted in accordance with an illustrative embodiment. As depicted, dependency structure **600** is an example a dependency structure in dependency structures **213** in **Figure 2**. In particular, dependency structure **600** is a data structure used to describe a dependency in dependencies **133** in **Figure 1**. As depicted, dependency structure **600** includes rule **602**, graphical indicator **604**, and description **606**.

Dependency structure **600** may be used to generate an indication of the presence of dependency structure **600** with respect to parts that may be installed using shop order instances. For example, dependency structure **600** may be displayed in conjunction with, or as part of, the status of the shop order instance on graphical user interface **207** in **Figure 2**. For example, dependency structure **600** may be used to indicate that a particular shop order instance may not be performed before another one. In other words, the status of the shop order instance may be not ready. Dependency structure **600** may be used to indicate what the other shop order instance may need to be completed.

Rule **602** identifies at least one of a relationship between a number of parts, a relationship between a number of tasks, or a relationship between a number of parts and a number of tasks. For example, rule **602** may identify that a first part is
5 dependent on a second part. The second part may be required to be available before the first part can be installed.

As another illustrative example, rule **602** may identify that a second task requires a first task to be performed before the second task can be performed. The first task may be, for
10 example, inspecting a floor of an aircraft cabin. The second task may be to install a row of seats on the floor after the first task has been completed.

In yet another illustrative example, rule **602** may identify that a task requires a part to perform the task. For example,
15 the task may be to inspect the part, thus, requiring access to the part. Additionally, rule **602** may also identify that a particular type of access is required for a particular task for a particular part. For example, the task may be to inspect the bottom of the part, thus, requiring access to the bottom of the
20 part.

As depicted, graphical indicator **604** identifies an indicator for use when showing a dependency in graphical user interface **207**. Graphical indicator **604** is selected to draw attention to the fact that a dependency is present for a
25 particular shop order instance.

Description **606** in dependency structure **600** identifies information that may be displayed to an operator while showing the dependency in graphical user interface **207**. In one illustrative example, description **606** may identify another shop
30 order instance that may need to be performed. Description **606** may identify the shop order instance identifier, the part, or other information needed for an operator to understand what other work in another shop order instance may depend on the particular part or task for a current shop order instance.

In these illustrative examples, rule **602**, graphical indicator **604**, and description **606** may be selected by operators and by instructions in shop order instances. In other illustrative examples, these operators may be, for example, designers, engineers, managers, installers, or other operators that may provide input for the dependency identified by dependency structure **600**.

Turning now to **Figure 7**, an illustration of a graph of dependencies is depicted in accordance with an illustrative embodiment. In this illustrative example, the edges between tasks and parts in graph **700** are dependencies, such as dependencies **133** in **Figure 1**. In this illustration, the sequence of assembly is shown as going in the direction of arrow **702** over a period of time. Dependency inheritance for tasks and parts are in the direction of arrow **704**.

As depicted in graph **700**, task **706** has dependency **708** for part **710**; part **712** has dependency **714** for part **710**; task **716** has dependency **718** for task **706**; part **720** has dependency **722** for part **712**; and task **724** has dependency **726** for part **720** and dependency **728** for part **712**. Further, in this illustrative example, part **730** has dependency **732** for task **716**, dependency **734** for part **720**, and dependency **736** for task **724**.

Part **710**, part **712**, part **720**, and part **730** are examples of parts in parts **106** in **Figure 1**. Task **706**, task **716**, and task **724** are examples of tasks in tasks **118** in **Figure 1**. Dependency **708**, dependency **714**, dependency **718**, dependency **722**, dependency **726**, dependency **728**, dependency **732**, dependency **734**, and dependency **736** are examples of dependencies **133** in **Figure 1** that may be described using dependency structures **213** in **Figure 2**.

In these illustrative examples, graph **700** is based on parts **106**, tasks **118**, and dependencies **133**. Graph **700** may be created, modified, or created and modified by operators **122** in **Figure 1**.

Graph **700** may be also modified by instructions in shop order instances **132** in **Figure 1**. For example, an operator may

add a number of parts, a number of tasks, and a number of dependencies to graph **700**. An operator may also modify a number of parts, a number of tasks, and number of dependencies in graph **700**. For example, an operator may remove a dependency in graph **700** that is no longer necessary for a performance of an assembly of an aircraft. As another example, an operator may add a new dependency that is necessary for a performance of an assembly of an aircraft. As still another example, instructions may be provided in shop order instances **132** in **Figure 1** to add and modify parts, tasks and dependencies in graph **700**.

In other illustrative examples, the sequence of assembly and dependencies for tasks and parts may go in different and additional directions in graph **700**. For example, other dependencies for task **706** may include a dependency for task **716** and a dependency for part **712**.

The illustration of the different components that may be used in manufacturing environment **100** in **Figures 1-7** is not meant to imply physical or architectural limitations to the manner in which an illustrative embodiment may be implemented. Other components in addition to or in place of the ones illustrated may be used. Some components may be unnecessary. Also, the blocks are presented to illustrate some functional components. One or more of these blocks may be combined, divided, or combined and divided into different blocks when implemented in an illustrative embodiment. For example, although the illustrative examples are described with respect to an aircraft, an illustrative embodiment may be applied to other objects other than aircraft, such as, for example, without limitation, a vehicle, a submarine, a personnel carrier, a tank, a train, an automobile, a bus, a spacecraft, a surface ship, a spacecraft, a satellite, a rocket, an engine, a computer, harvesters, construction cranes, bulldozers, mining equipment, or other suitable types of objects.

In another illustrative example, a selection of section **304** with hotspot **306** may result in an inquiry being generated directly without using volume database **220**. For example, hotspot **306** may include a query for the volume corresponding to section **304**.

As another illustrative example, other information may also be present in dependency structure **600** in addition to rule **602**, graphical indicator **604**, and description **606**. For example, dependency structure **600** may also include a universal resource locator.

For example, a universal resource locator (URL) in an instance of dependency structure **600** may be a pointer to a document describing the dependency. The universal resource locator may be presented as a link to additional information. For example, the link may be shown when information about the instance of dependency structure **600** is presented in a graphical user interface. With this feature, an operator selecting the link as displayed in a graphical user interface results in the document pointed to by the universal resource locator being retrieved. The retrieved document may then be displayed, for example, in a window in the graphical user interface.

With reference now to **Figures 8-14**, illustrations of the display of graphical user interfaces for identifying the status of shop order instances are depicted in accordance with an illustrative embodiment. These figures illustrate one manner in which graphical user interface **207** in **Figure 2** may be implemented. The different graphical user interfaces may be displayed on a display system, such as display system **208** in **Figure 2**, and an operator may interact with the graphical user interfaces using an input system, such as input system **210** in **Figure 2**.

With reference to **Figure 8**, an illustration of a graphical user interface for viewing statuses of shop order instances is depicted in accordance with an illustrative embodiment. In this

illustrative example, graphical user interface **800** displays buildings **802** including building **804**, building **806**, and building **808**.

In this particular example, each building in buildings **802** in graphical user interface **800** represents a location where manufacturing of aircraft occurs. Each building may correspond to a database of aircraft that are manufactured within the building.

Turning now to **Figure 9**, an illustration of aircraft positions in a building is depicted in accordance with an illustrative embodiment. In this illustrative example, aircraft positions **900** are displayed in graphical user interface **902**. These positions correspond to tasks that may be performed at different stages of the assembly of an aircraft.

In this particular example, aircraft positions **900** include position **904**, position **906**, position **908**, position **910**, and position **912**. In these illustrative examples, certain tasks are performed in different positions in aircraft positions **900**. In other words, the aircraft assembly progresses from position to position with different parts being added to the aircraft at the different positions in aircraft positions **900**.

A selection of one of these positions results in identifying graphical representations for parts that would be installed at a particular position as well as any parts that may have been installed from a prior position. As a result, parts that are not to be installed into a subsequent position are not present. For example, an aircraft in position **912** is a fully configured aircraft. An aircraft in position **910** may not have seats and carpet. An aircraft in position **908** may not include stove ends, lavatories, galleys, and other parts. These different positions in aircraft positions **900** may have different conditions of assembly for the aircraft in these illustrative examples.

In these illustrative examples, each of these positions may have models associated with the position. These models may contain the parts that are present in the aircraft for a particular position. As a result, a selection of a position results in a selection of models that may be used to display graphical representations of parts. As a result, models for positions with fewer parts may be queried more quickly to identify information to generate graphical representations of parts for the aircraft.

Additionally, in these illustrative examples, shop order instances in a shop order database may be identified for each of the positions. In other words, each position may have a shop order database containing shop order instances that may be generated for those particular positions. As a result, positions with fewer parts have fewer shop order instances to monitor or manage. In this manner, faster query of a shop order database for a particular position may be made when that database is for a position with fewer parts. After the selection of the position, an operator may select a section of aircraft for review.

Turning now to **Figure 10**, an illustration of a graphical user interface of aircraft sections is depicted in accordance with an illustrative embodiment. In this illustrative example, graphical user interface **1000** displays sections **1002** for an aircraft in area **1004** of graphical user interface **1000**. In this illustrative example, sections **1002** are for position **912** of the aircraft in **Figure 9**.

As depicted, sectional view **1005** is displayed in area **1004** of graphical user interface **1000**. Sectional view **1005** is an example of one implementation for sectional view **223** shown in block form in **Figure 2** and **Figure 5**. In this particular example, sectional view **1005** may be for an aircraft in position **912** in **Figure 9**.

An operator may select a section from sections **1002**. As depicted, sections **1002** are examples of sections **300** in **Figure 3** as displayed in graphical user interface **1000**. Sections **1002** are selectable in this particular example. In other words, sections **1002** may include hotspots. These hotspots are not seen in this illustrative example. Hotspots are areas in graphical user interface **1000** that may be selected to cause an action. In these illustrative examples, these hotspots correspond to sections **1002**. The hotspots may encompass sections **1002** or may be around sections **1002** or some combination thereof.

Additionally, an identification of the parts present in the section is also made in response to the user selection of a particular section. This identification may include any parts that are present for the particular position of the aircraft in that section. In other words, the same section of an aircraft in different positions may have different parts that are present based on tasks for installing parts. This identification may be made through the use of states **226** in **Figure 2**.

In the illustrative example, an operator may select to view the entire aircraft by selecting entire aircraft in area **1008** in graphical user interface **1000**. In other words, the volume for display may be the entire aircraft. Further, an operator may select groups of sections **1002**. As depicted, the selection may be made by selecting one of area **1010**, area **1012**, area **1014**, area **1016**, area **1018**, and area **1020** in graphical user interface **1000**. In these illustrative examples, these areas have hotspots. In this manner, an operator may view different portions of an aircraft in a manner that suits the particular query that the operator desires.

Turning now to **Figure 11**, an illustration of a graphical user interface of aircraft sections is depicted in accordance with an illustrative embodiment. In this illustrative example, graphical user interface **1100** displays sections **1102** for an aircraft in area **1104** of graphical user interface **1100**.

As depicted, sectional view **1105** is displayed in area **1104** of graphical user interface **1100**. Sectional view **1105** is an example of one implementation for sectional view **223** shown in block form in **Figure 2** and **Figure 5**. In this particular
5 example, sectional view **1105** may be for an aircraft in position **904** in **Figure 9**.

In this illustrative example, only a portion of an aircraft is illustrated in the view of sections **1102** in sectional view **1105**. As depicted, only sections **1102** that are present in a
10 particular position are shown in this particular example. Further, sections **1102** also may be selectable. The selectable ability of sections **1102** may be enabled through the use of hotspots associated with sections **1102**. As a result, the selection of a particular section in sections **1102** may result in
15 the display of the volume from a model of aircraft containing the selected section.

As depicted, area **1108**, area **1110**, and **1112** also are selectable. These areas group sections **1102**. These areas may also have hotspots associated with them. The selection of one
20 of these areas results in a volume containing the different sections within an area being displayed.

The illustration of graphical user interface **800** with buildings **802** in **Figure 8**, graphical user interface **902** with aircraft positions **900** in **Figure 9**, graphical user interface
25 **1000** with sections **1002** in **Figure 10**, and graphical user interface **1100** with sections **1102** in **Figure 11** are examples of multilevel querying that may be performed in accordance with an illustrative embodiment. As depicted, the selection of a building from buildings **802** may select a particular model for an
30 aircraft. The particular model may be displayed with positions using graphical user interface **902**. The selection of a position may result in another view being displayed with sections **1002** in graphical user interface **1000** or sections **1102** in graphical user interface **1100**. In this manner, an operator may more easily

traverse models of different aircraft, depending on the position selected.

With reference next to **Figure 12**, an illustration of a window in a graphical user interface for identifying the status of shop order instances is depicted in accordance with an illustrative embodiment. In this illustrative example, graphical user interface **1200** is an example of graphical user interface **207** in **Figure 2**. Graphical user interface **1200** may be displayed in response to selection of a section of an aircraft from sections **1002** in **Figure 10**.

In this illustrative example, graphical user interface **1200** is a window with which an operator may interact to obtain a status of shop order instances. As depicted, the operator may enter an aircraft identifier in field **1202**. In this illustrative example, the identifier may be a line number for the aircraft. For example, 95 as shown in field **1204** indicates that this aircraft is the 95th aircraft of the type produced. For example, this aircraft may be the 95th Boeing 787 Dreamliner. This field acts as a filter. A line number is entered that allows all the shop order instances being managed for the given line to be identified. In the illustrative examples, 10,000 or more shop order instances may be present.

After the aircraft identifier has been entered, the shop order instances for that aircraft may be identified. In this illustrative example, an operator selects button **1206** to begin the process of identifying the shop order instances.

Turning next to **Figure 13**, an illustration of shop order instances in a graphical user interface is depicted in accordance with an illustrative embodiment. In this illustrative example, the results of a search for shop order instances are displayed within field **1300** of graphical user interface **1200**.

In this example, column **1301** provides a classification for the shop order instances. As depicted, column **1302** contains

identifiers for the shop order instances displayed in field **1300** in graphical user interface **1200**. In the illustrative example, these identifiers are identifiers for parts that are to be assembled for the shop order instances. In this example, column **1304** indicates the status of the shop order instances. As depicted, the status of a shop order instance may be complete or available. Of course, other statuses may be used. The statuses may include, for example, "ready for work," "unassigned," or other suitable types of statuses. Column **1306** provides a description of the shop order instances.

With reference next to **Figure 14**, an illustration of a menu for grouping shop order instances is depicted in accordance with an illustrative embodiment. In this depicted example, window **1400** is a menu that may be used to group the shop order instances. A selection of entry **1402** may initiate grouping of the shop order instances.

In **Figure 15**, an illustration of a grouping of shop order instances is depicted in accordance with an illustrative embodiment. The shop order instances have been grouped based on categories as can be seen by looking at column **1301** in graphical user interface **1200**. This grouping occurs in response to the selection of entry **1402** from window **1400** in **Figure 14**.

With reference now to **Figure 16**, an illustration of filtering options is depicted in accordance with an illustrative embodiment. In this illustrative example, control **1600** has been selected. The selection of control **1600** results in section **1602** being displayed within graphical user interface **1200**.

In this example, section **1602** includes field **1604**, field **1606**, field **1608** and field **1610**. Field **1604** allows for filtering based on classification of shop order instances. As depicted, a shop order instance is a unique identifier for a part. In other words, every part on an aircraft has a unique identifier even if the parts are the same type. For example, multiple displays for a seat may be all the same type but each

one has a unique identifier, which may take the form of a shop order instance in this example.

Field **1606** is configured to allow for filtering based on a particular instance of a shop order instance. Field **1608** is configured to receive a status for filtering shop order instances. Field **1610** allows for filtering based on the description of the shop order instance. Of course, other fields may be used in addition to or in place of these fields. These fields may allow for other types of filtering based on other information that may be present in a shop order instance.

In this illustrative example, a visualization of the status of shop order instances may be visually displayed with respect to geographic representations of parts on which the shop order instances are performed in the aircraft. This type of display may be initiated by the selection of button **1612**.

With reference next to **Figure 17**, an illustration of a graphical user interface with a visual representation of the status of shop order instances in an aircraft is depicted in accordance with an illustrative embodiment. In this depicted example, graphical user interface **1700** displays aircraft **1702** using a model aircraft. As seen in this illustrative example, graphical indicators **1704** indicate a status of shop order instances for parts **1706** within aircraft **1702**. In this illustrative example, graphical indicators **1704** may take the form of colors. As depicted, the colors for graphical indicators **1704** are displayed as part of the graphical representation of parts **1706** in aircraft **1702** in graphical user interface **1700**. The different colors may be used to indicate the different types of status.

In **Figure 18**, an illustration of a graphical user interface with a visual representation of the status of shop order instances in an aircraft is depicted in accordance with an illustrative embodiment. An operator is able to traverse

different parts of an aircraft to see the status of shop order instances in those different parts.

This traversal may be performed in a number of different ways. For example, the operator may select a section from sections **1002** as displayed by graphical user interface **1000** in **Figure 10**.

