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(54) **METHOD AND SYSTEM FOR FULFILLING REQUESTS IN AN INVENTORY SYSTEM**

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Related U.S. Application Data

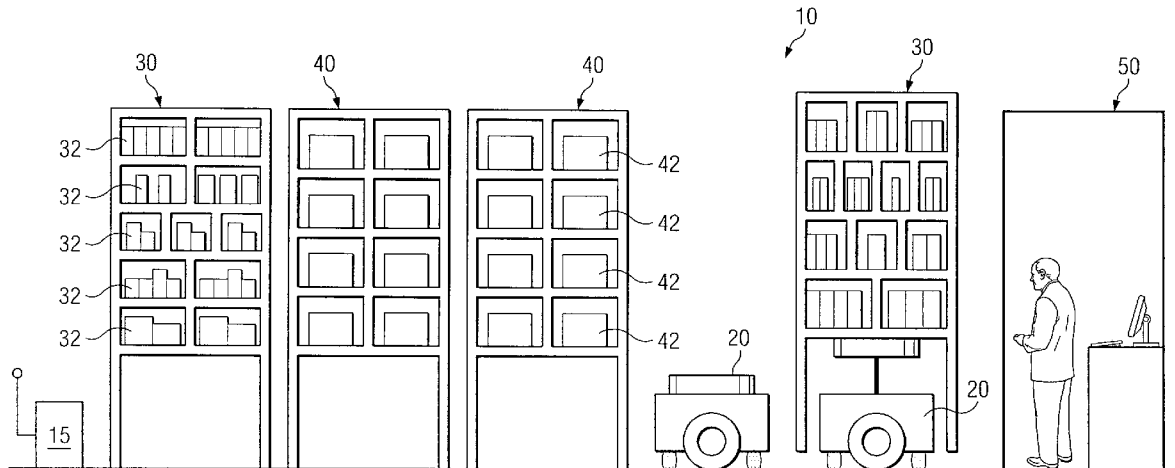(63) Continuation-in-part of application No. 11/185,198, filed on Jul. 19, 2005, Continuation-in-part of application No. 11/185,957, filed on Jul. 19, 2005, Continuation-in-part of application No. 11/185,467, filed on Jul. 19, 2005.

