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(54) **METHOD AND SYSTEM FOR AUTOMATING
PRODUCT CONFIGURATION**

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(57) **ABSTRACT**

Embodiments of the present invention relate to a method and system for implementing an easy-to-use graphical user interface (GUI) for creating a data file for product and process configuration. The data file could contain information relating to how a given product is to be made, such as a list of components and how they are to be assembled ("routings"). The GUI according to embodiments of the present invention reduces the amount of user manipulation required as compared with the prior art. According to the embodiments, a user is presented with a single screen display that lets the user maintain component lists and associated routings with simple, high-level input values.

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The screenshot displays the SAP iPEE WORKBENCH EXPRESS interface. At the top is a menu bar with options: PRODUCTION VERSION, EDIT, GOTO, VIEW, EXTRAS, ENVIRONMENT, SYSTEM, HELP. To the right of the menu bar is a toolbar with icons for file operations and a window titled 'SAP'. Below the menu bar is a title bar 'iPEE WORKBENCH EXPRESS' and another toolbar with icons for filtering and table sizes. The main area contains three data tables, each with a toolbar above it:

- PRODUCTION VERSIONS** (labeled 200.1): A table with columns: SELECTION, COMPLIANCE, MOD., POS, STATUS, PRODUCT, SHORT TEXT-PRODUCT, QTY, UoM, LOCAT., USAGE, PROD.VERS, DATE FROM, DATE TO, TIME FROM, TIME TO, LOT SIZE, LOT SIZE. A row is visible with values: 'S', 'JH S...', 'PRO', '15.04.2004', '31.12.9999', '00:00:00', '00:00:00'.
- COMPONENTS** (labeled 200.2): A table with columns: SELECTION, NODE-CHGD, VARIANT, CHANGE NO., FROM, VARIANT-DESCRIPTION, PRODUCT, SHORT TEXT-PRODUCT, QUANTITY, UoM, FIX.QUA., HEADER, OBJECTDE..., V.CREAT..., VARIANT-BY, VARI-CH..., VARIA.
- ROUTING** (labeled 200.3): A table with columns: SELECTION, OPERATION, NAME, OP., OPERATION-DESCRIPTION, O-OBJECTDE, O-CREATED, OPERAT-BY, OPER-CHGD, OPERAT-BY, O-LOGSYSTE, O-RELATSH, O-CONT. LO, O-LINKAGE, O-ACGR.SCR, O-USE MIN.

At the bottom right of the interface, there is a status bar showing 'AP6 (1) (001)', '160320', and 'INS'.