The operator may then zoom to different portions of the section displayed. As another example, the operator may zoom into different parts of the graphical representation of aircraft **1702** such as the one shown in graphical user interface **1700** in **Figure 17**. In other illustrative examples, an operator may select a particular shop order instance or group of shop order instances from a list. Selection of the shop order instance results in the display of graphical user interface **1800** in this particular example.

As depicted, graphical user interface **1800** illustrates passenger cabin **1802** of an aircraft. In this view, graphical indicators **1804** are displayed as part of the graphical representation of parts **1806** within passenger cabin **1802**.

As depicted, this view of passenger cabin **1802** may be initially based on a default point of view. This point of view may be set using point of view **408** in **Figure 4**. From this view of passenger cabin **1802**, an operator may traverse passenger cabin **1802** in a number of different ways.

For example, an operator may select a graphical representation in graphical representations for a part in parts **1806** in passenger cabin **1802**. The selection of the graphical representation for a part may provide a closer view of that part.

In another illustrative example, the graphical representations of parts **1806** in passenger cabin **1802** may be traversed using commands **1808** displayed in menu **1810**. In this illustrative example, commands **1808** include top **1812**, bottom **1814**, side **1816**, and perspective **1818**. Of course, these commands for different views are only examples and not meant to

encompass all the different types of commands that may be used to view graphical representations of particular parts. For example, commands such as zoom, pan, and other suitable commands also may be present in addition to or in place of the ones depicted in this illustrative example.

Additionally, in some cases a part identifier may be entered into part field **1820**. By entering a part identifier, different views of a particular part in parts **1806** may be seen by the operator. Additionally, the operator may also select a command for commands **1808** to provide a particular view of the part.

Of course, other processes may be used to traverse and view graphical representations of parts **1806** within passenger cabin **1802**. These types of processes may include those typically used with computer-aided design software and other types of software in which graphical representations of parts may be viewed and traversed.

Turning next to **Figure 19**, an illustration of a display of shop order instance information is depicted in accordance with an illustrative embodiment. In this illustrative example, window **1900** is displayed within graphical user interface **1800** when graphical indicator **1902** in graphical indicators **1804** is selected. As can be seen, graphical indicator **1902** is a color displayed in association with the graphical representation for seat **1904** in graphical user interface **1800**.

Turning now to **Figure 20**, an illustration of a graphical user interface with a visual representation of dependencies is depicted in accordance with an illustrative embodiment. Graphical user interface **1800** in **Figure 20** is an example of graphical user interface **1800** in **Figure 18**.

As depicted, graphical user interface **1800** illustrates passenger cabin **1802** of an aircraft. In this view, graphical indicators **1804** are displayed as part of the graphical representation of parts **1806** within passenger cabin **1802**. In

this example, part **2002** is a portion of the floor in passenger cabin **1802**. Parts **2004** and **2006** are rows of seats in passenger cabin **1802**. In this example, part **2008** is an interior wall panel in passenger cabin **1802**.

5 In this illustrative example, graphical indicator **2010** and graphical indicator **2012** are in the form of arrows and are displayed in graphical user interface **1800**. Graphical indicator **2010** and graphical indicator **2012** are examples of graphical indicator **604** in **Figure 6**. As depicted, graphical indicator
10 **2010** represents a dependency between part **2004** and part **2002**. In this illustrative example, a rule in the dependency between part **2004** and part **2002** indicates that part **2002** must be available before part **2004** can be installed. In this illustrative example, part **2002** is unavailable. Because part
15 **2002** is unavailable, the dependency between part **2004** and part **2002** has not been met. In these illustrative examples, graphical indicators of dependencies may be shown in graphical user interface **1800** when a threshold of time for meeting rules in dependencies has passed. In this illustrative example,
20 graphical indicator **2010** is shown in graphical user interface **1800** because the threshold of time for meeting rules in dependencies has passed for the dependency between part **2004** and part **2002**.

Additionally, graphical indicators, such as graphical
25 indicator **2012**, are also shown in graphical user interface **1800** when dependencies have been met. As depicted, a task for installing part **2008** in passenger cabin **1802** has been completed. In this illustrative example, graphical indicator **2012** represents a dependency between part **2006** and the task. In this
30 illustrative example, a rule in the dependency between part **2006** and the task indicates that the task must be completed before part **2006** can be installed. In these illustrative examples, graphical indicators of dependencies may be shown in graphical user interface **1800** for a period of time. For example,

responsive to the dependency between part **2006** and the task being met, graphical indicator **2012** is presented in graphical user interface **1800**. In this example, graphical indicator **2012** is presented in graphical user interface **1800** for a period of
5 time for displaying dependencies when the dependencies are met.

Illustrations of the different graphical user interfaces in **Figures 8-20** are provided only as examples of some implementations for graphical user interface **207** in **Figure 2**. These examples are not meant to limit the manner in which an
10 illustrative embodiment may be implemented. For example, although the different examples are displayed with reference to aircraft, similar displays may be used for other types of vehicles or objects. For example, the graphical user interfaces may be configured to display shop order instance information and
15 graphical representations of objects such as an automobile, a ship, a satellite, an engine, or some other suitable type of object.

As another illustrative example, the display of the different graphical user interfaces may be performed using other
20 graphical user interfaces in addition to or in place of the ones depicted. Further, the order of the graphical user interfaces may vary from the order described above.

In one illustrative example, graphical user interface **800**, graphical user interface **902**, and graphical user interface **1000**
25 may be omitted. Instead, an operator may begin with graphical user interface **1200** to perform an identification of the status of shop order instances.

With reference now to **Figure 21**, an illustration of a flowchart of a process for identifying the status of tasks is
30 depicted in accordance with an illustrative embodiment. The process illustrated in **Figure 21** may be implemented in manufacturing environment **100** in **Figure 1**. In particular, one or more of the different operations illustrated may be implemented using object manager **124**.

The process begins by identifying a model of the object (operation **2100**). The process then identifies tasks for assembling parts for the object (operation **2102**). The process identifies the status of the tasks (operation **2104**). The process then displays graphical representations of parts in a portion of the object using the model (operation **2106**). The process then displays a set of graphical indicators in association with the graphical representations of parts (operation **2108**), with the process terminating thereafter. The set of graphical indicators indicates a status of a portion of the tasks for the parts displayed using the graphical representations.

Turning now to **Figure 22**, an illustration of a flowchart of a process for identifying the status of shop order instances is depicted in accordance with an illustrative embodiment. This process is an example of one manner in which the assignment of tasks through shop order instances may be managed. In particular, dedication of a status of different tasks in shop order instances may be identified in accordance with an illustrative embodiment. The different operations illustrated in **Figure 22** may be implemented using status identifier **206** in **Figure 2**.

The process begins by displaying a graphical user interface with a group of buildings in a manufacturing facility (operation **2200**). The graphical user interface includes hotspots for the buildings that can be selected. A hotspot is a portion of the graphical user interface that may be selected to cause an action. In these illustrative examples, the buildings are hotspots that may be selected by an operator.

The process then receives user input selecting a building (operation **2202**). In the illustrative example, each building may be used to assemble a particular aircraft. The particular aircraft may be a particular type of aircraft such as the model. In some cases, more than one building may be used to assemble

the same type of aircraft but the particular aircraft may be a specific build for a customer with specific options. In other words, different aircraft of the same type may be assembled in different buildings that have different options although they are of the same type.

Next, a model of the aircraft is identified from a selection of the building in the group of buildings in the manufacturing facility (operation **2203**). Positions in the building are identified (operation **2204**). Each building may have different positions for the aircraft that are being assembled. Further, even if a building has the same positions, the status of an aircraft at a particular building at particular positions may be different from other buildings. Further, even with the same positions, different aircraft may be assembled in the positions in different buildings.

The positions are displayed in a graphical user interface (operation **2206**). In these illustrative examples, the different positions are hotspots that may be selected through user input entered by an operator. The process then receives user input for selecting a position.

The process then identifies a sectional view for the aircraft based on a selection of a position (operation **2208**). In the illustrative example, each position may have a different sectional view that may be displayed. The sections of an aircraft in a position are the sections manufactured at the position selected in these illustrative examples. The sectional view includes sections for that particular position.

As depicted, the sectional view may be, for example, sectional view **223** in sectional views **224** as shown in **Figure 2**. Different sectional views are present for different positions in this illustrative example. Sectional view **1005** in **Figure 10** and sectional view **1105** in **Figure 11** are examples of sectional views that may be selected depending on the position selected for the aircraft in operation **2208**.

In these illustrative examples, the sectional views were selected for parts that are present in the aircraft for the position. These are parts that may already be present from assembly of the aircraft in a prior position or may be parts that are to be assembled in the position selected.

The process then displays sections of the aircraft (operation **2210**). In operation **2210**, the sections are displayed in the sectional view of the aircraft. Further, the different sections are displayed in association with hotspots that may be selected by user input entered by an operator. The process then detects a selection of a section from sections displayed in the graphical user interface (operation **2212**). In operation **2212**, the section has hotspots associated with the volume identifier. The selection of a section of an aircraft involves selecting the hotspot associated with the aircraft. The hotspot points to a volume identifier, such as volume identifier **222** in **Figure 2**. In some cases, the hotspot may be a link pointing to the volume identifier. For example, the hotspot may be an index used to identify a volume identifier.

The process then identifies a volume in the model corresponding to the section selected from the sections displayed in the graphical user interface (operation **2214**). In these illustrative examples, each section of an aircraft is associated with the volume for the aircraft. This volume is identified from volume identifiers associated with sections in the sectional view using the volume identifier pointed to by the hotspot selected for the section. The volume identifier may include information defining the volume. For example, volume identifier **222** may include volume descriptor **402** as depicted in **Figure 4**. In particular, the identifier may include a group of coordinates defining the volume in the model.

The process then displays the section in the graphical user interface using the volume in the model identified for the section selected (operation **2218**). In these illustrative

examples, the parts are displayed as graphical representations rather than a list of parts. The display of the parts may be manipulated by the operator to view the parts of different perspectives and different identifications.

5 The process then displays a set of graphical indicators in association with graphical representations of the parts displayed on the graphical user interface (operation **2220**). In this illustrative example, the graphical indicators take the form of colors used to display the graphical representations of the parts. For example, colors may comprises at least one of
10 red indicating that work for a part on a shop order instance is available, green indicating that the work for the part on the shop order instance is completed, yellow indicating that the work for the part on the shop order instance is in progress, and
15 grey indicating that the work for the part is unassigned to the shop order instance.

A determination is made as to whether the review of status for shop order instances has been completed (operation **2222**). If the review has been completed, the process terminates.

20 Otherwise, a determination is made as to whether a new section of the aircraft has been selected for the position of the aircraft (operation **2224**). If any section has been selected, the process then returns to operation **2210** as described above.

25 If a new section has not been selected, a determination is made as to whether a new position has been selected for the aircraft (operation **2226**). If a new position has been selected, the process then returns to operation **2208** as described above. If a new position has not been selected, the process determines
30 whether a new building has been selected (operation **2228**). If a new building has been selected, the process returns to operation **2204**. Otherwise, the process returns to operation **2222**.

Turning now to **Figure 23**, an illustration of a flowchart of a process for identifying information about the status of a shop

order instance is depicted in accordance with an illustrative embodiment. The process illustrated in **Figure 23** may be implemented using status identifier to **206** in **Figure 2**.

5 The process begins by receiving user input selecting a group of parts (operation **2300**). In operation **2300**, the user input making the selection of the group of parts may be selected from one of a selection of the group of parts from a list of the parts and a selection of the group of parts from a display of the graphical representation of the parts in the graphical user
10 interface.

The process then identifies a status for the group of parts selected (operation **2302**). The status may be made by querying a shop order database containing shop order instances. The database may be one specific for a particular section when these
15 operations are implemented with operations in **Figure 22**. In another case, the database may be shop order instances for an entire aircraft depending on the particular implementation.

The process then displays information about the shop order instance (operation **2304**), with the process terminating
20 thereafter. This information may be displayed in the graphical user interface in association with the graphical representation of the group of parts selected through the user input. For example, information may be displayed in a window near or on top of the graphical representation of the group of parts selected.
25 The information displayed may be information such as illustrated for shop order instance **500** in **Figure 5**.

This process may be repeated any number of times for different parts selected from the graphical representations of those parts in a graphical user interface. In this manner, an
30 operator may more easily identify shop order instances in a status of the shop order instances for particular portions of an aircraft that may be of interest to the operator.

With reference now to **Figure 24**, an illustration of a flowchart of a process for managing dependencies for at least

one of a number of parts or a number of tasks in an aircraft is depicted in accordance with an illustrative embodiment. The process illustrated in **Figure 24** may be implemented in manufacturing environment **100** in **Figure 1**. In particular, one
5 or more of the different operations illustrated may be implemented using object manager **124**. This process may be implemented to manage dependency structures **213** in **Figure 2** for performing tasks **118** as assigned using shop order instances **132**.

The process begins by identifying at least one of a number
10 of parts or tasks for an assembly of parts (operation **2400**). The process then identifies a number of dependencies of at least one of the parts or the tasks for the assembly (operation **2402**). The dependencies are displayed (operation **2404**). The display of the dependencies may take various forms. For example, a
15 dependency chart that is similar to the dependency illustrated in graph **700** in **Figure 7** may be used.

The process displays options for modifying the number of dependencies (operation **2406**). The process then receives user input from an operator (operation **2408**). Next, a determination
20 is made as to whether the user input changes the number of dependencies (operation **2410**).

If a change is made to the number of dependencies, the process then stores the change (operation **2412**). The change to the number of dependencies may include new dependencies, removed
25 dependencies, and modified dependencies.

The change is reflected in the display of dependencies (operation **2414**) with the process terminating thereafter. With reference again to operation **2410**, if the user input does not change the dependencies, the process also terminates.

30 With reference now to **Figure 25**, an illustration of a flowchart of a process for displaying graphical indicators of dependencies is depicted in accordance with an illustrative embodiment. The process illustrated in **Figure 25** may be implemented in manufacturing environment **100** in **Figure 1**. In

particular, one or more of the different operations illustrated may be implemented using object manager **124**.

The process begins by identifying parts displayed in a graphical user interface (operation **2500**). The process also identifies tasks performed with respect to the parts displayed (operation **2502**). The process further identifies dependencies for at least one of the parts displayed and the tasks performed (operation **2504**). In these illustrative examples, each dependency is defined by a dependency data structure.

The process still further identifies a graphical indicator for each dependency in the dependency data structure of each respective dependency (operation **2506**). The process then displays the identified graphical indicators for the identified dependencies (operation **2508**). In this illustrated process, the dependency data structure of each respective dependency is an example of dependency structure **600** in **Figure 6**. The graphical indicator for each dependency is an example of graphical indicator **604** in **Figure 6**.

Next, the process receives a user input selecting a graphical indicator for a dependency (operation **2510**). The process identifies information about the dependency (operation **2512**). The process then displays the identified information (operation **2514**), with the process terminating thereafter. In this illustrated process, the identified information for the dependency includes description **606** in **Figure 6**. The identified information may also include rule **602** in **Figure 6** and a status for whether the dependency has been met.

The flowcharts and block diagrams in the different depicted embodiments illustrate the architecture, functionality, and operation of some possible implementations of apparatuses and methods in an illustrative embodiment. In this regard, each block in the flowcharts or block diagrams may represent a module, a segment, a function, and/or a portion of an operation or step. For example, one or more of the blocks may be

implemented as program code, in hardware, or a combination of the program code and hardware. When implemented in hardware, the hardware may, for example, take the form of integrated circuits that are manufactured or configured to perform one or more operations in the flowcharts or block diagrams. When implemented as a combination of program code and hardware, the implementation may take the form of firmware.

In some alternative implementations of an illustrative embodiment, the function or functions noted in the blocks may occur out of the order noted in the figures. For example, in some cases, two blocks shown in succession may be executed substantially concurrently, or the blocks may sometimes be performed in the reverse order, depending upon the functionality involved. Also, other blocks may be added in addition to the illustrated blocks in a flowchart or block diagram.

For example, operations for other functions relating to shop order instances also may be used in addition to or in place of the ones depicted. In one illustrative example, operations may be included to verify or update the status of shop order instances displayed in graphical user interfaces in accordance with an illustrative embodiment. As another illustrative example, operation **2200** and operation **2202** may be omitted when only a single building is present.

Turning now to **Figure 26**, an illustration of a block diagram of a data processing system is depicted in accordance with an illustrative embodiment. Data processing system **2600** may be used to implement computer system **126** in **Figure 1**. In this illustrative example, data processing system **2600** includes communications framework **2602**, which provides communications between processor unit **2604**, memory **2606**, persistent storage **2608**, communications unit **2610**, input/output unit **2612**, and display **2614**. In this example, communications framework may take the form of a bus system.

Processor unit **2604** serves to execute instructions for software that may be loaded into memory **2606**. Processor unit **2604** may be a number of processors, a multi-processor core, or some other type of processor, depending on the particular implementation.

