

PACKAGING CONTROLLER FOR CUSHIONING PRODUCING SYSTEM

Related Application Data

This application claims priority of U.S. Provisional Application No. 60/141,452 filed on June 29, 1999 and is a continuation-in-part of U.S. Application No. 09/096,123 filed June 11, 1998, both of which are incorporated herein by reference in their entireties.

Field of the Invention

The present invention relates to a cushioning conversion system which converts sheet stock material into cushioning material. More particularly, the present invention relates to a cushioning conversion system including a packaging controller, wherein the system is adapted to provide recommended packaging and/or packaging information to an operator based on the parts to be packaged, and further to provide for programming of the packaging information, and further to provide for packaging production productivity enhancements. Features of the invention, however, have a more general application to packaging systems using various types of dunnage products and packaging supplies.

Background of the Invention

In the process of shipping a part from one location to another, a protective packaging material is typically placed in the shipping container to fill any voids, provide blocking and bracing, and/or to cushion the part during the shipping process. Some commonly used protective packaging materials are plastic or cellulose foam peanuts, plastic bubble wrap, shredded paper or cardboard, and converted paper pads. Converted paper pads, being made from paper and particularly kraft paper, are biodegradable, recyclable and composed of a renewable resource. Consequently, converted paper pads have become increasingly important in light of many industries adopting more progressive policies in terms of environmental responsibility. The conversion of paper sheet stock material into relatively low density paper pads may be accomplished by a cushioning conversion machine, such as those disclosed in U.S. Patent Nos. 4,026,198; 4,085,662; 4,109,040; 4,237,776; 4,557,716; 4,650,456; 4,717,613; 4,750,896; 4,968,291; 4,884,999; 5,607,383 and 5,836,538. (These patents are all assigned to the assignee of the present invention and their entire disclosures are hereby incorporated herein by reference.)

By controlling the conversion machine, such as through the use of a controller that may be programmed, pads of a variety of lengths can be created. This feature allows a single machine to satisfy a wide range of cushioning needs. For example, relatively short pad lengths can be employed in conjunction with small and/or unbreakable articles, while

longer pad lengths can be employed in connection with larger and/or fragile articles. Moreover, a set of pads (either of the same or different lengths and/or different configurations such as a star, a cross or a spiral/coil) can be employed in conjunction with uniquely shaped and/or delicate articles, such as electronic equipment.

5 In some instances, a manufacturer or shipping interest may ship a wide variety of parts wherein each of the parts has different packaging requirements. While a cushioning conversion system, such as that described above, can provide a wide variety of pads of different lengths at the request of the operator to meet the differing requirements, it is often a time consuming process to determine for each part presented the best way to package
10 the part and then to instruct the cushioning conversion machine to produce the required number of pads having the appropriate lengths. Also, the reliability of the packaging operation is oftentimes dependent on the skill level of the operator, in particular the packer. In the case of complex packaging systems involving the packaging of many different types of product with different packaging requirements, the necessary skill level may preclude
15 the use of low cost, low skill packers (or operators in general).

Another consequence of shipping a wide variety of parts having different packaging requirements is the variability of consumption of packaging materials used to pack the part or parts, such as dunnage stock material, tape, containers (cartons, boxes, etc.), etc. Heretofore, the monitoring of packaging material inventories was accomplished manually
20 by a person checking the inventory levels and reordering additional supplies when needed. In the case of paper sheet stock rolls used in the aforesaid cushioning conversion machines to produce dunnage pads, typically an order for the stock rolls and/or other packaging materials would be placed with a distributor. The distributor would then fill the order from stock on hand or place an order with its supplier to directly ship the packaging
25 materials to the end user. Like in the case of the end user, the monitoring of packaging material inventories at the distributor's facilities was accomplished manually by a person checking the inventory levels and reordering additional supplies when needed. These existing systems have been labor intensive and time consuming.

A need therefore exists for improvements in packaging systems, and particularly in
30 the efficient and effective packaging of parts in containers.

Summary of the Invention

According to one aspect of the invention, a packaging system comprises a packaging material supply device for supplying a packaging material; and a packaging

system controller for providing packaging instructions related to at least one part to be packaged and instructing the packaging material supply device to provide the packaging material for the at least one part to be packaged. In a preferred embodiment there is provided an output peripheral for providing packaging instructions; and the packaging
5 controller instructs the packaging material supply device to provide packaging instructions via the output peripheral.

According to another aspect of the invention, a method of packaging parts comprises the steps of identifying at least one part to be packaged; retrieving packaging instructions associated with the at least one part to be packaged; and controlling a
10 packaging material supply device using the packaging instructions.

According to a further aspect of the invention, a method of packaging differing parts, comprises the steps of determining a step by step set of packaging instructions associated with each of a plurality of parts; programming the set of packaging instructions using an instruction programming tool; and storing the set of packaging instructions for
15 subsequent retrieval.

According to yet another aspect of the invention, a packaging system comprises a packaging system controller for providing packaging instructions related to at least one part to be packaged, and a display for displaying the packaging instructions to a packer for use in packing the part, wherein the packaging instructions are programmed using an
20 instruction programming tool, the instruction programming tool having a database of previously stored images.

According to a still further aspect of the invention, a packaging system and method are characterized by a packaging system controller for sequentially providing packaging instruction steps related to at least one part to be packaged, and an output device for
25 conveying the packaging instruction step to a packer for use in packing the part, and wherein the packaging system controller automatically advances from a first packaging instruction step to a second packaging instruction step after a predetermined amount of time.

Brief Description of the Drawings

30 Figure 1 is a block diagram illustrating a packaging system according to the present invention;

Figure 2 is an illustration of a packaging system according to the present invention including a cushioning conversion machine and a packaging system controller;

Figure 3 is a block diagram illustrating a portion of the packaging system controller according to the present invention;

Figure 4 is a flow chart illustrating an operational flow diagram of the packaging system according to the present invention;

5 Figure 5 is a flow chart illustrating a packaging routine preview feature which allows a packer to verify whether the appropriate packaging routine has been retrieved for the identified part to be packaged;

Figure 6a is an output peripheral display and user interface illustrating a predetermined set of retrieved packaging instructions for an identified part to be packaged;

10 Figure 6b is an output peripheral display and user interface which highlights a method of identifying or entering the parts to be packaged according to one aspect of the present invention;

Figure 6c is an output peripheral display illustrating in greater detail a particular step of a predetermined set of retrieved packaging instructions for the packaging of the
15 identified part;

Figure 7 is a flow chart illustrating an operational flow diagram for the generation of packaging material and the provision of packaging instructions to an operator for the packaging of one or more parts;

20 Figure 8 is a flow chart illustrating the operation of the packaging system including a packaging material manipulation apparatus for either coiling generated packaging material and/or initiating a pick-and-place control routine for automated packaging;

Figure 9 is a flow chart illustrating a method for providing inventory control, inventory monitoring and automatic re-ordering for packaging materials according to predetermined consumption thresholds;

25 Figure 10 is a block diagram illustrating a programming terminal according to the present invention;

Figure 11 is a flow chart illustrating an operation flow diagram of an instruction programming tool according to the present invention;

30 Figure 12 is an output peripheral display and user interface which highlights a method of identifying instruction steps for a part to be packaged according to one aspect of the invention;

Figure 13 is an output peripheral display and user interface which highlights a method of programming an instruction step for a part to be packaged;

Figure 14 is an output peripheral display and user interface which highlights a method of accessing previously stored images;

Figure 15 is a flow chart illustrating a method for monitoring operator packaging productivity and providing a productivity report according to the present invention;

5 Figure 16 is a flow chart illustrating in greater detail an exemplary method of monitoring productivity and generating the productivity report of Figure 13;

Figures 17A-17D are flow charts illustrating in detail the operation of the packaging system of Figure 2 according to one embodiment of the present invention;

10 Figure 18 is a flow chart illustrating a method of pacing a packager and monitoring the packager's performance according to one aspect of the present invention;

Figure 19 is a first output peripheral display and user interface which highlights the method of pacing the packager and monitoring the packager's performance; and

Figure 20 is a second output peripheral display and user interface which highlights the method of pacing the packager and monitoring the packager's performance.

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Detailed Description of the Invention

The present invention will now be described with reference to the drawings wherein reference numerals are used to refer to like elements throughout. In one embodiment of the present invention, an automated packaging system and method is disclosed which includes a packaging material generator such as a cushioning conversion machine and a
20 packaging system controller. An operator, wishing to efficiently package a known, identified part, interacts with the packaging system to produce an appropriate amount of packaging material in an appropriate sequence for packaging the part within an identified container. In addition, the packaging system and method provides detailed packaging instructions to the operator in either a textual and/or pictorial format, thereby providing
25 packaging efficiency and consistency which results in reduced part damage and reduced packaging costs.

A known part to be packaged is identified by, for example, reading or entering its part identification number. Once the part to be packaged is identified, the packaging system retrieves a predetermined set of packaging instructions which uniquely correspond
30 to the identified part. The packaging instructions preferably indicate the recommended packaging container, generate the necessary packaging material and provide step by step instructions to aid the operator in the packaging of the part. Preferably, each instruction step is provided to the operator via a computer display terminal in conjunction with a length

(or amount) of packaging material generated by the packaging material generator. The packaging system reduces packaging costs by dictating the proper container and the proper amounts of packaging material. Consequently, excess, wasteful packaging voids are eliminated. In addition, the detailed packaging instructions reduce the need for highly experienced operators since the container, amounts of packaging material, the sequence with which the packaging material are generated and the manner in which the packaging material is to be used for efficient packaging is dictated and explained by the packaging system.

Referring now to the drawings in detail, and initially to Figures 1-4, a packaging system and method according to the present invention is shown. In Figure 1, the packaging system 10 includes a packaging material generator 12 for generating packaging material to be used in packaging identified parts. According to the present invention, the term "parts" is broadly used to include a single part, a kit including a known arrangement of parts, and various items requiring shipment, regardless of the nature of the part, be it an article, product, component, piece, etc. The packaging material generator 12 includes a controller 14 for controlling the various operational components (not shown) within the generator 12 as will be discussed in greater detail *infra*. A packaging system controller 16 is coupled to the packaging material generator 12 and communicates to the packaging material generator 12 via the controller 14. The packaging system controller 16 is also coupled to an output peripheral 18 and an input peripheral 20, respectively, and is operable to retrieve a predetermined set of packaging instructions in response to the identification of a part to be packaged, which is preferably identified via the input peripheral 20.

The predetermined packaging instructions are preferably retrieved from a memory (not shown) associated with the packaging system controller 16 or a communication network having a network database 21 and are selectively sent to the controller 14 and the output peripheral 18. The packaging instructions sent to the controller 14 preferably relate to the generation of particular lengths (or amounts) of packaging material in a particular sequence. In addition, as will be described in greater detail *infra*, the packaging instructions may further include post-generation packaging material manipulation control signals for manipulating the generated packaging material for particular packaging options such as coiling or the implementation of a pick-and-place functionality.

The packaging instructions which are sent to the output peripheral 18 (e.g., a computer display monitor) are preferably detailed explanatory type instructions which aid the operator in the efficient packaging of the identified part. The explanatory instructions include, for example, explanatory text accompanying graphical pictures of the part to be packaged, the packaging material, the container, etc. Preferably, the instructions provided via the output peripheral 18 clearly illustrate the manner in which the packaging material engages the parts to be packaged and how the packaging material engages the packaging container to properly and efficiently secure the part within the container. Such instructions may further include video type instructions including audio data, as may be desired. The packaging instructions may also include pre and/or post packaging information such as instructions for selecting and erecting a particular container, inserting a liner, taping instructions, shipping instructions, etc.