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(57) **ABSTRACT**

A method for fulfilling requests in an inventory system includes receiving a request indicating an activity to be completed. The method also includes selecting a holder to fulfill the request and an inventory station at which to fulfill the request. The inventory station is associated with a queue that includes a plurality of queue spaces. The method further includes moving the selected holder from a first location to a second location remote from the selected inventory station. Additionally, the method also includes determining that a trigger event has occurred and, in response to determining that the trigger event has occurred, moving the selected holder from the second location to a queue space of a queue associated with the selected inventory station.
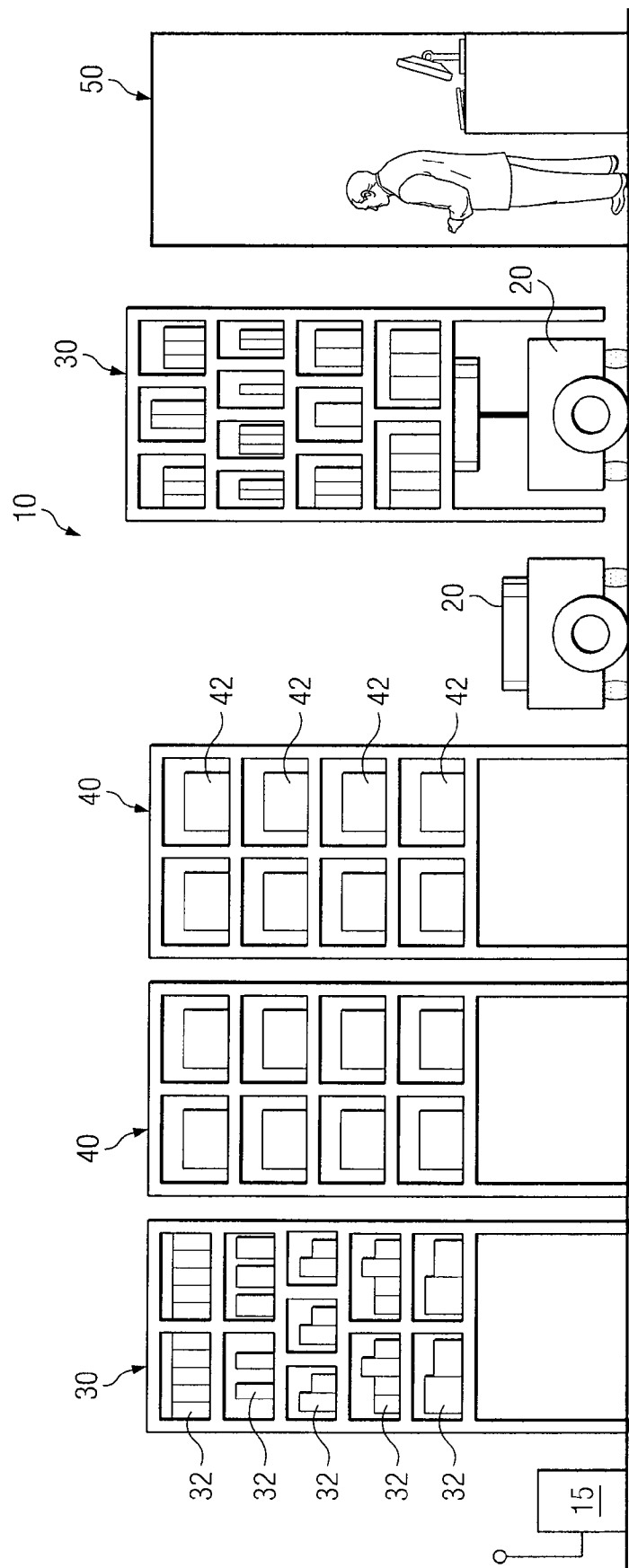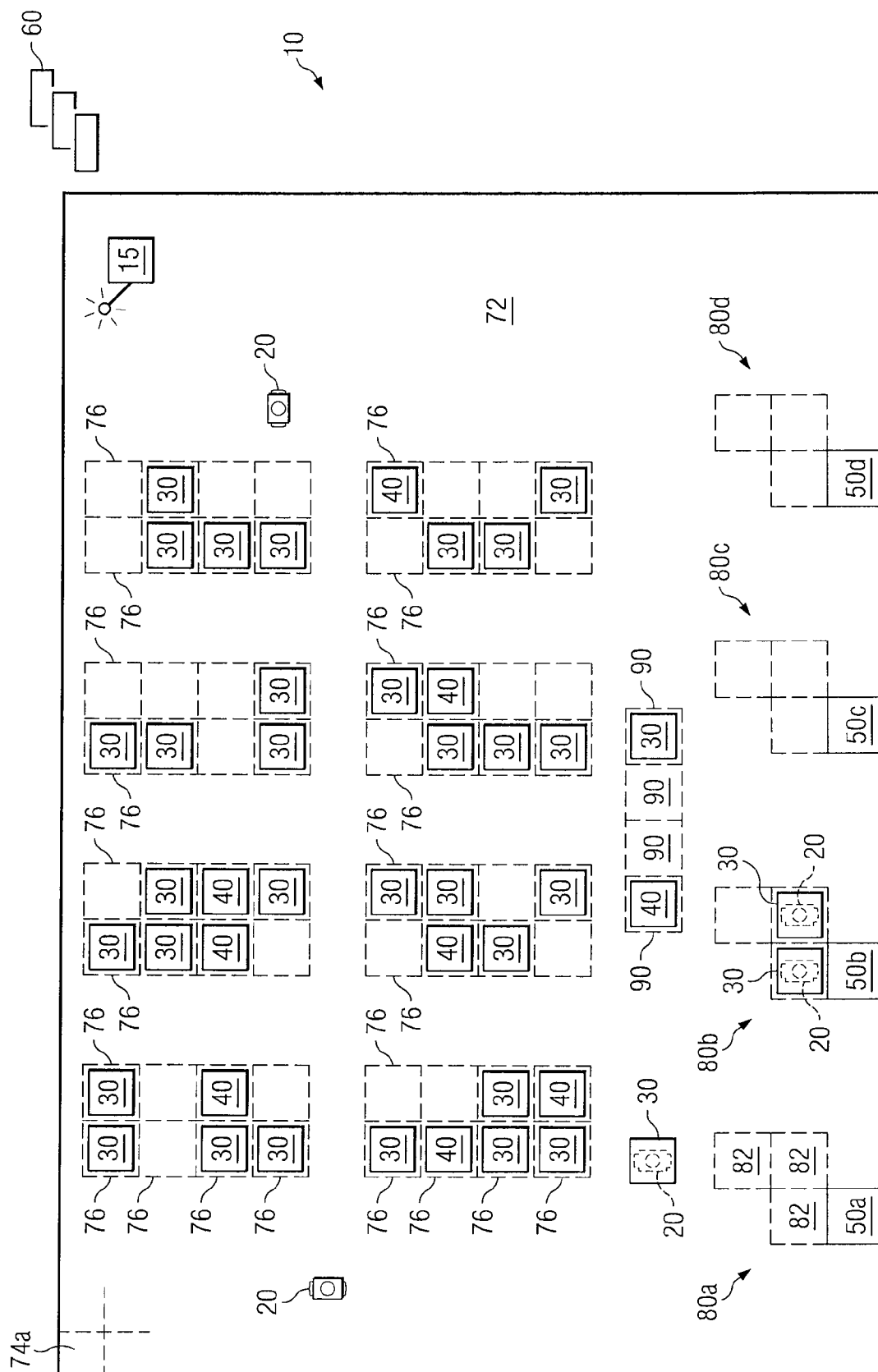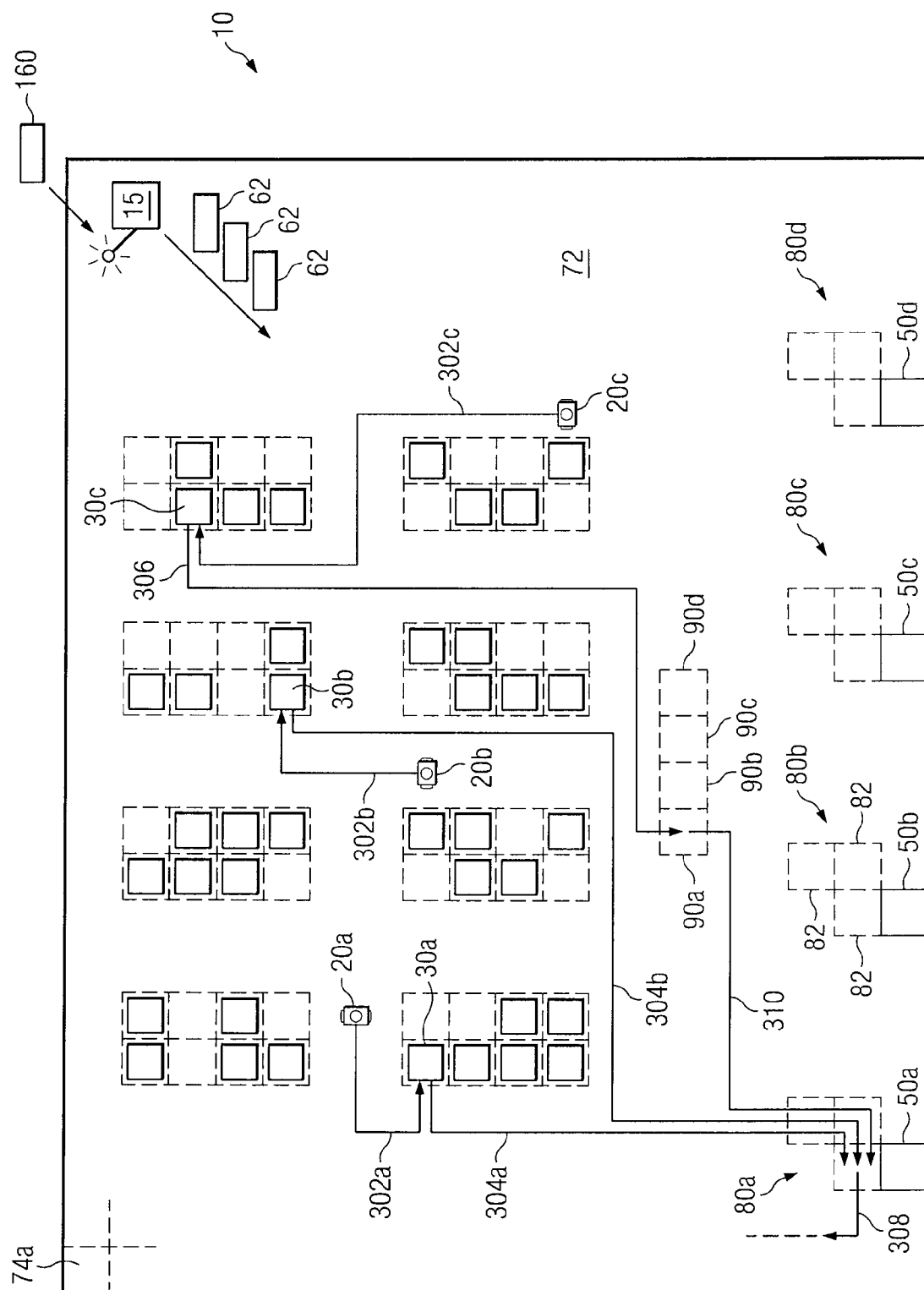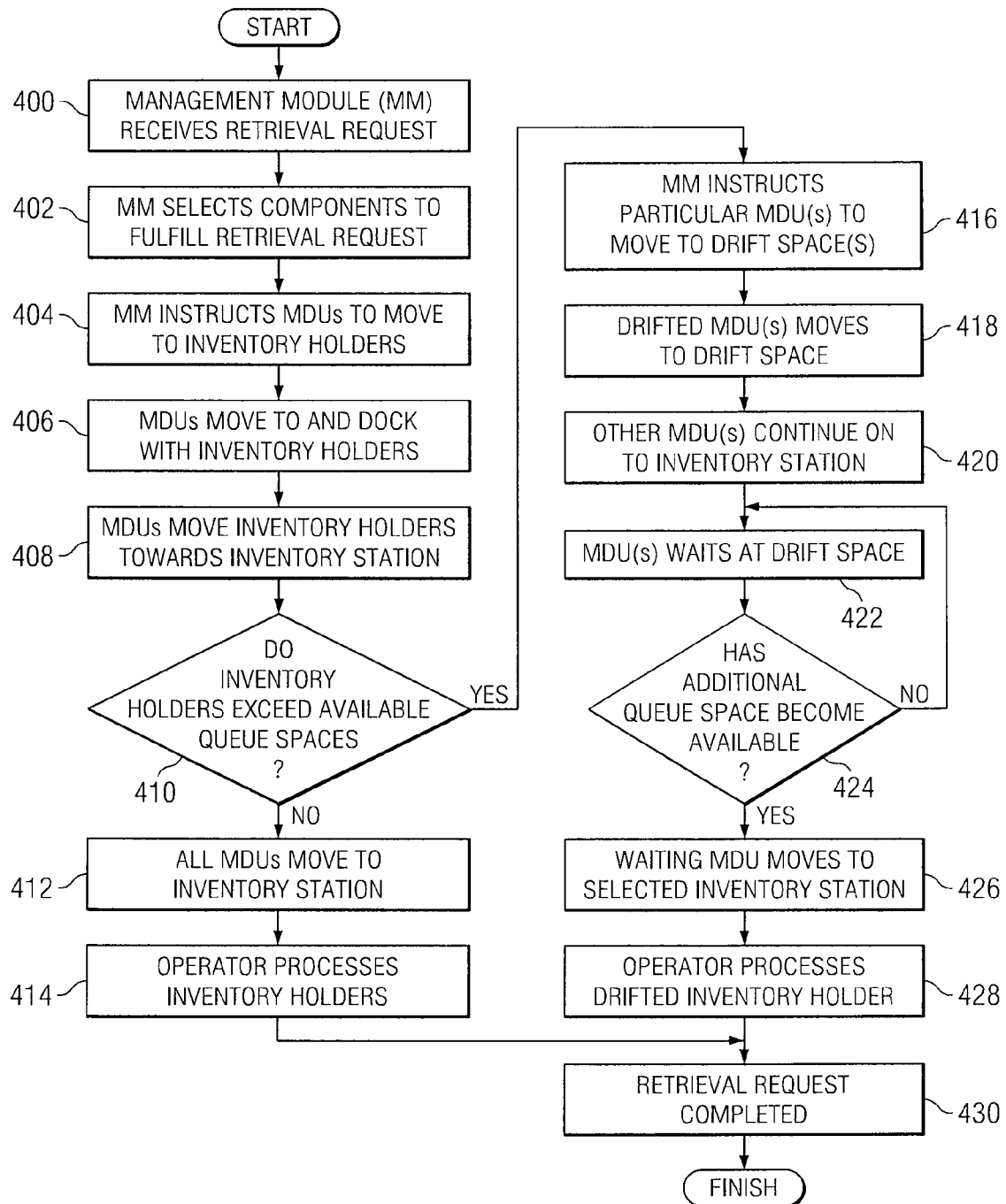
FIG. 1

