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**G4A** AUXB

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**US 20020099612 A1**

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(54) Abstract Title: **Administration of a manufacturing process**

(57) A sales order is received at a sales office (110) and entered into a sales terminal (112) . The sales order is communicated to a sales and orders management system (114) located at a central office (116) . A manufacturing requirement is generated from the sales order and a component listing of parts and configurations associated with manufacturing of the products is generated. The component listing is communicated to an assembly management system (118) and therefrom to a local assembly system (120) where the products are manufactured. At least one parameter of the manufacturing process is controlled in response to the component listing. For example, the component listing may comprise information related to configuration of the product, the materials required for manufacturing, the configuration of assembly units, and the manufacturing process controlled accordingly. The invention is particularly suited for a distributed, (semi-) automated manufacturing system for diverse products.

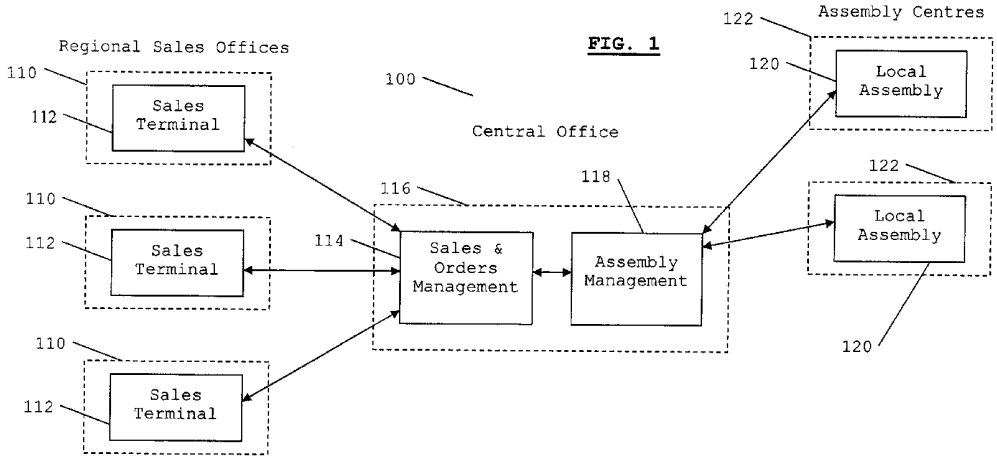


FIG. 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

**Original Printed on Recycled Paper**

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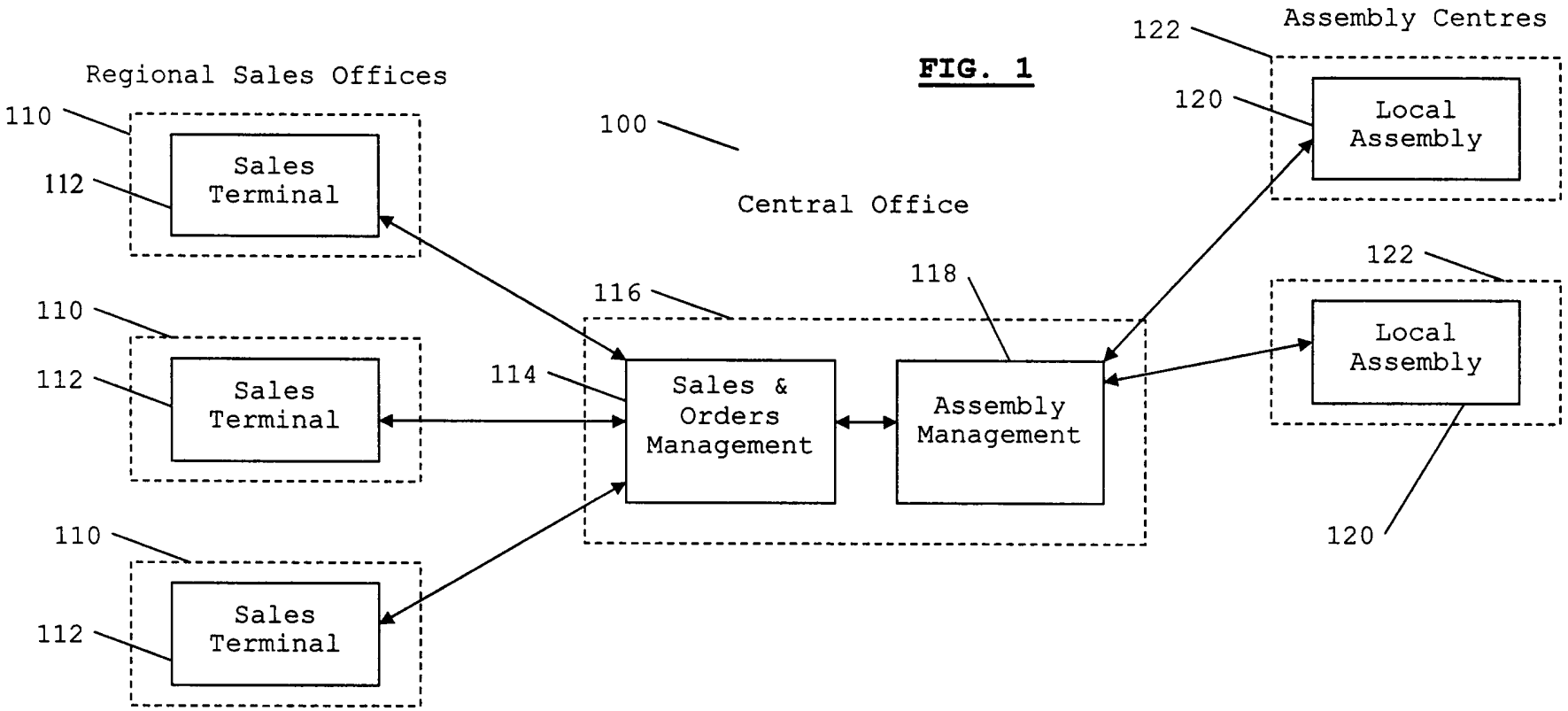
**FIG. 1**


Regional Sales Offices
110
112
Sales Terminal
110
112
Sales Terminal
110
112
Sales Terminal
100
Central Office
116
114
Sales & Orders Management
118
Assembly Management
Assembly Centres
122
120
Local Assembly
122
Local Assembly
120