Turning now to Figure 2, the packaging system 10 of Figure 1 according to a preferred embodiment of the present invention is illustrated. The packaging system 10 includes a cushioning conversion machine 12 as the packaging material generator and a personal computer 16 constitutes the packaging system controller of Figure 1. The personal computer 16 is coupled to an input peripheral 20 (not shown) such as a keyboard, a bar code reader, a mouse, etc. for entering data or commands. The personal computer 16 is also coupled to a display monitor 18 which corresponds to the output peripheral 18 of Figure 1 and may also be connected to a computer network. The input peripheral 20 and the display monitor 18 are used for operator interaction with the cushioning conversion machine 12.

The cushioning conversion machine 12 preferably includes a frame 24 upon which the various components of a conversion assembly 25 are mounted and a machine controller 14 (which is illustrated schematically) for controlling the cushioning conversion machine 12 including the components of the conversion assembly 25. The frame 24 has mounted thereto or included therein a stock supply assembly 26 including a web separating assembly and stock support bar (not shown) which holds a roll of stock (e.g., paper) for conversion by the conversion assembly 25 into a cushioning material (not shown). The illustrated conversion assembly 25 is composed of plural conversion assemblies including a forming assembly 30, a feeding/connecting assembly 32 powered by a feed motor 34, and a severing or cutting assembly 36 powered by, for example, a cut motor 38 selectively engaged with the cutting assembly 36 by a clutch 40. Also provided is

a post-cutting constraining assembly or outlet 42 for guiding the cushioning material from the cutting assembly.

During the conversion process, the forming assembly 30 causes the lateral edges of the stock material (not shown) to turn inwardly to form a continuous strip having two lateral pillow-like portions and a central band therebetween as such stock material is advanced through the forming assembly. The feeding/connecting assembly 32, including a pair of meshed gear-like members (gears) in the illustrated cushioning conversion machine, performs a feeding, e.g., pulling, function by drawing the continuous strip through the nip of the two cooperating and opposing gears of the feeding/connecting assembly 32 by drawing the stock material through the forming assembly 30 for a duration which is determined by the length of time that the feed motor 34 rotates the opposed gears. The feeding/connecting assembly 32 additionally performs a "connecting" function as the two opposed gears coin the central band of the continuous strip as it passes therethrough to form a coined strip. As the coined strip travels downstream through the feeding/connecting assembly 32, the cutting assembly 36 cuts the strip into sections of a desired length. These cut sections exit from the post-cutting constraining assembly 42 and are then available for use in the packaging of the part.

The machine controller 14 is preferably a microprocessor based programmable controller such as that described in co-owned U.S. Patent No. 5,897,478 issued April 27, 1999, incorporated herein by reference. The machine controller 14 controls the operation of the various components of the cushioning conversion machine 12 (e.g., the feeding/connecting assembly 32, or more specifically the feed motor 34, and the cutting assembly 36, or more specifically the cut motor, etc.) to form one or more pads of particular lengths in accordance with a number of control signal inputs. Such control signal inputs may include inputs from machine sensors, such as maybe employed to detect jams or accurately measure pad length formation, for example, and inputs from the personal computer 16 (i.e., the packaging system controller) via a control line 44. Specifically, when it is desired that an appropriate length of pad be formed, the machine controller 14 causes power to be supplied to the feed motor 34 for a duration which is sufficient for the conversion assembly 25 to produce the desired length of pad. Power to the feed motor 34 is then disabled and the machine controller 14 causes the cut motor clutch 40 to engage the cut motor 38 with the cutting assembly 36 to sever the pad at the desired length.

Referring now to Figure 3, a detailed block diagram of the packaging system controller 16 of Figure 1 is shown in accordance with a preferred embodiment of the present invention. The packaging system controller 16 preferably includes a central processing unit (CPU) 50 which is coupled to a bus 52. The CPU or processor 50 can be
5 any of a plurality of processors, such as a Pentium™, a Power PC™, Sparc™, or any other similar and compatible processor. The CPU 50 functions to perform various operations described herein as well as carries out other operations related to the packaging system controller 16. The manner in which the CPU 50 can be programmed to carry out the functions relating to the present invention will be readily apparent to those having ordinary
10 skill in the art based on the description provided herein. The bus 52 includes a plurality of signal lines 54 for conveying addresses, data and control between the CPU 50 and a number of system bus components. The other system bus components include a memory 58 (including a random access memory (RAM) 60 and a read only memory (ROM) 62) and a plurality of ports for connection to a variety of input/output (I/O) devices which collectively
15 comprise the output peripheral 18 and the input peripheral 20, respectively. The memory 58 serves as data storage and may store appropriate operating code to be executed by the CPU 50 for carrying out the functions described herein.

The RAM 60, hard drive 78 or other type storage medium provides program instruction storage, working memory for the CPU 50 and the predetermined packaging
20 instructions associated with the particular parts to be packaged. Preferably, the packaging instructions correspond to the parts to be packaged through a look-up table, however, other storage and retrieval techniques such as an algorithmic search engine are contemplated as falling within the scope of the present invention. For example, the predetermined packaging instructions may be stored on the hard drive 78 or other data
25 storage medium (e.g., a CD-ROM) and be accessed by the CPU 50 according to program instructions within the RAM 60.

The ROM 62 contains software instructions known as the basic input/output system (BIOS) for performing interface operations with the I/O devices. Also stored in the ROM 62 is a software routine which operates to load a boot program. The boot program will
30 typically be executed when the packaging system controller 16 is powered on or when initialization of the packaging system controller 16 is needed.

The I/O devices include basic devices such as data storage devices (e.g., floppy discs, tape drives, CD-ROMs, DVD-ROM, CD-RW, hard discs, etc.). Typically, the I/O

devices communicate with the CPU 50 by generating interrupts. The CPU 50 distinguishes interrupts from among the I/O devices through individual interrupt codes assigned thereto. Response of the CPU 50 to the I/O device interrupts differ, among other things, on the devices generating the interrupts. Interrupt vectors may also be provided to
5 direct the CPU 50 to different interrupt handling routines.

The interrupt vectors are generated during initialization (*i.e.*, boot up) of the packaging system controller 16 by execution of the BIOS. Because responses of the CPU 50 to device interrupts may need to be changed from time to time, the interrupt vectors may need to be modified from time to time in order to direct the CPU 50 to different
10 interrupt handling routines. To allow for the modification of the interrupt vectors, they are stored in the RAM 60 during operation of the packaging system controller 16.

A disk control subsystem 70 bi-directionally couples one or more disk drives 72 (*e.g.*, floppy disk drives, CD-ROM drives, DVD-ROM drives, CD-RW drives, etc.) to the system bus 52. The disc drive 72 works in conjunction with a removable storage medium
15 such as a floppy diskette or CD-ROM. A hard drive control subsystem 76 bi-directionally couples a rotating fixed disk or hard drive 78 to the system bus 52. The hard drive control subsystem 76 and hard drive 78 provide mass storage for CPU instruction data, for example.

The disk drive 72 and disk control subsystem 70 may be utilized to download one
20 or more pieces of data to the RAM 60 or system hard drive 78. For each part or collection of parts, for example, data relating to the proper container to be used for packaging, the part identification number, the packaging material generation control requirements (both the amount and sequencing) and user packaging instructions (including text, graphics, digital photos and/or video data) may be provided. Therefore as the packaging
25 requirements change or additional parts are required to be packaged, the packaging system controller 16 can be dynamically updated.

A terminal control subsystem 86 is also coupled to the bus 52 and provides output to the output peripheral 18, typically a CRT or LCD monitor, but could also include a printer, and receives inputs from a manual input device 20 such as a keyboard. Manual
30 input may also be provided by a pointing device such as a mouse or other type input peripherals such as a bar code reader, scanner or digital camera. In addition, the input device 20 may include a microphone for receiving voice instructions and be processed by the CPU 50 according to voice recognition techniques as is well known by those skilled in

the art. Further, the input peripheral 20 may include a touch activated display such as a capacitive touch screen. Any type of data input device is contemplated as falling within the scope of the present invention.

A network adapter 90 is provided for coupling the packaging controller 16 to a
5 network. Such a network adapter 90 is coupled to the system bus 52 and allows for providing communication linkage to other systems either local or remote to the packaging system 10. In addition, other types of computer hardware may also be connected to the bus 52. For example, a modem 91 may be provided for transmitting, according to instructions provided by the CPU 50, various pieces of information such as re-order
10 requests to inventory distributors for updating inventories in the event that re-order thresholds are satisfied. The modem 91 may establish direct data connections or exchange data messages and signals over a network such as a WAN, LAN or the Internet.

Turning now to Figures 3 and 4, a method 100 is provided in which the packaging system 10 of Figure 1 provides packaging material and packaging instructions to a user.
15 The method 100 preferably begins with the entry of an identification number of a known part to be packaged at step 102. The identification step 102 may be carried out in a number of ways. For example, the part may have a part identification number on it which may be manually input to the packaging system controller 16 via the input peripheral 20 such as by typing the part number into the system using a keyboard or keypad.
20 Alternatively, a pull-down menu illustrated on the output peripheral 18 (e.g., the computer display) may be accessed using a mouse as the input peripheral 20. The pull-down menu may include a list of all the known parts which have associated sets of predetermined packaging instructions in the packaging system 10. By selecting the part number in the pull-down menu using the mouse, the part to be packaging is identified.

25 In yet another alternative method of entering the part to be packaged, step 102 may include reading the part identification number from the part (or its associated packaging request paperwork) using a pattern recognition device such as a bar code reader or a video monitor with optical character recognition. In still another alternative method, the input peripheral 20 may include a microphone for receiving audio signals and
30 the part may be entered by reading aloud the part number into the microphone of the packaging system 10. In such a case, the microphone receives the acoustic sounds and transmits the data to the CPU 50 which identifies the part using voice recognition techniques. For example, the microphone may receive the acoustic sounds and convert

the sounds into analog signals and then transmit the data to the CPU 50 which converts the audio data into digital data using, for example, an A/D converter. Lastly, although a few methods of identifying the part 102 are described above, it should be understood that other methods exist for identifying the part and each is contemplated as falling within the scope of the present invention.

Once the part is entered, the CPU 50, according to the programmed instructions within the RAM 60, retrieves a packaging control methodology which includes a predetermined set of packaging instructions which are associated with the identified part as step 104. The data used is retrieved from an associated memory such as the hard drive 78 or a data recording medium in the disk drive 72 or the network drive. For example, the instructions may be stored on the hard drive 78 or on a CD-ROM in the disk drive 72, or obtained from a remote storage device or memory via the modem 91 or network adapter 90. Upon identifying the part to be packaged, the CPU 50 retrieves the packaging instructions associated with the part at step 104.

In a preferred method of the present invention, the CPU 50 uses a look-up table or an algorithmic search engine to retrieve the predetermined packaging instructions. In such a method, each part number is tied to an address space which contains the packaging instructions associated with the part number. The CPU 50, using the addresses corresponding to the address space, retrieves the instructions and discriminates which instructions pertain to packaging material generator control instructions and which are directed toward operator packaging instructions. According to the present invention the term "operator" is used to broadly mean anyone interfacing with the packaging system and may include, for example, a packer, a customer, a user, a supervisor, etc.

The CPU 50 sends the instructions directed to packaging material generator control to the controller 14 of the packaging material generator 12 to initiate the generation of the appropriate amount of packaging material in the proper sequence. For example, in the preferred embodiment of the present invention, the packaging material generator 12 is a cushioning conversion machine. In such a case, the control instructions to the controller 14 will dictate how many cushioning pads to produce to properly package the part, the proper length for each pad and the order or sequence in which the pads will be produced. Therefore the retrieved packaging instructions from the CPU 50 will provide for the control of the packaging material generator at step 108 of Figure 4.