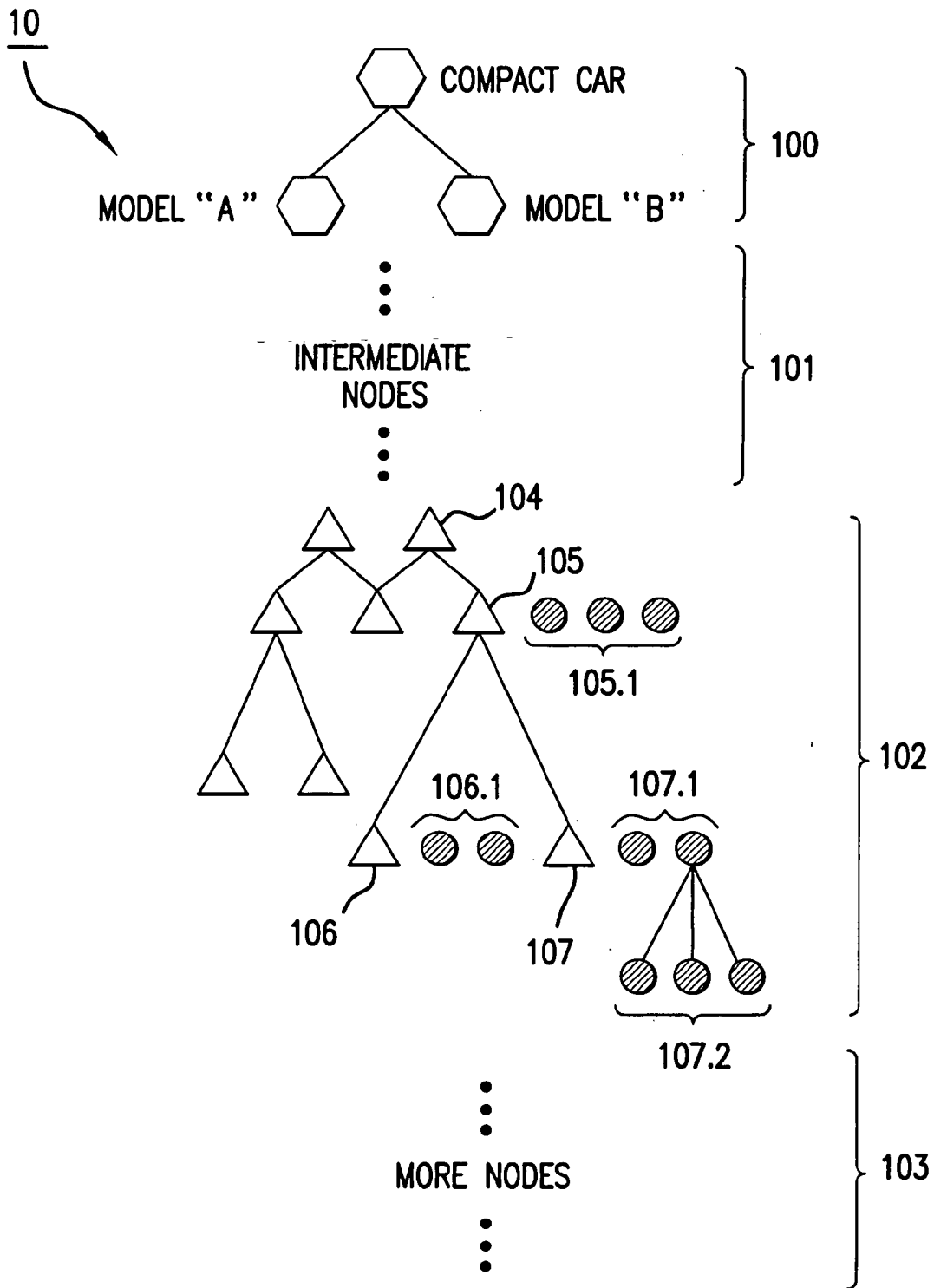


FIG. 1
PRIOR ART



FIG. 2

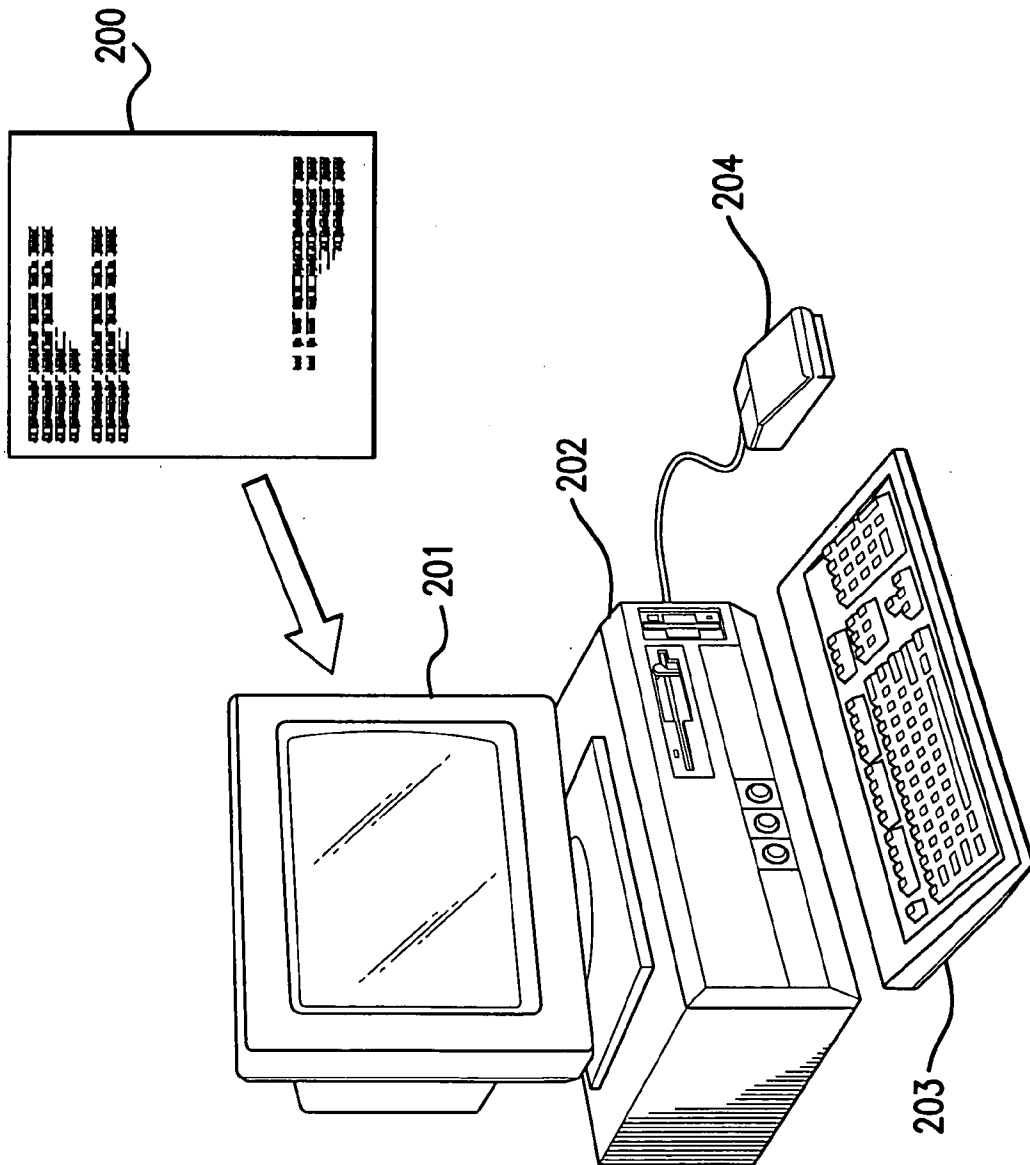


FIG. 2A

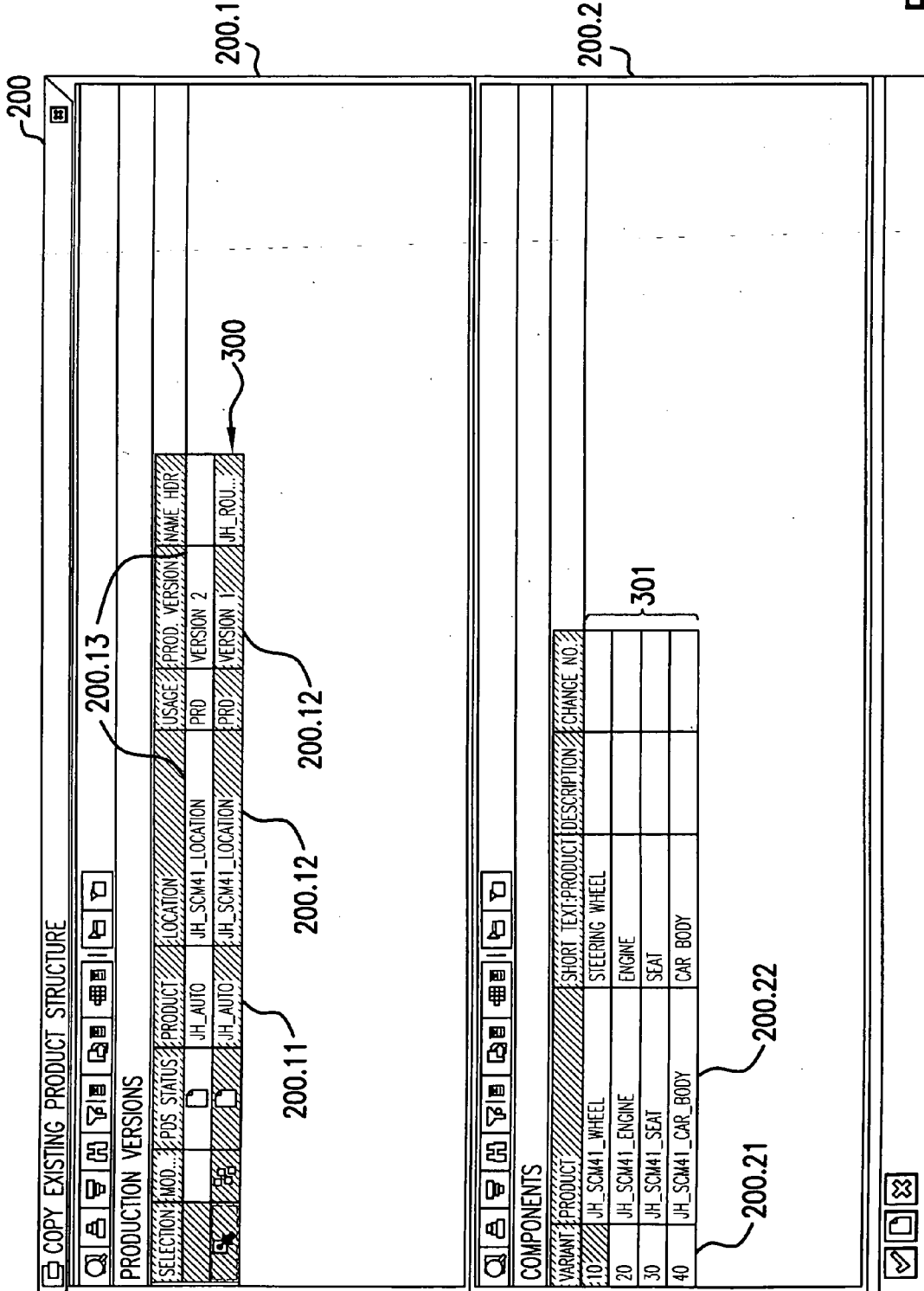


FIG.3

SAP

PRODUCTION VERSION : JH_AUTO / JH_SCM41_LOCATION / PRD / VE

PRODUCTION VERSIONS

SELECTION	COMPLIANCE	MOD...	POS	STATUS	PRODUCT	SHORT	TEXT	PRODUCT	QUANTITY	USM	LOCATION	USAGE	PRODUCTION	VERSION	FROM	DATE	TO	TIME	FROM	TIME	TO
	000				JH_AUTO	1	ST	JH_SCM41_LOCATION			JH_SCM41_LOCATION	PRD	VERSION 1		01.01.2...	01.0...	00:00:00	00:00:00			
					JH_AUTO			JH_SCM41_LOCATION			JH_SCM41_LOCATION	PRD	VERSION 1		15.04.2...	31.1...	00:00:00	00:00:00			

COMPONENTS

SELECTION	MODE	CHGD	VARIANT	CHANGE	NO.	FROM	ED	VARIANT	DESCRIPTION	PRODUCT	SHORT	TEXT	PRODUCT	QUANTITY	USM	ETX	QUA...	HEADER	OBJECTIDE...	V.CREAT...
			10			JH_SCM41_WHEEL			STEERING WHEEL				JH_SCM41_WHEEL	1	PC				15.04.2...	
			20			JH_SCM41_ENGINE			ENGINE				JH_SCM41_ENGINE	1	PC				15.04.2...	
			30			JH_SCM41_SEAT			SEAT				JH_SCM41_SEAT	2	PC				15.04.2...	
						JH_SCM41_CAR_BODY			CAR BODY				JH_SCM41_CAR_BODY						15.04.2...	

ROUTING

SELECTION	OPERATION	NAME	OP.	OPERATION	DESCRIPTION	TO	OBJECTIDE	TO	CREATED	OPERAT	BY	OPER	CHGO	OPERAT	BY	Q	LOG	SYS	IE	O	RE	LA	S	H	O	O	AGGR	S	CR	O	USE	MIN		