FIG. 2

FIG. 3

START

400 — MANAGEMENT MODULE (MM) RECEIVES RETRIEVAL REQUEST

402 — MM SELECTS COMPONENTS TO FULFILL RETRIEVAL REQUEST

404 — MM INSTRUCTS MDUs TO MOVE TO INVENTORY HOLDERS

406 — MDUs MOVE TO AND DOCK WITH INVENTORY HOLDERS

408 — MDUs MOVE INVENTORY HOLDERS TOWARDS INVENTORY STATION

DO INVENTORY HOLDERS EXCEED AVAILABLE QUEUE SPACES ?   410

YES

NO

412 — ALL MDUs MOVE TO INVENTORY STATION

414 — OPERATOR PROCESSES INVENTORY HOLDERS

MM INSTRUCTS PARTICULAR MDU(s) TO MOVE TO DRIFT SPACE(S) — 416

DRIFTED MDU(s) MOVES TO DRIFT SPACE — 418

OTHER MDU(s) CONTINUE ON TO INVENTORY STATION — 420

MDU(s) WAITS AT DRIFT SPACE   422

HAS ADDITIONAL QUEUE SPACE BECOME AVAILABLE ?   424

NO

YES

WAITING MDU MOVES TO SELECTED INVENTORY STATION — 426

OPERATOR PROCESSES DRIFTED INVENTORY HOLDER — 428

RETRIEVAL REQUEST COMPLETED — 430

FINISH

FIG. 4

FIG. 5

START

600 — MANAGEMENT MODULE (MM) SELECTS MOBILE DRIVE UNITS (MDUs) AND CONTAINER HOLDERS

602 — MM INSTRUCTS MDUs TO MOVE TO CONTAINER HOLDERS

604 — MDUs MOVE TO AND DOCK WITH CONTAINER HOLDERS

606 — MM INSTRUCTS MDUs TO MOVE CONTAINER HOLDERS TO DRIFT SPACES

608 — MDUs MOVE CONTAINER HOLDERS TO DRIFT SPACES

610 — DRIFTED CONTAINER HOLDERS WAIT IN DRIFT SPACES

612 — HAS MM RECEIVED A CONTAINER REQUEST?   NO

YES

614 — MM SELECTS CONTAINER HOLDER WAITING IN DRIFT SPACES

616 — MM INSTRUCTS MDU TO MOVE TO AND DOCK WITH DRIFTED CONTAINER HOLDER

618 — MDU MOVES TO AND DOCKS WITH CONTAINER HOLDER

620 — MM INSTRUCTS MDU TO MOVE DRIFTED CONTAINER HOLDER TO INVENTORY STATION

622 — MDU MOVES DRIFTED CONTAINER HOLDER TO INVENTORY STATION

624 — MM SELECTS REPLACEMENT CONTAINER HOLDER AND MDU

626 — MM INSTRUCTS MDU TO MOVE TO REPLACEMENT CONTAINER

628 — MDU MOVES TO AND DOCKS WITH REPLACEMENT CONTAINER HOLDER

630 — MM INSTRUCTS MDU TO MOVE REPLACEMENT CONTAINER TO VACATED DRIFT SPACE

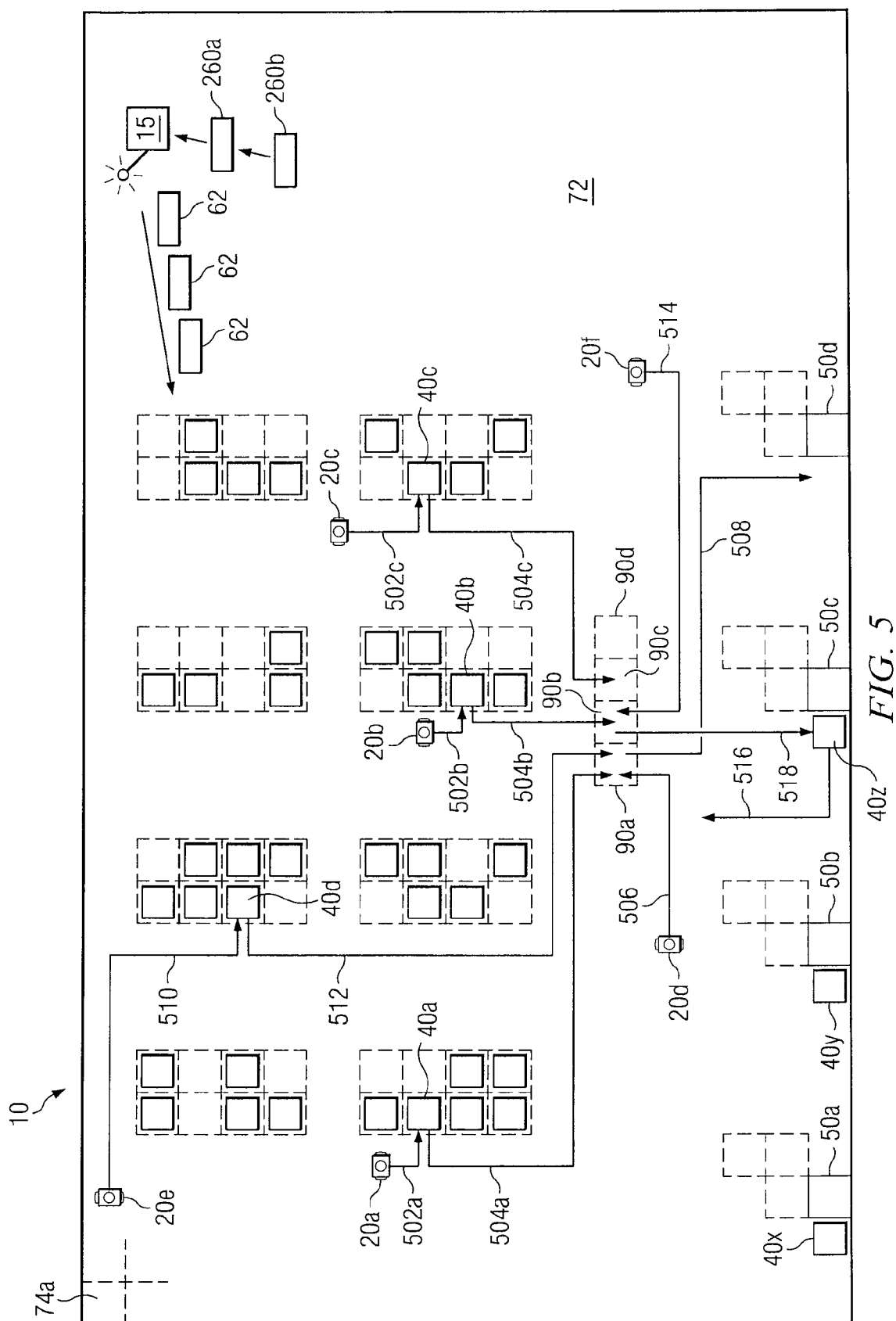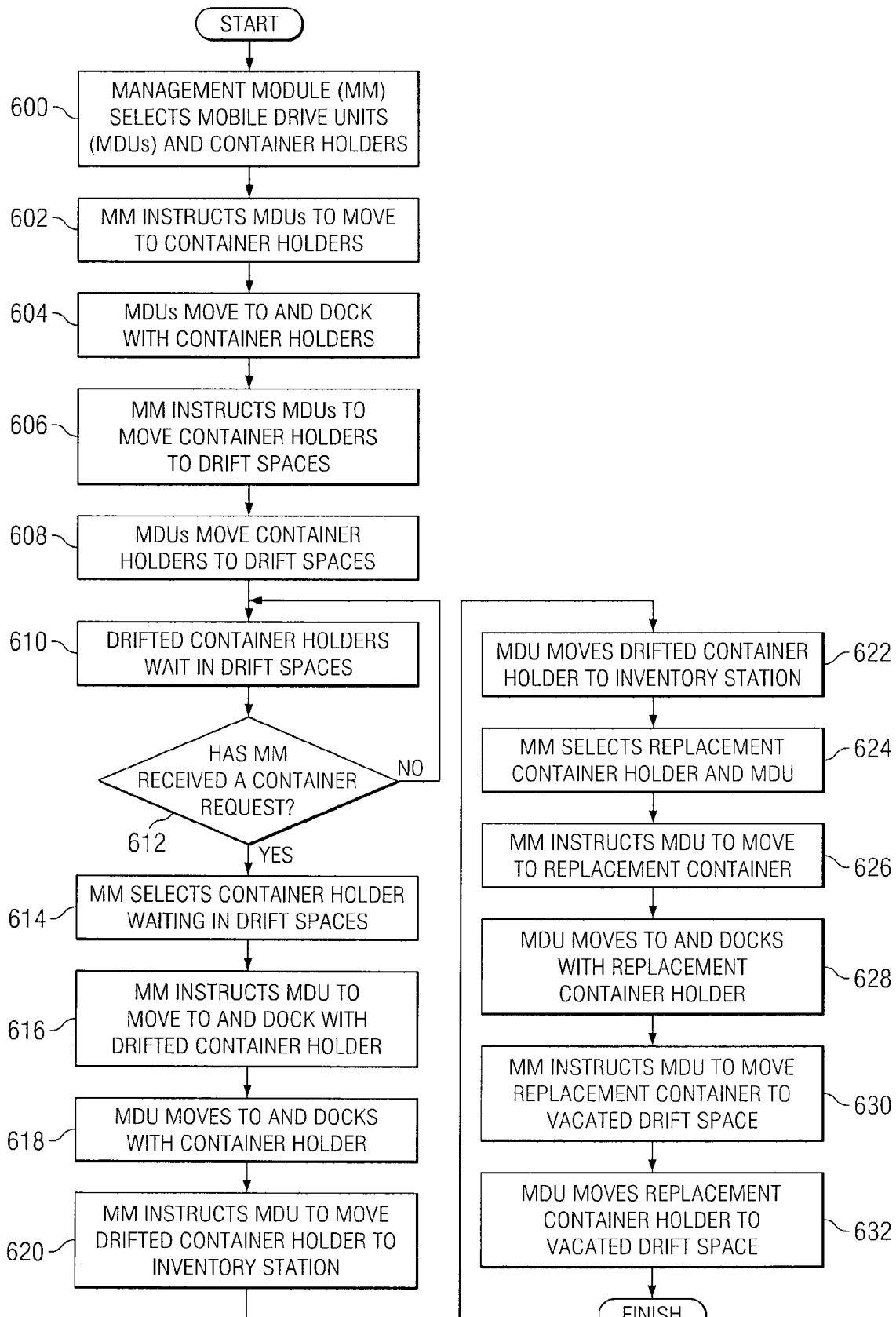632 — MDU MOVES REPLACEMENT CONTAINER HOLDER TO VACATED DRIFT SPACE

FINISH

FIG. 6

METHOD AND SYSTEM FOR FULFILLING REQUESTS IN AN INVENTORY SYSTEM

RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. application Ser. No. 11/185,198, filed Jul. 19, 2005 and entitled "Method and System for Replenishing Inventory Items;" a continuation-in-part of U.S. application Ser. No. 11/185,957, filed Jul. 19, 2005 and entitled "Method and System for Retrieving Inventory Items;" and a continuation-in-part of U.S. application Ser. No. 11/185,467, filed Jul. 19, 2005 and entitled "Method and System for Storing Inventory Holders."