The CPU 50 also sends the instructions directed to the operator to the output peripheral 18 (preferably a computer display) to provide step by step explanatory instructions at step 110 to ensure that the packaging material generated by the generator 12 is properly used in packaging the part and that the part is being packaged in the proper container. Preferably, the instructions consist of text and graphics data which are used by the CPU 50 to drive the output peripheral 18 and thereby provide pictorial outputs with accompanying textual instructions. In addition, the instructions are preferably provided in a sequence which correspond to the order in which the packaging material is generated. Although the preferred embodiment of the present invention provides the packaging instructions at step 110 using graphics and text, the packaging instructions may also further include video and/or audio data for the packaging instructions. Any form of packaging instructions is contemplated as falling within the scope of the present invention.

Therefore if the identified part to be packaged requires three pieces of cushioning pads to be generated in lengths of 12", 18" and 15", respectively, the packaging instructions which are retrieved by the CPU 50 will result in a generation of a 12" cushioning pad while a graphical illustration with an accompanying textual explanation of how to use the 12" pad to properly package the part will be provided on the display 18. Once the operator takes the 12" pad, the cushioning conversion machine 12 detects the condition (preferably through use of a sensor) and then automatically generates the next pad (the 18" pad) according to the predetermined packaging instructions, while a graphical illustration with accompanying text is provided on the display 18 to illustrate how to properly utilize the generated pad. Lastly, after the second pad is taken by the operator, the last pad is produced by the cushioning conversion machine 12 with its associated instructions on the display to illustrate how to complete the packaging process. Consequently, the present invention ensures that the proper packaging container and the proper amount of packaging material is used in the packaging of an identified part. In addition, the packaging system 10 provides the proper amount of packaging material in the proper sequence and provides guidance in the packaging of a part within the proper container to ensure that the part is efficiently packaged independently of the experienced level of the operator. Furthermore, the present invention results in the elimination of waste packaging material, enables packaging consistency and reduces packaging damage.

In the above example, a cushioning conversion machine was used as the packaging material generator 12. Although a cushioning conversion machine is used in

the preferred embodiment of the present invention, the packaging system 10 may also be used in conjunction with other types of packaging material generators or dispensers, such as Styrofoam peanut generators and/or dispensers, bubble-wrap generators and/or dispensers, air pad machines, void fill generators (e.g., material shredders), etc. Any type of packaging material generator and/or dispenser (i.e., any packaging material supply device) is contemplated as falling within the scope of the present invention. In addition, in the above example, the packaging instructions of step 110 were limited to identifying the proper packaging container and how to utilize the generated packaging material to pack the identified part. The packaging instructions may, however, include additional instructions such as specifying which type of packaging tape or sealer to use in closing the container, how to seal the container using the tape, whether documentation is to be included within the container and what type of mailing label to use. In addition, the packaging instructions may include pre-packaging instructions such as instructions relating to the selection and erection of the proper container, etc.

In addition to the features of Figure 4, the method 100 may also include a preview feature, as illustrated in Figure 5. Once the known part to be packaged is identified (step 102) and the CPU 50 retrieves the packaging control methodology (i.e., the packaging instructions, step 104), the CPU 50 sends the packaging preview data to the output peripheral 18 which allows the operator to view the identified part and all the steps involved in the packaging process at step 112. The preview feature allows the operator to verify whether or not the proper part has been identified at step 114. For example, if after reviewing the display packaging preview at step 112 the operator determines that the wrong part has been identified (i.e., the part identification number was incorrectly entered, etc.), the operator can return to the beginning of the method 100 and repeat the step of identifying the part to be packaged at step 102 (i.e., re-enter the part identification number) prior to generating any packaging material, thereby avoiding potential waste. If, however, the operator verifies through use of the preview screen that the identified part is the correct part at step 114, the method 100 continues and the CPU 50 sends the predetermined instructions to the controller 14 and display 18 (steps 108 and 110) for the packaging of the identified part.

The method 100 of Figure 5 is illustrated in greater detail according to an exemplary embodiment of the preview display feature shown in Figures 6a -6c and in the flow chart of Figure 7. Figure 6a is an exemplary display screen on the output peripheral

18. Figure 6a preferably includes a windows-type display interface 120 having a part identification window 122, a part title box 124 and a box number window 126 for displaying the proper packaging container which corresponds to the identified part. The interface 120 further includes a window 128 which allows a user to indicate how many of the identified parts are to be packaged and a preview window 130 which illustrates a preview of the packaging process associated with the identified part. The preview window 130 includes, for each step in the packaging process, a step identifier 132a, a packaging material amount identifier 132b, a window 132c which indicates the number of pads required to complete the identified step, and a packaging illustration box 132d. Lastly, the interface 120 includes a preview acceptance window 134 which allows a user, after reviewing the preview window 130, to verify that the packaging instructions are correct ("Accept") or exit the process ("Exit").

Once the part to be packaged is entered, however, the CPU 50 retrieves the packaging instructions and inputs the various pieces of data onto the screen as shown in Figure 6a such as the identification of the packaging container and the box number window 126 and the name of the part in the part title box 124. Preferably, the number of parts to be packaged is manually input into the box 128, however, the present invention may automatically receive such data when reading the part identification number or, alternatively, an order, job or lot number. In addition, the preview of the packaging methodology for the identified part is displayed by the CPU 50 in the window 130 for verification by the user.

One manner of identifying the part to be packaged is simply entering the part identification number into the window 122. Alternatively, one may also use a pull-down menu using a mouse, as illustrated in Figure 6b, by scrolling up and down within the pull-down menu. A user may then select the proper part from all the known parts which are listed within the system 10. Once selected, the CPU 50 retrieves the predetermined packaging functions associated with the identified part from the memory (e.g., hard drive 78 or external drive 72) and populates the windows 124, 126 and 130. The user may then verify the instructions by evaluating the preview window 130 and selecting the proper option in the preview acceptance window 134.

If the packer selects "Accept" in the preview acceptance window 134, the packaging system 10 begins the packaging process by using the retrieved packaging instructions to control the packaging material generator 12 and provide the display

instructions such as providing pre-packaging instructions such as the selection of the proper container, instructions regarding how to utilize the generated packaging material, and post-packaging instructions such as how to properly seal the container and where to send the completed package (steps 108 and 110, respectively). One exemplary display instruction corresponding to step 110 is illustrated in Figure 6c. In Figure 6c, the output peripheral 18 displays an enlarged packaging display window 144 having, for example, two graphical display regions 146a and 146b and a text explanation region 146c. The graphical regions 146a and 146b may consist of one or more pictures and/or textual annotations which illustrate how the packaging material which is produced by the packaging material generator 12 is used to secure the identified part within the selected container. The text explanation window 146c preferably identifies which step within the packaging process is being executed, which pad for the step is being illustrated (when multiple pads are being used for a single step), and the length of the pad being produced. In addition, the window 146c may include further text instructions to further aid the operator in the packaging of the identified part. Lastly, the packaging display window 144 includes a stop/finish function region 148 which allows the user to stop the process or indicate that the packaging step is completed.

Preferably, the packaging display window 144 uses text and graphics to communicate and explain the packaging step to the operator. Alternatively, the packaging instructions may further include video and/or audio data and therefore the display window 144 may include a video illustrating the packaging procedure with accompanying audio instructions. Once the operator clicks or otherwise activates the stop/finish region 148, the CPU 50 returns the operator to a display window 120 similar to Figure 6a.

A detailed flow chart illustrating the steps involved in providing the retrieved packaging instructions (steps 108 and 110) to the packaging material generator 12 and to the output peripheral 18 is provided in Figure 7. The CPU 50 begins at the first part to be packaged at step 150. In some cases, instead of simply packaging a single part, a plurality of identical parts will need to be packaged (see window 128 of Figure 6a). The present invention contemplates providing instructions for either a single or multiple parts to be packaged, as may be desired. The CPU 50 then begins at the first step of the packaging process (step 152) where it begins providing the packaging instructions for the first step in the packaging process at step 154. As illustrated in Figure 6a, for example, the first step may include the forming of a single pad having a length of 60" into a coil and

placing the coil in the packaging container so that it underlies the part to be packaged within the container. In conjunction with providing the packaging instructions on the output peripheral 18 to the operator, the CPU 50 transmits the appropriate control signals to the controller 14 at step 156 to generate the appropriate packaging material to complete the first step, that is, generating a pad having a length of 60". After completing the first step, the CPU 50 determines whether all the steps are complete at step 158. Since the packaging process for the part in this particular example includes three separate packaging steps, the method proceeds to step 160 where the CPU 50 increments to the next step of the packaging process (i.e., step 2).

In the second step of the packaging process, the CPU 50 provides the packaging instructions for the second step at step 154. As illustrated in Figure 6a, the second step may include the forming of a single pad having a length of 60" into a coil and placing the coil in the box so that it also underlies another portion of the part to be packaged within the container. In conjunction with sending the packaging instructions to the output peripheral 18, the CPU 50 transmits the appropriate control signals to the controller 14 in step 156 in accordance with the packaging instructions to generate the appropriate packaging material to complete the second step. After completing the second step, the CPU 50 again determines whether all the steps are completed at step 158. Since the packaging process is still not complete, the method continues to step 160 and again provides packaging instructions at steps 154 and 156, respectively.

After the completion of all three steps, the CPU 50 determines that the steps are completed at step 158 and then the packaging process for that particular part is completed and the method continues to step 162, wherein the CPU 50 queries whether all the parts that need to be packaged are complete. If additional parts still remain to be packaged, the method continues to step 164 and the CPU 50 increments to the next part and again begins the packaging process step at step 152. If all the parts to be packaged are completed at step 162, the CPU 50 continues to step 166 and the packaging process is completed.

As stated above, the CPU 50 retrieves packaging instructions which constitute a packaging control methodology which is associated with the identified part to be packaged. The packaging instructions which are retrieved by the CPU 50 in response to the identification of the part to be packaged include both control instructions to control the operation of the packaging material generator 12 and operator instructions to help the

operator properly use the generated packing material so as to efficiently package the part within the specified container.

In addition to the above packaging instructions, the packaging instructions may further include packaging material manipulation instructions which provide control functions in addition to the generation of the packaging material. For example, the packaging material manipulation instructions may include instructions to activate a coiler 168 (FIG. 1) to take a cushioning pad which has been produced by the packaging material generator 12 and form a coil with the pad for use in packaging the part within the packaging container.

Alternatively, the manipulation instructions may activate a pick-and-place apparatus 169 (FIG. 1) to effectuate an automated system to take a generated pad and place it into a packaging container without the need of an operator. In yet another alternative arrangement, an automated packing mechanism such as the pick-and-place apparatus 169, a robot or a pad insertion system may be used in conjunction with an operator to improve the productivity of the packing station. Although a coiling operation and a pick-and-place control functionality are provided as two examples for the packaging material manipulation instructions, additional packaging material manipulation instructions may also be included and are contemplated as falling within the scope of the present invention. Like the packaging instructions, the packaging material manipulation instructions are predetermined and are associated with the particular part to be packaged and therefore are retrieved by the CPU 50 after the part has been properly entered.