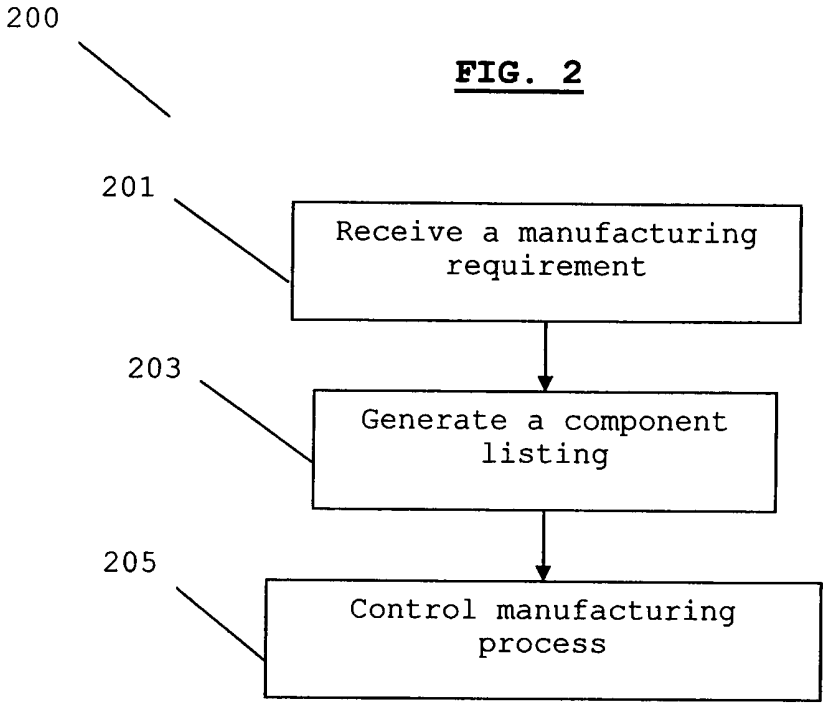

200
201
Receive a manufacturing requirement
203
Generate a component listing
205
Control manufacturing process