TECHNICAL FIELD OF THE INVENTION

[0002] This invention relates in general to inventory systems, and more particularly to a method and system for efficient storage and retrieval of inventory items.

BACKGROUND OF THE INVENTION

[0003] Modern inventory systems, such as those in mail-order warehouses, airport luggage systems, and custom-order manufacturing facilities, face significant challenges in responding to requests for inventory items. In inventory systems tasked with responding to large numbers of diverse orders, slow responses to orders may result in an ever-increasing backlog of inventory requests. Furthermore, in inventory systems encompassing substantial amounts of physical space, response times may depend heavily on the location of inventory items and resources to be used in fulfilling a received order. As a result, efficient use of time, space, and system resources can be crucial to successful operation and management of an inventory system.

SUMMARY OF THE INVENTION

[0004] In accordance with the present invention, the disadvantages and problems associated inventory storage have been substantially reduced or eliminated. In particular, a mobile inventory system is provided that includes one or more mobile drive units capable of moving components between locations within a physical space associated with the mobile inventory system for purposes of completing tasks relating to inventory items.

[0005] In accordance with one embodiment of the present invention, a method for fulfilling requests within an inventory system includes receiving a request indicating an activity to be completed. The method also includes selecting a holder to fulfill the request and an inventory station at which to fulfill the request. The inventory station is associated with a queue that includes a plurality of queue spaces. The method further includes moving the selected holder from a first location to a second location remote from the selected inventory station. Additionally, the method also includes determining that a trigger event has occurred and, in response to determining that the trigger event has occurred, moving the selected holder from the second location to a queue space of a queue associated with the selected inventory station.

[0006] In accordance with another embodiment of the present invention, a system for fulfilling requests within an inventory system includes a plurality of holders, a plurality of inventory stations, and a management module. The inventory holders are capable of storing objects. Inventory items may be removed from the inventory holders at the inventory stations, and each inventory station is associated with a queue comprising a plurality of queue spaces. The management module is capable of receiving a request indicating an activity to be completed and selecting a holder to fulfill the request. The management module is also capable of selecting an inventory station at which to fulfill the request and instructing a mobile drive unit to move the selected holder from a first location to a second location remote from the selected inventory station. Additionally, the management module is capable of determining that a trigger event has occurred, and in response to determining that the trigger event has occurred, instructing the mobile drive unit to move the selected holder from the second location to a queue space of a queue associated with the selected inventory station.

[0007] Technical advantages of certain embodiments of the present invention include the ability to optimize use of space and system resources in completing tasks and minimizing task-completion times. Further technical advantages of certain embodiments of the present invention include providing a flexible and scalable inventory storage solution that can be easily adapted to accommodate system growth and modification. Other technical advantages of the present invention will be readily apparent to one skilled in the art from the following figures, descriptions, and claims. Moreover, while specific advantages have been enumerated above, various embodiments may include all, some, or none of the enumerated advantages.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] For a more complete understanding of the present invention and its advantages, reference is now made to the following description, taken in conjunction with the accompanying drawings, in which:

[0009] FIG. 1 illustrates components of an inventory system according to a particular embodiment;

[0010] FIG. 2 is an overhead view of a particular embodiment of the inventory system illustrated in FIG. 1;

[0011] FIG. 3 illustrates example operation of a particular embodiment of the inventory system while completing certain tasks;

[0012] FIG. 4 is a flowchart detailing the steps completed by certain embodiments of the inventory system in executing the example operation illustrated in FIG. 3;

[0013] FIG. 5 illustrates example operation of a particular embodiment of the inventory system while completing other tasks;

[0014] FIG. 6 is a flowchart detailing the steps completed by certain embodiments of the inventory system in executing the example operation illustrated in FIG. 5; and

[0015] FIG. 7 is a block diagram illustrating the contents of a management module that may be included in particular embodiments of the inventory system.

DETAILED DESCRIPTION OF THE INVENTION

[0016] FIG. 1 illustrates an inventory system 10 according to a particular embodiment of the present invention. Inventory system 10 includes a management module 15, one or more mobile drive units 20, one or more inventory holders 30, one or more container holders 40, and one or more inventory stations 50. In response to commands communicated by management module 15, mobile drive units 20 transport inventory holders 30 and container holders 40 within a physical area associated with inventory system 10 for purposes of fulfilling

orders received by inventory system **10**. In particular embodiments, the fulfillment of a particular order may involve the completion of several tasks by inventory system **10** and reducing the time that inventory system **10** spends completing such tasks can improve system throughput. Additionally, in particular embodiments, effective use of the finite physical area available for use by the various components of inventory system **10** can lead to greater system efficiency. As a result, particular embodiments of inventory system **10** may utilize certain techniques to anticipate tasks to be completed by certain components and to position the relevant components so as to reduce the time required to complete the anticipated tasks. Furthermore, certain techniques may be implemented to relieve congestion caused by less sophisticated techniques for positioning these elements. In particular, inventory system **10** may utilize a technique (referred to herein as "drifting") to move components to designated destinations in anticipation of tasks to be completed involving the drifted components.

[0017] Management module **15** receives and/or generates requests that initiate particular operations involving mobile drive units **20**, inventory holders **30**, inventory items **32**, container holders **40**, containers **42**, inventory stations **50**, and/or other elements of inventory system **10**. Management module **15** may select components of inventory system **10** to perform these operations and communicate commands, instructions, and/or other appropriate information to the selected components to facilitate completion of these operations. Although the description below focuses on embodiments of inventory system **10** that receive requests (such as operation requests **60** illustrated in FIG. **1**) from other components of inventory system **10**, management module **15** may alternatively or additionally generate such requests itself using any appropriate techniques.

[0018] Additionally, management module **15** may represent a single component, multiple components located at a central location within inventory system **10**, and/or multiple components distributed throughout inventory system **10**. For example, management module **15** may represent components of one or more mobile drive units **20** that are capable of communicating information between the mobile drive units **20** and coordinating movement of mobile drive units **20** in transporting inventory holders **30**. In general, management module **15** may include any appropriate combination of hardware and/or software suitable to provide the described functionality and may further include components located on mobile drive units **20**, inventory stations **50**, or other elements of inventory system **10**.

[0019] Mobile drive units **20** move inventory holders **30** between locations within a workspace associated with inventory system **10**. Mobile drive units **20** may represent any devices or components appropriate for use in inventory system **10** based on the characteristics and configuration of inventory holders **30** and/or other elements of inventory system **10**. In a particular embodiment of inventory system **10**, mobile drive units **20** represent independent, self-powered devices configured to freely move about the associated workspace. In alternative embodiments, mobile drive units **20** represent elements of a tracked inventory system **10** configured to move inventory holder **30** along tracks, rails, cables, or other guidance elements traversing the associated workspace. In such an embodiment, mobile drive units **20** may receive power through a connection to the guidance elements, such as a powered rail.

[0020] Additionally, mobile drive units **20** may be capable of communicating with management module **15** to receive information identifying selected inventory holders **30**, transmit locations of mobile drive units **20**, or exchange any other suitable information used by management module **15** or mobile drive units **20** during operation. Mobile drive units **20** may communicate with management module **15** wirelessly, using wired connections between mobile drive units **20** and management module **15**, and/or in any other appropriate manner. As one example, particular embodiments of mobile drive unit **20** may communicate with management module **15** and/ or with one another using 802.11, Bluetooth, or any other appropriate wireless communication protocol. As another example, in a tracked inventory system **10**, tracks or other guidance element upon which mobile drive units **20** move may be wired to facilitate communication between mobile drive units **20** and other components of inventory system **10**.

[0021] Furthermore, as noted above, management module **15** may include components of individual mobile drive units **20**. Thus, for the purposes of this description, communication between management module **15** and a particular mobile drive unit **20** may represent communication between components of a particular mobile drive unit **20**. In general, mobile drive units **20** may be powered, controlled, and propelled in any manner appropriate based on the configuration and characteristics of inventory system **10**.

[0022] Inventory holders **30** store inventory items **32**. In a particular embodiment, inventory holders **30** include multiple storage bins with each storage bin capable of holding a different type of inventory item **32**. Inventory holders **30** are capable of being carried, rolled, or otherwise moved by mobile drive units **20**. In particular embodiments, inventory holder **30** may provide additional propulsion to supplement that provided by mobile drive unit **20** when moving inventory holder **30**. Additionally, in particular embodiments, each inventory holder **30** may have a plurality of faces, and each bin may be accessible only through specific faces of the relevant inventory holder **30**. Mobile drive units **20** may be configured to rotate inventory holders **30** at appropriate times to present particular faces of inventory holders **30** and the associated bins to an operator or other components of inventory system **10**.