Turning now to Figure 8, a flow chart is disclosed which illustrates an exemplary flow diagram by which the CPU 50 retrieves the packaging instructions which include the packaging material manipulation instructions and how the packaging material manipulation instructions are utilized by the system in providing additional control functionality. Figure 8 illustrates a method 170 by which additional control functionality is provided using the retrieved packaging instructions from the CPU 50. As discussed, the CPU 50 retrieves the packaging instructions which correspond to the part to be packaged and sends the control instructions to the packaging material generator 12 at step 108. The packaging instructions also include the packaging material manipulation instructions. At step 172, the CPU 50 queries whether the material which is being generated by the packaging material generator 12 is to be coiled. If the packaging instructions indicate that the packaging material is to be coiled (YES), the coiler 168, which is functionally coupled to the

packaging material generator 12, is activated at step 174 and the generated packaging material, having a length in accordance with the packaging instructions, is coiled at step 176 using the coiler 168 which is functionally coupled to the packaging material generator. After being coiled at step 176, two options exist, which depend upon the control

5 instructions. In one case, the coiled packaging material is simply made available to the operator to manually take and utilize the coil in the packaging of the part at step 178. In another case, the packaging instructions further include control instructions which initiate the pick-and-place apparatus 169, for example, at step 180. The control instructions dictate a control routine which allows the pick-and-place apparatus 169 to take the coiled
10 packaging material and automatically place it within the packaging container.

Alternatively, if at step 172 the packaging instructions do not contain any control signals requiring the generated packaging material to be coiled (NO), the generated packaging material may simply be made available to the operator for use in packaging the identified part at step 182. Alternatively, however, the packaging instructions may include
15 control instructions for the initiation of the pick-and-place apparatus 169 for use in an automated packaging routine at step 184.

As previously discussed, the cushioning conversion machine 12 includes a controller 14 which controls the operation of the cushioning conversion machine 12. In addition, the controller 14 also controls the coiler 168 based on the packaging instructions
20 provided by the packaging system controller 16 of Figure 1. In this manner, the coiling apparatus 168 may operate in conjunction with the cushioning conversion machine 12 to provide additional manipulation control to the packaging material in accordance with the retrieved packaging instructions by the CPU 50. The operation of the coiler 168 is also described in U.S. Patent Application Serial Nos. 09/551,094 filed April 18, 2000 entitled
25 "Cushioning Conversion System and Method for Making a Coil of Cushioning Product" and 60/172,060 filed December 23, 1999 entitled "Cushioning Conversion System, Handheld Coiler and Method for Producing Coiled Cushioning Product, each incorporated by reference herein in their entirety.

As discussed *supra*, an alternative packaging material manipulation apparatus may
30 include the packaging material pick-and-place system 169 (FIG. 1), Example pick and place type systems contemplated by the present invention such as the one described in U.S. Patent No. 5,749,821 entitled "Cushioning Conversion System for Converting Paper

Stock into Cushioning Material with a Staging Area and a Pick and Place Assembly", which is incorporated by reference herein in its entirety.

The packaging material manipulation control feature of the present invention has been discussed in conjunction with the coiler 168 and the pick-and-place system 169, however, these devices are merely exemplary and this feature extends to other manipulation control functions such as robotic control functionality for automated packaging. Other types of dunnage manipulators and manipulation techniques include the pad discharge and insertion apparatus shown and described in U.S. Patent Application No. 09/156,109 filed on September 18, 1998 entitled Dunnage Pad Production and Packaging System, which is hereby incorporated herein by reference in its entirety. In addition, although the discussion of the packaging material manipulation control feature was disclosed in conjunction with the cushioning conversion machine 12 of Figure 2, this feature extends to other types of packaging material generators and/or dispensers which are contemplated as falling within the scope of the present invention.

The packaging system 10 of Figure 1 may also be utilized to provide an inventory control feature which tracks the consumption of various packaging items or materials in conjunction with its automated generation and supply of packaging material. One exemplary method 350 of providing such inventory control (which may alternatively be considered a monitoring of consumption) is illustrated in Figure 9. As discussed previously in conjunction with Figure 4, the packaging system 10 identifies the part to be packaged at step 102 and the CPU 50 retrieves the packaging control methodology consisting of packaging instructions at step 104. Using the packaging instructions, the packaging material generator is controlled at step 108 while an operator is concurrently receiving graphical and textual packaging instructions on an output peripheral 18, such as a CRT display, at step 110.

As each part is packaged, various items associated with the packaging process are consumed. For example, each part is packaged within a particular packaging container or box and each part uses a specified amount of packaging material. In addition, the packaging of the part also includes the use of a specified amount of packaging tape depending on the specified container size as well as other materials such as the insertion of warranty cards, manufacturer's documentation, etc. into the packaging container. As these various packaging materials are consumed during the packaging process, inventories of these items are depleted. The present invention monitors the consumption

of these packaging items and automatically generates re-order requests when the inventory control level of the packaging material has dropped below a pre-set value, thus ensuring that inventories are not fully depleted at inopportune times.

The method 350 monitors the amount of packaging materials consumed by the packaging material generator 12 at step 352, wherein, for example, the packaging system controller 16 keeps track of the number of each type of packaging container used at step 354, calculates the amount of packaging material used by the machine 12 at step 356, and keeps track of the other various packaging items at step 358, respectively.

In one example of the present invention, step 354 is performed when the packaging instructions have been retrieved by the CPU 50 and confirmed by the operator. Since the packaging instructions preferably identify the appropriate packaging container, the CPU 50 updates a list within a memory such as an inventory database to indicate that one of the identified containers has been used. Similarly, since the packaging instructions will dictate the amount of packaging material to be generated and used for the packaging of the identified part (e.g., three pads each having a length of 60" in Figure 6a) the CPU 50 calculates the total amount of packaging material that will be used and updates the list within the memory. Lastly, for each identified part, the packaging instructions will preferably dictate the amount of packaging tape to be used as well as which additional items such as warranty cards and documentation are to be packaged within the container. The CPU 50, using the retrieved packaging instructions, then updates a list within the memory. As the list within the memory is continuously updated, the CPU 50 takes each item within the list and compares them with predetermined re-order thresholds either continuously or periodically, as may be desired. If an item in the updated list satisfies its associated re-order criteria or threshold, the CPU 50 generates a re-order request at step 360 (Figure 9). In addition, the CPU 50 may generate a consumption report using the updated list at step 362 for review as may be desired. Preferably, the re-order thresholds may be adjusted as may be desired. Therefore if, for example, procurement procedures change so that re-ordering may be made at lower inventory levels, the re-order threshold may be adjusted, thereby making the packaging system dynamic.

The re-order thresholds may also be dynamic in the sense that the threshold is a function of the packaging rate. For example, if the packaging system controller 16 via the CPU 50 identifies that the rate of consumption of the various packaging materials is above a certain rate, the packaging system controller 16 may increase one or more thresholds to

ensure that a re-order request is generated soon enough to ensure that inventories are not unduly depleted. Likewise, if a consumption rate falls below a predetermined rate, the packaging system controller 16 may decrease one or more thresholds to ensure that a re-order request be generated at a later time since the time required to consume the remaining inventory will be greater and thus prevent excess inventories from being generated.

According to the present invention, the method 350 may provide a re-order request in various ways. For example, when the CPU 50 determines that a packaging item such as packaging tape must be re-ordered (e.g., the amount of remaining packaging tape falls below the associated re-order threshold), the CPU 50 may send the re-order message requesting that packaging tape be ordered to the output peripheral 18 (e.g., the display) so that the operator can communicate the re-order request to personnel in an inventory control department. Alternatively, the CPU 50 may, using the network adaptor 90 of Figure 3 transmit the re-order request directly to inventory control or the purchasing department over a local network. In yet another alternative aspect of the present invention, the CPU 50 may, using a modem, for example, transmit the re-order request directly to the appropriate inventory distributor or to a packaging materials manufacturer for production planning purposes. In any event, the present invention provides an automated inventory control system and method to continuously monitor the consumption of one or more packaging materials and re-order the materials prior to their complete depletion.

Preferably, the CPU 50 updates the packaging materials at various times instead of continuously. For example, instead of the CPU 50 decrementing an amount paper each time a cushioning conversion machine produces a length of dunnage, the CPU 50 may alternatively, decrement the amount of paper each time a roll of paper is completely consumed and is being replaced by a new roll. Such a function can be effectuated by a sensor which identifies the end of a roll. Similarly, the CPU 50 can update the packaging materials list each time a roll of tape is completely consumed, etc.

In yet another aspect of the present invention, the method 350 of Figure 9 may operate in conjunction with multiple packaging material generators 12. In such a case, the memory containing the updated list is shared over a computer network linking the packaging system controllers 16 of each packaging system 10. As each packaging

system 10 consumes various packaging items, the global list is then continuously updated.

Referring now to Figures 1 and 10, a programming terminal 1000 is illustrated. The programming terminal 1000 is used to program the packaging control methodology
5 described above and provide the methodology, including the control signals for the packaging material generator 12 (step 108 of Figure 5) and the packaging instructions to be displayed on the output peripheral display 18 (step 110 in Figure 5), to the packaging system 10. The programming terminal 1000 is a computing device very similar to the packaging system controller 16 illustrated in Figure 3. The programming terminal 1000
10 can be connected directly to the packaging system 10 or located remotely and communicate with the packaging system 10 via a network interface. Alternatively, the programming terminal 1000 can generate packaging control methodology sets, or instruction sets, saved on machine-readable medium or on the network database 21 to be read by the packaging system controller 16. One skilled in the art will appreciate that the
15 operational logic of the programming terminal 1000 described below can be executed on the packaging system controller 16, thus alleviating the need for a programming terminal 1000 separate from the packaging system controller 16.

The programming terminal 1000 includes a computer system 1002. The computer system 1002 has a processor 1004 for executing instructions, usually in the form of
20 computer code (i.e., software), to carry out a specified logic routine and a memory 1006 for storing data, software, logic routine instructions, computer programs, files, operating system instructions, and the like. The memory 1006 can comprise several devices and includes, for example, volatile and non-volatile memory components. Volatile components typically do not retain data values upon a loss of power. Non-volatile retain data upon the
25 loss of power. Thus, the memory 1006 can be, for example, random access memory (RAM), read only memory (ROM), hard disk, floppy disk, compact disk (including, but not limited to, CD-ROM, DVD-ROM, and CD-RW), tapes, and or other memory components, including drives and players for these memory types.

The processor 1004 and the memory 1006 are coupled to a local interface 1008.
30 The local interface 1008 can be, for example, a data bus with accompanying control bus, or a network between a processor and/or processors and a memory or memories. The computer system 1002 also has a video interface 1010, a number of input interfaces 1012,

a modem and/or network adapter 1014, a number of output interfaces 1016, each being coupled to the local interface 1008.

The programming terminal 1000 also has a display 1018 coupled to the local interface 1008 via the video interface 1010. Although shown as a cathode ray tube (CRT), the display device may alternatively be, for example, a liquid crystal display (LCD), a plasma display, an electro-luminescent display, indicator lights, or light emitting diodes. In addition, the programming terminal 1000 has several input devices, including, but not limited to, a keyboard 1020, a mouse 1022, a microphone 1024, a scanner 1026 and a camera 1028, each being coupled to the local interface 1008 via the input interfaces 1012.

It is noted that the camera 1028 can be, for example, a digital still picture camera or a video camera. The modem or network adapter 1014 is coupled to an external network or some other computing device 1030, allowing the exchange of data signals, voice signals, video signals and the like via the external network 1030, as is well known in the art. The external network 1030 may be, for example, the Internet, a wide area network (WAN), a local area network (LAN), direct data link or other similar network. It is noted that the programming terminal 1000 can be accessed and used by a remote user via the external network 1030 and modem 1014. The programming terminal 1000 can also include output devices coupled to the local interface 1008 via the output interfaces 1016, such as audio speakers 1032, a printer 1034, and the like.

The computer system 1002 is programmed to display and execute an instruction programming tool in graphical user interface (GUI) format. Alternatively, the computer system 1002 has logic stored in the memory 1006 capable of being executed to display and function as the instruction programming tool. As is known in the art, the GUI includes a menu bar disposed across the top of the display 1018, having a series of pull down menus from which a programming terminal 1000 administrator, or user, can access various features of the instruction programming tool. As is appropriate, the GUI will also have pop-up menus to illustrate selection choices when a certain feature is selected, scroll bars allowing the user to navigate through a displayed window, drop-down menus which drop down from the menu bar or other selected area, and content sensitive menus for highlighting options available or unavailable to the user depending upon the context of the selected content sensitive menu.