**FIG. 2**

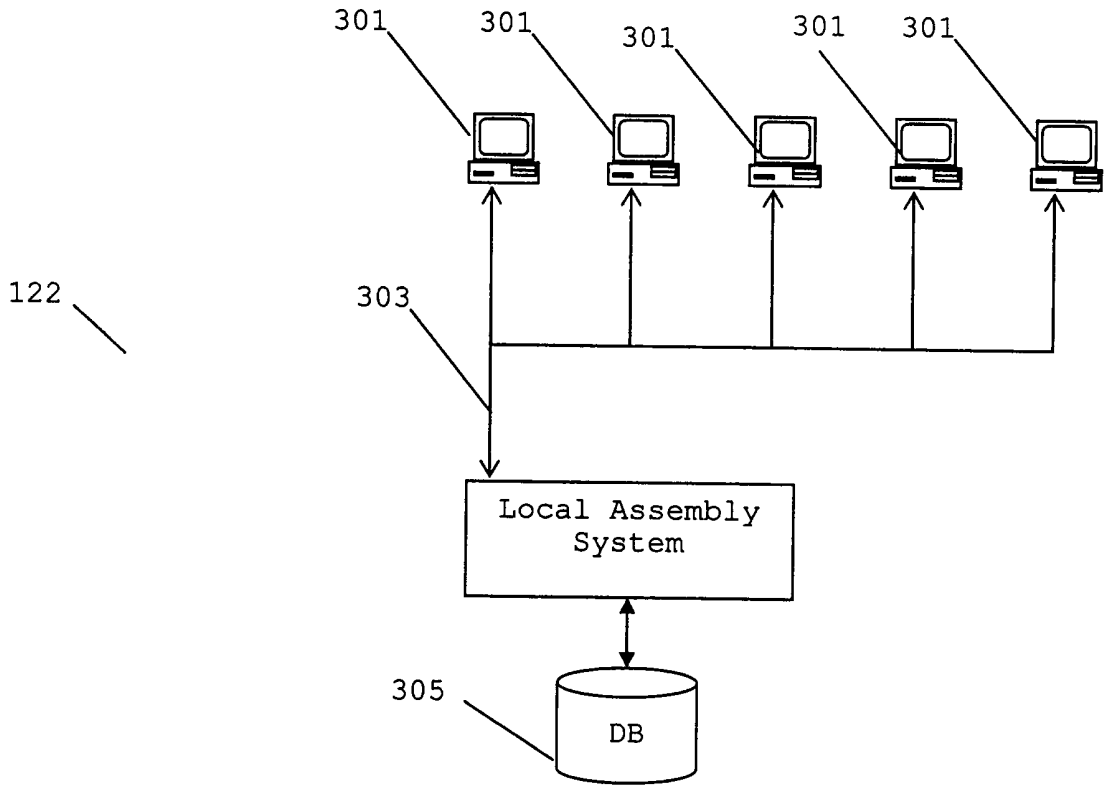



FIG. 3

**FIG. 4**

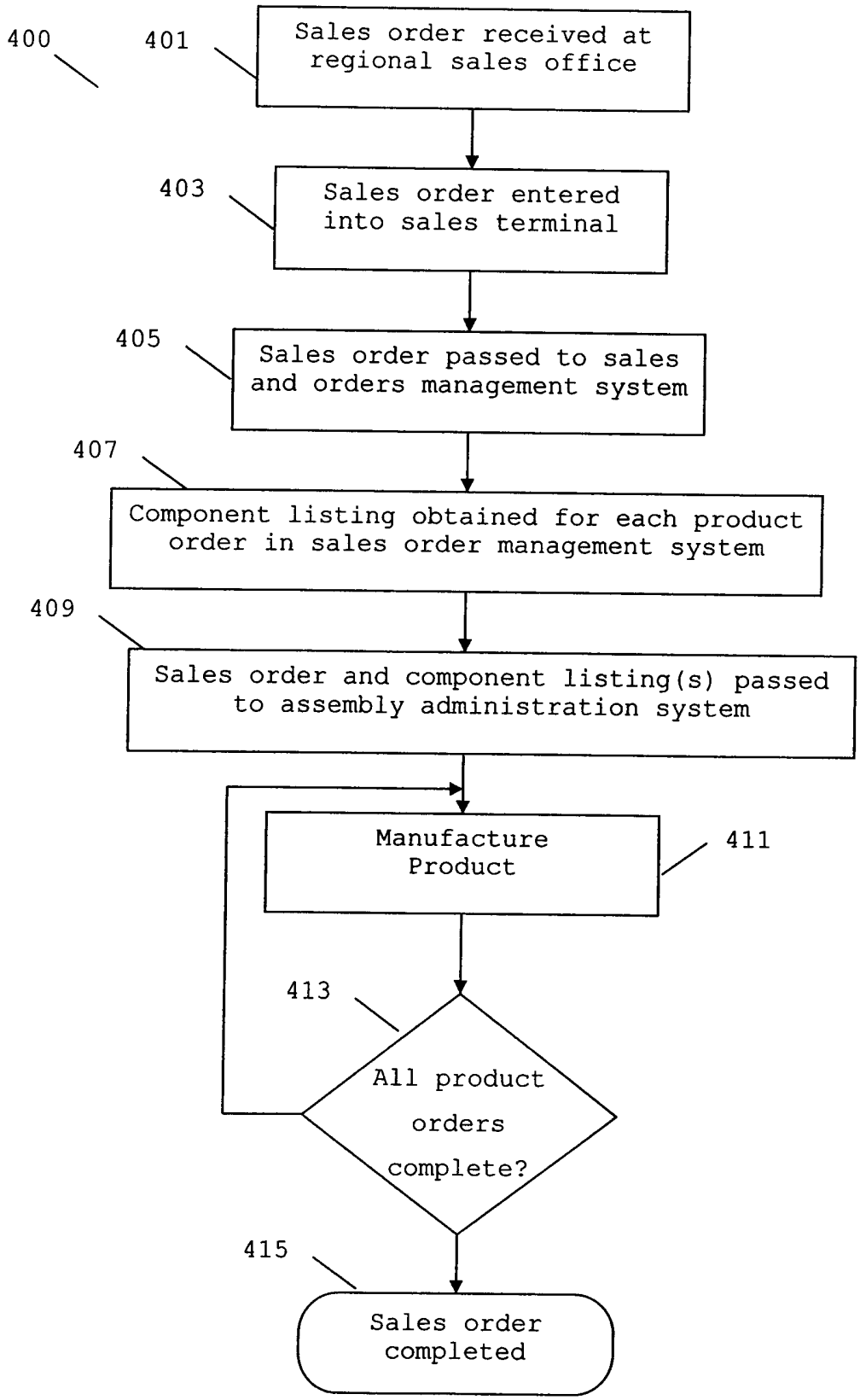
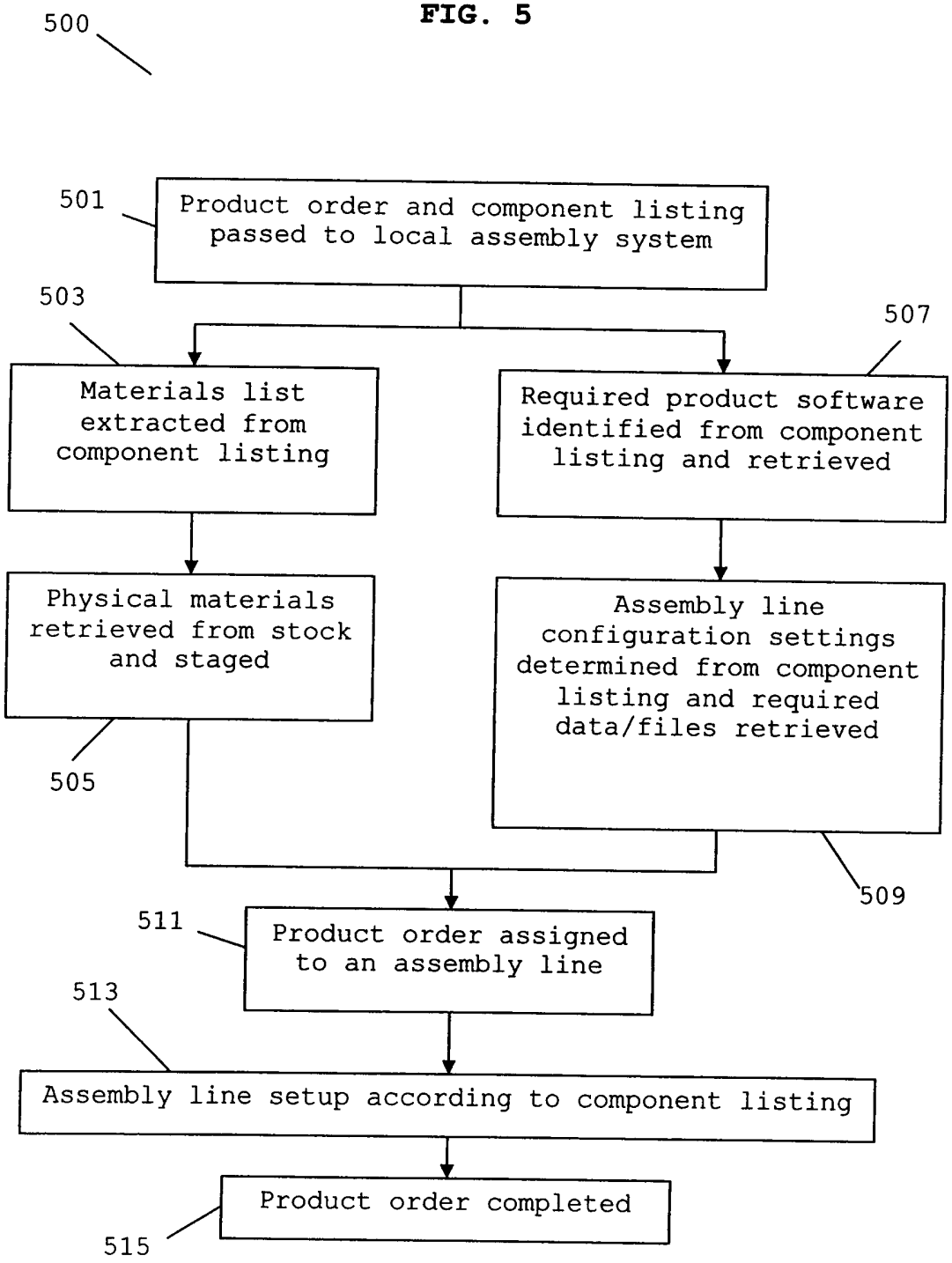

400
401
Sales order received at regional sales office
403
Sales order entered into sales terminal
405
Sales order passed to sales and orders management system
407
Component listing obtained for each product order in sales order management system
409
Sales order and component listing(s) passed to assembly administration system
Manufacture Product
411
413
All product orders complete?
415
Sales order completed

FIG. 5


500
501
Product order and component listing passed to local assembly system
503
Materials list extracted from component listing
507
Required product software identified from component listing and retrieved
Physical materials retrieved from stock and staged
505
Assembly line configuration settings determined from component listing and required data/files retrieved
509
511
Product order assigned to an assembly line
513
Assembly line setup according to component listing
Product order completed
515

# METHOD AND APPARATUS FOR MANUFACTURING

## Field of the Invention

The present invention relates to a method and apparatus for manufacturing and, in particular, for controlling an at least partially automated manufacturing process.

## Background of the Invention

Manufacturing processes, including product assembly or product configuration, typically comprise the basic steps of:

(i) Receiving an order for a quantity of the product;

(ii) Allocating the materials required for the manufacture of the product for that order; and

(iii) Assigning the order to one or more manufacturing/assembly/configuration lines.

In order for such processes to be efficient, both in terms of time and cost, numerous factors have to be taken into consideration. Such factors include by way of example:

(i) Stock control/management (i.e. keeping track of required materials in stock, ordering new stock as required, etc.);

(ii) Order tracking (i.e. keeping track of individual orders throughout the manufacturing process); and

(iii) Manufacturing line set up (i.e. relocating of required materials for each order to the line, setting

up machines etc. for the specific order, arranging packing and shipping as required, etc.).

Further factors can also affect such processes, for example:

(i) Changes of and/or customisation to the product and/or materials of the product;

(ii) Non-dedicated manufacturing and/or assembly and/or configuration lines (i.e. where a line may be used for various different products, and therefore requires adapting each time the product being manufactured/assembled/configured is changed; and

(iii) Personnel involved in the process.

In order to reduce detrimental effects caused by such factors, it is therefore important for manufacturing processes to be carefully controlled.