Memory **2606** and persistent storage **2608** are examples of storage devices **2616**. A storage device is any piece of hardware that is capable of storing information, such as, for example, without limitation, data, program code in functional form, and/or other suitable information either on a temporary basis and/or a permanent basis. Storage devices **2616** may also be referred to as computer readable storage devices in these illustrative examples. Memory **2606**, in these examples, may be, for example, a random access memory or any other suitable volatile or non-volatile storage device. Persistent storage **2608** may take various forms, depending on the particular implementation.

For example, persistent storage **2608** may contain one or more components or devices. For example, persistent storage **2608** may be a hard drive, a flash memory, a rewritable optical disk, a rewritable magnetic tape, or some combination of the above. The media used by persistent storage **2608** also may be removable. For example, a removable hard drive may be used for persistent storage **2608**.

Communications unit **2610**, in these illustrative examples, provides for communications with other data processing systems or devices. In these illustrative examples, communications unit **2610** is a network interface card.

Input/output unit **2612** allows for input and output of data with other devices that may be connected to data processing system **2600**. For example, input/output unit **2612** may provide a connection for user input through a keyboard, a mouse, and/or some other suitable input device. Further, input/output unit

2612 may send output to a printer. Display **2614** provides a mechanism to display information to a user.

Instructions for the operating system, applications, and/or programs may be located in storage devices **2616**, which are in communication with processor unit **2604** through communications framework **2602**. The processes of the different embodiments may be performed by processor unit **2604** using computer-implemented instructions, which may be located in a memory, such as memory **2606**.

These instructions are referred to as program code, computer usable program code, or computer readable program code that may be read and executed by a processor in processor unit **2604**. The program code in the different embodiments may be embodied on different physical or computer readable storage media, such as memory **2606** or persistent storage **2608**.

Program code **2618** is located in a functional form on computer readable media **2620** that is selectively removable and may be loaded onto or transferred to data processing system **2600** for execution by processor unit **2604**. Program code **2618** and computer readable media **2620** form computer program product **2622** in these illustrative examples.

In one example, computer readable media **2620** may be computer readable storage media **2624** or computer readable signal media **2626**. In these illustrative examples, computer readable storage media **2624** is a physical or tangible storage device used to store program code **2618** rather than a medium that propagates or transmits program code **2618**.

Alternatively, program code **2618** may be transferred to data processing system **2600** using computer readable signal media **2626**. Computer readable signal media **2626** may be, for example, a propagated data signal containing program code **2618**. For example, computer readable signal media **2626** may be an electromagnetic signal, an optical signal, and/or any other suitable type of signal. These signals may be transmitted over

communications links, such as wireless communications links, optical fiber cable, coaxial cable, a wire, and/or any other suitable type of communications link.

The different components illustrated for data processing system **2600** are not meant to provide architectural limitations to the manner in which different embodiments may be implemented. The different illustrative embodiments may be implemented in a data processing system including components in addition to and/or in place of those illustrated for data processing system **2600**. Other components shown in **Figure 26** can be varied from the illustrative examples shown. The different embodiments may be implemented using any hardware device or system capable of running program code **2618**.

Illustrative embodiments of the disclosure may be described in the context of aircraft manufacturing and service method **2700** as shown in **Figure 27** and aircraft **2800** as shown in **Figure 28**. Turning first to **Figure 27**, an illustration of an aircraft manufacturing and service method is depicted in accordance with an illustrative embodiment. During pre-production, aircraft manufacturing and service method **2700** may include specification and design **2702** of aircraft **2800** in **Figure 28** and material procurement **2704**.

During production, component and subassembly manufacturing **2706** and system integration **2708** of aircraft **2800** in **Figure 28** takes place. Thereafter, aircraft **2800** in **Figure 28** may go through certification and delivery **2710** in order to be placed in service **2712**. While in service **2712** by a customer, aircraft **2800** in **Figure 28** is scheduled for routine maintenance and service **2714**, which may include modification, reconfiguration, refurbishment, and other maintenance or service.

Each of the processes of aircraft manufacturing and service method **2700** may be performed or carried out by a system integrator, a third party, and/or an operator. In these examples, the operator may be a customer. For the purposes of

this description, a system integrator may include, without limitation, any number of aircraft manufacturers and major-system subcontractors; a third party may include, without limitation, any number of vendors, subcontractors, and suppliers; and an operator may be an airline, a leasing company, a military entity, a service organization, and so on.

With reference now to **Figure 28**, an illustration of an aircraft is depicted in which an illustrative embodiment may be implemented. In this example, aircraft **2800** is produced by aircraft manufacturing and service method **2700** in **Figure 27** and may include airframe **2802** with systems **2804** and interior **2806**. Examples of systems **2804** include one or more of propulsion system **2808**, electrical system **2810**, hydraulic system **2812**, and environmental system **2814**. Any number of other systems may be included. Although an aerospace example is shown, different illustrative embodiments may be applied to other industries, such as the automotive industry.

Apparatuses and methods embodied herein may be employed during at least one of the stages of aircraft manufacturing and service method **2700** in **Figure 27**.

For example, one or more illustrative embodiments may be implemented during system integration **2708**. The different illustrative examples may be implemented to identify a status of shop order instances used to perform tasks to assemble parts on aircraft **2800**. Additionally, an illustrative embodiment also may be implemented during maintenance and service **2714**. For example, the status of the shop order instances for performance of tasks to assemble parts for maintenance, upgrades, refurbishment, and other operations during maintenance and service **2714** may be identified using an illustrative embodiment.

Turning now to **Figure 29**, an illustration of a manufacturing system is depicted in accordance with an illustrative embodiment. Manufacturing system **2900** is a

physical hardware system and is configured to manufacture products, such as aircraft **2800** in **Figure 28**.

As depicted, manufacturing system **2900** includes manufacturing equipment **2902**. Manufacturing equipment **2902**

5 includes at least one of fabrication equipment **2904** or assembly equipment **2906**.

Fabrication equipment **2904** is equipment that may be used to fabricate components for parts used to form aircraft **2800**. For example, fabrication equipment **2904** may include machines and
10 tools. These machines and tools may be at least one of a drill, a hydraulic press, a furnace, a mold, a composite tape laying machine, a vacuum system, a lathe, or other suitable types of equipment. Fabrication equipment **2904** may be used to fabricate
15 at least one of metal parts, composite parts, semiconductors, circuits, fasteners, ribs, skin panels, spars, antennas, pharynx, or other suitable types of parts.

Assembly equipment **2906** is equipment used to assemble parts to form aircraft **2800**. In particular, assembly equipment **2906** may be used to assemble components and parts to form aircraft
20 **2800**. Assembly equipment **2906** also may include machines and tools. These machines and tools may be at least one of a robotic arm, a crawler, a faster installation system, a rail-based drilling system, or a robot. Assembly equipment **2906** may be used to assemble parts such as seats, horizontal stabilizers,
25 wings, engines, engine housings, landing gear systems, and other parts for aircraft **2800**.

Manufacturing system **2900** also includes control system **2908**. Control system **2908** is a hardware system and may also include software or other types of components. Control system
30 **2908** is configured to control the operation of manufacturing equipment **2902**. Control system **2908** may be implemented using hardware. The hardware may include computers, circuits, networks, and other types of equipment. The control may take the form of direct control of manufacturing equipment **2902**. For

example, robots, computer-controlled machines, and other equipment may be controlled by control system **2908**. In other illustrative examples, control system **2908** may manage operations performed by human operators **2910** in manufacturing aircraft

5 **2800**. In these illustrative examples, object manager **124** in **Figure 1** may be implemented in control system **2908** to manage the manufacturing of aircraft **2800** in **Figure 28**.

In the different illustrative examples, human operators **2910** may operate or interact with at least one of manufacturing equipment **2902** or control system **2908**. This interaction may be performed to manufacture aircraft **2800**.

Of course, manufacturing system **2900** may be configured to manufacture other products. Although manufacturing system **2900** has been described with respect to manufacturing in the aerospace industry, manufacturing system **2900** may be configured to manufacture products for other industries. For example, manufacturing system **2900** may be configured to manufacture products for the automotive industry as well as any other suitable industries.

20 In this manner, operators may visualize information about the status of shop order instances using a graphical user interface. This visualization includes displaying graphical indicators of the status of shop order instances in association with graphical representations of the parts on which tasks are performed.

Further, control system **2908** with object manager **124** may monitor the manufacturing of aircraft **2800**. This monitoring may be through the status of shop order instances as described above. The status of shop order instances may also be used to visually display the status of the manufacturing of aircraft **2800**. This display may be based on the positions in an assembly line for aircraft **2800**.

Additionally, an analysis of the shop order instances may also be used to identify and flag problem areas. These problem

areas may be, for example, areas in which completion of shop order instances may be slower than desired, areas in which non-conformances are greater than desired, or other undesirable situations. Control system **2908** may control manufacturing equipment **2902** to halt manufacturing in a problem area until the problem is resolved. In other illustrative examples, control system **2908** may send instructions to human operators **2910** to halt manufacturing and resolve an issue in a problem area.

Turning now to **Figure 30**, an illustration of a visualization of an assembly line for an aircraft is depicted in accordance with an illustrative embodiment. In this depicted example, graphical user interface **3000** is an example of graphical user interface **207** in **Figure 2**.

As depicted, graphical user interface **3000** displays positions **3002** in assembly line **3004** for aircraft **2800** in **Figure 28**. In this example, position **3006** is flagged with graphical indicator **3008**. Graphical indicator **3008** indicates that a problem is present in position **3006**. This problem may be identified through an analysis of shop order instances that are being performed.

Assembly of aircraft **2800** in assembly line **3004** may be halted until the problem in position **3006** as identified by graphical indicator **3008** is resolved. The analysis and control may be performed using control system **2908** in these illustrative examples.

With reference now to **Figure 31**, an illustration of a flowchart of a process for managing the manufacturing of an aircraft is depicted in accordance with an illustrative embodiment. The process illustrated in **Figure 31** may be implemented in control system **2908** in **Figure 29**. This process may be implemented to identify a problem that may or that may require resolution.

The process begins by identifying shop order instances for an assembly line (operation **3100**). The process then analyzes

the shop order instances for the assembly line (operation **3102**). This analysis may be performed using object manager **124** in **Figure 1** which may be implemented in control system **2908** in **Figure 29**.

5 A determination is made as to whether a problem area is present (operation **3104**). A problem area may be, for example, one in which shop order instances are not performed as quickly as desired, non-conformances are greater than desired for completed shop order instances, or other issues that may
10 increase the time and expense for manufacturing aircraft in these illustrative examples. Of course, a problem area may be any area in which the manufacturing performed for a position does not meet a desired metric.

 If a problem area is identified, the process halts work
15 (operation **3106**). The work may be halted for a portion or all of the assembly line depending on the particular issue identified for the problem area. Additionally, the process displays an indication of the problem area in a graphical user interface (operation **3108**). An example of this display is
20 displayed in graphical user interface **3000** in **Figure 30**.

 A determination is made as to whether the issue in the problem area has been resolved (operation **3110**). If the issue has been resolved, the process restarts the work (operation **3112**). The process then returns to operation **3100**. Otherwise,
25 the process returns to operation **3108**.

 With reference again to operation **3104**, if a problem area is not identified, the process returns to operation **3100**. By returning to operation **3100**, the process identifies shop order instances that are currently present.

30 Of course, this process may include other operations not illustrated in addition to or in place of the ones depicted. Further, some operations may be performed at the same time more different orders. For example, operation **3106** and operation

3108 may be performed simultaneously or in a reverse order from the one depicted.

The visualization may be performed without operators having to know coordinates for locations in the aircraft. In these illustrative examples, the graphical user interface displays graphical representations of the aircraft that allows the operators to view different portions of the aircraft without using coordinates to traverse the views of the aircraft.

In particular, an illustrative embodiment may be useful to operators in the manufacturing facility. With one or more illustrative embodiments, an operator may load an entire aircraft, a specific section, or the portions of an aircraft to identify the status of shop order instances.

This display of status for shop order instances may be more helpful to operators as compared to viewing lists of information about the status of shop order instances. One or more illustrative embodiments allow an operator to visually navigate through an aircraft to view the status of shop order instances. With this information, operators may more easily determine when to perform tasks for shop order instances relative to other shop order instances.

Further the disclosure comprises embodiments according to the following clauses:

Clause 1. A method for processing shop order instances

(132) for an aircraft (104), the method comprising:

identifying (2100) a model (216) of the aircraft (104);

identifying the shop order instances (132) for the aircraft (104);

identifying a status (137) of the shop order instances (132);

displaying graphical representations (214) of parts (106) for a group of shop order instances (132) in a graphical user interface (207) on a display device; and

displaying a set of graphical indicators (231) in association with the graphical representations (214) of the parts (106) displayed in the graphical user interface (207), wherein the set of graphical indicators (231) indicates the status (137) of the shop order instances (132).

Clause 2. The method of clause 1 further comprising:

managing an assembly of the aircraft (104) based on the graphical representations (214) of the parts (106) for the group of shop order instances (132) and the set of graphical indicators (231) displayed in the graphical user interface (207).

Clause 3. The method of clause 1 further comprising:

identifying the group of shop order instances (132) from a user input.

Clause 4. The method of clause 3, wherein identifying the group of shop order instances (132) from the user input

comprises:

receiving the user input with a selection of the group of shop order instances (132).

Clause 5. The method of clause 3, wherein identifying the group of shop order instances (132) from the user input

comprises:

receiving the user input with a selection of a group of parts (106) in the aircraft (104).

Clause 6. The method of clause 5, wherein the selection of the group of parts (106) is selected from one of a selection of the group of parts (106) from a list of the parts (106) and a selection of the group of parts (106) from a display of the

graphical representations (214) of the parts (106) in the graphical user interface (207).

Clause 7. The method of clause 1 further comprising:
5 displaying information (128) about a shop order instance (500) for a part selected from the graphical representations (214) of the parts (106) displayed in the graphical user interface (207).

10 Clause 8. The method of clause 1, wherein the set of graphical indicators (231) is selected from at least one of a color, cross hatching, an icon, highlighting, and animation.

Clause 9. The method of clause 1, wherein the set of
15 graphical indicators (231) comprises colors comprising at least one of red indicating that work for a part on a shop order instance (500) is available, green indicating that the work for the part on the shop order instance (500) is completed, yellow indicating that the work for the part on the shop order instance
20 (500) is in progress, and grey indicating that the work for the part is unassigned to the shop order instance.

Clause 10. The method of clause 1, wherein a shop order instance (500) in the shop order instances (132) includes an
25 identifier (502) for the shop order instance (500), a status (518), an identification of a group of parts (106) assembled, and a group of instructions (512) for assembling the group of parts (106).

Clause 14. An aircraft management system comprising:
30 an object manager (124) configured to identify a model (216) of an aircraft (104); identify shop order instances (132) for the aircraft (104); identify a status (137) of the shop order instances (132); display graphical representations (214) for parts (106) for a group of shop order instances (132) in a

graphical user interface (207) on a display device; and display a set of graphical indicators (231) in association with the graphical representations (214) of the parts (106) displayed in the graphical user interface (207), wherein the set of graphical indicators (231) indicates the status (137) of the shop order instances (132).

Clause 15. The aircraft management system of clause 14, wherein the object manager (124) is further configured to identify the group of shop order instances (132) from a user input.

Clause 16. The aircraft management system of clause 15, wherein in being configured to identify the group of shop order instances (132) from the user input, the object manager (124) is configured to receive the user input with a selection of the group of shop order instances (132).

Clause 17. The aircraft management system of clause 15, wherein in being configured to identify the group of shop order instances (132) from the user input, the object manager (124) is configured to receive the user input with a selection of a group of parts (106) in the aircraft (104).

Clause 18. The aircraft management system of clause 17, wherein the selection of the group of parts (106) is selected from one of a selection of the group of parts (106) from a list of the parts (106) and a selection of the group of parts (106) from a display of the graphical representations (214) of the parts (106) in the graphical user interface (207).

Clause 19. The aircraft management system of clause 14, wherein the object manager (124) is further configured to display information (128) about a shop order instance (500) for

a part selected from the graphical representations (214) of the parts (106) displayed in the graphical user interface (207).

Clause 20. The aircraft management system of clause 14,
5 wherein the set of graphical indicators (231) is selected from at least one of a color, cross hatching, an icon, highlighting, and animation.

Clause 21. The aircraft management system of clause 14,
10 wherein the set of graphical indicators (231) comprises colors comprising at least one of red indicating that work for a part on a shop order instance (500) is available, green indicating that the work for the part on the shop order instance (500) is completed, yellow indicating that the work for the part on the
15 shop order instance (500) is in progress, and grey indicating that the work for the part is unassigned to the shop order instance.

Clause 22. The aircraft management system of clause 14,
20 wherein a shop order instance (500) in the shop order instances (132) includes an identifier (502) for the shop order instance (500), a status (518), an identification of a group of parts (106) assembled, and a group of instructions (512) for assembling the group of parts (106).