With additional reference to Figure 11, an instruction programming tool logic routine 1050 is illustrated. Upon activating the logic routine 1050, the user of the programming

terminal 1000 is requested to log in using a password scheme or digital signature verification scheme in step 1052. The log in step 1052 provides a measure of access control to the instruction programming tool. Once logged in, the instruction programming tool will display GUI windows relating to various aspects of the instruction programming tool on the display 1018.

With additional reference to Figure 12, an example window 1054 is illustrated. The window 1054 has a menu bar 1056 having drop down menus including, for example, a file menu, an edit menu, and a report menu. The file menu contains links and commands that are generally well known in the art and include file manipulation commands such as new, open, close, save, save as, print and exit.

The edit menu contains selectable links to features which are specific to the instruction programming tool and include, for example, settings, new/add part, edit part, new/add supplies, edit supplies, new/add vendors, and edit vendors. Using a mouse pointer 1058, as is well known in the art, the user can select the various commands appearing under the edit menu. Programming of the packaging system controller 16 generally begins in step 1060 by programming basic operating parameters of the packaging system controller 16. This is accomplished by choosing the settings menu item from the edit menu. Upon selecting the settings menu item, the instruction programming tool will generate a settings window (not shown) and display the settings window on the display 1018. The settings window contains various selection menus and fields to be populated by the user. These menus and fields include a machine type field for specifying the type of packaging material generator 12 to be controlled, a location of the packaging material generator 12 (such as the United States or Europe), a measurement unit field (such as English inch measurements or metric centimeter measurements), access control information used by the logic routine 1050 in step 1052, communication port and network settings, a shipping address field, a billing address field, a return address field and a contact person field(s). The address and contact person information is used on supply reorder forms and reports generated by the packaging system controller 16, as discussed in more detail herein.

Once basic operating parameters are programmed in step 1060, the user can define a part to be packaged in step 1062 by selecting the new/add part menu item from the edit menu. Upon selecting the new/add part menu, the programming terminal 1000 will display a new/add part window (not shown) on the display 1018. Using the new/add part

window, the user defines the new part by inputting a part number, a description and/or picture of the part. In addition, the user may define other characteristic of the part, such as a bar code value associated with the part. The bar code value can later be used by the packaging system controller 16 to verify that the packager has selected the correct part for packaging or to automatically retrieve the instruction set for the part.

Once the part has been defined with the part number and associated description, an instruction set programming window 1064 (Figure 12) will be displayed on the display 1018. The instruction set programming window 1064 has a header 1066 which contains the part number and/or the description of the part. The instruction set programming window 1064 also has an instruction summary region 1068. The instruction summary region 1068 is initially blank, but once the user programs instruction steps for packing the part identified in the header 1066, summaries of the instruction steps will appear in the instruction summary region 1068 in the order the instruction steps are to be carried out.

The instruction set programming window 1064 has a plurality of function buttons 1070. An add instruction button 1072 allows the user to add an instruction step to the instruction set for the specified part. More specifically, the add instruction button 1072 directs the instruction programming tool to display an instruction step template window 1074 as illustrated in Figure 13. Briefly, the instruction step template window 1074 is used to program and enter information relevant to the packaging methodology steps used to generate the graphical displays 146 and packaging material generator 12 commands. In the illustrated example, the instruction step template window 1074 displays a template populated with information to carry out an intermediate packaging step of the instruction set for packaging the specified part.

The instruction step template window 1074 has an image region 1076 where graphics associated with the packaging step are shown. The number of images and their layout can be specified using various image layout menus 1077. Images can be illustrated directly on the instruction template window 1074 or imported using an import button 1078. The import button will link the user to an import picture window (not shown) allowing the user to browse existing files containing desired images that have previously been generated by a drawing program, a CAD program, a digital camera and/or associated photo editing software tool, a video camera and/or video editing software tool or the scanner 1026 and associated scanning/editing software. The pre-existing image files can be saved in standardized formats, such as JPEG, MPEG, TIFF, PICT, and the like.

Alternatively, the import image window can allow the user to directly capture a scanned image using the scanner 1026 or an image taken with the camera 1028.

From the instruction step template windows 1074 the user can also select an image from a pre-defined library database containing various images by selecting a library button 1080. The library button 1080 will link the user to a library window 1081 (FIG. 14) allowing the user to browse through previously saved drawings, clip art, stenciled images, photographs and the like. The library window 1081 can be provided with a preview feature so that the image can be reviewed by the user before selecting the image and associating it with the instruction step being defined in the instruction step template window 1074.

The library database, in addition to having a database of pictures, drawings, illustrations and video clips, can have databases of textual instructions and packaging material generator 12 control commands. Additionally, multiple items of stenciled images can be combined to form more complex drawings. For example, a drawing of a cushioning pad can be superimposed on a drawing of a box to show the orientation of the pad with respect to the box.

With continued reference to Figure 14, the library window 1081 has a file selection browser 1082 for finding a desired image from previously saved images on a computer readable medium. The library window 1081 also has an image preview area 1083 to display a graphic representation of an image selected using the browser 1082. The library window 1081 may also be provided with a selection menu 1084 to allow the user to specify how a selected image should be displayed on the graphical display 146. In the illustrated exemplary layout selection menu 1084, the graphical display 146 being programmed may have no pictures, one picture or two pictures. By selecting one of the layout choices from the layout selection menu 1084, the user can specify where on the graphical display 146 the image is to appear. It is noted that the layout selection menu 1077 can be the same as, similar to or different from the layout selection menu 1084 of Figure 14. In the illustrated example, the layout selection menu 1077 is intended to have expanded functionality and a greater image capacity than the layout selection menu 1084. Once the user has found an image and specified the image's layout, the user may return to the instruction step template window 1074 by selecting an okay button 1085. Upon returning to the instruction step template window 1074, the selected image will appear in the image region 1076. Alternatively, the user may elect to forgo displaying an image and return to the instruction step template window 1074 by selecting a cancel button 1086.

The instruction template window 1074 also has a text instruction region 1088 in which the user can enter textual instructions for the packer to follow, via typing or copying from previously saved text. Additionally, the user can specify a name for the instruction step in a step name menu 1090. A default set of names, including previously used names, can be placed in a pull down menu for fast retrieval. Alternatively, a unique name can be typed.

The user can specify various control operations for the packaging material generator 12 to carry out during the execution of the instruction step. For example, the user can specify a quantity of pads for the packaging material generator 12 to generate and the length of those pads using a number of pads menu 1092 and a pad length menu 1094 respectively. Other materials to be used during the instruction step can also be programmed in additional supply menus (not shown) such as tape, glue, staples, warranty cards, and the like. The instruction step can be supplemented with additional information regarding these supplies, as well as boxes. The additional information can include bar code values for use by the packaging system controller 16 to verify that the user has selected the correct item.

The user can specify whether the present instruction step requires a box using a box menu 1096. Usually, only the first instruction step in an instruction set will instruct the user to obtain and set-up a box. However, if a box is needed for the instruction step, the user can specify the box by a serial number, the box's dimensions, or other identifying characteristics of the box using the box menu 1096.

The instruction template window 1074 also has a first time only check box 1098 which will allow the user to specify to the packaging system controller 16 whether the instruction step should only be displayed to the packer during the first pass through the instruction set, if more than one of the same part is to be packaged. The check box 1098 is useful, for example, when certain steps are directed to the set-up of a packaging work station.

Using a delay time menu 1100, the user can set an amount of time that the packaging system controller 16 will display the instruction step before automatically proceeding to the next instruction. As will be discussed in more detail below, the entered delay time establishes a time during which the packer should complete the instruction step. The delay time is therefore also used to pace the packager, and enhance and monitor the

packager's productivity. The delay time can be set in seconds, from zero seconds to hundreds of seconds, as is needed for the packaging step.

Alternatively, a manual action to be completed by the packager can be specified in a manual action menu 1101. In order for the packaging system controller 16 to proceed to the next instruction step, the manual action must be completed. Manual actions can include pressing a keyboard key, a mouse button, or a touch screen. Other manual actions include manipulating an object, such as removing a cushioning pad from the packing material generator 12 or scanning a bar code disposed on a box to confirm that the packer has selected the correct box. Even if a manual action is specified in the manual action menu 1101, a delay time can be entered in the delay time menu 1100. As will be described in more detail below, the delay time is used to pace the packager.

It is noted that certain information entered into the instruction step template window 1074, such as the number of pads and pad length, is used by the packaging system controller 16 to generate machine instructions to the packaging material generator 12 and, more specifically, the controller 14, to invoke a response by the packaging material generator 12 to perform the specified action. In addition, the instruction step template window 1074 has a control functions button 1102 to link the user to a control functions window (not shown). The control functions window has menus for specifying additional instructions for the packaging material generator 12 such as commands for the coiler 168, commands for the pick and place system 169, and so forth.

The instruction template window 1074 has navigation buttons 1104, including a previous instruction button to display the instruction step template window 1074 associated with the preceding instruction step in the instruction set and a next instruction button for displaying the instruction step template window 1074 associated with the next instruction step in the instruction set. The navigation buttons 1104 also include an okay button which will store the information entered by the user in the memory 1006 and return the user to the instruction set programming window 1064. The navigation buttons also include a cancel button to return the user to the instruction set programming window 1064 without storing any new or changed information entered in the instruction step template window 1074.

Referring back now to Figure 12, the instruction set programming window 1064 has a delete instruction button 1106. After selecting one of the instructions displayed in the

instruction summary region 1068 with the mouse pointer 1058, the user can select the delete instruction button 1106 to remove the instruction, if desired.

The instruction set programming window 1064 has a copy instruction button 1108 for linking the user to an instruction library window (not shown) similar to the library window 1081 of Figure 14. The instruction window allows the user to browse through previously defined and stored instruction steps, select an appropriate instruction step and add a copy of that instruction step to the instruction set being assembled. Alternatively, the user can select an instruction displayed in the instruction summary region 1068 with the mouse pointer 1058 and press the copy instruction button 1108 to copy the selected instruction.

To replicate the selected instructions, the user will then press a paste instruction button 1110. If the user would like to reposition an instruction step in the instruction set, the user will select a move instruction button 1112 which has functionality to move a selected instruction to a new position in the instruction set. The user may modify an existing instruction by selecting the instruction step in the instruction summary region 1068 and then selecting an edit instruction button 1114 which will link the user to the instruction step template window 1074 associated with that instruction step. Once the associated instruction step template window 1074 has been displayed the user can make any appropriate modifications and store those modifications by selecting the okay navigation button 1104.

The instruction set programming window 1064 also has a link instruction to preview button 1116 to logically associate a selected instruction step or instruction steps with the preview function discussed in more detail above. Using the link instruction to preview button 1116, the user can specify which instruction step(s) from the instruction set are to be displayed in the preview window 130 (FIG. 6A) for the specified part.

Once the user has programmed and/or edited the instruction steps for a part's instructions set, the user can store the instruction set in the memory 1006 by selecting an okay button 1118 or can exit the instruction set programming window 1064 without saving any additions or changes by selecting a cancel button 1120.

Using the edit menu from the menu bar 1056, the user can select an edit part menu which will prompt the user for a part number. Once the part number has been entered, or selected from a menu of existing part numbers, the instruction programming tool will link the user to the instruction set programming window 1064 associated with the part. Once

linked to the instruction set programming window 1064 the user can modify the instruction set as needed by following the procedures discussed above.