As will be appreciated, optimisation of manufacturing processes is a complex process involving many diverse parameters. Typical manufacturing processes are managed manually or predominantly manually in order to provide the required flexibility and optimised performance. However, this is a very time consuming task and is associated with high manufacturing costs. Automated manufacturing control processes are known. However, these control processes tend to have reduced reliability and be inflexible, and, in particular, the automated manufacturing control processes tend not to provide the desired flexibility for manufacturing processes catering for manufacturing of many diverse products having different configurations.

Accordingly, it would be advantageous to have an improved system for manufacturing and preferably a system having improved flexibility, improved optimisation, reduced cost, reduced associated workload and/or facilitating automatic manufacturing control.

**Statement of Invention**

In accordance with a first aspect of the present invention, there is provided a method of manufacturing as claimed in Claim 1.

In accordance with a second aspect of the present invention, there is provided a storage medium storing processor-implementable instructions as claimed in Claim 18.

In accordance with a third aspect of the present invention, there is provided an apparatus for manufacturing as claimed in Claim 19.

Further aspects and advantageous features of the present invention are as described in the appended Claims.

In summary, the present invention relates to a method and apparatus for manufacturing. Manufacturing processes include for example making and/or producing and/or constructing and/or configuring and/or assembling and/or packing one or more products. Manufacturing may for example include configuring software for a product, generating warrantee documents, selecting parts to be included with a product, generating and/or including appropriate user manuals, etc.

In one aspect, the present invention provides a method of manufacturing comprising the steps of:

receiving a manufacturing requirement;

generating a component listing in response to the manufacturing requirement; and

controlling at least one parameter of an at least partially automated manufacturing process in response to the component listing.

The manufacturing requirement may preferably be determined in response to an order for a quantity of at least one product. Specifically the manufacturing requirement may be equivalent, similar or identical to a sales order. The component listing is preferably generated automatically in response to the manufacturing requirement, for example by use of predetermined associations between different manufacturing requirements and elements of component lists.

The present invention allows for a component listing for each product of a sales order to be used for managing a manufacturing process. The invention allows for a very flexible control of a manufacturing process wherein the component listing may facilitate accommodating a significant diversity of products. The invention is particularly suited for automated manufacturing process control, which may be facilitated by the use of the component listing. Each stage of the manufacturing process may be automatically set up and controlled for each product to be assembled, even where the product is capable of being customised by a customer.

## Brief Description of the Drawings

Exemplary embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

FIG. 1 illustrates an example of a manufacturing system adapted to support the inventive concepts of the preferred embodiments of the present invention;

FIG. 2 illustrates a flowchart of a method of manufacturing in accordance with an embodiment of the invention;

FIG. 3 illustrates an example of an implementation of an assembly centre in accordance with an embodiment of the present invention;

FIG. 4 illustrates a flowchart of a process for a sales order in accordance with an embodiment of the present invention; and

FIG. 5 illustrates a flowchart of a process for a product order in accordance with an embodiment of the present invention.

## Description of Preferred Embodiments

The following description focuses on an embodiment of the invention applicable to a system for assembly of a product. However, it will be appreciated that the invention is not limited to this application but may be

applied to many other manufacturing processes and systems including configuration and test processes.

FIG. 1 illustrates an example of a manufacturing system 100 adapted to support the inventive concepts of the preferred embodiments of the present invention. As illustrated in FIG. 1, the system of the preferred embodiment comprises a plurality of sales offices 110 where orders for products may be received. The sales offices 110 are located at different geographic locations. Each of the sales offices 110 comprises a sales terminal 112, which is connected to a sales and orders management system 114 situated at a remote central office 116. The sales terminal 112 and sales and orders management system 114 may specifically be implemented as suitable software running on suitable general purpose Personal Computers.

In the embodiment of FIG. 1, the central office 116 further comprises an assembly management system 118 coupled to the sales and orders management system 114. The assembly management system 118 may also be implemented as suitable software running on a suitable general purpose Personal Computer and may specifically be implemented in the same Personal Computer as the sales and orders management system 114. In the illustrated embodiment, the assembly management system 118 is coupled to a plurality of remote local assembly systems 120 situated in local assembly centres 122. The local assembly systems 120 typically comprise one or more manufacturing or assembly machines or units operable to assemble at least parts of a product.

FIG. 2 illustrates a flowchart 200 of a method of manufacturing in accordance with an embodiment of the invention.

The method initiates in step 201 wherein a manufacturing requirement is received. In the preferred embodiment of the present invention, when considering the manufacturing system 100 of FIG. 1, the sales and orders management system 114 receives a sales order from the sales terminal 112 of one of the sales offices 110. This sales order may directly be considered a manufacturing requirement or may be further processed by the sales and orders management system 114 to generate a manufacturing requirement. The manufacturing requirement may, for example, be a requirement for a number of specific products to be manufactured.

Step 201 is followed by step 203 wherein a component listing is generated in response to the manufacturing requirement. In the preferred embodiment, the sales and orders management system 114 generates a component listing comprising an indication of all or some of the parts, elements and functions required for meeting the manufacturing requirement. Thus, the sales and orders management system 114 may generate the component listing as a list of parts and elements required to manufacture the quantity of products indicated in the sales order.

Step 203 is followed by step 205 wherein at least one parameter of an at least partially automated manufacturing process is controlled in response to the component listing. In the preferred embodiment, the component listing is passed from the sales and orders

management system 114 to the assembly management system 118. The assembly management system 118 then determines one or more control parameters or characteristics of the manufacturing process. For example, the assembly management system 18 may determine the required number of manufacturing units to be allocated to meet the manufacturing requirement. The assembly management system 118 consequently communicates the appropriate control characteristics or commands to one or more of the local assembly systems 120, which are operable to be configured in response to control characteristics or commands.

The manufacturing process of the local assembly systems 20 is thus at least partially controlled by the remote assembly management system 118 in response to the component listing generated by the sales and orders management system 114 in response to the manufacturing requirement.

In some embodiments, the control characteristics or commands may comprise or consist in the component listing, and the local assembly centres 122 may comprise functionality for controlling the manufacturing in response to the component listing.

Specific details, features, advantages and aspects of preferred embodiments of the invention will be described in more detail in the following.

In the preferred embodiment, the method of manufacturing comprises receiving a sales order and converting the sales order into a manufacturing requirement.

Preferably, when considering the manufacturing system 100 of FIG. 1, the sales order is received at the sales office 110 and the conversion into a manufacturing requirement is performed either at the sales terminal 112 or the sales and orders management system 114. In the simplest embodiment, the sales order may directly be used as the manufacturing requirement.

A sales order may be received in any known manner. For example, a customer may contact a sales person by telephone and orally place an order with the sales person. Such an order may subsequently be confirmed in writing if necessary.

Alternative methods of receiving a sales order include receiving written orders by way of traditional postal means or by electronic mail. A further alternative may be by way of a sales order received over a computer network, such as the Internet.

As a specific example, a sales order may comprise at least the following information:

(i) Customer identification;

(ii) Identification of the product(s) being ordered; and

(iii) Quantity(ies) of the product(s) being ordered.