25 Thus, with one or more illustrative embodiments, obtaining the status of shop order instances may reduce the amount of time needed by operators performing tasks to assemble an aircraft and other objects.

30 The description of the different illustrative embodiments has been presented for purposes of illustration and description, and is not intended to be exhaustive or limited to the embodiments in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the

art. Further, different illustrative embodiments may provide different features as compared to other illustrative embodiments. The embodiment or embodiments selected are chosen and described in order to best explain the principles of the
5 embodiments, the practical application, and to enable others of ordinary skill in the art to understand the disclosure for various embodiments with various modifications as are suited to the particular use contemplated.

CLAIMS:

What is claimed is:*

- 5 1. A manufacturing system comprising:
a control system configured to control manufacturing
equipment configured to manufacture an aircraft (104); and
an object manager in the control system, wherein the object
manager is configured to identify a model (216) of the
10 aircraft (104); identify shop order instances (132) for the
aircraft (104); identify a status (137) of the shop order
instances (132); display graphical representations (214) for
parts (106) for a group of shop order instances (132) in a
graphical user interface (207) on a display device; and display
15 a set of graphical indicators (231) in association with the
graphical representations (214) of the parts (106) displayed in
the graphical user interface (207), wherein the set of graphical
indicators (231) indicates the status (137) of the shop order
instances (132).
- 20 2. The manufacturing system of claim 1 further comprising:
the manufacturing equipment, wherein the manufacturing
equipment includes at least one of fabrication equipment or
assembly equipment.
- 25 3. The manufacturing system of claim 1 comprising:
an object manager configured to identify a model (216) of
an aircraft (104); identify shop order instances (132) for the
aircraft (104); identify a status (137) of the shop order
30 instances (132); display graphical representations (214) for
parts (106) for a group of shop order instances (132) in a
graphical user interface (207) on a display device; and display
a set of graphical indicators (231) in association with the
graphical representations (214) of the parts (106) displayed in

the graphical user interface (207), wherein the set of graphical indicators (231) indicates the status (137) of the shop order instances (132).

5 4. The manufacturing system of claim 1, wherein the object manager is further configured to identify the group of shop order instances (132) from a user input.

10 5. The manufacturing system of claim 4, wherein in being configured to identify the group of shop order instances (132) from the user input, the object manager is configured to receive the user input with a selection of the group of shop order instances (132).

15 6. The manufacturing system of claim 4, wherein in being configured to identify the group of shop order instances (132) from the user input, the object manager is configured to receive the user input with a selection of a group of parts (106) in the aircraft (104).

20 7. The manufacturing system of claim 6, wherein the selection of the group of parts (106) is selected from one of a selection of the group of parts (106) from a list of the parts (106) and a selection of the group of parts (106) from a display of the graphical representations (214) of the parts (106) in the graphical user interface (207).

25 8. The manufacturing system of claim 3, wherein the object manager is further configured to display information about a shop order instance (500) for a part selected from the graphical representations (214) of the parts (106) displayed in the graphical user interface (207).

9. The manufacturing system of claim 3, wherein the set of graphical indicators (231) is selected from at least one of a color, cross hatching, an icon, highlighting, and animation.

5 10. The manufacturing system of claim 3, wherein the set of graphical indicators (231) comprises colors comprising at least one of red indicating that work for a part on a shop order instance (500) is available, green indicating that the work for the part on the shop order instance (500) is completed, yellow
10 indicating that the work for the part on the shop order instance (500) is in progress, and grey indicating that the work for the part is unassigned to the shop order instance (500).

11. The manufacturing system of claim 3, wherein a shop order
15 instance (500) in the shop order instances (132) includes an identifier for the shop order instance, a status (137), an identification of a group of parts (106) assembled, and a group of instructions (512) for assembling the group of parts (106).

20 12. A method for managing an assembly of an aircraft (104) comprising:

Identifying (2100) a model (216) of the aircraft (104);
identifying the shop order instances (132) for the
aircraft (104);

25 identifying (2104) a status (137) of the shop order instances (132);

displaying (2106) graphical representations (214) of parts (106) for a group of shop order instances (132) in a graphical user interface (207) on a display device; and

30 displaying (2108) a set of graphical indicators (231) in association with the graphical representations (214) of the parts (106) displayed in the graphical user interface (207), wherein the set of graphical indicators (231) indicates the status (137) of the shop order instances (132).

5 13. The method of claim 12 further comprising:
displaying information (128) about a shop order
instance (500) for a part selected from the graphical
representations (214) of the parts (106) displayed in the
graphical user interface (207).

10 14. The method of claim 12, wherein the set of graphical
indicators (231) is selected from at least one of a color, cross
hatching, an icon, highlighting, and animation.

15 15. The method of claim 12, wherein the set of graphical
indicators (231) comprises colors comprising at least one of red
indicating that work for a part on a shop order instance (500)
is available, green indicating that the work for the part on the
shop order instance (500) is completed, yellow indicating that
20 the work for the part on the shop order instance (500) is in
progress, and grey indicating that the work for the part is
unassigned to the shop order instance (500).

25

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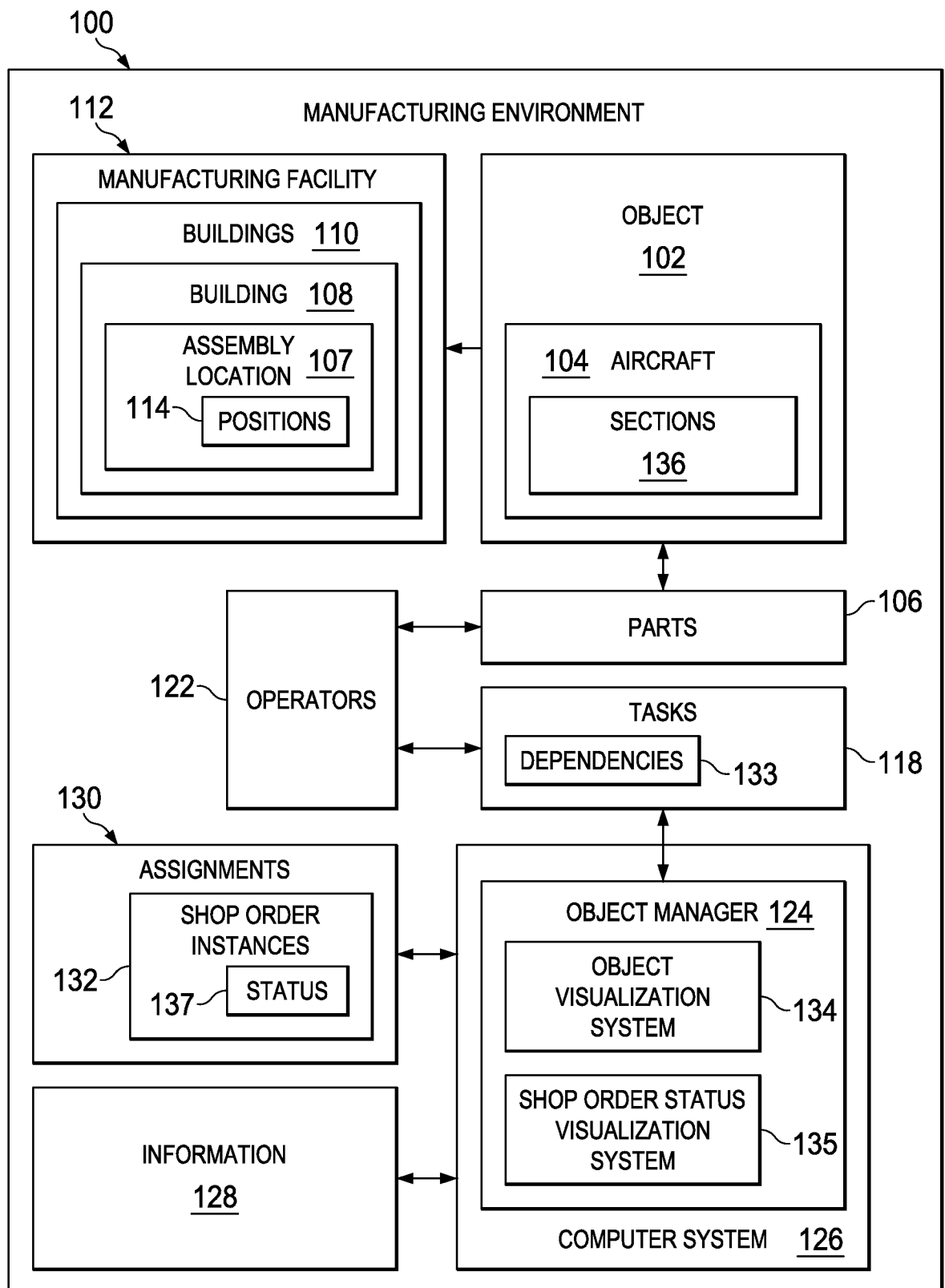


FIG. 1

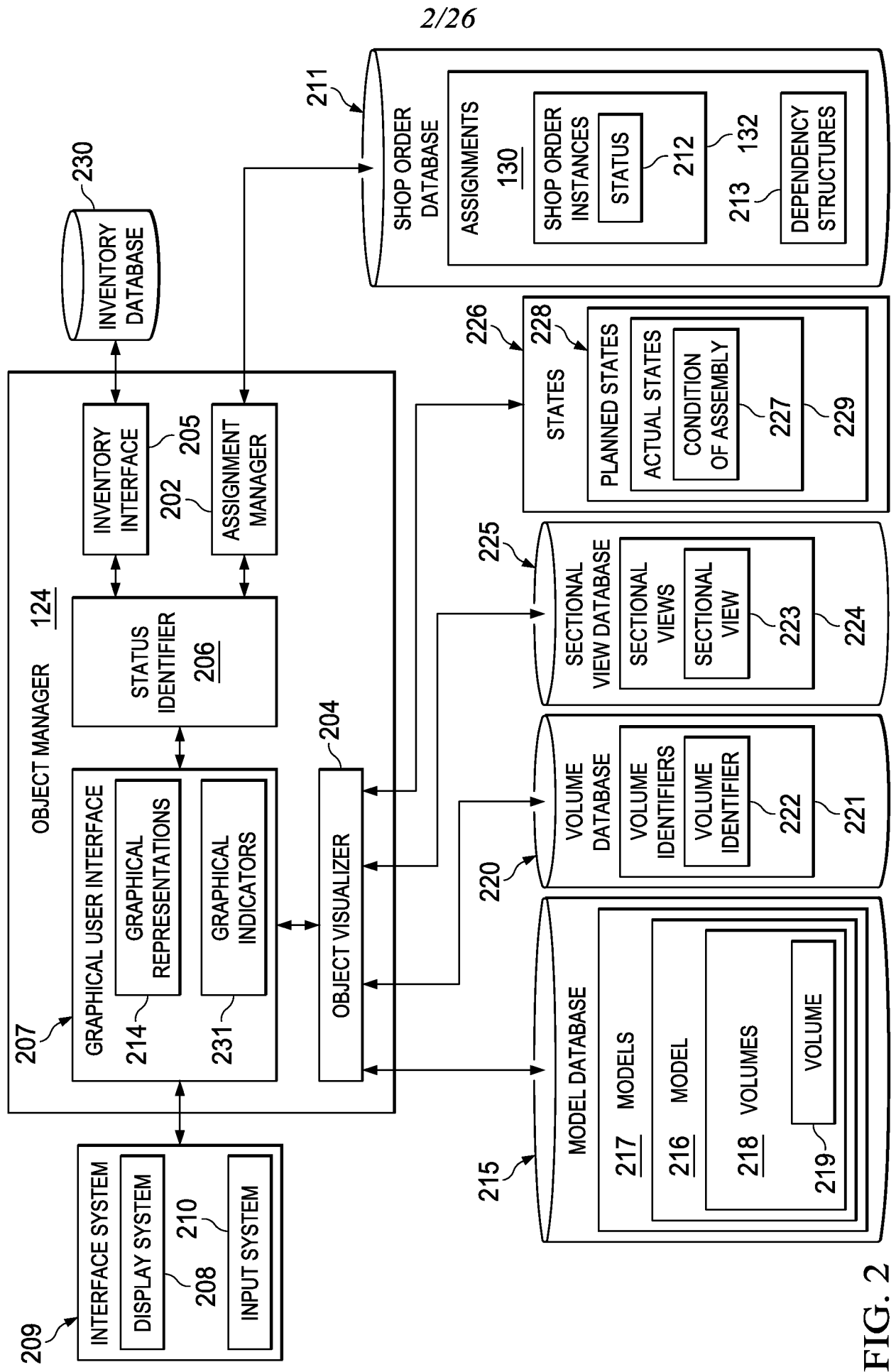


FIG. 2

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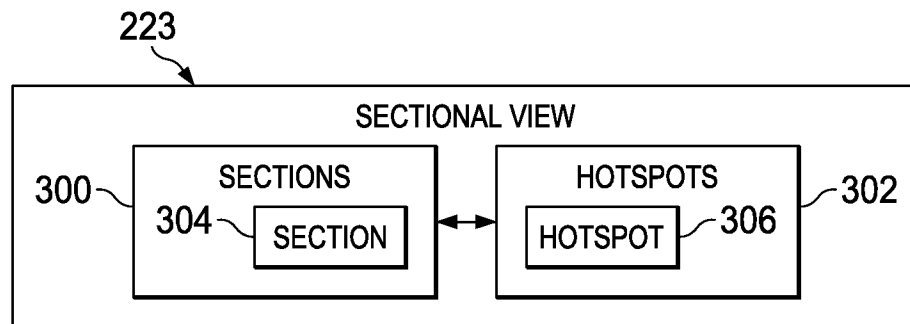


FIG. 3

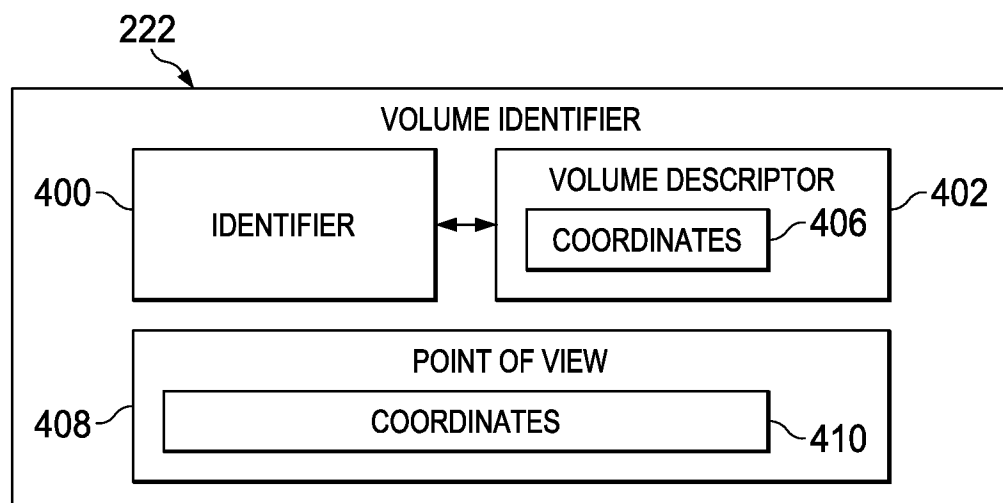


FIG. 4

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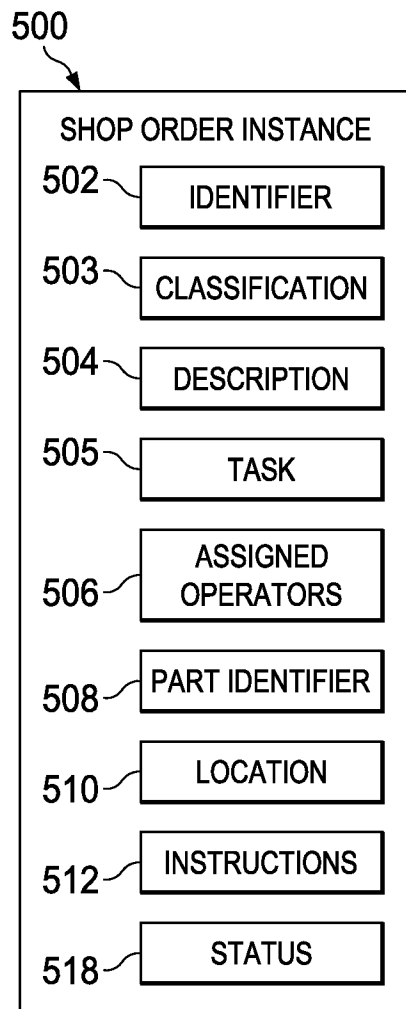