The instruction programming tool also allows the user to set-up and maintain a database of supplies and supply vendors in step 1122 of the logic routine 1050 (Figure 11)

5 . Using the edit menu from the menu bar 1056, the user can add suppliers or edit suppliers for various consumable items such as boxes, tapes, warranty cards, packaging dunnage, glue, staples, and the like. The supplier information will be used to generate re-order forms for ordering these supplies once the re-order threshold has been reached. In addition, the user can select an add supply or an edit supply menu from the edit menu on
10 the menu bar 1056 to create and maintain a database of supplies. The database of supplies contains information related to the supply (e.g., a box having a specified description and dimensions), the typical cost of that supply, the supplier associated with the supply, inventory information such as quantity of the supply on hand, the re-order threshold, and how many of the supply should be re-ordered upon reaching the re-order
15 threshold.

Once the operating parameters, parts, instructions and database of supplies and supply vendors has been entered and stored using the instruction programming tool, this collection of information can be stored in a memory directly associated with the packaging system controller 16 or on a computer readable medium accessible by the packaging
20 system controller 16. Alternatively, the information can be stored on a network database 21 accessible by the packaging system controller 16 or retrieved by the packaging system controller 16 from the programming terminal 1000 via a network interface. One skilled in the art will appreciate that these steps of making the collection of information available to the packaging system controller 16 will be modified appropriately in the embodiment where
25 the instruction programming tool is executed directly on the packaging system controller 16.

In Figure 15, when the packaging system 10 identifies a part to be packaged, the method 400 initiates, via the CPU 50, a global packaging timer at step 402, which is used to determine the amount of time required to package each part. In one embodiment of the
30 present invention, a timer associated with the CPU 50 is utilized. In addition, once the packaging instructions initiate control of the packaging material generator (step 108), the method 400 initiates via the CPU 50 one or more timers for determining the amount of time

required to complete each of the steps of the predetermined packaging process for the identified part at step 404.

Once the packaging of the identified part is complete at step 406, the global timer is stopped at step 408. The global timer thus indicates the amount of time required to package a single part. After the packaging of each part is completed, the CPU 50 takes the time data for each packaging part and saves it in a memory such as the hard drive 78 of Figure 3. In addition to the time data, the CPU 50 also records other pertinent information such as the packaging material generator identification number, an operator identifier, and a code which indicates which predetermined set of packaging instructions are associated with the time data. The CPU 50 may then utilize the saved data in generating the productivity report at step 410. Alternatively, the CPU 50 may be programmed to time-stamp and date stamp each step and further programmed to process the various time-stamps to determine the time data.

The productivity report generated at step 410 may appear as a report 412 as illustrated in Figure 15. In generating such a report 412, the CPU 50 performs mathematical operations on some of the data in accordance with programmed instructions to generate additional productivity characteristics which are helpful in evaluating greater productivity. For example, for the packaging of a plurality of identical parts, an average global time may be calculated according to known techniques to gauge the average time it takes for a given operator to complete the packaging of a particular part. In addition, an average time for each step of the packaging process may be calculated. Therefore the report 412 allows one to analyze which packaging steps need to be addressed to best improve the packaging productivity. Lastly, the productivity data may be used for the documentation of various processes and procedures such as ISO 9001 certification, etc.

In addition, the collected time can be normalized in several ways. For example, the time data may be normalized with respect to the particular packaging process uniquely associated with the identified part to allow for productivity comparisons across various packaging processes. Using such data one can focus on the particular packaging processes that need the most improvement. Also, the time data may be normalized across all the various operators to allow for direct comparisons between various operators who perform different packaging processes. In such a normalization, for example, a 1.0 would indicate an average packaging productivity while numbers greater than 1.0 would

indicate a productivity less than average and numbers less than 1.0 would indicate a productivity greater than average.

Lastly, the collected time data may be dated and used to generate productivity trending information to monitor changes in packaging productivity over time. Although the above example discussed various steps within the process which may be measured with regard to time, the present invention also contemplates measuring various other characteristics which may be associated with productivity. Each such characteristic is contemplated as falling within the scope of the present invention. In addition, while several exemplary mathematical operations are disclosed (and performed by the CPU 50) to generate productivity characteristics, it is understood that other types of statistical techniques and mathematical operations may also be employed to provide other types of productivity measurement criteria. Each such form of productivity measurement and data manipulation are contemplated as falling within the scope of the present invention.

An exemplary method by which the packaging system 10 may monitor the time required to execute each step for each part of the packaging process (step 404 of Figure 15) is illustrated in greater detail in Figure 16. Once the CPU 50 has retrieved the packaging instructions associated with the identified part at step 104 of Figure 15, the CPU 50 initializes two counting variables ("i" which represents the number of parts which need to be packaged and "j" which represents the number of steps required to package each part) at step 420. At step 422, the CPU 50 transmits the retrieved packaging instructions to the controller 14 of the packaging material generator 12 which begins generating the packaging material for the first part ($i = 1$) using the first step in that packaging process ($j = 1$). As the first step is initiated, the CPU 50 initiates a timer at step 424 for part $i = 1$ and step $j = 1$. The CPU 50 then monitors whether the first step (step $j = 1$) is complete at step 426.

When it is indicated that the first step (step $j = 1$) is complete, (YES) the CPU 50 stops the timer which is measuring the time duration of the first step (step $j = 1$) at step 428 and store the time value in memory. The controller 14 of the packaging material generator 12 then continues to the next packaging step at step 430 ($j = j + 1$; $j = 2$). The CPU 50 then inquires at step 432 whether all the steps of the packaging process are complete by comparing the incremented variable j (in this case, $j = 2$) to a threshold value which when met indicates the maximum number of steps in the particular packaging process has been exceeded. If all the steps are not complete, the variable j will not be

equal to the threshold value, and the method 404 will return to step 422 and the controller will generate packaging material for the second step ($j = 2$) of the first part ($i = 1$).

Likewise, steps 424, 426, 428, 430 and 432 will continue until all the steps in the packaging of the first part are completed (YES at step 432), at which point the CPU 50

5 stops the timer which measures the total time required to package the part at step 434.

The data regarding the amount of time required to package the first part is then stored in the appropriate memory for later analysis. The controller 14 then continues to the packaging of the next part at step 436 ($i = i + 1$; $i = 2$) and the CPU 50 inquires at step 438 whether all the parts to be packaged have been completed (*i.e.*, whether i is equal to a

10 threshold). If all the parts to be packaged are not completed (NO) the method 404 continues to step 440, wherein the CPU 50 resets the step counter variable j back to $j = 1$ and begins the timing process for a second part at step 422, wherein $i = 2$ and $j = 1$.

The timing of the various steps for the second part ($i = 2$) then continues with steps 424-432. After the times are measured for the various steps of part $i = 2$, steps 434

15 through 438 are again repeated until all of the parts to be packaged are complete ($i =$ the threshold value at step 438) and the method 404 ends at step 442. The CPU 50 then takes all the data which has been saved for each step j and each part i and saves the data in the appropriate memory for use in generating the productivity report at step 410 which may have a display output similar to the report 412 of Figure 15.

20 As discussed above in conjunction with Figures 1-16, the packaging system 10 of the present invention provides for the efficient, optimized packaging of various parts by identifying a part to be packaged, retrieving predetermined packaging instructions associated with the identified package and using the retrieved packaging instructions to provide control of the packaging material generator and provide graphical/textual

25 packaging instructions to the operator via a display.

Yet another embodiment in which such functionality may be provided is discussed below in conjunction with Figures 17a-17d. The operation of the packaging system 10 generally, and specifically the functions executed by the packaging system controller 16, is described below in detail with reference to the flow charts illustrated in the Figures 17a-

30 17d.

Initially, during execution of the programmed instructions within the packaging system controller 16, a display is provided on the output peripheral 18 such as a CRT monitor in step 500, prompting the operator to identify the part to be packaged, such as by

providing a part number as well as a number of such parts to be packaged. (As used herein, solid lines in the flow chart represent generally the flow of the program steps and dashed lines indicate the flow of data or messages. Moreover, while the program flow is represented as linear or serial for the purposes of description simplicity, it is recognized
5 that the program is preferably executed in an event driven manner with steps being executed in a time-slice fashion.)

Upon initialization of program operation, a database 501 of the part and the corresponding packaging information is made accessible at step 502, part information is provided to the program in an accessible format 504 and initialization of flags, pointers,
10 counters and/or other program control variables is performed in step 506. The operator can then indicate to the packaging system 10 the part number of the part or parts to be packaged and the number of parts to be packaged at step 508. Based on the identification of the part to be packaged, the program will retrieve from the information for a packaging process from the database 501 and provide to the operator, as a confirmation, a
15 description of the part which the operator identified for packaging at step 510. A description may be in the form of the name of the part or preferably an image of the part to be packaged. The operator then confirms that the program has identified the correct part to be packaged at step 512 and the program begins the process of producing pads (in the case where the packaging material generator is a cushioning conversion machine) and
20 instructing the operator in the proper or recommended packaging the part.

First, a monitor flag is set to one (1) to indicate that the display on the monitor 18 has not been then updated to reflect the beginning of the packaging sequence at step 514. The program then checks, as shown in Figure 17b, that the required number of parts have not yet been packaged at step 516. Assuming that the required number of parts have not
25 yet been packaged, and, as in this example, this is the first time through the program, the program will initialize the current step counter equal to one at step 518, meaning that the correct number of pads of the correct lengths are to be produced for the first step in the process of packaging the identified part. The number of steps having been executed in the packaging process is then examined at step 520 and if the current step is less than 4
30 (for a part packaging process having three packaging steps) and the quantity of pads to be produced is greater than 0 at step 522, a wake-up code is provided to the machine controller 14 at step 524.

The purpose of the wake-up code is to inform the machine controller 14 to begin looking for the appropriate instructions from the packaging system controller 16. Previous to receiving the wake-up code, the machine controller 14 will ignore any codes, such as those randomly generated by noise in the input port of the machine controller 14 so as not to take any unintended action in the event that noise on the line would match one of the instructional codes to the machine controller at step 524. Once the wake-up code has been sent to the machine controller at step 524, a timed handshake function is implemented through steps 526 to 532 which ensures that the packaging system controller 16 and the machine controller 14 are communicating correctly.

The handshake function includes starting a timer at step 526, waiting to receive a message at step 530 from the machine controller 14 and checking any received message to determine whether the received message is the intended message, for example, the word "Ranpak" at step 532. In the event the message is not received from the machine controller 14 within the appropriate time, the timer will time out at step 528, an error code will be displayed at step 534 and the packaging controller 16 will inquire to the operator whether it should try to reestablish communication with the machine controller 14 at steps 536 and 538. If the operator does not reestablish control of the machine controller 14, the program is terminated, otherwise the program will cycle again starting with step 520.

Assuming that a message was received from the machine controller 14 at steps 530 and 532 before the timer timed out and the message was the appropriate message, the packaging system controller 16 will instruct the machine controller 14 as to the number of pads to be produced and their order of generation (step 540 of Figure 17c).

Alternatively, instead of providing the pad length and the number of pads to be produced to the machine controller 14 in one step, the section of program code can be executed through a loop in which the machine controller 14 is instructed to produce one pad of the appropriate length as many times as needed to produce the correct number of pads.

Communication between the packaging system controller 16 and the machine controller 14 is again coordinated through a timed handshake function through steps 542 through 548, similar to the handshake function described above relative to steps 524 through 532 to confirm that the machine controller 14 received the length and the number of pads to be produced.

Accordingly, after the machine controller 14 has been instructed to produce a pad of the appropriate length at step 540, a timer is started at step 542 and the program will

monitor whether a message is received at step 546 before the timer times out at step 544. If a message is received, the message will be checked to determine whether it was the intended message. In this case, the intended message may be a carriage return 548, for example. If the timer timed out before a message was received or the incorrect message was received, an error code will be displayed at step 534 of Figure 17b and the operator will be prompted as to whether the packaging system controller 16 should attempt to re-establish communication with the machine controller 14 at step 536.