Specifically, one or more of the products may be capable of being customised for, or by, the customer, i.e. one or more aspects of the product may be varied. For example, the customer may be able to select from a range of external covers or exteriors for the product, select from

a range of features and/or functionality of the product (in particular where the product is an electronic device controlled by way of software), etc.

Thus, the sales order preferably also comprises details of the customisation required for/by the customer. Alternatively, or additionally, some or all of the customisation may be customer specific, and therefore is automatically identified solely by the customer identification.

Table 1 below illustrates an example of the information provided in a sales order, in addition to the identity of the customer:

Table 1

| **Generic Product** | **Quantity** | **Colour** | **S/ware Option** | **Units per over pack** | **Over Packs per pallet** | **Delivery Information** |
|---|---|---|---|---|---|---|
| P1 | 5,000 | Blue | 1 | 20 | 10 | Customer X FR |
| P1 | 10,000 | Red | 2 | 20 | 10 | Customer X De |
| P2 | 15,000 | Blue | 4 | 15 | 15 | Customer X GB |

In this particular example, the customer, i.e. Customer X, has placed an order for three products.

The first product is based on a generic product P1, for which the customer has ordered a quantity of five

thousand (5,000). The order also contains customisable information, such as the colour, software option and packaging information.

For the first product, the customer has specified the colour blue and software option 1. For the packaging, the customer has specified twenty units per over pack, and 10 over packs per pallet. Finally, for delivery information "Customer X FR" indicates that the customer has specified that the product be delivered to their French depot. The specific address for the French depot of Customer X is preferably already known, and can be retrieved from a customer database.

The second product ordered is based on the same generic product as the first product ordered. However, the customer has specified different options, and for the product to be delivered to their German depot. The third product ordered is based on a different generic product, and is to be delivered to the customer's depot in Great Britain, as illustrated in Table 1.

In the preferred embodiment, the sales order is entered into one of the sales terminal 112, either manually or automatically, and the sales order is passed to the sales and orders management system 114 at the central office 116.

For the embodiment illustrated in FIG. 1, sales orders are received by a plurality of regional sales offices 110, located separate to the central office 116 in which the sales and orders management system 114 is located. However, the present invention may equally be applied

where sales orders are received solely at the central office 116, or any other alternative sales structure.

On receipt of a sales order, the sales and orders management system 114 preferably assigns a sales order number to the sales order, and begins to process the order.

In the preferred embodiment of the present invention, the sales and order management system 114 generates a component listing for each product in the sales order. All information relating to a sales order is preferably stored in a database (not shown) to which the sales and orders management system 114 has access.

Alternatively, or additionally, it is within the scope of the present invention for the component listings to be generated prior to the order being received by the sales and orders management system 114, for example by the sales terminal 112. In this manner, the component listings may be provided to the sales and orders management system 114 of the central office 116 along with the sales order.

In a further alternative, the component listings may be fully or partially generated at a later stage, for example by an assembly management system 118.

Preferably, the sales and orders management system 114 also logs and tracks orders and sales, updates customer accounts, etc.

The component listing, which may alternatively be referred to as a Bill Of Materials (BOM), preferably comprises a list of component identifiers for every component required for the assembly of the product. Preferably, the component identifiers are in the form of part numbers, although any alternative identifiers may be used.

Preferably, such components include not only physical materials, such as printed circuit boards, electronic modules, screws, casings, etc., but also components such as software files to be loaded into a memory element of the product, labels and artwork to be printed onto labels, etc.

Preferably, the component listing further comprises a list of all packaging materials used for packaging the product once it has been assembled. Such packaging not only includes the packaging for each individual product unit, but also any packaging materials used for over packs and for pallets.

For example, each individual product unit is packaged in a box such as would be purchased by a consumer, as opposed to the customer.

Such unit boxes are themselves packaged in over packs, for example twenty unit boxes to an over pack. These over packs facilitate delivery of unit boxes to retail outlets of the customer, whereby one or more over packs can be delivered to a retail outlet. The unit boxes can then be removed from the over packs at the retail outlet and, for example, placed on to shelves.

The over packs are themselves packaged on pallets, for example ten over packs to a pallet. These pallets facilitate delivery of over packs, and thereby unit boxes, to a warehouse of the customer, whereby one or more pallets can be delivered to the warehouse. The over packs can then be removed from the pallets and distributed to retail outlets of the customer.

It is also preferable that the component listing also comprises a list of any literature, accessories and supplementary items to be included with the packaged product. For example, for electronic devices such as cellular telephones and the like, literature such as a user manual, warranty card, etc. would be included in each unit box along with the product unit. Furthermore, items such as a charger, personal hands-free headset, battery and the like would also be included within the unit box with the product unit. Thus, although these are not components specifically required for the assembly of the product itself, they are preferably included in the component listing.

In the preferred embodiment, the manufacturing requirement comprises a plurality of sub-manufacturing requirements. For example, a sub-manufacturing requirement may exist for each product or part of a product that is to be manufactured. Additionally, or alternatively, different categories associated with the products to be manufactured may be designated and the manufacturing requirement may comprise a sub-manufacturing requirement for each category.

The component listing may be generated in any suitable manner. In the preferred embodiment, the component listing may be generated by collecting or collating a plurality of component listings, each of which being associated with one of the sub-manufacturing requirements.

As a specific example, each sub-manufacturing requirement may correspond to a single product of a sales order. For example, three products may be defined in a sales order and a manufacturing requirement may be generated as the individual manufacturing requirement of the first product combined with the individual manufacturing products of the second and third product respectively. A component listing may then be generated by separately determining the component listing associated with the first, second and third product respectively and merging these component listings together.

In the preferred embodiment, the step of generating the component listing comprises performing a data look up in a data storage comprising associations between manufacturing requirements and components of component lists. For example, a database may contain a component listing for all valid variations/customisations of a product. In this manner, when a sales order is received, the corresponding manufacturing requirement may be generated and used to access, for example, a database comprising a component listing for all possible manufacturing requirements. Specifically, a database associating component listings with products may be generated and stored. When a sales order comprises a specific product, this may be included in the

manufacturing requirement and the database may be accessed to return the component listing stored for that product.

In the preferred embodiment, the manufacturing process may further comprise the step of designating the manufacturing requirement as invalid, if there is no predetermined component listing corresponding to the manufacturing requirement. For example, if there is no component listing that corresponds to the sales order, the products of the sales order or manufacturing requirement, the manufacturing requirement and/or sales order may be designated as invalid. Preferably, the appropriate sales office is informed of this designation, thereby enabling them to take the appropriate action.

The assessing and selecting of the appropriate component listing is preferably performed automatically. However, it is within the contemplation of the present invention for this to be performed manually, e.g. by the salesperson.

Alternatively, the product may comprise constituent parts that can be individually customised in order to customise the overall product unit. For example, the product unit may comprise an electronic constituent, such as an electronic module, in which all electronic hardware components are housed. The product unit may also comprise a housing constituent comprising a front housing cover and a rear housing cover that when the product unit is assembled encloses the electronic constituent. Finally, the product unit may comprise a software

constituent, which during assembly is loaded into a memory element of the electronic constituent.