[0023] Inventory items **32** represent any objects suitable for storage, retrieval, and/or processing in an automated inventory system **10**. For the purposes of this description, "inventory items" may represent any one or more objects of a particular type that are stored in inventory system **10**. As one example, inventory system **10** may represent a mail order warehouse facility, and inventory items may represent merchandise stored in the warehouse facility. During operation, mobile drive units **20** may retrieve inventory holders **30** containing one or more inventory items requested in an order to be packed for delivery to a customer. Moreover, in particular embodiments of inventory system **10**, boxes containing completed orders may themselves represent inventory items.

[0024] As another example, inventory system **10** may represent a merchandise-return facility. In such an embodiment, inventory items may represent merchandise returned by customers. Units of these inventory items may be stored in inventory holders **30** when received at the facility. At appropriate times, a large number of units may be removed from a particular inventory holder **30** and packed for shipment back to a warehouse or other facility.

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[0025] As yet another example, inventory system 10 may represent a manufacturing facility with inventory items 32 representing individual components of a manufacturing kit to be included in an assembled product, such as electronic components for a customized computer system. In such an embodiment, inventory system 10 may retrieve particular components identified by a specification associated with an order for the product so that a customized version of the product can be built. Although a number of example embodiments are described, inventory system 10 may, in general, represent any suitable facility or system for storing and processing inventory items. Similarly, inventory items 32 may represent objects of any type suitable for storage, retrieval, and/or processing in a particular inventory system 10.

[0026] In particular embodiments, inventory system 10 may also include container holders 40 that hold containers 42 in which inventory items 32 may be grouped for various tasks completed in such embodiments of inventory system 10. In a given embodiment, container holders 40 may have any appropriate structure and be configured to store containers 42 in any suitable manner based on the type of containers 42 utilized in inventory system 10 or any other appropriate factors. For example, in particular embodiments, container holders 40 include one or more platform or shelves on which containers 42 rest. As another example, in particular embodiments, container holders 40 include a plurality of bins each holding containers 42 of a different size or type.

[0027] Additionally, in particular embodiments, container holders 40 may be substantially similar or identical to inventory holders 30. Certain embodiments of inventory system 10 may include general-purpose holders that can be used as both inventory holders 30 and container holders 40. For example, in particular embodiments, inventory system 10 may include a number of holders that may be dynamically designated as an inventory holder 30 or a container holder 40 depending on whether inventory items 32 or containers 42 are stored on the relevant holder at that particular time. Moreover, in particular embodiments, holders may be configured to simultaneously store both inventory items 32 and containers 42 and a particular holder may, at a particular point in time, represent both an inventory holder 30 and a container holder 40.

[0028] Containers 42 represent any appropriate form of container into or onto which inventory items 32 can be placed for storage, shipping, or other appropriate purposes. Examples of containers 42 include, but are not limited to, boxes, pallets, bins, cartons, and envelopes. In particular embodiments, containers 42 are independent of the container holders 40 in which containers 42 are stored, and as a result, containers 42 may be removed from container holders 40 for processing or transferred to other container holders 40. As one example, containers 42 may represent boxes in which or pallets on which inventory items 32 associated with a particular order may be stored for delivery, and the relevant container 42 may then be shipped to a customer associated with that order. As another example, containers 42 may represent bins or other containers in which inventory items 32 may be placed for long term storage and then moved to a special location or removed from inventory system 10.

[0029] Inventory stations 50 represent locations designated for the removal of inventory items 32 from inventory holders 30, the introduction of inventory items 32 into inventory holders 30, the transfer of inventory items 32 to containers 42, and/or the processing or handling of inventory items 32 in any other suitable manner. Inventory stations 50 may also repre-

sent any appropriate components for processing or handling inventory items 32, such as scanners for monitoring the flow of inventory items 32 in and out of inventory system 10, communication interfaces for communicating with management module 15, and/or any other suitable components. Inventory stations 50 may be controlled, entirely or in part, by human operators or may be fully automated. Moreover, the human or automated operators of inventory stations 50 may be capable of performing certain tasks to inventory items 32, such as packing or counting inventory items 32, as part of the operation of inventory system 10.

[0030] Although "inventory station" as used in the following description refers to locations at which any appropriate processing operation supported by inventory system 10 may be completed, particular embodiments of inventory system 10 may include specialized inventory stations 50 suitable for performing only a single processing task supported by inventory system 10. Moreover, a particular embodiment of inventory system 10 may include inventory stations 50 that are, in general, capable of handling multiple types of operation requests 60 but, at any given time, configured to handle only one particular type of operation requests 60.

[0031] FIG. 2 is an overhead view of a particular embodiment of inventory system 10 illustrating example operation of the relevant embodiment. In FIG. 2, the elements described above with respect to FIG. 1 are located within a workspace 70. Workspace 70 represents an area associated with inventory system 10 in which mobile drive units 20 can move and/or inventory holders 30 can be stored. For example, workspace 70 may represent all or part of the floor of a mail-order warehouse in which inventory system 10 operates. Although FIG. 2 shows, for the purposes of illustration, an embodiment of inventory system 10 in which workspace 70 includes a fixed, predetermined, and finite physical space, particular embodiments of inventory system 10 may include mobile drive units 20 and inventory holders 30 that are configured to operate within a workspace 70 that is of variable dimensions and/or arbitrary geometry.

[0032] Additionally, in certain embodiments, workspace 70 may be associated with a grid, tessellation, tiling, or other appropriate division of area to facilitate the use of space resources within inventory system 10 by the various elements of inventory system 10. The illustrated embodiment of FIG. 2 utilizes a grid that divides workspace 70 into a plurality of spaces that are each associated with a particular area of workspace 70 and referred to generically in this description as a "space 74." FIG. 2, for purposes of simplicity, illustrates a single space 74 (shown as "space 74a"), but for purposes of this description it is assumed that a grid divides the entirety of workspace 70 into spaces 74 and other types of spaces, as described further below.

[0033] In particular embodiments, various areas within inventory system 10 may be designated for, dedicated to, or otherwise associated with certain activities or uses.

[0034] As one example, the embodiment of inventory system 10 in FIG. 2 includes a plurality of storage spaces 76, which represent physical locations where components of inventory system 10 can rest when not being used by inventory system 10 to complete tasks. For example, in particular embodiments, inventory holders 30 and/or container holders 40 may be stored in storage spaces 76 when not being used to fulfill orders. Spaces 74 may be statically designated as stor-

age spaces **76** or may be designated as storage spaces **74** during operation depending on the needs or priorities of inventory system **10**.

[0035] As another example, the embodiment of inventory system **10** illustrated in FIG. **2** includes a plurality of inventory stations **50** that are each associated with a queue **80** into which components may, under certain circumstances, move or be placed to await processing upon arrival at inventory stations **50**. Each queue **80** provides an area for one or more mobile drive units **20**, inventory holders **30**, container holders **40**, and/or other components to rest until the associated inventory station **50** is ready to process a request or perform other tasks associated with the relevant component. In particular embodiments, queues **80** are each associated with a particular physical area of inventory system **10**. For example, in the illustrated embodiment, queues **80** are each associated with a plurality of queue spaces **82** in which mobile drive units **20**, inventory holders **30**, container holders **40**, or other components may wait while stored in the corresponding queue **80**. In particular embodiments, a particular queue **80** may be statically associated with a fixed group of queue spaces **82**. In alternative embodiments, a particular queue **80** may be associated with a dynamically-assigned group of queue spaces **82** determined based on the type of tasks to be completed at the associated inventory station **50**, a traffic metric for the associated inventory station **50**, and/or any other appropriate factors.

[0036] As yet another example, the embodiment of inventory system **10** illustrated in FIG. **1**, includes a plurality of drift spaces **90**. Drift spaces **90** each represent an area of workspace **70** utilized by inventory system **10** to allow components of inventory system **10**, during the completion of a particular task involving that element, to move towards a particular destination or otherwise be positioned so as to reduce a travel time to the relevant destination. In particular embodiments, the relevant element may remain in a particular drift space **90** or a particular group of drift spaces **90** until a trigger event (or events) occurs. After the trigger event occurs, the element may then move toward the relevant system resource for completion of the task. In particular embodiments, spaces **74** may be statically designated as drift spaces **90**, while in alternative embodiments, spaces **74** may be dynamically designated as drift spaces **90** depending on the resource needs of inventory system **10**, the availability of spaces **74**, and/or other appropriate considerations. As described further bellow, drift spaces **90** may be utilized in various ways to improve throughput or otherwise increase system efficiency of certain embodiments of inventory system **10**.

[0037] When functioning, the various components of inventory system **10** complete certain operations involving inventory items **32** and/or the components of inventory system **10** themselves. Management module **15** manages the operation of components and the use of various system resources to facilitate the fulfillment of these tasks. Although the description below focuses on an embodiment of inventory system **10** capable of performing specific operations, a particular embodiment of inventory system **10** may be configured to perform any appropriate operations associated with the storage, processing, transport, or removal of inventory items **32**.