Assuming the appropriate message was received from the machine controller 14, and the packaging system controller 16 is executing the first packaging step for the part to be packaged at step 550, the appropriate display will be presented on the monitor 18 at step 552 and a picture of the part being packaged according to the first step will be displayed at step 554. If this is not the first time in the program for this part to be packaged (NO at step 550), a five second delay is instituted at step 556 before the picture of the part being packaged in accordance with the next step in the packaging process is displayed at step 554. The purpose of this five second delay is so that the operator has time to examine the display of the first step in packaging the part before the display is replaced by the display corresponding to the second step of packaging the part.

Concurrently with displaying the picture of the part being packaged, the packaging system controller 16 will begin requesting the machine controller 14 at a set time interval to provide it with the status of producing the requested pad or pads (steps 558, 560) and again begin the timed handshake function (steps 570-76), as discussed above. If the message has been received from the machine controller 14, the message is examined to determine if an error has occurred in producing the pad at steps 578 and 580 of Figure 17d. If no error has occurred, the message will either indicate that the cushioning conversion machine is still in the process of producing a pad or pads (steps 578 and 580), and the packaging system controller 16 will again inquire as to the status of the pad production (steps 558-576) until it has been determined that the required pads have been produced. The timer is then disabled at step 582 and the packaging system controller 16 will continue to the next step in the packaging process by incrementing the packaging step counter at step 584 and setting the display flag to indicate that a picture of the part being packaged is currently being displayed at step 586. The machine controller 14 will then begin the process of producing the pads for the next packaging step in providing the packaging recommendation to the operator (steps 520-586).

If the three packaging steps have been completed for the identified part, as indicated by the step counter being equal to 4 at step 520 of Figure 17b, the part quantity counter is decremented at step 588 and the packaging system controller 16 will determine whether all of the same parts have been packaged or not (step 516). If not, the machine controller 14 will again produce the necessary pads and instruct the operator with recommendations. If all like parts have been packaged, the display on the output peripheral 18 is returned to the display prompting the operator for an indication of the next part type to be packaged (step 590, Figure 17a) and the process is repeated for the next part.

Referring now to Figure 18, a packager pacing logic routine 1200 is illustrated. In its most basic embodiment, the packager pacing logic routine 1200 is executed by the packaging system controller 16 and controls the pace with which the packaging material generator 12 produces packaging material and the pace with which the graphical instruction sets are displayed on the display 18. In general, these rates are based on values entered in the delay time menu 1100, as discussed more fully above with respect to Figure 13.

Starting in step 1202, a part to be packaged is identified and the packaging system controller 16 retrieves the packaging control methodology for the part, as discussed in greater detail above. The part to be packaged may be identified by a number of methods, including, for example, the packer entering a part identification number into the packaging system controller 16 or scanning a bar code associated with the part. Alternatively, a facility management computer used to control the flow of parts through a facility having the packaging system 10, can be used to dictate (i.e., send an electronic message) to the packager system 10 the next part to be packaged.

Once the part has been identified and the packaging control methodology has been retrieved, the packaging system controller 16 controls the packaging material generator 12 via the controller 14, and displays instructions for the packager in step 1204. It is noted that step 1204 of Figure 18 generally corresponds to steps 108 and 110 of Figure 4. An example first instruction step is illustrated in Figure 19. In the illustrated example, three identical parts have been identified for packaging meaning that the packaging pacing logic routine 1200 will repeat itself three times.

It is noted that the packager is provided with various control buttons 1208 located on the display 18. The control buttons 1208 include a back button 1210, a forward button

1212, a pause button 1214 and a break button 1216. The back button 1210 allows the user to backtrack to the previously displayed instruction. However, when the first instruction of an instruction set is being displayed the back button 1210 can be turned off and made unavailable to the packager since no prior steps are available for viewing. The forward button 1212 allows the packager to proceed to the next step when the instruction step has been completed. However, in instances where a manual action is required, the forward button may be turned off and made unavailable to the packager in favor of sensing the specified manual action.

As the graphical display 146 for the instruction step is displayed, the packaging system controller 16 will start a step timer in step 1206. The step timer is used to track how long it takes the packager to complete the currently displayed instruction step. The pause button 1214 allows the user to pause the display of instructions and the generation of packaging material by the packaging material generator 12, but will not stop the step timer 1206. As will become more apparent below, the pause button 1214 is used to provide the operator more time to complete the displayed step. The break button 1216 allows the user to both pause the display of new instructions, the generation of packaging material, and stop the step timer. The break button 1216 allows the packager to take a lunch break or direct his or her attention to other matters. If desired, the packaging system controller 16 can be programmed to limit the packager's use of the break button 1216 by allowing only a certain number of breaks per shift, allowing only a certain amount of time per break and/or allowing only a certain total of break time per shift, before restarting the step timer 1206.

To assist the packager, the displayed instruction can have one or more icons, such as the stop sign illustrated in Fig. 19. The icon(s) are intended to directly or indirectly represent the manual action needed to complete the instruction step or to illustrate the time remaining before the packaging system controller 16 will proceed to the next step automatically (i.e., expiration of the delay time). In addition to an icon for manual actions, a countdown timer can be displayed on the graphical display 146 to illustrate how much time the packager has to complete the step without falling behind the time programmed in the delay time menu.

As mentioned above, a step may be completed by performing a manual action. If a manual action has been programmed, the packaging system controller 16 will not proceed to the next step until the manual action is completed by the packager. For example, as

illustrated in Figure 19, the first step instructs the packager to assemble a particular box and then scan a bar code located on the box in order to proceed to the next step.

Fig. 20 illustrates a second step for packaging the part where no manual action has been programmed to complete the step. Rather, at the expiration of the delay time, the packaging system controller 16 will proceed to the next instruction step automatically. If the packager is not ready for the next step, the packager may press the pause button 1214, go on break using the break button 1216 or return to the prior step by pressing the back button 1210. If the packager is ready for the next step before the expiration of the delay time, the packager may proceed to the next step using the forward button 1212. To continue advancing through the packaging instruction steps after using the pause button 1214 or break button 1216, the packager can select the forward button 1212. To assist the packager, the time remaining before the expiration of the delay time may be displayed in a timer icon 1218.

Returning to Fig. 18, the packager pacing logic routine 1200 will detect the completion of the instruction step and stop the step timer in step 1220. If the step has a manual action, the completion of the step is based on the performance of the manual action. The end value of the step timer for an instruction step having a manual action will be the time from the starting of the step timer in step 1206 to the completion of the manual action.

If the instruction step does not have a manual action, the completion of the instruction step is detected when the first of the following two conditions occurs. The first condition is when the packager presses the forward button 1212 before the expiration of the programmed delay time. If the first condition is met first, the end value of the step timer will be the time from the starting of the step timer to the pressing of the forward button 1212. The second condition is when the packaging system controller 16 proceeds to the next step at or after the expiration of the programmed delay time. It is noted that proceeding to the next step could occur at the natural expiration of the programmed delay time or sometime thereafter if the packager has used the back button 1210 or the pause button 1214. If the second condition is met first, the end value of the step timer will be the time from the starting of the step timer to the time when the packaging system controller 16 progresses to the next instruction step. One skilled in the art will appreciate that the end value of the step timer is, generically, the time the packager takes to complete the displayed instruction step.

Next, the packaging system controller 16 will subtract the delay time from the end timer value to derive a Δt value for the instruction step in step 1222. Next, the packaging system controller 16 will add the Δt value to a log to provide a record of packager performance in step 1224. The log can simply be an aggregate record of how fast the packager operates in relation to the aggregate of the delay times for the steps completed or can keep track of more sophisticated packager performance, such as tracking packager performance for each step, each part or each shift. It is noted that if the operator completes the step before the expiration of the delay time, Δt will be a negative value thereby indicating that the operator is working faster than the programmed delay times. However, a positive Δt indicates that the packager is working slower than the programmed delay times.

After adding Δt to the log, the packaging system controller 16 will proceed to step 1226 where the packaging system controller 16 will determine whether the last instruction step in the instruction set has been completed. If the last step has not been completed, the packager pacing logic routine 1200 will return to step 1204 and display the next instruction step and send commands to the packaging material generator 12 as programmed. If the last step has been completed, the packaging system controller 16 will monitor and log the time between the completion of the last instruction step and the start of packaging the next part in step 1228. The monitored time between parts can be compared against an expected time value for the time interval between parts. Alternatively, the packaging system controller 16 can be programmed to automatically display the first instruction step for packaging the next part, thereby commencing the step timer and the tracking of the packager's performance as described in more detail above.

The packaging system of the present invention also includes a productivity monitoring system which collects and summarizes various productivity statistics. For example, the productivity monitoring system collects data for various productivity criteria such as, but not limited to, the number of orders packed, the number of items packed, the total weight packed, the average time per order and the average amount of packaging material generated per order. In addition, various time frames of data may be collected and additional processing may be employed to normalize various productivity criteria, provide trending analysis, etc.

Returning now to Figures 10 and 12, the programming terminal can be used to specify and format various types of reports generated by the packaging system controller

16. For example, the format of the foregoing productivity reports and packager log can be specified. Reports are formatted by selecting the reports menu from the menu bar 1056 and completing GUI display screens. Other reports include a purchase order form, an inventory report to list quantities of supplies on hand, and a packaging instruction report
5 allowing the user to print out the information normally displayed on the graphical display 146 (Figures 6c, 19, 20) or the instruction step template 1074. The packaging instruction reports can be used to consolidated multiple instruction steps on a single page to provide the reader of the report consolidated information about the packaging instructions for a particular part. Another report is a packaging activity report which tracks the parts the
10 packaged using the packaging system 10 to provide a consolidated report on overall packaging facility performance. The packaging activity report preferably includes each part number packed, the associated description of those parts, the quantity of each part packaged, the average time taken to package each part, the quantity of supplies used to package the parts and any other information the user is interested in.

15 Although the logic routines 1050 and 1200 (Figures 11 and 18) of the present invention are embodied in software as discussed above, this logic may alternatively be embodied in hardware or a combination of software and hardware. If embodied in hardware, the foregoing logic can be implemented as a circuit or state machine that employs any one of or a combination of a number of technologies. These technologies
20 may include, but are not limited to, discrete logic circuits having logic gates for implementing various logic functions upon an application of one or more data signals, application specific integrated circuits having appropriate logic gates, programmable gate arrays (PGA), field programmable gate arrays (FPGA), or other components, etc. Such technologies are generally well known by those skilled in the art and, consequently, are not
25 described in detail herein.

The diagrams described herein show the architecture, functionality, and operation of an implementation of the foregoing logic. If embodied in software, each block may represent a module, segment, or portion of code that contains one or more executable instructions to implement the specified logical function(s). If embodied in hardware, each
30 block may represent a circuit or a number of interconnected circuits to implement the specified logical function(s). Although the block diagrams and flow charts show a specific order of execution, it is understood that the order of execution may differ from that which is depicted. For example, the order of execution of two or more blocks may be altered

relative to the order shown. Also, two or more blocks shown in succession in may be executed concurrently or with partial concurrence. In addition, various blocks may be omitted. It is understood that all such variations are within the scope of the present invention.

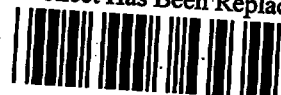
5 Also, the logic can be embodied in any computer-readable medium for use by or in connection with an instruction execution system such as a computer/processor based system or other system that can fetch or obtain the logic from the computer-readable medium and execute the instructions contained therein. In the context of this document, a "computer-readable medium" can be any medium that can contain, store, or maintain logic
10 and/or data for use by or in connection with the instruction execution system. The computer readable medium can be any one of many physical media such as, for example, electronic, magnetic, optical, electromagnetic, infrared, or semiconductor media. More specific examples of a suitable computer-readable medium would include, but are not limited to, a portable magnetic computer diskette such as floppy disk, a hard disk, a
15 random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory, or a compact disc.