In this manner, rather than the database containing component listings for all variations/customisations of the entire product unit, the database contains component listings for all variations/customisations for each of the constituents of the product unit. Thus, when a sales order is received, the details of the sales order are assessed and the appropriate component listing for each constituent of the product unit is selected and retrieved from the database. These can then be concatenated or otherwise combined to produce the overall component listing for the product unit.

In this manner, the overall database size can be reduced, and maintenance of the database is simplified.

The generation of the component listing may thus comprise selecting the component listing from a plurality of predetermined component listings in response to the manufacturing requirement. This may include selecting a plurality of component listings that are concatenated into one component listing.

In some embodiments, predetermined component listings may be retrieved or selected and consequently modified in accordance with the specific information of the manufacturing requirement.

In one embodiment of the present invention, a list of all components that have been approved for use is stored on a database, along with the part number for each component.

Where the product unit comprises distinct constituents, preferably the components for the various constituents are grouped accordingly, or provided in separate lists. In this manner, when a sales order is received, the details of the sales order are assessed and, depending on the customisation required, the appropriate components are selected and used to generate a component listing.

Once again, the assessing and selecting of the appropriate component listing is preferably performed automatically. However, it is within the contemplation of the present invention for this to be performed manually, e.g. by the salesperson.

Sales orders are preferably handled by the central sales and orders management system (for example the sales and orders management system 114 of FIG. 1), which has access to a database in which all sales orders are stored. The central sales system preferably also has access to the component listings database, and is responsible for generating the component listing for each product of an order, as described above.

Once the full component listing has been generated, the central sales system preferably passes the order to the assembly administration system 118, along with the component listing, where the assembly process is managed.

Table 2 below illustrates a simple example of a component listing for the first product of Table 1 above. In particular, Table 2 illustrates how it relates to the sales order information for that product (in the specific

case that the sales order information corresponds to the manufacturing requirement):

Table 2

| **Component Listing** | **Relevant Order Information** |
|---|---|
| GP-####-0001 (Generic product P1)<br>EM-####-0001 (electronic module)<br>ML-####-0001 (module label)<br>CS-####-0001 (core software)<br>BX-####-0001 (box)<br>BI-####-0001 (box insert)<br>BL-####-0001 (box label) | Generic product - P1 |
| CL-####-0001 (P1 colour blue)<br>FC-####-0001 (front cover)<br>RC-####-0001 (rear cover) | Colour - Blue |
| SO-####-0001 (P1 option 1 - Customer X)<br>RF-####-0001 (resource files)<br>OF-####-0001 (optional feature 1)<br>OF-####-0001 (optional feature 3) | Software option - 1 (Customer X) |
| OP-####-0020 (x20 over pack) | Units per over pack - 20 |
| PL-####-0010 (x10 pallet) | Over packs per pallet - 10 |
| DI-####-0001 (Del Customer X FR) | Delivery information - Customer X FR |

As can be seen, the component listing comprises part numbers for the various components that make up the product. The generic product specified in the order information, which for this example is P1, preferably has associated with it a generic product part number, which for the illustrated embodiment is represented by "GP-####-0001".

For the illustrated embodiment, the components required for the generic product include an electronic module, a module label, core software, a box, a box insert and a box label. The generic product part number is used to identify the part numbers of the components required for that particular generic product, and are listed below the generic product part number.

In the same way, a part number is associated with each item of order information, from which required components can easily be identified and incorporated into the component listing.

In addition, it is possible for customer specific components to be incorporated, without the need for the customer to manually specify them. For example, in the above example, the resource files of the product may include customer specific graphics and logos. Such logos have preferably been previously arranged and agreed with the customer, for example from previous orders and/or negotiations.

In this manner, the order information may include the customer identification for the software option. Thus,

the part number for the software option is specific to Customer X.

As previously mentioned, the sales order or manufacturing requirement may be for more than one product. Where this is the case, a component listing may be generated for each product to which the sales order relates. Alternatively, or additionally, a combined component listing may be generated.

Sales order information, for example the sales order number, component listings, etc. are passed to an assembly management system (for example the assembly management system 118 of FIG. 1), which for the illustrated embodiment is also located in the central office 116 of FIG. 1. However, it will be appreciated that the assembly management system 118 may be located separate to the sales and orders management system 114, e.g. at another physical location.

The assembly management system 118 preferably stores the received information in a database (not shown). The assembly management system 118 processes the received information, for example by assigning product orders to appropriate assembly centres 122, keeping track of orders, etc.

The assembly management system 118 may be interrogated by, or otherwise provide information to, the sales and orders management system 114 regarding the status of orders.

Preferably, each product order is assigned a product order number. Alternatively, this may be assigned by the sales and orders management system 114.

The assembly management system 118 handles tasks related to the assembly of products, such as allocating serial numbers to product orders, assignment of orders to assembly centres 122, etc.

Where a product to be assembled requires software components, the assembly management system 118 preferably also maintains a database (not shown) of such software components. Alternatively, the assembly management system 118 may have access to such a database maintained elsewhere, or simply have access to information regarding such a database. In any case, the assembly management system 118 is preferably able to determine the location of required software components in order to either provide such location information to assembly centres 122, or to provide the software components themselves.

In this manner, even where a plurality of assembly centres 122 are used, software components need only be managed and maintained at a single location, and can easily be updated or otherwise maintained.

Where more than one assembly centre 122 is used, the assembly management system 118 may assign product orders depending upon various parameters. For example, assembly centres 122 may be specific to products. Referring back to the example illustrated in Table 1 above, one assembly centre 122 may be specific to products based on generic

product P1, whilst another assembly centre 122 may be specific to products based on generic product P2. Alternatively, or additionally, product orders may be assigned to an assembly centre 122 by virtue of its geographical relationship with the delivery address.

For the embodiment illustrated in FIG. 1, the assembly management system 118 is located in the central office 116, and communicates with local assembly systems 120 in a plurality of assembly centres 122. However, the present invention may equally be applied to a scenario where only one assembly centre 122 is used, where the assembly management system 118 is located at an assembly centre 122 or indeed any other physical or logical manufacturing structure or distribution arrangement.

It will be appreciated that where the assembly management system 118 is located at an assembly centre 122, the assembly management system 118 may perform the tasks associated with a local assembly system 120 for that assembly centre 122.

As previously mentioned, a sales order may be placed for quantities of more than one product. Where this is the case, a component listing may be generated for each product within the order. Alternatively, a single component listing comprising a plurality of sub-component listings corresponding to each product may be generated.

In the preferred embodiment a suitable component listing is provided to an assembly centre 122, along with information such as:

(i) Sales order number;

(ii) Product order number (identifying each product within a sales order);

(iii) Quantity of product ordered;

(iv) Date of sales order;

(v) Due date for delivery of order/product; and/or

(vi) Delivery address/information for product; etc.

Alternatively, such information may be included as part of the component listing itself.

The information is preferably provided by the assembly management system 118 to a local assembly system 120, located at the assembly centre 122.