AP6 (1) (001) 160320 INS

FIG.4

200

200.2

200.21

200.22

200.23

200.24

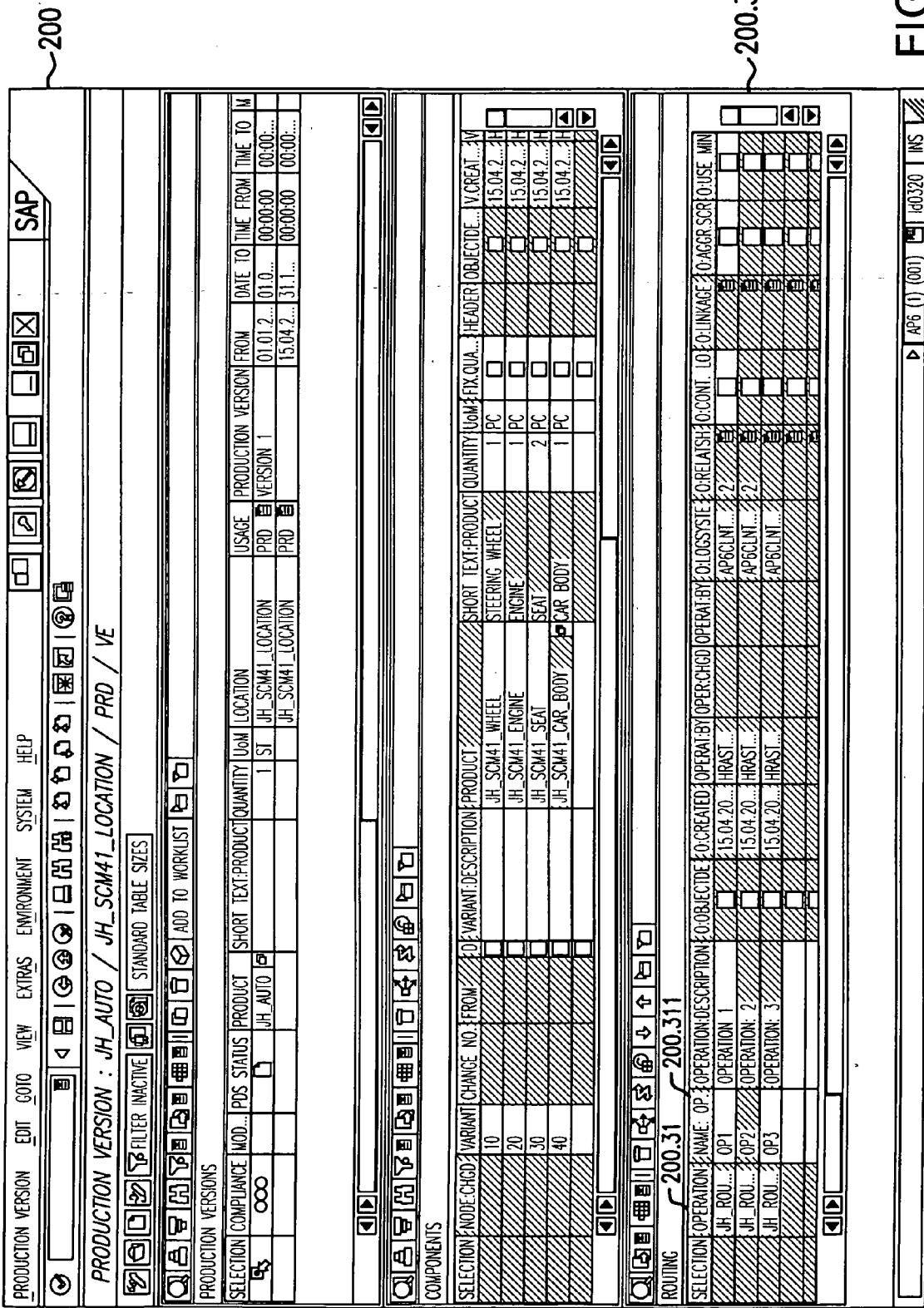


FIG. 5

PRODUCTION VERSION
EDIT GOTO VIEW EXTRAS ENVIRONMENT SYSTEM HELP
SAP

PRODUCTION VERSION : JH_AUTO / JH_SCM41_LOCATION / PRD / VE

PRODUCTION VERSIONS

SELECTION	COMPLIANCE	MOD...	PDS STATUS	PRODUCT	SHORT TEXT	PRODUCT QUANTITY	UOM	LOCATION	USAGE	PRODUCTION VERSION	FROM	DATE TO TIME	TIME TO
<input type="checkbox"/>	000		<input type="checkbox"/>	JH_AUTO		1	ST	JH_SCM41_LOCATION	PRD	VERSION 1	01.01.2...	01.0...	00:00:00
<input type="checkbox"/>			<input type="checkbox"/>	JH_AUTO				JH_SCM41_LOCATION	PRD		15.04.2...	31.1...	00:00:00

COMPONENTS

SELECTION	QUANTITY	UOM	FIX	OBJ	HEAD	OBJECT	DATE	VAR	BY	VAR	LOG	SYSTEM	OPERATION	SHORT	NAME	ACTIVITY
<input type="checkbox"/>	1	PC	<input type="checkbox"/>				15.04.2...	HR	AST				OP1	JH...	ACT1	
<input type="checkbox"/>	1	PC	<input type="checkbox"/>				15.04.2...	HR	AST				OP2	JH...	ACT2	
<input type="checkbox"/>	2	PC	<input type="checkbox"/>				15.04.2...	HR	AST				OP3	JH...	ACT3	
<input type="checkbox"/>	1	PC	<input type="checkbox"/>				15.04.2...	HR	AST				OP4	JH...	ACT4	

ROUTING

SELECTION	MO	LENGTH	OF	BREAKS	IN	TIME	UNI	M-SHIFT	PRO	MODE	ACTION	POINT	PRIMARY	RESOURCE	DESCRIPTION	PRIMA	RESOURCE	TYPE	PRIMARY	LOCATION
<input type="checkbox"/>													JH...	RESOURCE 1						JH_SCM41...