FIG. 5

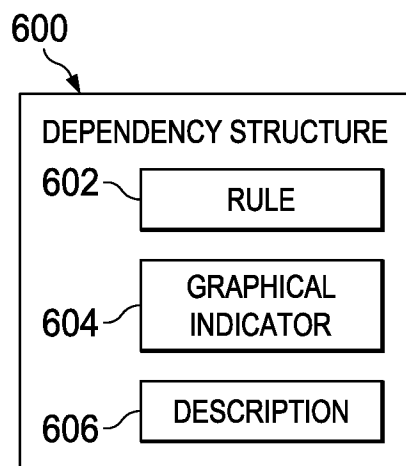


FIG. 6

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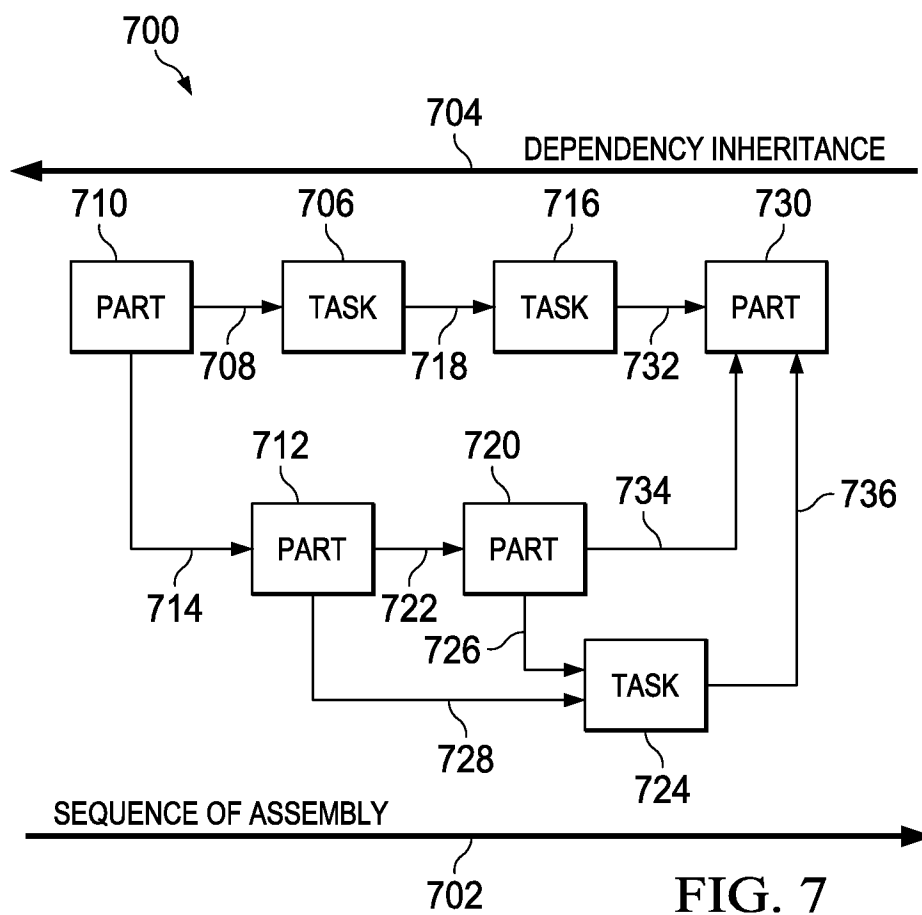
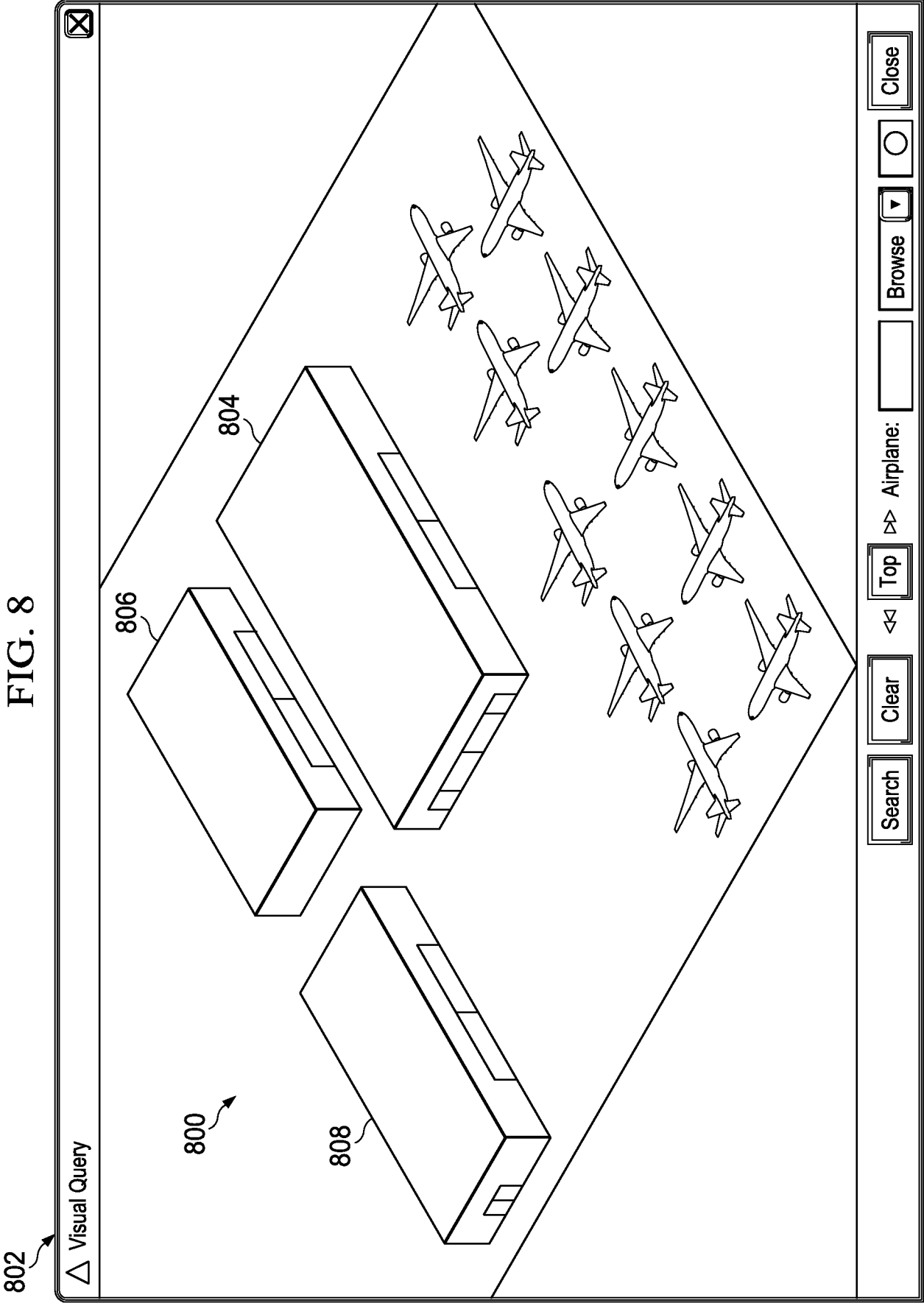


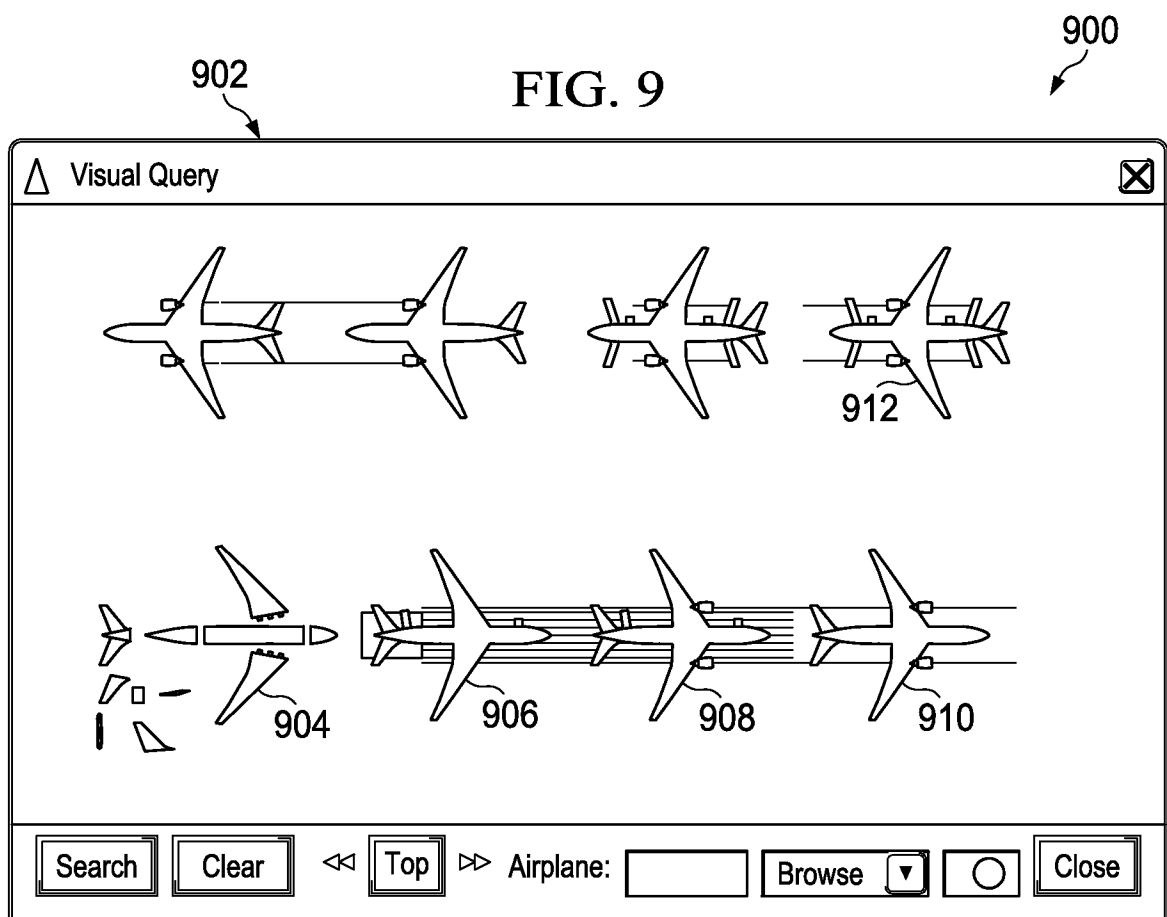
FIG. 7

FIG. 8



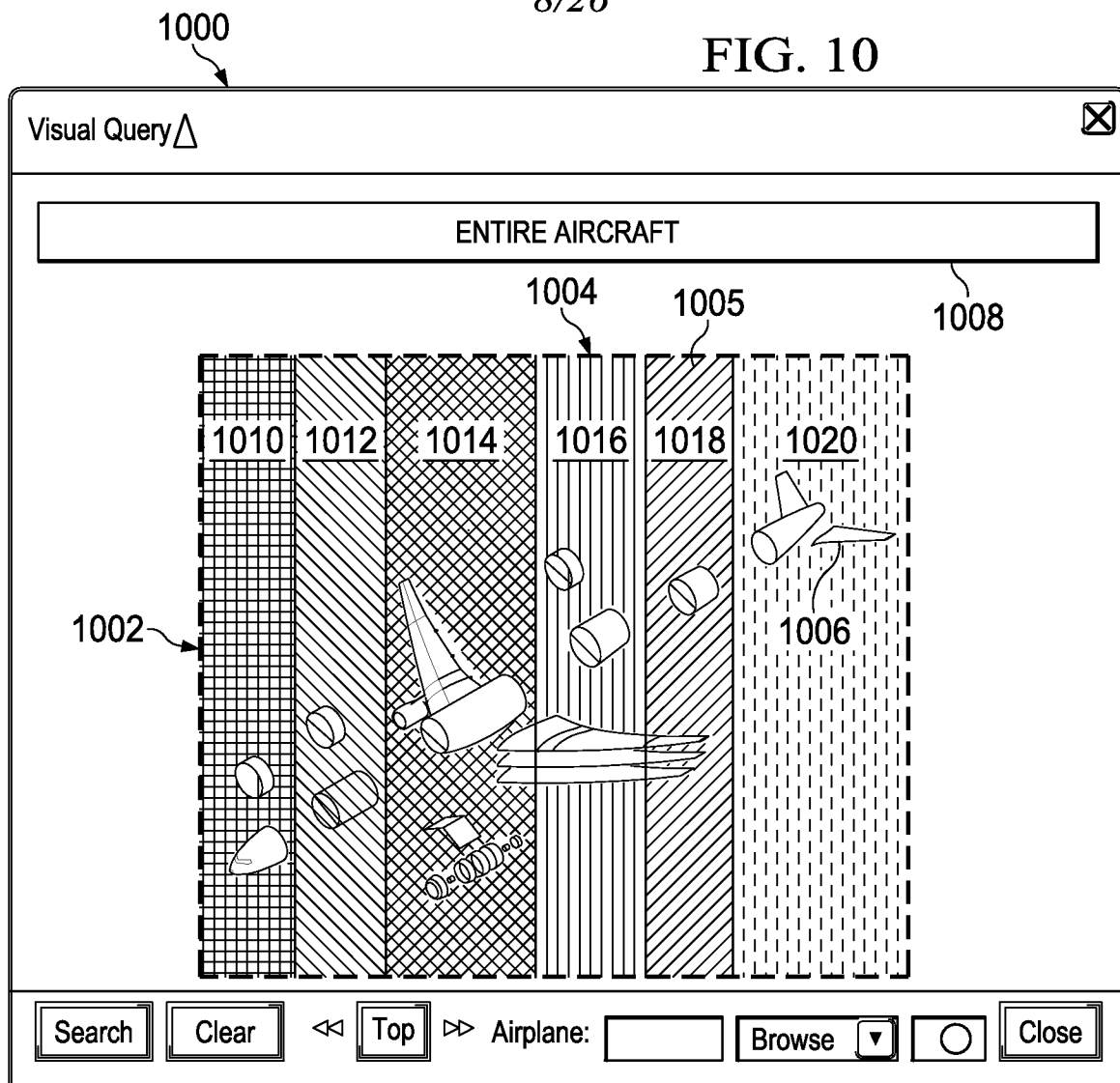
7/26

FIG. 9

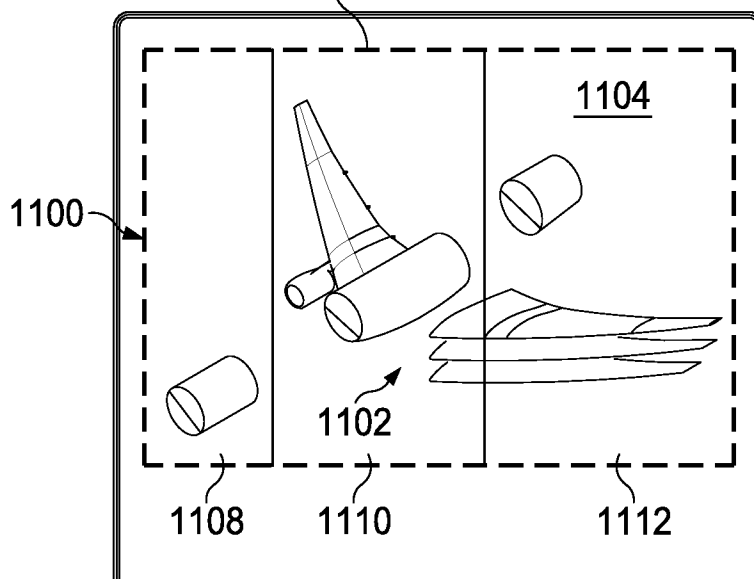


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FIG. 10



1105 FIG. 11



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FIG. 12

1200

SOIs Now

SOI*	Instance Number **	Status*	Description*	Additional Info**	Calculated
------	--------------------	---------	--------------	-------------------	------------

1202

1206

1) Read SOI Data from CDW

A) Airplane: 95 1204 B) Optionally value SOI, Status, or Instance Number below. C) GO

Due to data quality issues,
not all SOI to 3D geometry ☒ Vintage * 01/15 08:41 Vintage ** 1/11 02:14
matches are available

☒ 2) Optionally Filter the Available SOI records Shown: 0

3) Take an Action with Listed Items

Color Scheme Export to Query Color Legend Close

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FIG. 13

1200

1301

SOIs Now-- Airplane: 95 1302 1304 1306

SOI*	Instance Number**	Status*	Description*
fad 12345	0000001	AVAILABLE	QT TO VERIFY...
	0000011	COMPLETE	VERIFY...
	0000021	COMPLETE	VERIFY...
oag 78234	0000001	COMPLETE	VERIFY...
	0000001	COMPLETE	VERIFY...
	0000001	COMPLETE	VERIFY...
fad 987123	0001231	COMPLETE	VERIFY...
	0004321	AVAILABLE	VERIFY...
	0002221	COMPLETE	QT TO VERIFY...
	0000111	COMPLETE	VERIFY...
	0000231	COMPLETE	VERIFY...
fad 111178	0000341	COMPLETE	VERIFY...
	0000661	COMPLETE	QT TO VERIFY...
	0000761	COMPLETE	QT TO VERIFY...
	0000331	AVAILABLE	QT TO VERIFY...
	0007731	AVAILABLE	QT TO VERIFY...
	0004121	COMPLETE	VERIFY...
	0023221	COMPLETE	VERIFY...
	0033311	COMPLETE	VERIFY...
	0232331	COMPLETE	VERIFY...
	0001341	COMPLETE	VERIFY...
fad 999921	0055661	COMPLETE	VERIFY...
	0002761	COMPLETE	VERIFY...
	0007731	COMPLETE	VERIFY...
fad 999921	0001231	AVAILABLE	QT TO VERIFY...