As previously mentioned, the component listing may contain part numbers for not only physical materials and parts, but also for components such as software, label artwork, etc. The part numbers for the physical materials and parts can be extracted from the component listing to provide a materials list. Thus, a materials requirement for the manufacturing process may be extracted in response to the component listing.

The materials list can then be used to ensure that the required materials are in stock. This may be carried out by the sales and orders management system 114, prior to the order and component listing(s), etc. being passed on to the assembly management system 118. Alternatively, this may be carried out by the assembly management system 118 once it has received the order and component

listing(s), by the sales terminal 112 or by the local assembly system 120.

In order for products to be assembled, it is necessary for the physical materials, etc. to be retrieved from stock. The materials list may also be used for this purpose, providing the list of all the necessary parts required for manufacturing a single product unit. This is multiplied by the quantity of products required for the order, to retrieve all the necessary physical materials.

The retrieved materials are preferably then 'staged' until an assembly line is assigned. The quantity of a product required for an order may be assigned to a single assembly line, and assembled in one go. Alternatively, the quantity of a product for an order may be divided into assembly units.

For example, as mentioned above, a product order may be shipped by way of pallets. A quantity of a product may be divided into pallets, and assigned to an assembly line, one pallet at a time. In this manner, any errors that are found to have occurred during an assembly can be traced to individual pallets. This is more convenient than having to trace errors to an entire product order.

Product orders are preferably prioritised either by the due date for delivery of the product to the customer, or by the date on which the sales order (of which the product order forms a part) was received. The product orders are then assigned to an assembly line in order of priority.

Assignment of the assembly line may take place in advance, or alternatively may take place once the next assembly line is made available.

It will be appreciated that where only one assembly line exists or is available, assignment of the assembly line is not necessary.

FIG. 3 illustrates an example of an implementation 122 of an assembly centre in accordance with an embodiment of the invention. In the example of FIG. 3, an assembly line comprises one or more computer terminals 301, each of which is operable to control aspects of the manufacturing or assembly process. For example, each computer terminal 301 may control one assembly unit or machine. The computer terminals 301 are connected to the local assembly system (for example the local assembly system 120 of FIG. 1), for example by way of a local area network (LAN) 303. The local assembly system 120 is connected to a database 305.

In the preferred embodiment, at least one manufacturing unit is automatically configured in response to the component listing. Specifically each terminal 301 is preferably automatically set up and/or configured for each new product order, or part thereof.

For example, the terminals 301 may be required to perform different functions, such as downloading software to a memory element of each product unit, configuring software and/or hardware of each product unit, final quality audit (FQA) testing each or a selection of product units,

printing label artwork, programming serial or other identification numbers, etc.

The setting up of the terminals 301 is preferably controlled/ performed automatically by the local assembly system 120. The local assembly system 120 determines from the component listing how each terminal 301 is to be set up. For example, from the component listing, the local assembly system 120 may identify any software that is to be downloaded to a product unit.

Thus, preferably, a software requirement is extracted and configured in response to the component listing. As previously mentioned, software files, or at least their location may be provided by the assembly management system 118. Where the location of such files is provided, the local assembly system 120 retrieves the required files, as identified by the component listing, and stores them in a database 305. The local assembly system 120 then automatically provides the relevant terminal(s) 301 with the location of the software files in the database 305. In this manner, when a terminal 301 is required to download software to a product unit, the required software can be retrieved from the database 305 automatically, without requiring intervention from an operator.

Alternatively, or additionally, at least one manufactured product may be configured in response to the component listing.

Thus, specifically, the local assembly system 120 is preferably able to determine from the component listing

how each product unit is to be configured. This may be achieved by each generic product and/or customisation having specific configuration settings, which can be stored, for example, in the database 305. In this manner, for each product order, the local assembly system 120 identifies the generic product and/or customisations of the product order, and retrieves the configuration information from the database 305. Thus, a terminal 301 required to perform such configuration, or instruct an operator to perform such configuration, can automatically be provided with the required configuration information, without intervention by an operator.

Additionally, or alternatively, at least one product test may be configured in response to the component listing. For example, information defining how a generic product and/or customisation is/are to be tested, e.g. for a final quality audit (FQA) can also be stored in the database 305. Such information may include what tests should be performed, how such tests should be performed, what proportion of the product order should be tested, etc. Once again, a terminal 301 required to perform such testing, or provide such information to an operator, can be automatically provided with the information retrieved from the database 305.

In an alternative embodiment, such testing may be defined by a customer in the sales order, or may be customer specific. Where this is the case, such information can be included as part of the component listing, whereby specific tests or test sets are identified by their own part numbers, etc.

Furthermore, the database 305 may store instructions for operators on how different product units are to be assembled, configured etc, depending on the generic product and any customisation thereof. The local assembly system 120 is able to determine from the component listing the appropriate instructions and automatically provide these to the relevant terminals 301.

As will be appreciated, the present invention allows the various terminals 301 of an assembly line to be automatically set up for each product order, in accordance with the relevant component listing. In this manner, each terminal 301 is automatically provided with the required information, data, instructions, etc. More importantly, the amount of manual setting up, that an Operator is required to perform, is minimal. This reduces the likelihood of mistakes being made due to human error. It also reduces the required skill level of an Operator, and therefore the amount of Operator training required.

Furthermore, since operator instructions can automatically be provided to help the Operator, even less training is required.

Preferably the database 305 is regularly updated, or synchronised with a central database or information source. In this manner, the latest files and information sources are used, and can be changed or updated at regular intervals.

Alternatively, rather than each local assembly system comprising its own database, each local assembly system may have access to a central database. However, this may in some embodiments have the disadvantage that if access to such a central database is not available for some reason, all assembly centres could become inoperable. Thus, local databases are preferred in most embodiments.

Preferably, the status of each product order is monitored by the assembly management system (for example the assembly management system 118 of FIG. 1). This may be achieved by each local assembly system 120 reporting any changes in status information to the assembly management system 118. Alternatively, the assembly management system 118 may periodically interrogate each local assembly system 120.

Specifically, the local assembly systems 120 may determine if all products included in the component list have been manufactured, packed and shipped, and if so, it may be determined that the manufacturing requirement and the sales order has been fulfilled. Thus, the system may comprise means for determining, in response to the component list, whether the manufacturing requirement has been satisfied.

FIG. 4 illustrates a flowchart 400 of a process for each sales order in accordance with an embodiment of the present invention. The method commences in step 401 with a sales order being received at one of the sales offices 110. In step 403, the sales order is manually entered into the sales terminal 112 of the sales office 110.

Step 403 is followed by step 405 wherein the sales order is passed from the sales terminal 112 to the sales and orders management system 114. The sales and orders management system 114 generates a manufacturing requirement, which in the specific example corresponds directly to the sales order, i.e. the sales order is used as the manufacturing requirement.

Step 405 is followed by step 407 wherein a component listing is generated for each product of the sales order. The component listings are then passed to the assembly management system 118 in step 409 (in some embodiments the component listings may be combined into a single file or a single component listing). In the illustrated embodiment, the sales order is also passed to the assembly management system 118.