200

200.2

200.3

FIG.6

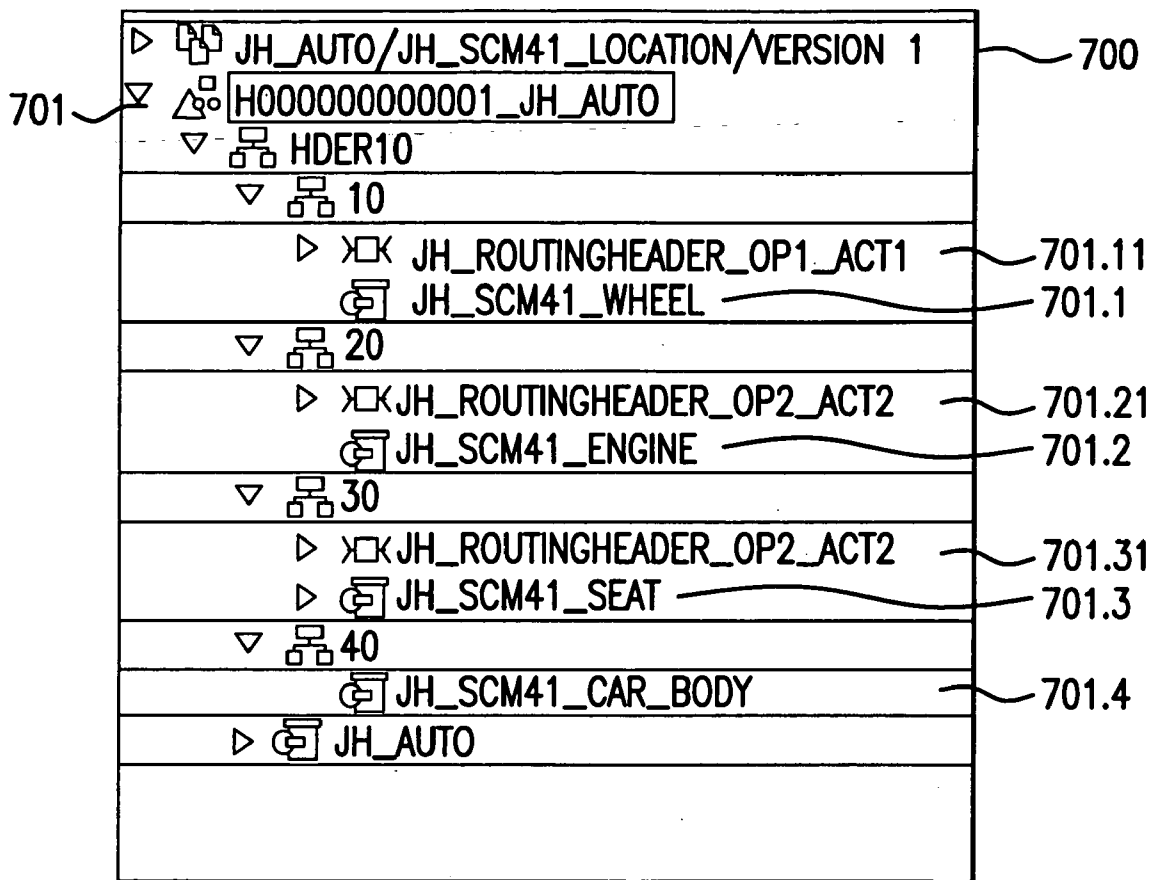


FIG.7

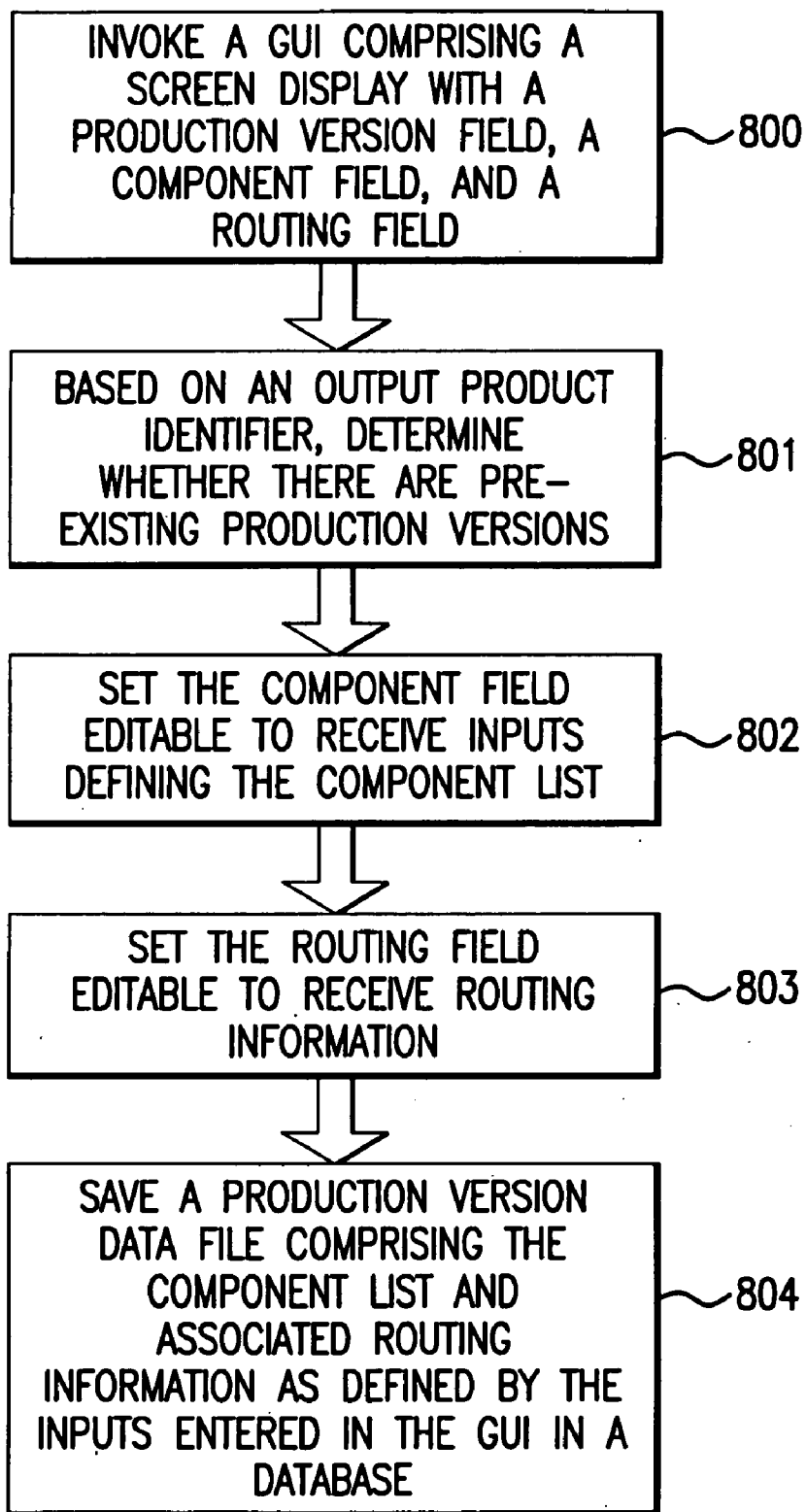


FIG. 8

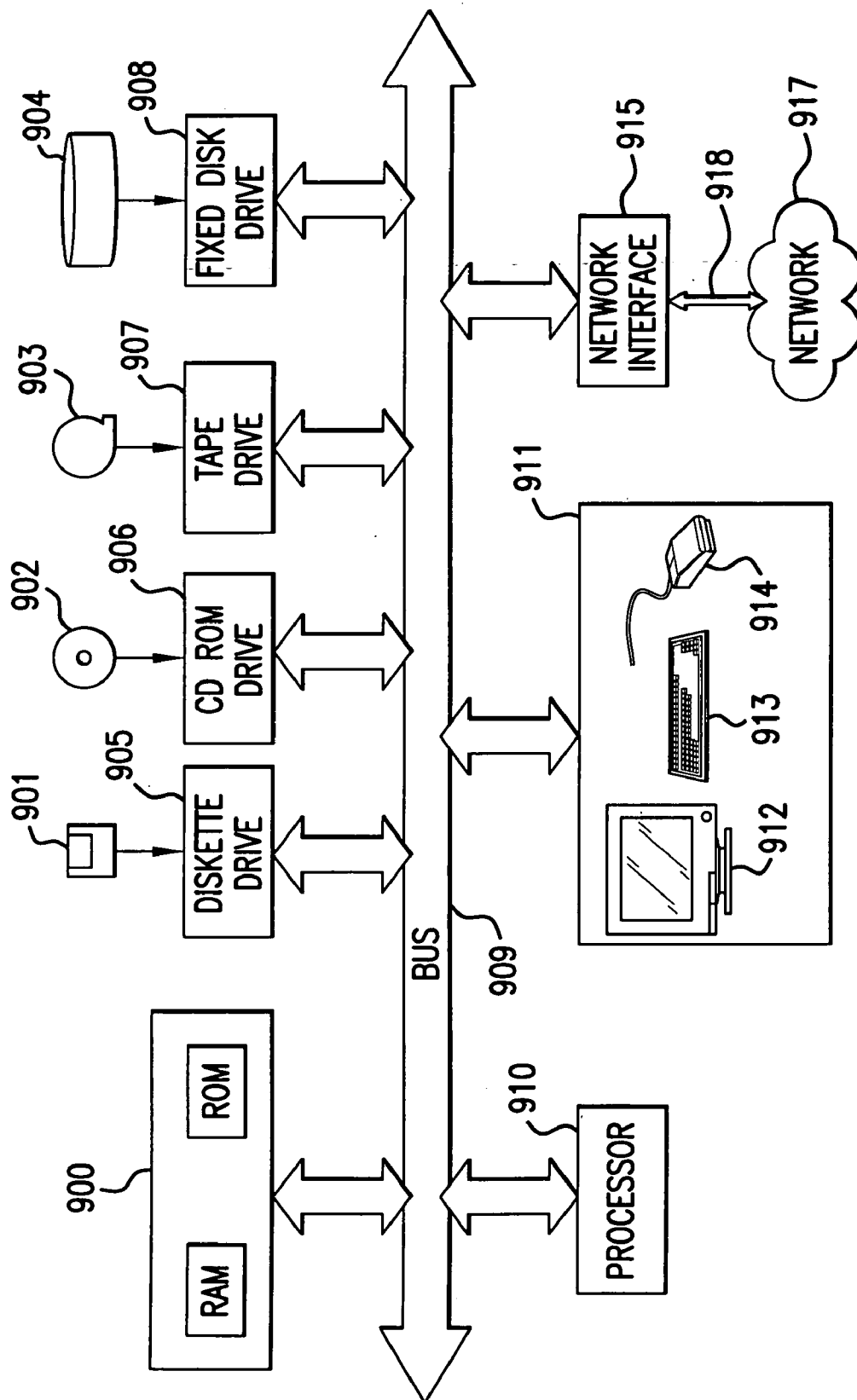


FIG. 9

METHOD AND SYSTEM FOR AUTOMATING PRODUCT CONFIGURATION

FIELD OF THE INVENTION

[0001] Embodiments of the present invention relate generally to computer-based product configuration systems.

BACKGROUND INFORMATION

[0002] Computer software tools have become indispensable to managing the complexity entailed in designing and manufacturing many modern products. Automobiles are one example of such products.

[0003] One aspect of the complexity involved in the design and manufacture of an automobile is the great number and variability of its constituent parts. Typically an automobile model is assembled from a catalogue of parts according to a particular set of design specifications. Because of the number and variability of parts, it can be difficult for designers to ensure that the combinations of the parts are correct.

[0004] An approach that uses a computer-based system and associated software to help manage this aspect of complexity is described in U.S. Pat. No. 6,223,094 ('094). As described in the '094 patent, a complex product such as an automobile may be represented in terms of a hierarchical data structure. A top or highest node of the data structure represents the end product (e.g., a compact car), while lower or subordinate nodes represent the components of the end product and associated production processes. A data structure of this kind, used in conjunction with, for example, a graphical user interface (GUI) with various different views tailored to specific user needs, helps to simplify design and production.

[0005] More specifically, the GUI may enable users, e.g., designers, to specify particular values to design a desired end product. The values may act to select particular variants of components of the end product. That is, a component may be represented in terms of its function within a product or as an abstraction of materials that may be used for the component, and there may be a number of possible variants associated with the component. The variants may be actual concrete realizations of the function or abstraction of the component: for example, one concrete realization of a component abstracted as a "seat" could be a leather seat, while another might be a vinyl seat. Based on the desired end product, only one of these realizations might be suitable for inclusion in the end product.

[0006] FIG. 1 shows an example in the prior art of a hierarchical data structure 10 corresponding to a "configurable product." "Configurable" here means, among other things, that by providing specific values for characteristics of an end product via, for example, a GUI as described earlier, a desired end product may be defined. The end product could be tailored to, for example, particular customers or markets. The configuring process may generate a list of components referred to as an "order bill of materials" (order BOM) that describes everything needed to produce a given end product according to some specific customer or production order. The overall structure of nodes and variants from which an order BOM may be configured may be referred to as a "super" BOM.

[0007] Referring to FIG. 1, high-level nodes 100 include a top-level node that may represent a product class, such as a compact car, and high-level variants such as a model "A" and a model "B" of the compact car. The node structure 10 may further comprise intermediate nodes 101, not illustrated in detail, below the high-level nodes 100. A structure of additional intermediate nodes 102, below nodes 101, is shown with some particularity as an illustrative example. The node structure 10 may further comprise still more nodes 103, not shown in detail, at a lower level.