1300

1202

1206

1) Read SOI Data from CDW

A) Airplane: 95 1204 B) Optionally value SOI, Status, or Instance Number below. C) GO

Due to data quality issues, not all SOI to 3D geometry matches are available ☒ Vintage * 01/15 08:41 Vintage ** 1/11 02:14

2) Optionally Filter the Available SOI records Shown: 83420

3) Take an Action with Listed Items

Color Scheme Export to Query Color Legend Close

11/26

FIG. 14

1200

SOIs Now-- Airplane: 95 1302 1304 1306

1301

SOI*	Instance Number**	Status*	Description*
fad 12345	0000001	AVAILABLE	QT TO VERIFY...
	0000011	COMPLETE	VERIFY...
	0000021	COMPLETE	VERIFY...
oag 78234	0000001	COMPLETE	VERIFY...
	0000001	COMPLETE	VERIFY...
	0000001	COMPLETE	VERIFY...
fad 987123	0001231	COMPLETE	VERIFY...
	0004321	AVAILABLE	VERIFY...
	0002221	COMPLETE	QT TO VERIFY...
fad 111178	0000111	COMPLETE	VERIFY...
			VERIFY...
			VERIFY...
fad 111178	0007731	AVAILABLE	QT TO VERIFY...
	0004121	COMPLETE	VERIFY...
	0023221	COMPLETE	VERIFY...
	0033311	COMPLETE	VERIFY...
	0232331	COMPLETE	VERIFY...
	0001341	COMPLETE	VERIFY...
	0055661	COMPLETE	VERIFY...
	0002761	COMPLETE	VERIFY...
0007731	COMPLETE	VERIFY...	
fad 999921	0001231	AVAILABLE	QT TO VERIFY...

1400

1402

- Copy Field
- Copy ad-hoc Report on Selected
- Select All
- Group SOIs
- Associate to Query

1300

1202

1206

1) Read SOI Data from CDW

A) Airplane: 95 1204 B) Optionally value SOI, Status, or Instance Number below. C) GO

Due to data quality issues, not all SOI to 3D geometry matches are available ☒ Vintage * 01/15 08:41 Vintage ** 1 /11 02:14

+ 2) Optionally Filter the Available SOI records Shown: 83420

3) Take an Action with Listed Items

Color Scheme Export to Query Color Legend Close

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FIG. 15

1200

SOIs Now-- Airplane: 95 1302 1304 1306

1301

SOI*	Instance Number**	Status*	Description*
fad 12345	0000001	AVAILABLE	
	0000011		TEST...
	0000021		TEST...
oag 78234	0000001		TEST...
	0000001		TEST...
	0000001		TEST...
fad 987123	0001231	AVAILABLE	
	0004321		TEST...
	0002221	AVAILABLE	
	0000111		
	0000231	AVAILABLE	
	0000341		TEST...
fad 111178	0000661	PREVIEW	
	0000761		TEST...
	0000331		
	0007731		TEST...
	0004121		TEST...
	0023221		TEST...
	0033311		TEST...
	0232331		TEST...
	0001341		TEST...
	0055661		TEST...
fad 999921	0002761		TEST...
	0007731	AVAILABLE	
	0001231		TEST...

1300

1202

1206

1) Read SOI Data from CDW

A) Airplane: 95 1204 B) Optionally value SOI, Status, or Instance Number below. C) GO

Due to data quality issues, not all SOI to 3D geometry matches are available ☒ Vintage * 01/15 08:41 Vintage ** 1/11 02:14

+ 2) Optionally Filter the Available SOI records Shown: 83420

3) Take an Action with Listed Items

Color Scheme Export to Query Color Legend Close

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FIG. 16

1200

1301

SOIs Now-- Airplane: 95 1302 1304 1306

SOI*	Instance Number**	Status*	Description*
fad 12345	0000001	AVAILABLE	
	0000011		TEST...
	0000021		TEST...
oag 78234	0000001		TEST...
	0000001		TEST...
	0000001		TEST...
fad 987123	0001231		TEST...
	0004321		AVAILABLE
	0002221		
	0000111		TEST...
	0000231	AVAILABLE	
	0000341		TEST...
	0000661	AVAILABLE	
	0000761		TEST...
	0000331		
	0007731	PREVIEW	

1300

1202

1206

1) Read SOI Data from CDW

A) Airplane: 95 1204 B) Optionally value SOI, Status, or Instance Number below. C) GO

Due to data quality issues, not all SOI to 3D geometry matches are available ☒ Vintage * 01/15 08:41 Vintage ** 1/11 02:14

☐ 2) Optionally Filter the Available SOI records Shown: 83420

1604 1606 1608

SOI Instance Number: Status:

Description: 1610

☒ Match Applicability ☒ Current City ☒ Description

1600 1602

3) Take an Action with Listed Items

1612

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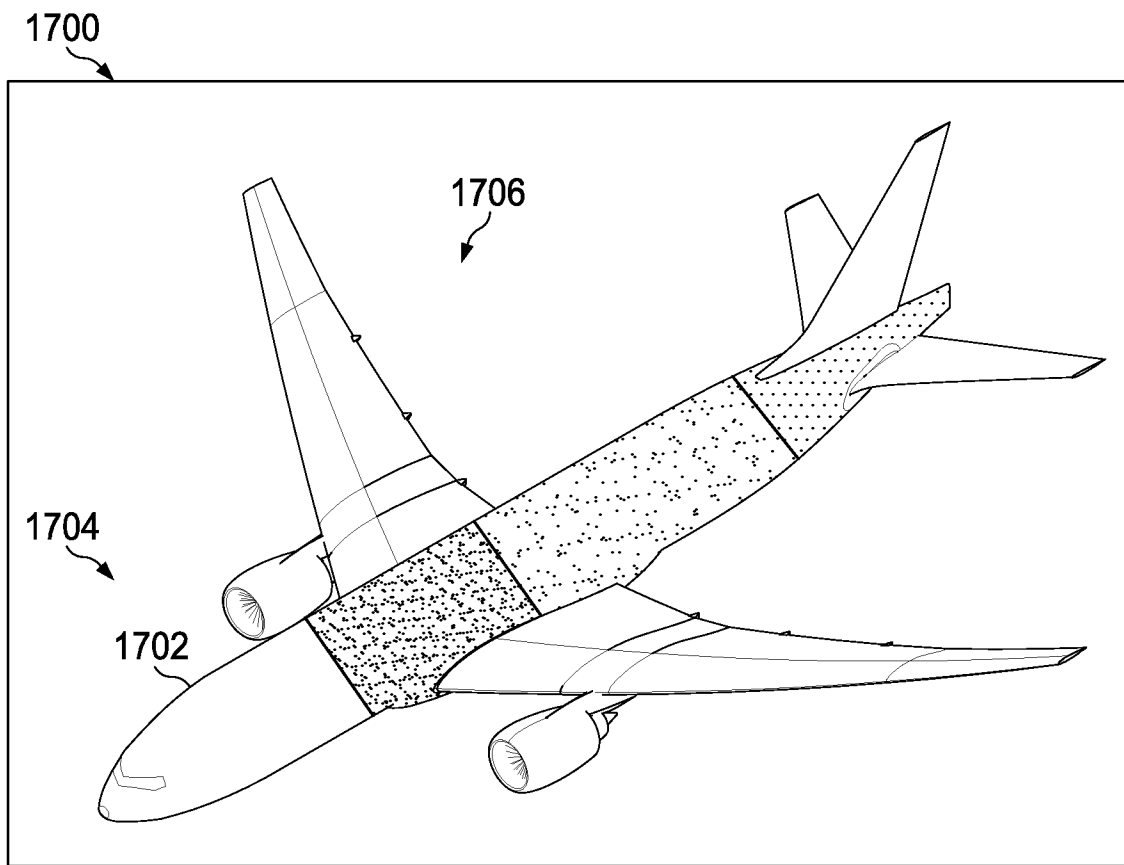


FIG. 17

1800

FIG. 18

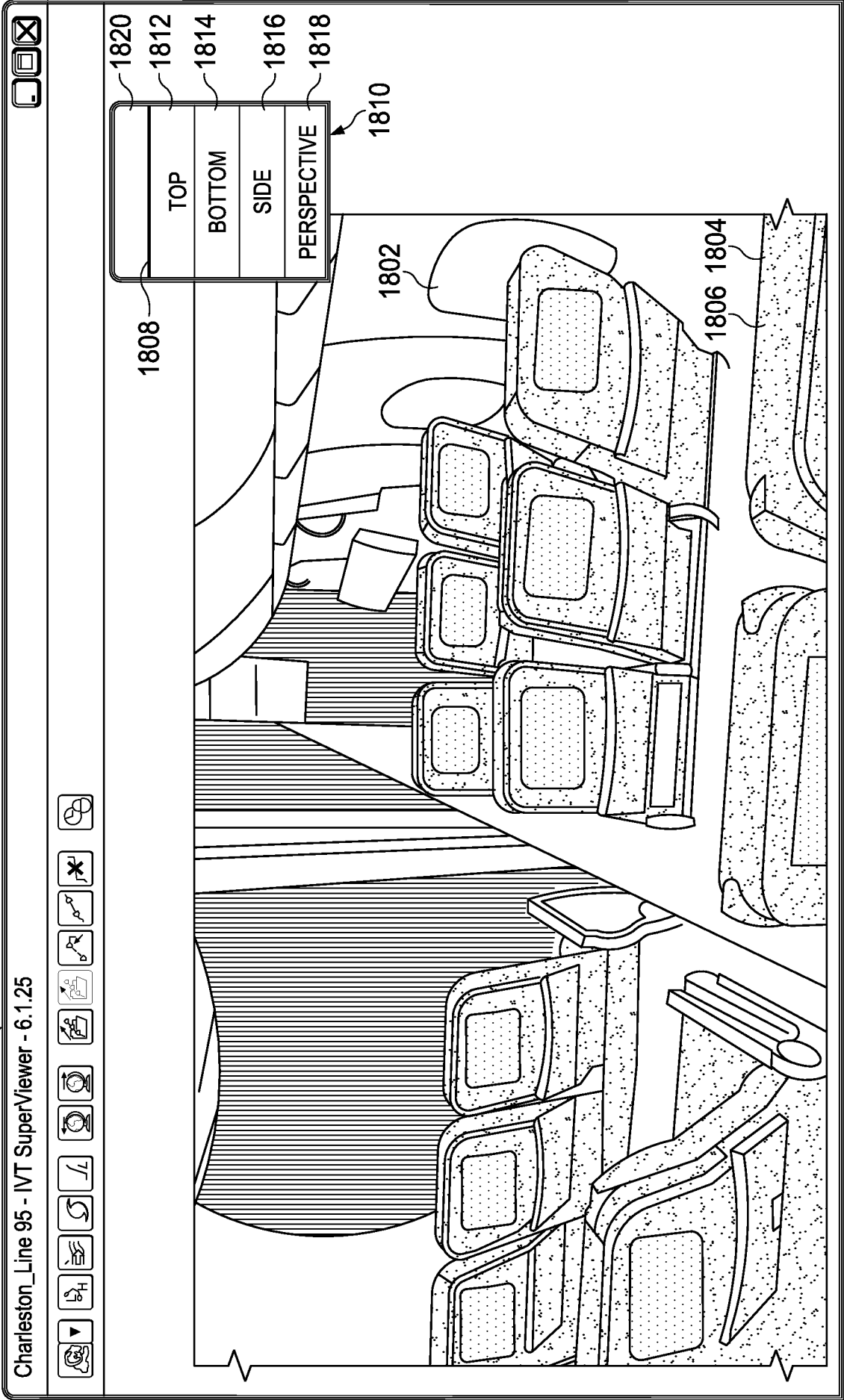
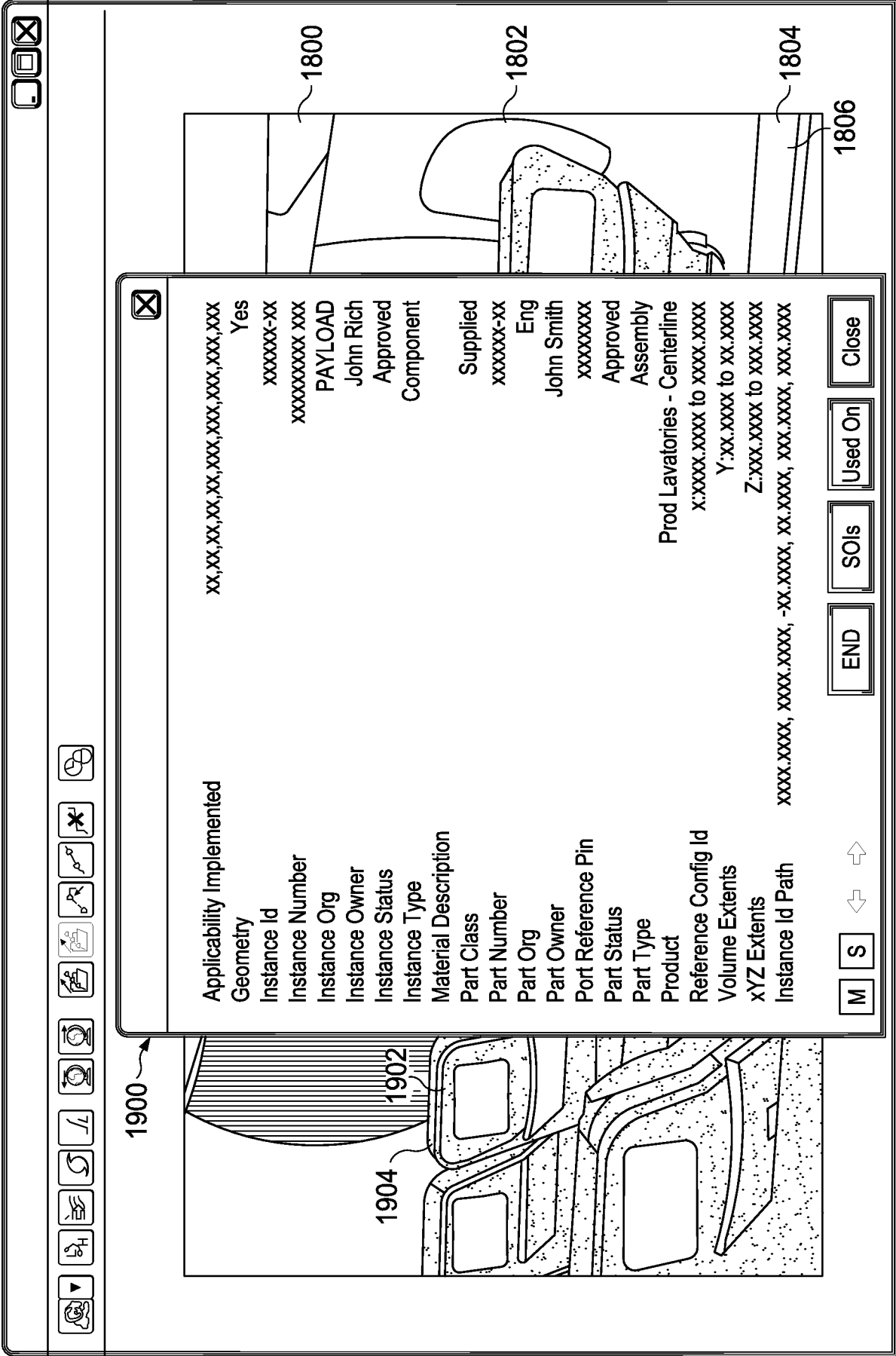
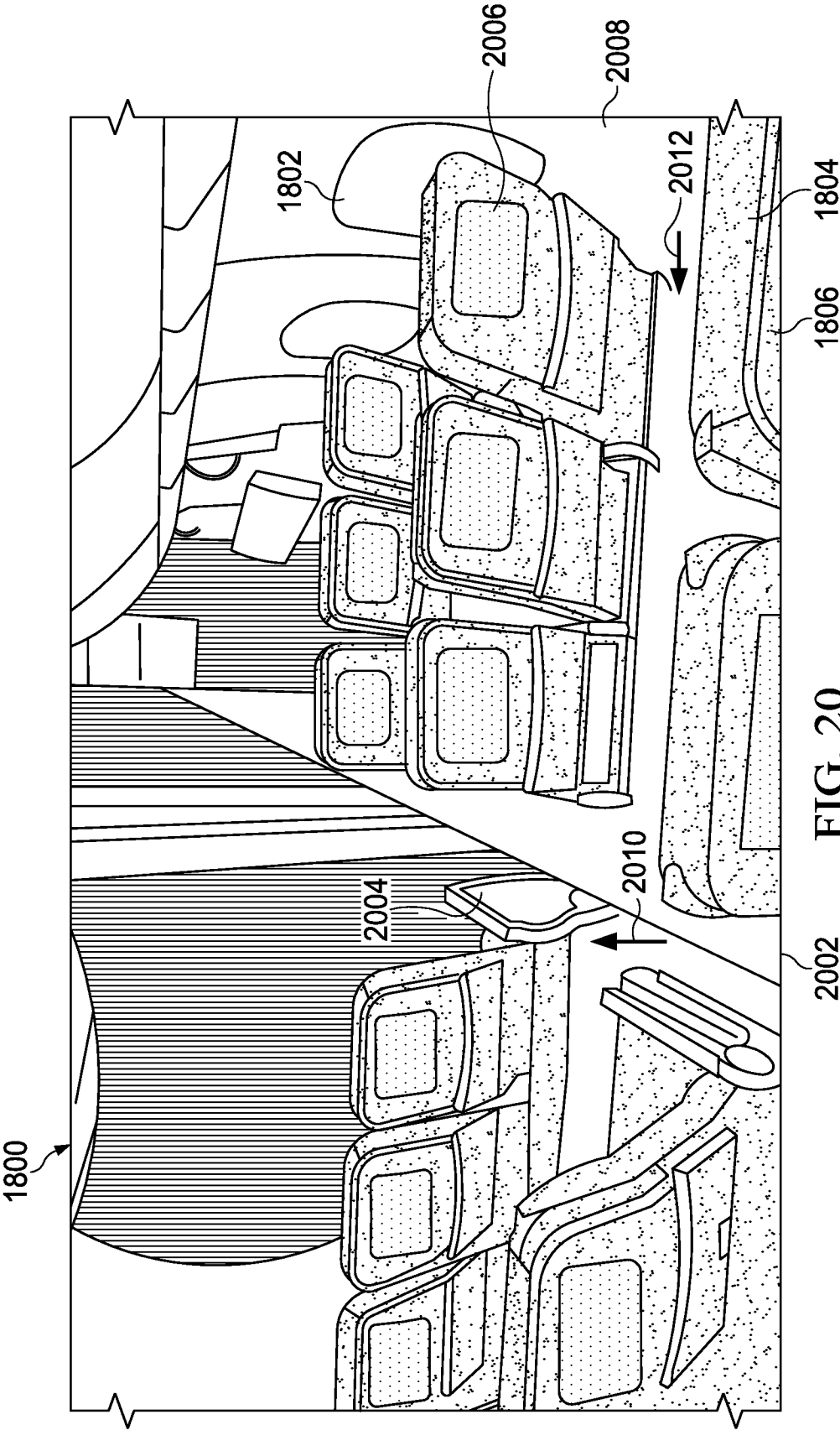