[0038] Management module **15** receives operation requests **60** requesting the completion of certain operations associated with inventory items **32**. For example, in particular embodiments, management module **15** receives operation requests **60** requesting the packaging and shipment of selected inventory items **32**. Additionally, in the illustrated embodiment, management module **15** receives or generates operation requests **60** relating to the maintenance and upkeep of inventory system **10**. For example, in particular embodiments, management module **15** receives or generates operation requests **60** related to restocking inventory items **32**, recharging mobile drive units **20**, delivering empty containers **42** to inventory stations **50**, and/or other suitable tasks that allow various components of inventory system **10** to respond to or be utilized in fulfilling orders. Operation requests **60** may represent communication of any form suitable for inventory system **10** and may include any appropriate information identifying inventory items **32**, components or resources of inventory system **10**, and/or specific operations to be completed.

[0039] As noted above, management module **15** may receive operation requests **60** from a human operator or other components of inventory system **10**. For example, an operator of inventory system **10** may manually enter operation requests **60** using a keyboard coupled to management module **15**. As another example, management module **15** may receive operation requests **60** from remote components over a network connection, such as an Internet connection. Alternatively, management module **15** may itself generate operation requests **60**. For example, management module **15** may be configured to initiate a particular operation based on a predetermined schedule or in response to a particular event and may generate operation requests **60** accordingly. In general, management module **15** may receive or generate operation requests **60** in any suitable manner.

[0040] In response to receiving or generating an operation request **60**, management module **15** may select components or other elements of inventory system **10** to complete the operation request **60**. Depending on the type of operation requested, management module **15** may select a particular mobile drive unit **20**, inventory holder **30**, container holder **40**, inventory station **50**, and/or other suitable components and elements of inventory system to facilitate completion of the relevant operation request **60**. Management module **15** may select the specific components for completing a particular operation request **60** based on any appropriate considerations. As one example, management module **15** may, in particular embodiments, select a particular inventory holder **30** to complete an operation based on factors including, but not limited to, its current distance from one or more mobile drive units **20**, the various types of inventory items **32** stored by the selected inventory holder **30**, its current location within workspace **70**, and/or other operation requests **60** the selected inventory holder **30** is currently being used to fulfill. As another example, management module **15** may, in particular embodiments, select a mobile drive unit **20** to fulfill a particular task based on factors including, but not limited to, its distance from a selected inventory holder **30**, a power supply level associated with the selected mobile drive unit **20**, and/or its current activity. More generally, however, management module **15** may select suitable components to complete tasks associated with a particular operation request **60** based on any appropriate factors, considerations, or criteria.

[0041] After management module **15** selects suitable components and/or elements to complete operation request **60**, management module **15** may then communicate information to the selected components indicating tasks to be completed by these components or their operators and/or identifying one

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or more of the other selected components involved in completion of the requested operation. For example, in the illustrated embodiment, management module **15** communicates task requests **62** to selected components to communicate information regarding tasks to be completed by the receiving components and/or other components to be involved in completing the relevant tasks. Task requests **62** may represent communication of any suitable form to initiate completion of tasks by the receiving components, such as instructions, commands, and/or requests appropriately formatted for the receiving components.

[0042] The selected components may then utilize the received information to complete tasks associated with the relevant operation request **60**. For example, based on instructions received from management module **15**, a selected mobile drive unit **20** may move a selected inventory holder **30** to a selected inventory station **50** so that an operator of the selected inventory station **50** may pick requested inventory items **32** from the selected inventory holder **30** and pack them for shipment. Similarly, an operator of an inventory station **50** may receive information from management module **15** identifying inventory items **32** to be selected from an inventory holder **30** moved to the relevant inventory station **50** and packed in a container **42** as part of fulfilling an operation request **60** received by management module **15**.

[0043] Because, in particular embodiments, the operation of inventory system **10** is constrained by limits on space, system components, and/or other resources, the efficient use of such resources may increase the throughput and efficiency of inventory system **10**. As a result, in particular embodiments, management module **15** may employ various techniques to progressively move, or "drift," inventory holders **30**, container holders **40**, or other components of inventory system **10** towards inventory stations **50**, other system resources, or other destinations within workspace **70**. By moving the relevant component towards its destination in stages, management module **15** may be able to time its arrival in a manner that results in more efficient use of space and system resources.

[0044] To facilitate this drifting, certain areas within workspace **70** may be designated as drift spaces **90**, where components can wait until an appropriate event has occurred triggering further movement of the component, either to another intermediate location or a final destination. Drift spaces **90** may represent any appropriately sized and shaped area of workspace **70** and may be located at any suitable location within workspace **70**. Additionally, as noted above, drift spaces **90** may represent fixed, predetermined locations within workspace **70** or may represent a dynamically allocated areas of workspace **70** that may be selected and designated as appropriate during operation of inventory system **10**.

[0045] Drift spaces **90** may be used by management module **15** in any appropriate manner in completing the tasks associated with operation requests **60**. For example, in particular embodiments, management module **15** may park a component destined for a particular system resource, such as an inventory station **50**, in a drift space **90** until certain conditions are satisfied (e.g., the resource becomes available for use by the component or the number of other components waiting in the vicinity of the system resource falls below some maximum threshold). This may allow management module **15** to limit congestion in the vicinity of the system resource but also allow management module **15** to reduce the completion time of the relevant operation by positioning the

relevant component closer to the system resource while the component waits for the system resource.

[0046] Additionally, the use of drift spaces **90** may allow a system component to be positioned close to multiple different instances of a particular system resource and move to the first instance that becomes available. For example, a component may be moved to a drift space **90** removed from all active inventory stations **50** but in relatively close proximity to these inventory stations **50**. The component may then wait in its drift space **90** until an inventory station **50** needs the component or an inventory station **50** becomes available to complete a task involving that component. Because the component is moved to an appropriate drift space **90** prior to an inventory station **50** becoming available or needing the component, the component can be quickly repositioned at any of the inventory stations **50** as soon as appropriate.

[0047] Furthermore, in certain embodiments, a particular drift space **90** may be designated exclusively for drifting particular types of components, drifting components associated with a particular trigger event, drifting components for a particular purpose, and/or drifting components destined for a particular location. For example, a first drift space **90** may be designated as a waiting place for inventory holders **30** responding to specific retrieval requests **160**, while a second drift space **90** may be designated as a waiting place for container holders **40** waiting for a container request **260** to fulfill. Depending on the configuration of inventory system **10**, such exclusive drift spaces **90** may be designated when inventory system **10** begins operation or at any appropriate time during operation.

[0048] Alternatively, a particular drift space **90** may be designated for use for any type of drifting, and drift spaces **90** may be used interchangeably by components of inventory system **10**. For example, in particular embodiments, a particular drift space **90** may be used, at different times, as a waiting place for both inventory holders **30** and container holders **40** en route to various different locations. Furthermore, in certain embodiments, a type of a particular drift space **90** may be designated dynamically during operation of inventory system **10**.

[0049] As a result, drift spaces **90** may be used in many different ways to provide improved efficiency and throughput in inventory system **10**. Additionally, in particular embodiments, drift spaces **90** may be used flexibly to dynamically optimize the effectiveness of inventory system **10**. Consequently, the use of drift spaces **90** may provide numerous benefits in inventory system **10**. Specific embodiments, however, may provide some, none, or all of these benefits.

[0050] FIGS. **3-6** provide specific examples of how drift spaces **90** may be used in particular embodiments of inventory system **10** in fulfilling particular types of operation requests **60**. As explained further below, in particular embodiments, the use of drift spaces **90** may limit congestion, reduce task-completion times, and/or otherwise improve system efficiency or throughput. As a result, certain embodiments of inventory system **10** may provide a number of operational benefits. Specific embodiments may, however, provide some, none, or all of these benefits.

[0051] FIGS. **3** and **4** illustrate one example of how drift spaces **90** can be used in particular embodiments of inventory system **10** to improve system efficiency in responding to particular types of operation requests **60**. In particular, FIGS. **3** and **4** describe the operation of certain embodiments of inventory system **10** in responding to a particular type of

operation request **60** (referred to here as a "retrieval request **160**") that identifies one or more inventory items **32** to be retrieved from storage in inventory system **10**. In response to receiving retrieval request **160**, management module **15** instructs mobile drive units **20** to transport inventory holders **30** storing inventory items **32** requested by retrieval request **160** to a particular inventory station **50** so that the requested inventory items **32** can be collected and prepared for shipping. If several inventory holders **30** are involved in fulfilling retrieval request **160**, management module **15** may utilize drift spaces **90** to position one or more of these inventory holders **30** close to the relevant inventory station **50** and then move them to that inventory station **50** as space becomes available nearby. Thus, as explained further below, drift spaces **90** may allow management module **15** to limit the number of inventory holders **30** that are placed in the vicinity of the relevant inventory station **50** while at the same time reducing the lengthy wait time that could result if additional inventory holders **30** had to be retrieved from their original storage spaces **76** when inventory station **50** was ready to process these inventory holders **30**.

[0052]   FIG. **3** illustrates an overhead view of a particular embodiment of inventory system **10** in fulfilling an example retrieval request **160**. As noted above, retrieval request **160** is an operation request **60** that identifies one or more types of inventory items **32** to be retrieved from storage in inventory system **10**. In particular embodiments, retrieval request **160** may represent a customer order received by inventory system **10** and may identify one or more inventory items **32** to be packaged and shipped to the ordering customer. Inventory items **32** ordered by the customer may be retrieved from inventory holders **30** at an inventory station **50** and packaged for shipping (e.g., in a container **42**) or otherwise processed in accordance with the retrieval request **160**.