[0008] As the node structure 10 is traversed from high-level nodes to low-level nodes, the nodes may be viewed as representing components of the end product at progressively finer levels of granularity. For example, node 104 could represent, generically, "an engine" while nodes 105-107 represent specific components of the engine and associated variants thereof. For example, node 105 could represent a specific engine component, and associated variants 105.1 could represent three different possible concrete realizations of that specific engine component. Along similar lines, nodes 106 and 107 could represent components of component 105, and associated variants 106.1 and 107.1, respectively. There could be variants of variants 107.2 in the node structure 10.

[0009] As noted above, there are known GUIs that work with data corresponding to a hierarchical node structure as shown in FIG. 1. However, one disadvantage of such a GUI is that it requires manipulation of data at the node and variant level. It may be appreciated from the discussion of FIG. 1 that a hierarchical node structure comprising such nodes and variants can become quite complex. Thus, manipulating data at a node and variant level can require detailed knowledge of the hierarchical node structure, and require a laborious and error-prone manual process that involves entering data on multiple screen displays.

SUMMARY OF THE INVENTION

[0010] Embodiments of the present invention relate to a GUI for product configuration that reduces the amount of user manipulation required as compared with the prior art. According to the embodiments, high-level user inputs are processed by background functionality to automatically generate data corresponding to node structures, without the user having to manipulate data at the node and variant level. Instead, the user is presented with a single screen display comprising fields for entering simple, high-level input values.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 shows an example of a prior art hierarchical node structure used in product and process maintenance;

[0012] FIG. 2 shows a screen display of a GUI according to embodiments of the present invention;

[0013] FIG. 2A shows a display device and input devices that may be used to manipulate the GUI;

[0014] FIGS. 3-6 show various operations associated with the screen display;

[0015] FIG. 7 shows an example of a production version data file according to embodiments of the present invention;

[0016] FIG. 8 shows a process flow according to embodiments of the present invention; and

[0017] FIG. 9 shows a computer system for implementing embodiments of the invention.

DETAILED DESCRIPTION

[0018] Embodiments of the present invention relate to an easy-to-use GUI for creating a “production version.” A production version is a data file containing information relating to how a given product is to be made. The production version could be used in a manufacturing facility, for example, to inform and guide the various processes involved in manufacturing the product. More specifically, the production version could comprise component information and routing information. The component information includes such things as a list of the components of a product, quantities of the components, and the like. The routing information relates the components to processes for making the product.

[0019] An example now follows of creating a production version using a GUI according to embodiments of the present invention. FIG. 2 shows an example of a screen display 200 of a GUI according to embodiments of the present invention. Referring to FIG. 2A, the display 200 could be generated by computer-executable instructions according to embodiments of the present invention on a display device 201 coupled to a computer 202 and input devices such as a keyboard 203 and a mouse 204. The display 200 could present a plurality of fields for entry and display of information relating to product configuration. The GUI could perform background processing, as described in more detail further on, on information entered into the fields as part of operations according to embodiments of the present invention.