FIG. 19





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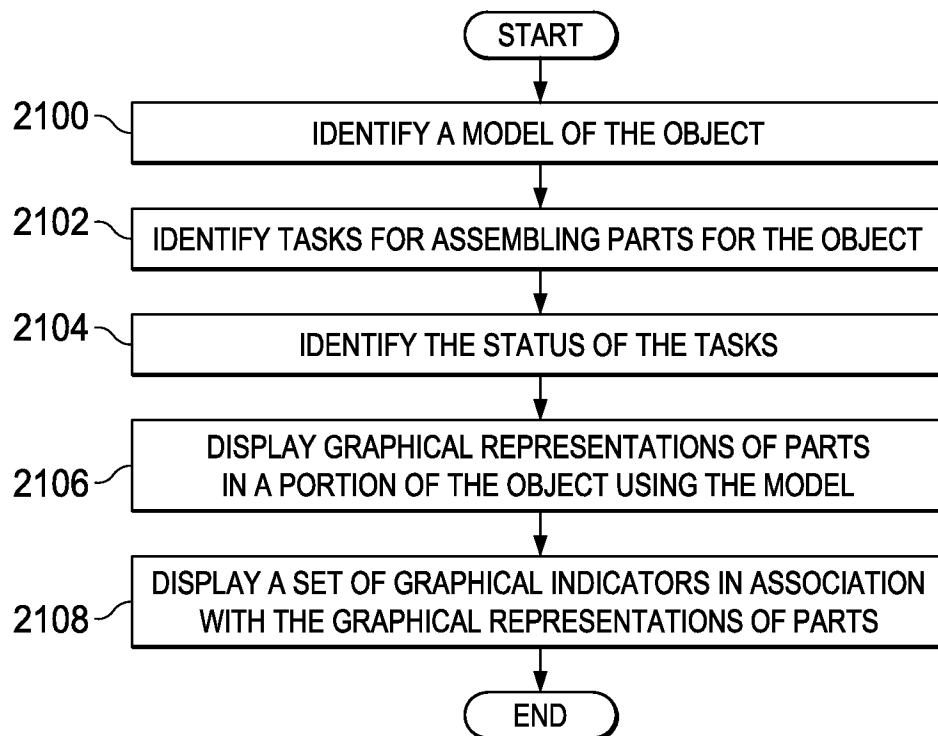
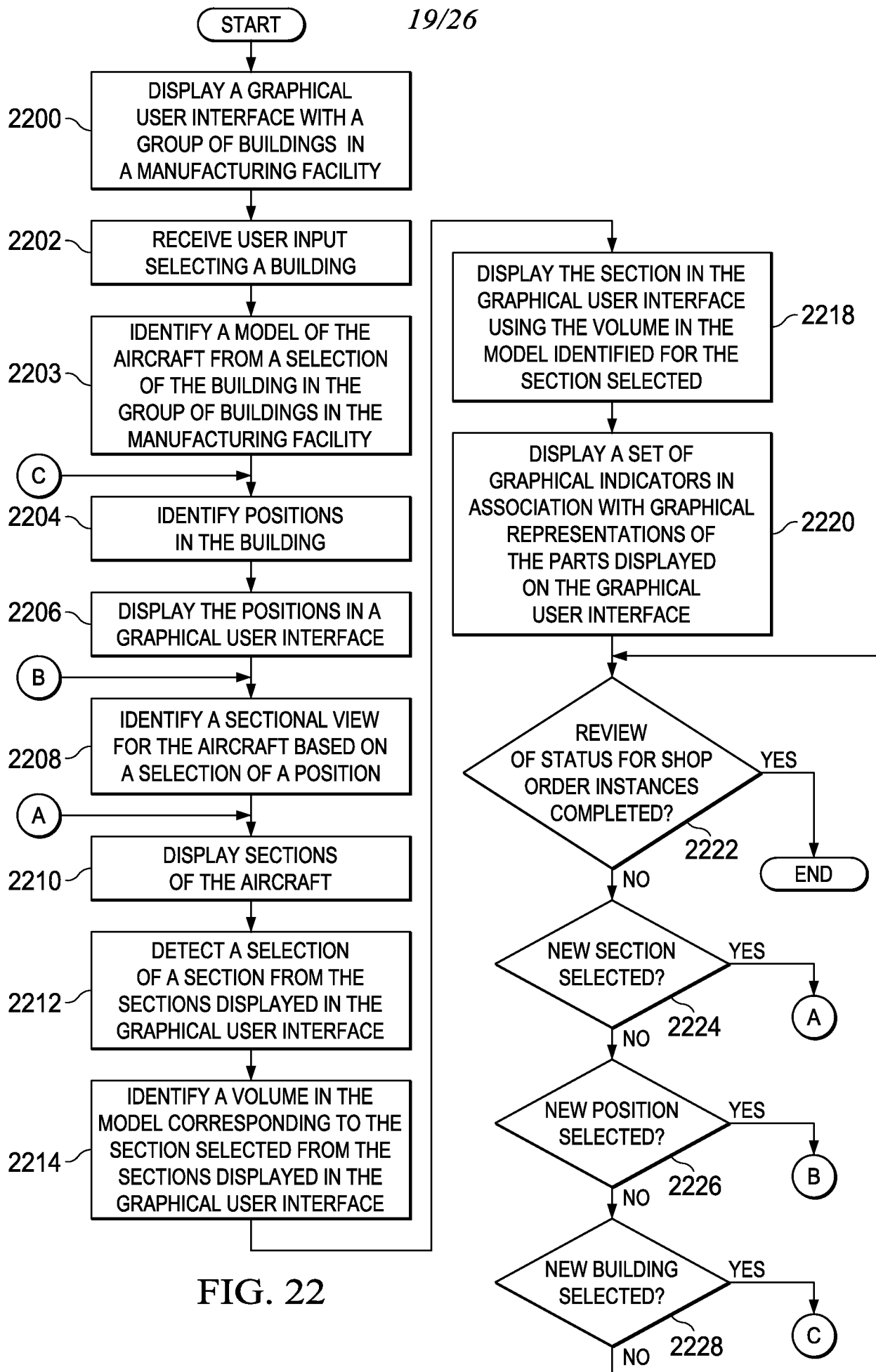