 Although the invention has been shown and described with respect to certain preferred embodiments, equivalent alterations and modifications will occur to others skilled in the art upon reading and understanding this specification and the annexed drawings. In
20 particular regard to the various functions performed by the above described integers (components, assemblies, devices, compositions, etc.), the terms (including a reference to a "means") used to describe such integers are intended to correspond, unless otherwise indicated, to any integer which performs the specified function of the described integer (i.e., that is functionally equivalent), even though not structurally equivalent to the
25 disclosed structure which performs the function in the herein illustrated exemplary embodiment or embodiments of the invention. In addition, while a particular feature of the invention may have been described above with respect to only one of several illustrated embodiments, such feature may be combined with one or more other features of the other embodiments, as may be desired and advantageous for any given or particular application.



CLAIMS

1. A packaging system comprising:
a packaging material supply device for supplying a packaging material; and
5 a packaging system controller for providing packaging instructions related to
at least one part to be packaged and instructing the packaging material supply device to
provide the packaging material for the at least one part to be packaged.
2. The packaging system of claim 1, wherein the packaging instructions are
10 programmed using an instruction programming tool, the instruction programming tool
having a database of previously stored images.
3. The packaging system of claim 1, wherein the packaging instructions are
programmed using an instruction programming tool, the instruction programming tool
15 being executed by the packaging system controller.
4. The packaging system of claim 1, wherein the packaging instructions are
programmed using an instruction programming tool, the instruction programming tool
being executed by a programming terminal, the programming terminal saving the
20 packaging instructions on a computer readable medium accessible by the packaging
system controller.
5. The packaging system of claim 1, wherein the packaging system controller
automatically advances from a first packaging instruction step to a second packaging
25 instruction step after a predetermined amount of time.
6. The packaging system of claim 1, wherein the packaging system controller
determines how long a packager takes to complete a packaging instruction step and
compares the determined length of time to a predetermined amount of time.
30
7. The packaging system of claim 1, wherein the packaging system controller
determines a time interval between a completion of a last packaging instruction step for a
first part to be packaged and a start of packaging a second part to be packaged.





8. The packaging system of claim 1, wherein the packaging system controller retrieves the packaging instructions, which are predetermined and related to the part to be packaged, from a memory associated with the packaging system controller.

5 9. The packaging system of claim 1, comprising a display for providing packaging instructions to an operator; and wherein the packaging system controller causes the packaging instructions to be provided on the display.

10 10. The packaging system of claim 9, wherein the display provides an illustration of the packing technique of the part being packaged.

11. The packaging system of claim 10, wherein the illustration comprises a packaging preview illustrating a technique of packaging the part being packaged.

15 12. The packaging system of claim 10, wherein the illustration provides a single packaging step associated with packaging the part being packaged.

20 13. The packaging system of claim 1, comprising an output peripheral for providing packaging instructions; and wherein the packaging controller provides to a packer the packaging instructions via the output peripheral.

25 14. The packaging system of claim 1, wherein the packaging material supply device includes a conversion machine that converts sheet stock material into a dunnage product.

15. The packaging system of claim 1, further comprising an input peripheral for providing an identification for the part to be packaged.

30 16. The packaging system of claim 15, wherein the input peripheral comprises at least one of a keyboard, a touch screen, an RF tag reader, a mouse, a bar code reader and a microphone.





17. The packaging system of claim 1, wherein the system functions comprise at least one of iterative packaging instructions, a packaging methodology preview for the at least one identified part to be packaged, post packaging material generation control, inventory consumption maintenance, automated inventory ordering, productivity measurement and analysis, consignment billing, and production planning notification.

18. The packaging system of claim 1, wherein the packaging material supply device includes a controller in communication with the packaging controller for implementing packaging material supply device control functions in response to commands from the packaging controller.

19. The packaging system of claim 18, wherein the packaging material supply device controller functions comprise at least one of initiating a generation of a selected amount of packaging material, severing the packaging material, and providing the packaging material for packaging the at least one part to be packaged.

20. The packaging system of claim 1, further comprising a memory coupled to the packaging controller, wherein a plurality of predetermined packaging instructions are stored in the memory, and wherein one of the plurality of packaging instructions is selected based on the at least one part to be packaged.

21. The packaging system of claim 20, wherein one of the plurality of packaging instructions is selected using at least one of a look up table and an algorithmic search engine.

22. The packaging system of claim 20, wherein the packaging instructions comprise at least one of selecting a particular container, providing one or more units of packaging material in a predetermined order, and an indication regarding how to utilize the one or more units of packaging material in a predetermined manner.

23. The packaging system of claim 1, wherein the packaging instructions comprise at least one of a video output, an audio output, a printed output, a text output and a graphical output.



24. A method of packaging parts, comprising the steps of:
identifying at least one part to be packaged;
retrieving packaging instructions associated with the at least one part to be
packaged; and
5 controlling a packaging material supply device using the packaging instructions.

25. The method of claim 24, further comprising the step of programming the
packaging instructions using an instruction programming tool, the step of programming the
packaging instruction including the step of retrieving a previously stored image from an
10 image database.

26. The method of claim 24, wherein the packaging instructions are
programmed using an instruction programming tool, the instruction programming tool
saving the packaging instructions on a computer readable medium for retrieval.
15

27. The method of claim 24, further comprising the step of automatically
advancing from a first packaging instruction step to a second packaging instruction step
after a predetermined amount of time.

28. The method of claim 24, further comprising the steps of determining how
20 long a packager takes to complete a packaging instruction step and comparing the
determined length of time to a predetermined amount of time.

29. The method of claim 24, further comprising the step of determining a time
25 interval between a completion of a last packaging instruction step for a first part to be
packaged and a start of packaging a second part to be packaged.

30. The method of claim 24, further comprising the step of providing at least a
portion of the packaging instructions to an operator, wherein the provided packaging
30 instructions indicate a preferred packaging methodology for the at least one part to be
packaged.



31. The method of claim 24, wherein packaging instructions are provided on a display for viewing by a packer.

32. The method of claim 24, wherein the step of identifying a part to be
5 packaged comprises the steps of:
inputting a part number associated with the part to a computer; and
matching the part number with a corresponding part number in a computer
memory.

10 33. The method of claim 32, wherein the step of inputting the part number
comprises at least one of entering the part number using a keyboard associated with the
computer, reading a bar code representing the part number using a bar code reader,
identifying the part number from a parts menu on the computer, and identifying the part
number using optical character recognition or video pattern recognition.

15 34. The method of claim 33, wherein the parts menu comprises a pull-down
menu and the part number is identified using at least one of mouse, a keyboard and a
touch screen.

20 35. The method of claim 32, wherein the step of inputting the part number
comprises:
speaking part identifying information into a microphone; and
converting the information into a digital signal corresponding to the part number
using voice recognition.

25 36. The method of claim 32, wherein the step of retrieving the packaging
instructions comprises the step of accessing a particular set of packaging instructions from
a plurality of packaging instructions stored in a memory.

30 37. The method of claim 24, wherein the packaging instructions indicate a
preferred container for packaging the part.



38. The method of claim 24, further comprising the step of monitoring a consumption of one or more materials used in packaging parts.

39. The method of claim 38, wherein the step of monitoring the consumption
5 comprises counting a number of containers used in packaging the parts.

40. The method of claim 38, wherein the step of monitoring the consumption comprises calculating an amount of cushioning material used in packaging the parts.

10 41. The method of claim 38, wherein the step of monitoring the consumption comprises calculating an amount of supplies used in packaging the parts, wherein the supplies include at least one of packaging tape, operating instructions, warranty cards, and address labels and identifying where the parts are destined.

15 42. The method of claim 38, further comprising the step of generating a consumption report indicating the consumption of the one or more materials.

43. The method of claim 42, further comprising the step of sending the consumption report to at least one of an inventory supplier and an inventory prediction
20 planner.

44. The method of claim 38, further comprising the step of generating a consignment billing report based on the amount of packaging materials consumed.

25 45. The method of claim 38, further comprising the steps of:
comparing the consumption of the one or more materials to one or more re-order thresholds; and
generating a re-order request if one or more of the re-order thresholds are satisfied.

30 46. The method of claim 45, wherein the step of generating a re-order request comprises automatically placing an order for additional materials with at least one of an inventory distributor and a production planner through a communications link.



47. The method of claim 24, further comprising the step of monitoring an amount of time of one or more steps associated with controlling the cushioning conversion machine using the packaging instructions, thereby providing an indication of productivity.

5 48. The method of claim 24, further comprising the step of monitoring a number of packages packaged within a predetermined amount of time, thereby providing an indication of productivity.

10 49. The method of claim 48, further comprising the step of generating a productivity report including data relating to the productivity of packaging the parts including at least one of a cushioning conversion machine identifier, an operator identifier, a packaging routine identifier, an amount of time needed to complete all the packaging instructions, an amount of time needed to complete one or more of the packaging instructions, a total number of packages packed per unit time, a normalized productivity
15 value, and a trending indicator.

50. A method of packaging differing parts, comprising the steps of:
determining a step by step set of packaging instructions associated with each of a plurality of parts;

20 programming the set of packaging instructions using an instruction programming tool; and

storing the set of packaging instructions for subsequent retrieval.

51. The method of claim 50, further comprising the steps of:
25 identifying a part to be packaged to a packaging system controller;
retrieving the set of packaging instructions;
controlling a cushion conversion machine for producing cushioning material using the set of packaging instructions; and
displaying a packaging explanation to a packager using the set of packaging
30 instructions.

52. The method of claim 51, wherein the step of identifying the part to be packaged includes receiving a signal from a facility management processor.



53. The method of claim 52, further including the step of verifying that a part selected by the packager is the identified part.

54. The method of claim 51, wherein the step of identifying the part of be
5 packaged includes inputting a part identification via an input peripheral.

55. The method of claim 54, further comprising the step of displaying a packaging methodology preview for the part.

10 56. The method of claim 51, further comprising the step of verifying that a packaging supply or container selected by the packager is consistent with a programmed packaging supply or container.

57. The method of claim 51, wherein the display of the packaging explanation
15 includes at least one of a video output, an audio output, a text output, a printed output and a graphical output.

58. The method of claim 50, further comprising the steps of retrieving a previously stored image from an image database and associating the retrieved image with
20 one of the packaging instruction steps.

59. The method of claim 50, wherein the set of packaging instructions are stored on a computer readable medium.

25 60. The method of claim 51, further comprising the step of automatically advancing from a first packaging instruction step to a second packaging instruction step after a predetermined amount of time.

61. The method of claim 51, further comprising the steps of determining how
30 long a packager takes to complete a packaging instruction step and comparing the determined length of time to a predetermined amount of time.



62. The method of claim 51, further comprising the step of determining a time interval between a completion of a last packaging instruction step for a first part to be packaged and a start of packaging a second part to be packaged.

5 63. A packaging system comprising:
a packaging system controller for providing packaging instructions related to at least one part to be packaged, and
a display for displaying the packaging instructions to a packer for use in packing the part,

10 wherein the packaging instructions are programmed using an instruction programming tool, the instruction programming tool having a database of previously stored images.

15 64. A packaging system comprising:
a packaging system controller for sequentially providing packaging instruction steps related to at least one part to be packaged, and
an output device for conveying the packaging instruction step to a packer for use in packing the part, and
wherein the packaging system controller automatically advances from a first
20 packaging instruction step to a second packaging instruction step after a predetermined amount of time.