[0020] Referring again to FIG. 2, the fields for entry of information in the display 200 may comprise a production version field 200.1, a component field 200.2, and a routing field 200.3. The fields represent all the data needed to describe a complete product, and in contrast to prior art GUIs, can be filled in with user input all in a single display 200. The production version field 200.1 may be used to specify a production version, which as noted above is a data file or “container” that contains component and routing information relating to a particular product. The component field 200.2 may be used to specify components of the product, quantities of the components, and the like. The routing field 200.3 may be used to specify processes for making or assembling the product and related information. The appearance (visibility of buttons, columns, field names, order and choice of fields, size of fields, etc.) of the display 200 may be controlled by profile definitions and user settings. The profile and user settings can also be used to define the functionality of a field or define default values for fields.

[0021] Production versions may be created from scratch, or pre-existing production versions may be retrieved from a master database and used as a starting basis for a modified production version. FIG. 3 shows an example of the latter. Based on search criteria entered by a user, the GUI according to embodiments of the invention may present a list of pre-existing production versions in the production version field 200.1 for the user to select from. More specifically, the search criteria may include an identifier of an output prod-

uct. Based on the identifier of the output product, a search for pre-existing production versions on the master database that relate to the output product may be executed. A result of the search may be presented as a list. In FIG. 3, the identifier of the output product is JH_AUTO (ref. no. 200.11), and the resulting list shows that two pre-existing production versions, JH_SCM41_LOCATION/VERSION 1 (ref. no. 200.12) and JH_SCM41_LOCATION/VERSION 2 (ref. no. 200.13) relate to the output product JH_AUTO. Reference number 300 indicates the selection in the production version field 200.1 of JH_SCM41_LOCATION/VERSION 1 for further processing.

[0022] As noted earlier, an advantage of the present invention is that it allows a user to enter high-level inputs and frees the user from the low-level manipulation of node and variant data. The output product identifier 200.11 is an example of such a high-level input. The output product identifier 200.11 is analogous to a node as discussed in connection with FIG. 1. In the particular case of the output product identifier 200.11, the node is a “header” node with an associated set of subordinate variants.

[0023] As further shown in FIG. 3, based on the production version selected from a list or otherwise entered in the production version field 200.1, a pre-existing component list 301 corresponding to the output product identifier may be retrieved and displayed in the component field 200.2. The component list 301 may comprise, for example, a variant sub-field 200.21 and a product sub-field 200.22. The product sub-field 200.22 and the variant sub-field 200.21 may respectively identify components, and specific variants of the components, of the product identified by the high-level output product identifier 200.11. For example, the component list 301 shows that the output product JH_AUTO of production version JH_SCM41_LOCATION/VERSION 1 includes a variant 10 of a component JH_SCM41_WHEEL (representing a steering wheel), a variant 20 of a component JH_SCM41_ENGINE (representing an engine), and so on. A different production version, e.g., JH_SCM41_LOCATION/VERSION 2 (ref. no. 200.13) not selected in this example, might contain a different component list for the output product JH_AUTO.

[0024] On the other hand, a new production version with its routing and component list could be created entirely from scratch, as noted earlier. In such a case, a new, unique output product identifier could be entered by a user into the corresponding field of the production version 200.1 (FIG. 2). Components of the newly-identified output product could be entered into the component field 200.2 of the display 200 as a new component list. Routing data for the new component list could be newly entered in the routing field 200.3. The new product identifier and associated component list and routing data could be subsequently saved to the database, and retrieved later by another process of modifying or displaying a production version.

[0025] The discussion now returns to the example, introduced above in connection with FIG. 3, of retrieving a pre-existing component list. Before a user is allowed to enter additions/deletions/modifications relating to a component list in display 200, a number of checks, such as authorization checks, may be performed in the background of the GUI. Once the checks have been performed and passed, the fields of the display 200 may be set editable. Referring now to

FIG. 4, it may be possible, for example, to enter component quantities in a quantity sub-field **200.23**, units of the quantities in a unit sub-field **200.24**, and the like.

[**0026**] After the component list and associated information have been entered, the corresponding routing may be defined in the routing field **200.3**. This is illustrated in **FIG. 5**. In **FIG. 5**, the routing field **200.3** is editable for entering operations **200.31** (with associated names **200.311**), activities and modes (activities and modes not shown in **FIG. 5**) which are used for structuring the routing. More specifically, an operation may comprise a plurality of activities which may be performed in various modes. As shown in **FIG. 6**, the operations **200.31** and associated activities **200.32** (with corresponding activity names **200.321**) defined as shown in **FIG. 5** may be mapped to or associated with components of the corresponding line number in the component field **200.2**. Advantageously, according to embodiments of the present invention, the sequence of operations/activities is automatically derived from the line order in the routing field **200.3**. In a completed production version, a sequence of operations/activities and the association of components with activities may guide an actual manufacturing process. For example, the component-to-activity mapping shown in **FIG. 6** might represent the sequence: "Install steering wheel in steering column (Operation 1, Activity 1); Install engine in car chassis (Operation 2, Activity 2); Install seat in car chassis (Operation 3, Activity 3); Paint car body (Operation 4, Activity 4)". The routing field **200.3** may further be used to assign resources **200.33** to the manufacturing process, such as specific workers.

[**0027**] **FIG. 6** further illustrates that the single screen display **200** can be formatted in such a way that routing information is enterable in the component field **200.2**. Although not shown, component information could similarly be enterable in the routing field **200.3**. This feature provides further flexibility and ease of use.

[**0028**] After entering values in the display **200** as described in the preceding, a user may save the values. More processing of the values may be performed, and a modified data file corresponding to a changed JH_AUTO/JH_SCM41_LOCATION/VERSION 1 may be saved. The data file may be saved on a machine-readable medium such as disk. **FIG. 7** shows a display of a data organization (i.e., a hierarchy of a single header node and associated variants) corresponding to the production version modified as described in the foregoing. That is, associated with a production version data file **700** identified as JH_AUTO/JH_SCM41_LOCATION/VERSION 1, there is a component list and related information, and associated routing information. These are grouped hierarchically under a header **701** identified as H00000001_JH_AUTO, which corresponds to a header node as described earlier. Under the header **701** are the identifiers **701.1**, **701.2**, **701.3**, **701.4** of the information relating respectively to the component variants entered in the sub-field **200.21** as further described earlier. Along with the variant information is the associated routing information with respective identifiers **701.11**, **701.21**, **701.31**.