FIG. 21



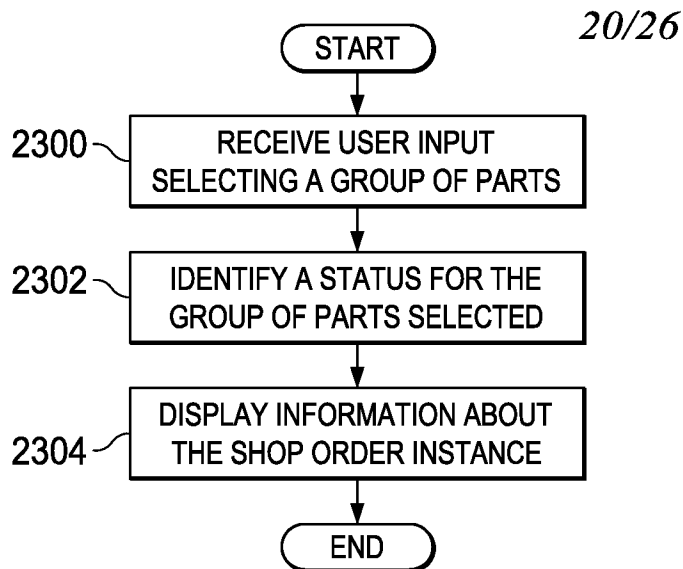


FIG. 23

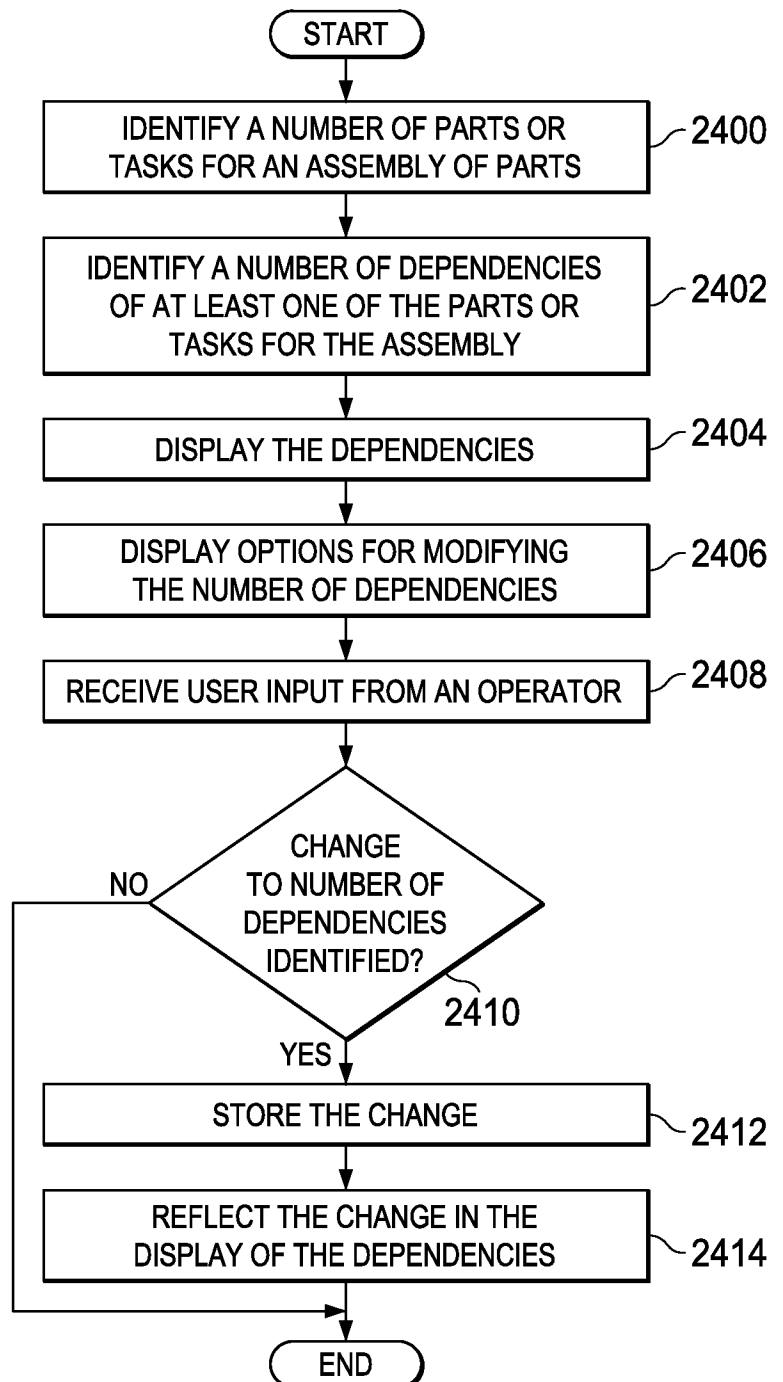


FIG. 24

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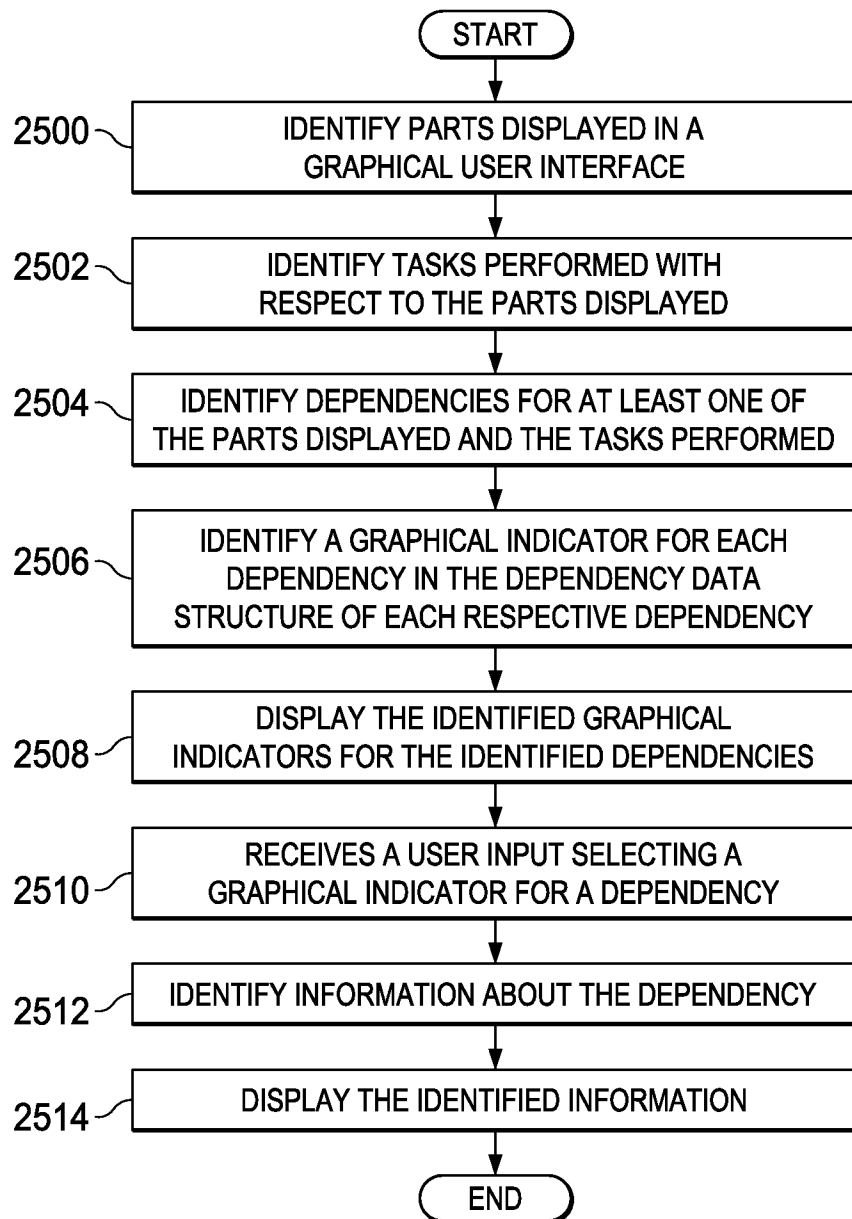
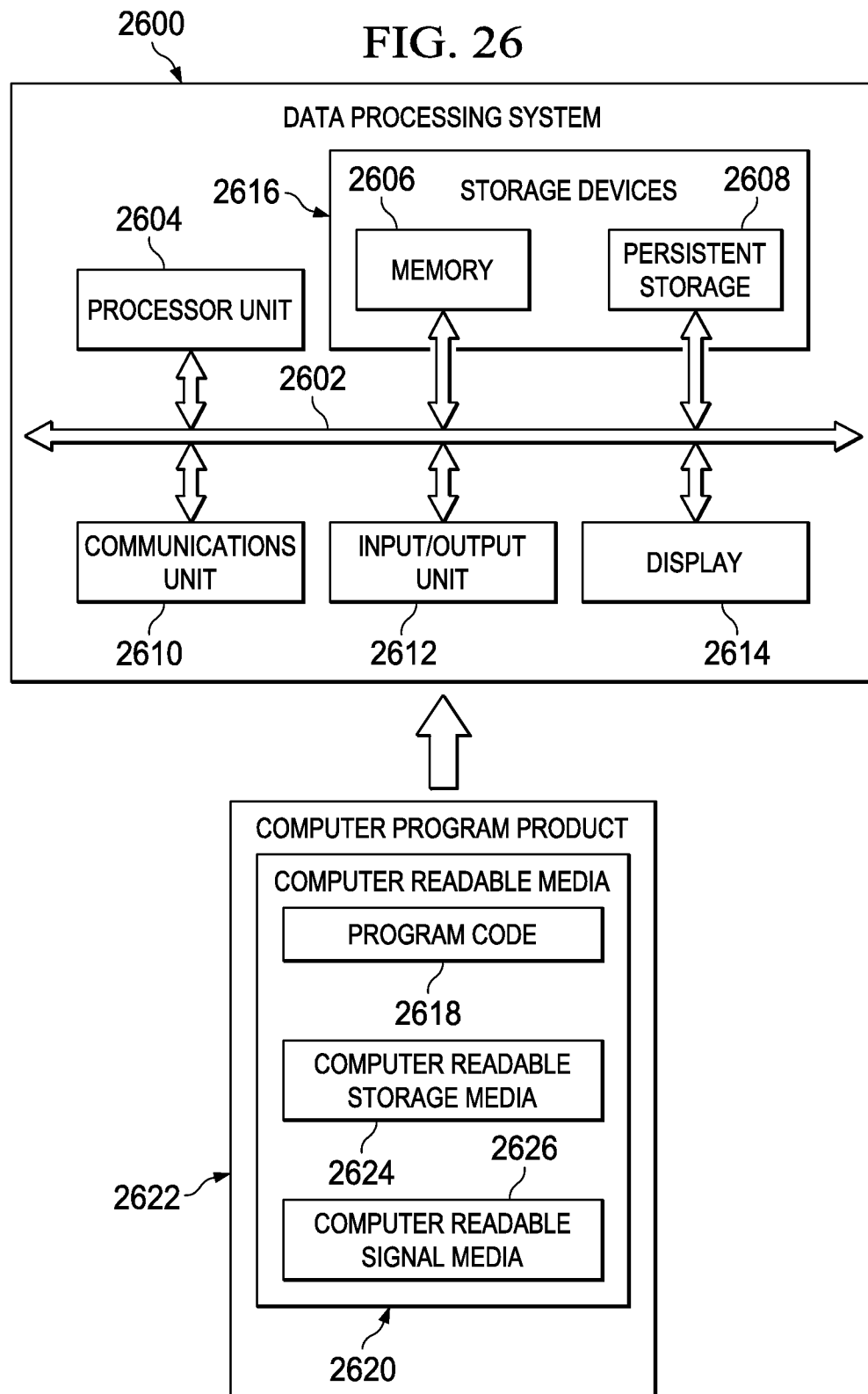
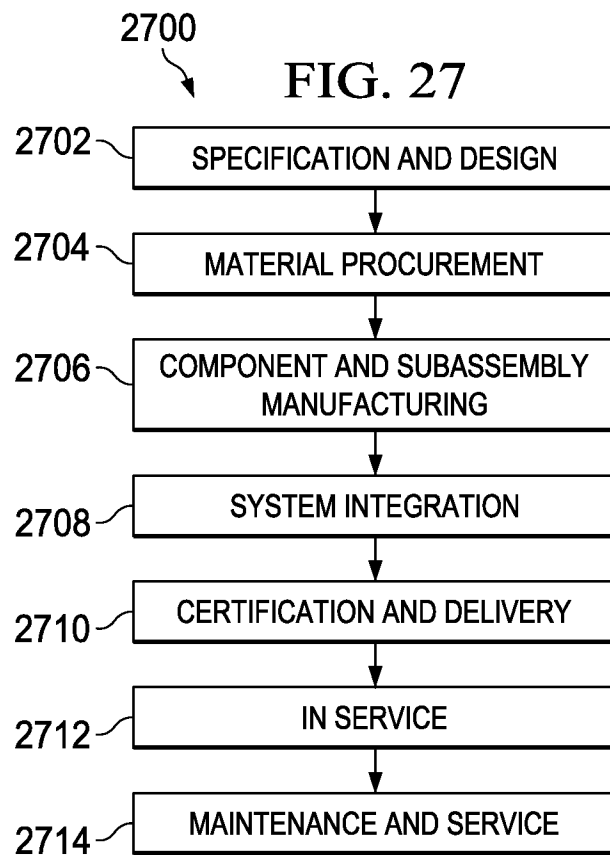
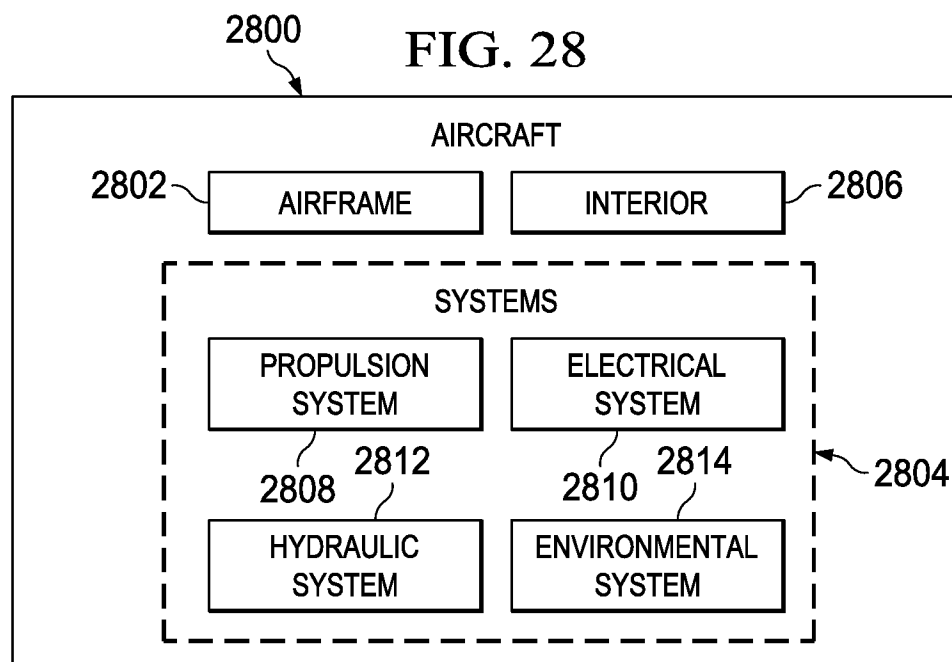


FIG. 25

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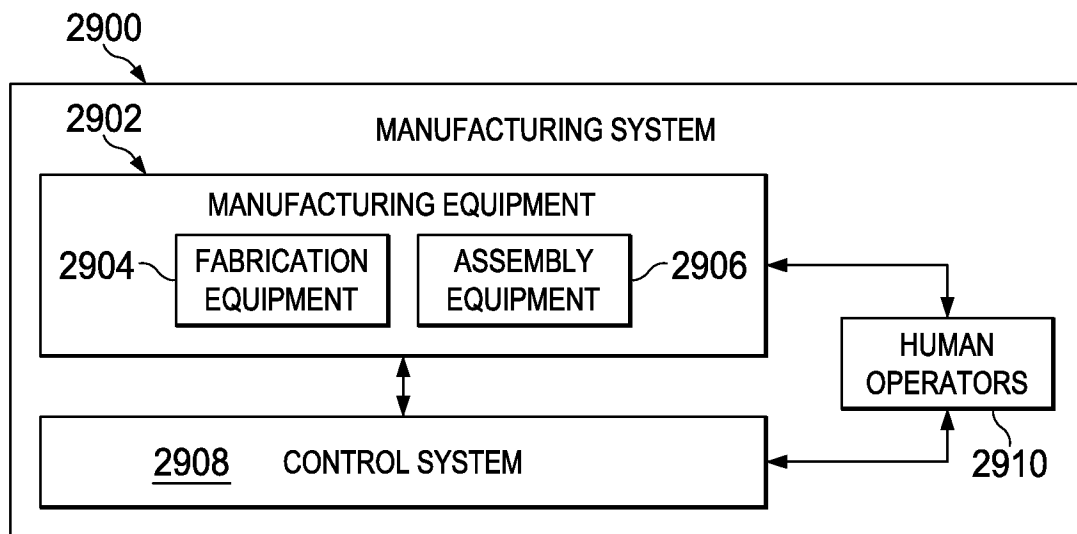
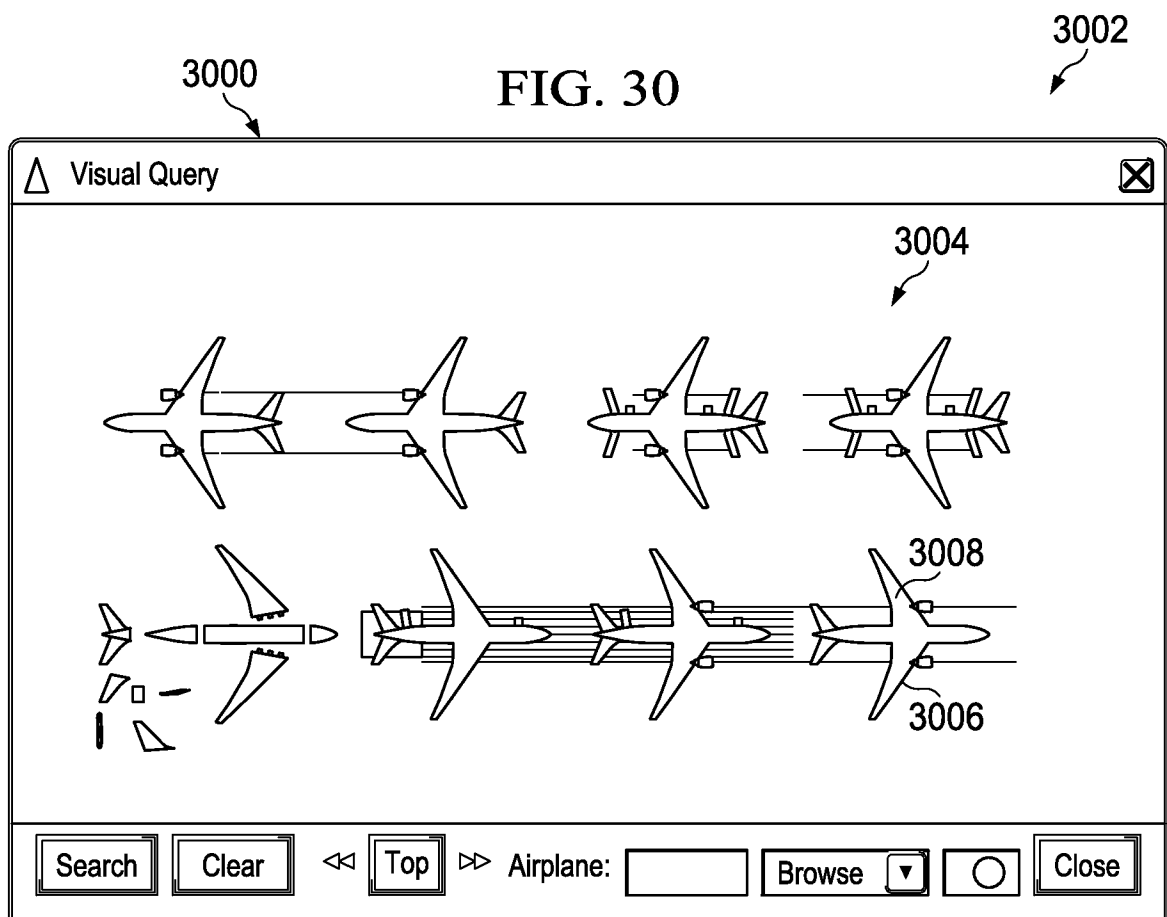


FIG. 29

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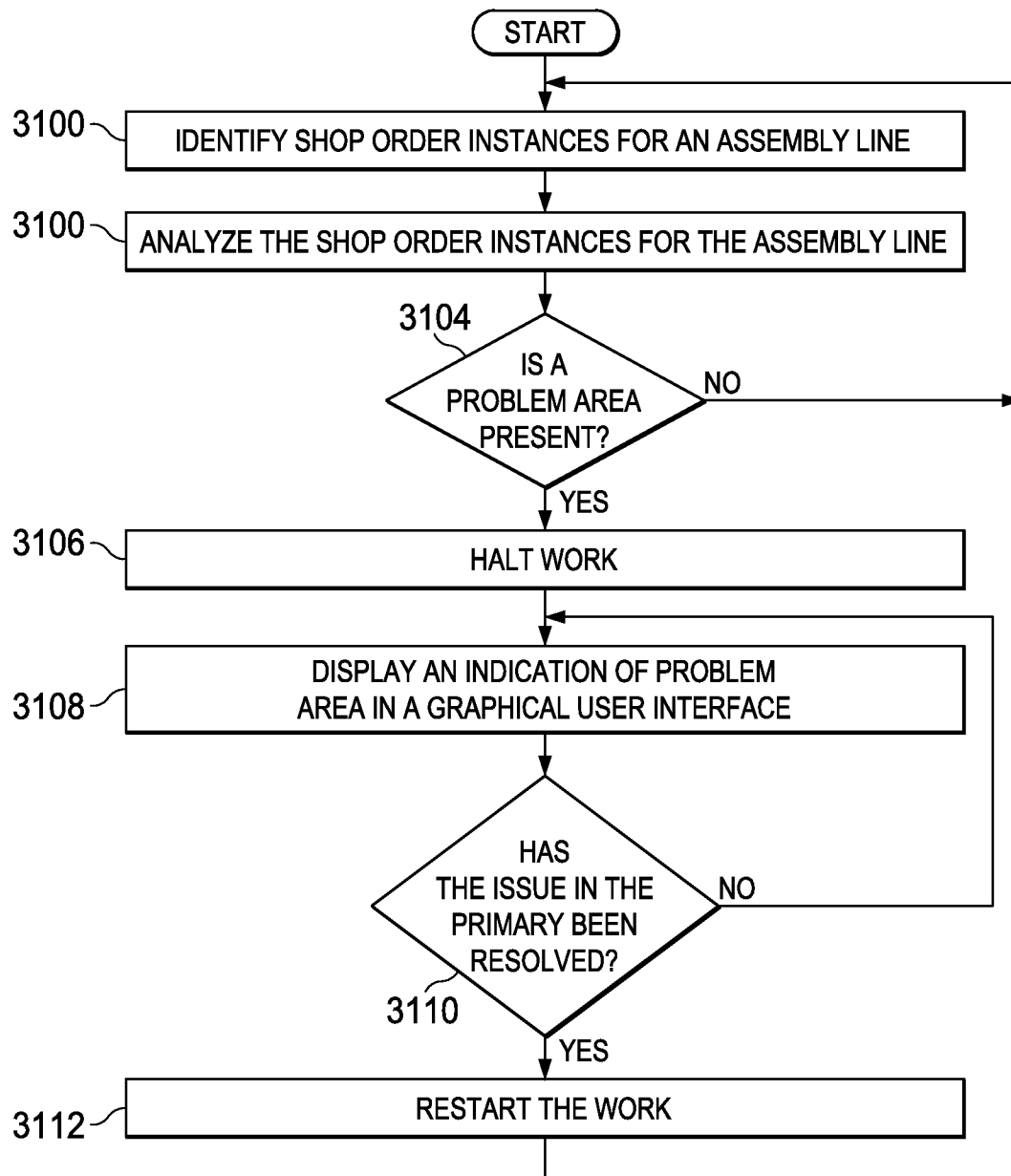


FIG. 31