[0053]   In the illustrated example, management module **15** responds to retrieval request **160** by selecting an inventory station **50**, one or more inventory holders **30**, and one or more mobile drive units **20** to fulfill retrieval request **160**. As noted above, management module **15** may select these components based on any appropriate considerations. FIG. **3** illustrates an example in which management module **15** selects three mobile drive units **20** (shown as mobile drive units **20**a, **20**b, and **20**c) three inventory holders **30** (shown as inventory holders **30**a, **30**b, and **30**c) to fulfill retrieval request **160** at a selected inventory station (shown as inventory station **50**a).

[0054]   After selecting the relevant components, management module **15** may communicate one or more task requests **62** to each of the selected mobile drive units **20** to facilitate transport of the selected inventory holders **30** to the selected inventory station **50**. The task requests **62** transmitted to each mobile drive unit **20** identify a selected inventory holder **30** in terms of its location or an identifier associated with the selected inventory holder **30**. The selected mobile drive units **20** then move to the selected inventory holders **30** (as shown by arrows **302**a-c in FIG. **3**) and dock with them. After docking, the selected mobile drive units **20** begin moving the selected inventory holders **30** towards the selected inventory station **50**.

[0055]   Depending on the number of inventory holders **30** selected to fulfill retrieval request **160**, the size of a queue associated with the selected inventory station **50**, and/or other appropriate considerations, management module **15** may instruct one or more mobile drive units **20** to temporarily move their associated inventory holder **30** to a drift space **90**.

For example, in the illustrated embodiment, management module **15** is configured to drift one or more inventory holders **30** destined for a particular inventory station **50** when the number of inventory holders **30** en route to that inventory station **50** is greater than two. As a result, in the illustrated example, management module **15** drifts one of the selected inventory holders **30**a-c instead of moving the relevant inventory holder **30** directly to inventory station **50**a.

[0056]   Furthermore, if management module **15** decides, in responding to retrieval request **160**, to drift one or more inventory holders **30**, management module **15** may select the inventory holder **30** or inventory holders **30** to drift based on any suitable criteria or consideration. For example, management module **15** may select inventory holders **30** to drift based on the distance between the drifted inventory holders **30** and the selected inventory station **50**, the inventory items **32** stored by the drifted inventory holders **30** (e.g., to allow retrieved inventory items **32** to be packaged in a particular order in a container **42**), the time required for the corresponding mobile drive unit **20** to transport the drifted inventory holders **30** to the selected inventory station **50**, and/or any other appropriate considerations or criteria.

[0057]   The mobile drive units **20** associated with inventory holders **30** to be drifted, then move the drifted inventory holders **30** to one of drift spaces **90**, while the remaining mobile drive units **20** move their corresponding inventory holders **30** to the selected inventory station **50**. In particular embodiments, management module **15** may select a particular drift space **90** for each drifted inventory holder **30**. For example, in particular embodiments, management module **15** selects an appropriate drift space **90** for each drifted inventory holder **30** from a list of currently-available drift spaces **90** and communicates a task request **62** identifying the selected drift space **90** and/or its locations to the mobile drive unit **20** docked to the drifted inventory holders **30**. Alternatively, in particular embodiments, mobile drive units **20** may themselves determine the drift spaces **90** that are available and select a particular drift space **90** from among the available drift spaces **90**. Thus, in the illustrated example, mobile drive units **20**a and **20**b move their respective inventory holders **30** to inventory station **50**a (as shown by arrows **304**a and **304**b). Additionally, management module **15** selects drift space **90**a for inventory holder **30**c and instructs mobile drive unit **20**c to move inventory holder **30**c to drift space **90**a. Mobile drive unit **20**c then moves to drift space **90**a (as shown by arrow **306**).

[0058]   The drifted inventory holders **30** then wait in drift spaces **90** until one or more trigger events occur. These trigger events may represent any suitable events associated with the drifted inventory holders **30**, the selected inventory station **50**, any other component of inventory station **50**, and/or any aspect of the operation of inventory system **10**. For example, in particular embodiments, the trigger events may be selected, in part, to limit the number of inventory holders **30** that are moved into the vicinity of the selected inventory station **50** at any given time. Thus, in such embodiments, the trigger events may relate to or involve the expiration of a delay period, an indication from the selected inventory station **50** (or an operator of the selected inventory station **50**) that a certain number of the selected inventory holders **30** have been processed, or any other occurrence that indicates or suggests a certain number of the selected inventory holders **30** have been or should have been moved out of the vicinity of the selected inventory station **50**.

[0059] Furthermore, in particular embodiments, a particular inventory holder 30 may wait in drift spaces 90 until multiple trigger events occur. For example, in certain embodiments, a particular drifted inventory holder 30 may wait in a drift space 90 until one or more other drifted inventory holders 30 move towards their final destinations and some other trigger event occurs. This may allow drifted inventory holders 30 to depart from drift spaces 90 in a particular order, based on a time of arrival, a priority level, and/or other factors. Furthermore, different inventory holders 30 may be associated with different trigger events. Consequently, in particular embodiments, all drifted inventory holders 30 in drift spaces 90 may wait for the same trigger event or events, and their corresponding mobile drive units 20 may move them to their destination when the trigger event or events occur. In other embodiments or under other circumstances, different inventory holders 30 may be associated with different trigger events, with each drifted inventory holder 30 waiting in a drift space 90 until the trigger event associated with that particular drifted inventory holder 30 occurs.

[0060] Depending on the configuration and capabilities of management module 15 and mobile drive units 20, management module 15 may notify a mobile drive unit 20 associated with a particular drifted inventory holder 30 that the trigger event associated with that inventory holder 30 has occurred, the mobile drive unit 20 may itself determine that the trigger event has occurred, or both components may be configured to detect some or all of the trigger events occurring in inventory system 10. Additionally, in particular embodiments, the trigger event may represent receipt, by the relevant mobile drive unit 20, of instructions (e.g., task requests 62) from management module 15 or another element of inventory system 10 instructing that mobile drive unit 20 to move an inventory holder 30 from a drift space 90 in which it is waiting to another destination.

[0061] Once the trigger event associated with a particular drifted inventory holder 30 has occurred and/or the mobile drive unit 20 transporting that drifted inventory holder 30 has received any appropriate notification of such occurrence, the transporting mobile drive unit 20 moves the relevant inventory holder 30 to its destination. At its destination, the drifted inventory holder 30 is processed in accordance with the retrieval request and inventory items 32 identified by retrieval request 160 are removed from the drifted inventory holder 30. These inventory items 32 may be combined with inventory items 32 selected from other inventory holders 30 to complete fulfillment of retrieval request 160.

[0062] In the illustrated example, the trigger event associated with drifted inventory holder 30c is the departure of one or more inventory holders 30 from queue 80a associated with inventory station 50a. As a result, when management module 15 determines that mobile drive unit 20a has exited queue 80a of inventory station 50 (as shown by arrow 308), management module 15 transmits a task request 62 to mobile drive unit 20c, which is waiting in drift space 90a. In response to this task request 62, mobile drive unit 20c moves inventory holder 30c to inventory station 50a (as shown by arrow 310). At inventory station 50a, inventory items 32 identified by retrieval request 160 are then removed from inventory holder 30c to complete the fulfillment of retrieval request 160.

[0063] Although FIG. 3 focuses on an example embodiment of inventory system 10 that implements the described techniques in a particular manner, various embodiments may implement the utilized techniques in any appropriate manner.

For example, in the described embodiment, a particular mobile drive unit 20 transports each drifted inventory holder 30 or container holder 40 to a drift space 90 and then waits with the drifted holder until the trigger event or events occur. In alternative embodiments, however, mobile drive units 20 may transport drifted inventory holders 30 to drift spaces 90 and leave these drifted inventory holders 30 in drift spaces 90. Other mobile drive units 20 may then be responsible for moving the drifted inventory holders 30 to their final destination once the trigger event or events occur. Moreover, in particular embodiments, a particular mobile drive unit 20 or group of mobile drive units 20 may be used to move all drifted inventory holders 30 between drift spaces 90 and a final destination of the drifted inventory holders 30 and/or between the various drift spaces 90 to manage the use of drift spaces 90.

[0064] Additionally, as noted above, drift spaces 90 in workspace 70 may, in particular embodiments, be utilized for more than one purpose or may be associated with more than one destination in workspace 70. Consequently, a particular drift space 90 may, at various different times, be used to drift inventory holders 30 destined for multiple different inventory stations 50. As a result, in fulfilling a subsequent retrieval request 160, the process described above may be repeated with a second mobile drive unit 20 destined for a second inventory station 50 waiting in the same drift space 90 for a particular trigger event to occur. Thus, in particular embodiments, drift spaces 90 may be used to flexibly drift mobile drive units 20 and inventory holders 30 destined for different inventory stations 50.

[0065] Furthermore, although the description above describes, for purposes of simplicity, an example in which a final destination is selected for drifted inventory holders 30 before they begin drifting, in alternative embodiments, a final destination for drifted devices may not be chosen until the relevant devices have begun drifting or until after these devices have finished drifting. For example, in particular embodiments, an inventory holder 30 may be selected for fulfilling a received order, but the inventory station 50 at which the received order will be fulfilled may not be determined until later. In such embodiments, the determination may be delayed altogether or a group of candidate inventory stations 50 may be selected when the relevant order is received but a specific inventory station 50 from the candidate group may not be selected until a later time. In such embodiments, management module 15 may select an inventory holder 30 or inventory holders 30 to fulfill the received order but determine that certain necessary or beneficial conditions have not been satisfied and may delay selection of a corresponding inventory station 50.