[**0029**] In view of the foregoing example, **FIG. 8** shows a process flow according to embodiments of the present invention. As shown in block **800**, the process may comprise invoking a GUI comprising a screen display having a

production version field, a component field, and a routing field. When the GUI is invoked, profile definitions may be read to determine an appearance and functionalities of fields of the display.

[**0030**] Values entered into the production version field may be processed to determine whether there are pre-existing production versions stored on a database that relate to the same output product. More specifically, as shown in block **801**, it may be determined based on an output product identifier whether there are any pre-existing production versions on the database that relate to the same output product. If there are, the production version(s) may be presented in the form of a list for the selection of an existing component list corresponding to the output product. Alternatively, an entirely new production version may be constructed based on values entered in the fields.

[**0031**] As shown in block **802**, the component field may be set editable to receive inputs defining the component list. In view of the above, the inputs could be modifications or additions to pre-existing information, or could be newly entered.

[**0032**] The routing field may be set editable to receive routing information associating activities and operations with components in the component list, as shown in block **803**. The routing information could be modifications or additions to pre-existing information, or could be newly entered.

[**0033**] As shown in block **804**, a production version data file comprising the component list and associated routing information as defined by the inputs entered in the GUI may be saved to a database.

[**0034**] **FIG. 9** shows a high-level representation of a computer system for implementing embodiments of the present invention, such as might be realized by a variety of known and commercially available hardware and software elements. The system comprises a memory **900** including ROM and RAM, processor **910** and user interface **911** comprising a video display **912**, keyboard **913** and mouse **914**. Elements may communicate via system bus **909**. The system may further comprise a network **917** connected by a network medium **918** and network interface **915**.

[**0035**] A computer program or collection of programs comprising computer-executable instructions for performing a method according to embodiments of the present invention may be stored and transported on machine-readable media such as diskette **901**, CD-ROM **902**, magnetic tape **903** and fixed disk **904**. To perform the embodiments, computer instructions may be retrieved from the machine-readable media **901-904** using their respective drives **905-908** into memory **900**, and executed by a processor **910**. The functionality disclosed hereinabove for performing the embodiments may find specific implementations in a variety of forms, which are considered to be within the abilities of a programmer of ordinary skill in the art after having reviewed the specification.

[**0036**] Several embodiments of the present invention are specifically illustrated and/or described herein. However, it will be appreciated that modifications and variations of the present invention are covered by the above teachings and within the purview of the appended claims without departing from the spirit and intended scope of the invention.

What is claimed is:

- 1. A method comprising:
 - presenting a graphical user interface (GUI) for computer-assisted product and process configuration, wherein in a single screen display of the GUI, data is enterable for completely defining a production version data file to guide the construction of a product, the single screen display comprising a production version selection field to select a pre-existing production version data file or create a new production version data file, a component field to hold an editable pre-existing component list or receive data defining a new component list, and a routing field to hold editable pre-existing routing data or receive new routing data, the routing data relating to activities and operations to be performed with the components defined in the component list to construct the product; and
 - based on data entered in the single screen display, generating the production version data file.
 - 2. The method of claim 1, wherein the component field comprises sub-fields for the definition of a quantity and units of a component.
 - 3. The method of claim 1, wherein the routing field comprises sub-fields for the definition of operations, activities and modes to be associated with the components in the component list.
 - 4. The method of claim 3, wherein an order of the lines in the routing field corresponds to an order of the activities and operations.
 - 5. A method comprising:
 - generating a single-screen display of a GUI;
 - based on a product identifier of a product entered into a production version field of the single-screen display, retrieving a corresponding component list from a component database and displaying the component list in the single-screen display;
 - setting fields in a component field of the single-screen display editable to receive input relating to components in the component list;
 - based on routing information entered into a routing field of the single-screen display, associating activities and operations with components in the component list; and
 - based on the component list and related input, and the associated routing information entered into the single-screen display, generating a production version data file to guide manufacturing of the product.
 - 6. The method of claim 5, wherein the single-screen display is formatted such that component information is enterable in the routing field, and routing information is enterable in the component field.
 - 7. A system comprising:
 - a processor;
 - a memory coupled to the processor to hold instructions executable by the processor to:
 - present a graphical user interface (GUI) for automated product configuration, wherein in a single screen display of the GUI, data is enterable for completely defining a production version data file to guide the construction of a product, the single screen display

- comprising a production version selection field to select a pre-existing production version data file or create a new production version data file, a component field to hold an editable pre-existing component list or receive data defining a new component list, and a routing field to hold editable pre-existing routing data or receive new routing data, the routing data relating to activities and operations to be performed with the components defined in the component list to construct the product; and
 - based on data entered in the single screen display, generate the production version data file.
- 8. The system of claim 7, wherein the component field comprises sub-fields for the definition of a quantity and units of a component.
- 9. The system of claim 7, wherein the routing field comprises sub-fields for the definition of operations and activities to be associated with the components in the component list.
- 10. A machine-readable medium storing instructions, the instructions when executed by a computer implementing a method comprising:
 - generating a single-screen display of a GUI;
 - based on a product identifier of a product entered into a production version field of the single-screen display, retrieving a corresponding component list from a component database and displaying the component list in the single-screen display;
 - setting fields in a component field of the single-screen display editable to receive input relating to components in the component list;
 - based on routing information entered into a routing field of the single-screen display, associating activities and operations with components in the component list; and
 - based on the component list and related input, and the associated routing information entered into the single-screen display, generating a production version data file to guide manufacturing of the product.
- 11. The machine-readable medium of claim 10, wherein the single-screen display is formatted such that component information is enterable in the routing field, and routing information is enterable in the component field.
- 12. A machine-readable medium storing instructions, the instructions when executed by a computer implementing a method comprising:
 - presenting a graphical user interface (GUI) for computer assisted product and process configuration, wherein in a single screen display of the GUI, data is enterable for completely defining a production version data file to guide the construction of a product, the single screen display comprising a production version selection field to select a pre-existing production version data file or create a new production version data file, a component field to hold an editable pre-existing component list or receive data defining a new component list, and a routing field to hold editable pre-existing routing data or receive new routing data, the routing data relating to activities and operations to be performed with the

components defined in the component list to construct the product; and

based on data entered in the single screen display, generating the production version data file.

13. The machine-readable medium of claim 12, wherein the component field comprises sub-fields for the definition of a quantity and units of a component.

14. The machine-readable medium of claim 12, wherein the routing field comprises sub-fields for the definition of operations and activities to be associated with the components in the component list.

* * * * *