In step 411, an at least partially automated manufacturing process manufactures a product of the sales order. The manufacturing process is controlled, at least partly, by the component list associated with the product being manufactured.

Step 411 is followed by step 413, wherein it is determined if all products of the sales order have been manufactured. If not, the process returns to step 411 wherein the next product is manufactured. Otherwise, the sales order is completed and the method terminates in step 415.

FIG. 5 illustrates a flowchart 500 of a process for each product order in accordance with a preferred embodiment

of the present invention. FIG. 5 specifically illustrates the process of step 411 of FIG. 4.

In step 501, the component listing of the product to be manufactured is passed to the local assembly system (for example local assembly system 120 of FIG. 1) that is responsible for the manufacturing of the product. The method then proceeds along two parallel paths corresponding to parallel process steps.

Step 501 is followed by step 503, wherein a materials list is extracted from the component listing. This is followed by the required physical materials being retrieved from stock, as shown in step 505.

Step 501 is additionally followed by step 507, wherein software comprised in the component listing is identified and retrieved. Step 507 is followed by step 509, wherein the assembly line is configured in accordance with configuration information comprised in and/or generated from the component listing.

Steps 505 and 509 are followed by step 511 wherein the product order is assigned to a specific assembly line. This is followed by the assigned assembly line being set-up to manufacture the product in step 513 and followed by the product being manufactured, as shown in step 515. When the product has been manufactured, the process proceeds, for example moving to step 413 of FIG. 4.

It is within the contemplation of the invention that the inventive concepts hereinbefore described are not limited to the described manufacturing system of the preferred

embodiment. Indeed, it is envisaged that the inventive concepts are applicable to any suitable manufacturing system.

It will be understood that the improved manufacturing system, as described above, tends to provide at least one of the following advantages:

(i) An improved flexibility of a manufacturing process is achieved. This is primarily achieved due to manufacturing being controlled by a component listing which may be flexibly generated and may include many diverse and varying parameters.

(ii) A low cost manufacturing process is achieved. The system is particularly suited for an automatic or semi-automatic manufacturing process, thereby obviating or reducing the requirements for manual intervention. This process reduces employee costs and also improves reliability, reduces repair costs and increases yield.

(iii) A manufacturing system suitable for a distributed operation is achieved. The manufacturing process may be directly or indirectly managed from remote locations allowing for each management function to be performed where it is most suitable.

Whilst the specific and preferred implementations of the embodiments of the present invention are described above, it is clear that one skilled in the art could readily apply variations and modifications of such inventive concepts.

Thus, an improved manufacturing system has been described where at least one of the aforementioned disadvantages with prior art arrangements has been alleviated.

**Claims**

1. A method of manufacturing comprising the steps of:

receiving a manufacturing requirement;

generating a component listing in response to the manufacturing requirement; and

controlling at least one parameter of an at least partially automated manufacturing process in response to the component listing.

2. The method of manufacturing according to claim 1 wherein the step of generating the component listing comprises performing a data look up in a data storage comprising associations between manufacturing requirements and components of component lists.

3. The method of manufacturing according to claim 1 or claim 2, wherein the step of generating the component listing comprises modifying a predetermined component listing in response to the manufacturing requirement.

4. The method of manufacturing according to any previous claim, wherein the step of generating the component listing comprises selecting the component listing from a plurality of predetermined component listings in response to the manufacturing requirement.

5. The method of manufacturing according to claim 4, further comprising the step of designating the manufacturing requirement as invalid if there is no predetermined component listing corresponding to the manufacturing requirement.

6. The method of manufacturing according to any previous claim, wherein the manufacturing requirement comprises a plurality of sub-manufacturing requirements; and the step of generating a component listing comprises collating a plurality of component listings associated with the plurality of sub-manufacturing requirements.

7. The method of manufacturing according to any previous claim, wherein each of the plurality of sub-manufacturing requirements corresponds to a subset of products associated with the manufacturing requirement.

8. The method of manufacturing according to claim 7 wherein each subset of products comprises a single product.

9. The method of manufacturing according to any previous claim further comprising the step of receiving a sales order; and wherein the step of receiving the manufacturing requirement comprises receiving the sales order and converting the sales order into a manufacturing requirement.

10. The method of manufacturing according to any previous claim, wherein the step of controlling comprises a step of extracting a materials requirement for the at least partially automated manufacturing process in response to the component listing.

11. The method of manufacturing according to any previous claim, wherein the step of controlling comprises extracting and configuring a software requirement in response to the component listing.

12. The method of manufacturing according to any previous claim wherein the step of controlling comprises automatically configuring at least one manufacturing unit in response to the component listing.

13. The method of manufacturing according to any previous claim wherein the step of controlling comprises automatically configuring at least one product test in response to the component listing.

14. The method of manufacturing according to any previous claim wherein the step of controlling comprises automatically configuring at least one manufactured product in response to the component listing.

15. The method of manufacturing according to any previous claim further comprising the step of determining, in response to the component list, if the manufacturing requirement has been met.

16. The method of manufacturing according to any previous claim wherein the steps of receiving the manufacturing requirement and generating the component listing are performed in a first location; the method further comprising the steps of at a remote second location:

generating the manufacturing requirement; and

communicating the manufacturing requirement from the second location to the first location.

17. The method of manufacturing according to any previous claim wherein the at least partially automated

manufacturing process is performed at a different location than the step of generating the component listing.

18. A storage medium storing processor-implementable instructions for controlling one or more assembly units in accordance with the method of any of claims 1 to 17.

19. An apparatus for manufacturing comprising:

means for receiving a manufacturing requirement;

means for generating a component listing in response to the manufacturing requirement; and

means for controlling at least one parameter of an at least partially automated manufacturing process in response to the component listing.

20. A method of manufacturing substantially as hereinbefore described with reference to, and/or as illustrated by, FIG. 2, FIG. 4 or FIG. 5 of the accompanying drawings.

21. An apparatus for manufacturing substantially as hereinbefore described with reference to, and/or as illustrated by, FIG. 1, FIG. 2, FIG. 3, FIG. 4 or FIG. 5 of the accompanying drawings.

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| **Application No:** | GB 0317718.5 | **Examiner:** | Ben James |
| **Claims searched:** | 1-21 | **Date of search:** | 8 December 2003 |

# Patents Act 1977 : Search Report under Section 17

## Documents considered to be relevant:

| Category | Relevant to claims | Identity of document and passage or figure of particular relevance |
|---|---|---|
| X | 1,2,6-15 &17-19 | US 2002/0188514 A1 (MACKENZIE J K et al.) Abstract |
| X | 1,2, & 6-19 | US 2002/0099612 A1 (BARNES J C et al.) Abstract |
| X | 1 & 19 | WO 03/012562 A1 (NIPPON STEEL CORP.) Abstract |

Categories:

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|---|---|---|---|
| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art |
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## Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[V]:

G4A

Worldwide search of patent documents classified in the following areas of the IPC[7]:

G06F

The following online and other databases have been used in the preparation of this search report:

EPODOC, WPI, JAPIO