[0066] For example, management module 15 may determine that a container holder 40 on which a particular order will be stored is not yet available. As a result, management module 15 may drift one or more inventory holders 30 associated with the order until the container holder 40 becomes available. Furthermore, to optimize throughput of system 10, management module 15 may wait to choose the inventory station 50 at which the order will ultimately be completed until the relevant container holder 40 is available. As a result, management module 15 may instruct mobile drive units 20 to retrieve the relevant inventory holders 30 and transport those inventory holders 30 to drift spaces 90. When an appropriate triggering event occurs (such as a particular order holder 40 becoming available), management module 15 may select an

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inventory station **50** at which to fulfill the received order and instruct mobile drive units **20** to move the drifted inventory holders **30** to the relevant inventory station **50**. As a result, the use of drift spaces **90** may allow management module **15** to select the optimal inventory station **50** at which to complete the received order based on the state of system **10** when the relevant container holder **40** finally becomes available.

[0067] Additionally, in particular embodiments, management module **15** may select a particular inventory holder **30** to fulfill multiple different orders at multiple different inventory stations **50**. In such embodiments, management module **15** may use drift spaces **90** to temporarily store the relevant inventory holder **30** before and during completion of the different orders, so that this inventory holder **30** can be positioned close to the relevant inventory stations **50** while its orders are still being completed. Consequently, in such embodiments, management module **15** may drift a particular inventory holder **30** until one (or a particular one) of the inventory stations **50** fulfilling the multiple orders associated with the drifted inventory holder **30** becomes available. After being transported to the available inventory station **50**, the inventory holder **30** may then be returned to drift spaces **90** until another inventory station **50** completing an order associated with that inventory holder **30** becomes available.

[0068] Thus, in general, drift spaces **90** can be used to move inventory holders **30** or other components of inventory system **10** towards their destination without increasing the congestion in the immediate vicinity of the destination. Limiting the congestion around inventory stations **50** and other system resources can improve efficiency and throughput in certain embodiments of inventory system **10**. As a result, particular embodiments of inventory system **10** can provide several operational benefits. Specific embodiments, however, may provide some, all, or none of these benefits.

[0069] FIG. **4** is a flowchart illustrating example operation of the embodiment of inventory system **10** shown in FIG. **3**. In particular, FIG. **4** illustrates the operation of inventory system **10** in fulfilling a retrieval request **160** received by management module **15**. The steps illustrated in FIG. **4** may be combined, modified, or deleted where appropriate, and additional steps may also be added to the flowchart. Additionally, the illustrated steps may be performed in any suitable order.

[0070] Operation begins at step **400** in the illustrated example with management module **15** receiving retrieval request **160**. As noted above, retrieval request **160** indicates one or more inventory items **32** to be retrieved from inventory system **10**. In response to receiving retrieval request **160**, management module **15** selects components of inventory system **10** to fulfill retrieval request **160** at step **402**. As part of selecting components to fulfill retrieval request **160**, management module **15**, in the described embodiment, selects one or more inventory holders **30** storing inventory items **32** identified by retrieval request **160**, an inventory station **50** at which to fulfill retrieval request **160**, and one or more mobile drive units **20** to transport the selected inventory holders **30** to the selected inventory station **50**. As discussed above, management module **15** may select these components based on any appropriate criteria or considerations.

[0071] At step **404**, management module **15** instructs each of the selected mobile drive units **20** to move towards a storage space **76** associated with a particular one of the selected inventory holders **30**. In response, the selected mobile drive units **20** each move to the storage space **76** identified to the relevant mobile drive unit **20** and dock with

their respective inventory holders **30** at step **406**. The selected mobile drive units **20** then begin to move their corresponding inventory holders **30** towards the selected inventory station **50** at step **408**.

[0072] At any point while fulfilling retrieval request **160**, management module **15** may decide, based on any appropriate factors, to drift one or more of the selected inventory holders **30** to limit congestion in the vicinity of the selected inventory station **50**, prevent an overflow of the queue **80** associated with the selected inventory station **50**, or otherwise improve the efficiency or throughput of inventory system **10**. For example, in the illustrated example, management module **15**, at step **410**, determines whether the number of selected inventory holders **30** exceeds the number of queue spaces **82** available in a queue **80** associated with the selected inventory station **50**. The available queue spaces **82** may represent queue spaces **82** in the relevant queue **80** that management module **15** has not already reserved for specific inventory holders **30** destined for the associated inventory station **50**, queue spaces **82** not already occupied by inventory holders **30**, or queue spaces **82** that are deemed available based on any other suitable criteria. If the number of selected inventory holders **30** does not exceed the number of queue spaces **82** available in the associated queue **80**, then operation continues at step **412** with all of the selected mobile drive units **20** continuing on to the selected inventory station **50**. At step **414**, the selected inventory holders **30** are then processed (e.g., requested inventory items **32** are removed from the selected inventory holders **30**) and retrieval request **160** is completed at step **430** as shown in FIG. **4**.

[0073] If, however, the number of selected inventory holders **30** does exceed the number of queue spaces **82** available in the associated queue **80**, then management module **15**, according to this example operation, decides to drift one or more inventory holders **30**, as shown by steps **416-426** of FIG. **4**. Specifically, at step **416**, management module **15** instructs a particular mobile drive unit or units **20** to move towards a drift space **90** in workspace **70**. At step **418**, the relevant mobile drive unit or units **20** move to a drift space **90**. Depending on the configuration of inventory system **10**, management module **15** may select the drift space **90** to be used or the relevant mobile drive unit **20** may itself choose a particular drift space **90**. At step **420**, the other mobile drive units **20** transporting inventory holders **30** continue on to the selected inventory station **50** where they are processed.

[0074] The drifted mobile drive unit or units **20** then wait, at step **422**, for a trigger event to occur. In the illustrated example, the trigger event relates to one or more queue spaces **82** becoming available in a queue **80** associated with the selected inventory station **50**. As a result, management module **15** and/or the drifted mobile drive unit or units **20** monitor the availability of queue spaces **82** in the queue **80** associated with the selected inventory station **50** and detect when an additional queue space **82** becomes available. For example, in particular embodiments, management module **15** may maintain a database in which information on the availability of queue spaces **82** (such as information on granted queue space reservations or location data for inventory holders **30** in workspace **70**). In such embodiments, management module **15** may determine based on this information when queue spaces **82** become available and may communicate this information to mobile drive units **20** to allow mobile drive units **20** to determine when queue spaces **82** become available. If the appropriate component determines at step **424** that no addi-

tional queue spaces 82 have become available, the waiting mobile drive unit or units 20 continue to wait with operation returning to step 422.

[0075] If, instead, the appropriate component determines that an additional queue space 82 has become available, the waiting mobile drive unit 20 or one of the waiting mobile drive units 20 moves to the selected inventory station 50 at step 426. When the released mobile drive unit 20 arrives at the selected inventory station 50, the drifted inventory holder 30 may then be processed at step 428. For example, an operator of the selected inventory station 50 may remove inventory items 32 identified by retrieval request 160 from the drifted inventory holder 30 and place them in a container 42 associated with retrieval request 160. If additional inventory holders 30 remain in drift spaces 90, steps 424-428 may be repeated for each as additional queue spaces 82 become available.

[0076] Once all the inventory items 32 requested by retrieval request 160 have been picked from the selected inventory holders 30, the packed container 42 may be shipped and/or fulfillment of retrieval request 160 may otherwise be completed as shown at step 430. Operation of inventory system 10 in fulfilling retrieval request 160 may then end as shown in FIG. 4.

[0077] FIGS. 5 and 6 illustrate another example of how drift spaces 90 can be used in particular embodiments of inventory system 10 to improve system efficiency in responding to particular types of operation requests 60. In particular, FIGS. 5 and 6 describe the operation of certain embodiments of inventory system 10 in responding to another type of operation request 60 (referred to here as a "container request 260") that requests delivery of containers 42 to a particular inventory station 50.

[0078] More specifically, in particular embodiments of inventory system 10, a container holder 40 may be positioned beside each inventory station 50. As noted above, containers 42 may represent boxes, pallets, or other suitable containers on or in which inventory items 32 may be grouped for storage, shipping, or other purposes. Positioning a container holder 40 next to each inventory station 50 may allow operators of inventory stations 50 to quickly obtain containers 42 when fulfilling retrieval requests 160 or other requests that involve containers 42. Operators can quickly reach into or onto the container holder 40 positioned next to their inventory station 50 whenever a new container 42 is needed. When the supply of containers 42 in the container holder 40 positioned next to an operator's inventory station 50 is exhausted, management module 15 may instruct a mobile drive unit 20 to deliver another container holder 40 having a fresh supply of containers to that operator's inventory station 50. As a result, inventory system 10 can ensure that a steady supply of containers 42 are provided to an inventory station 50 without requiring operators to leave inventory stations 50 to retrieve additional containers 42.

[0079] Thus, to reduce the delay experienced between use of the final container 42 in or on the container holder 40 positioned next to a particular inventory station 50 and delivery of another container holder 40 stocked with containers 42 to that inventory station 50, inventory system 10 may utilize drift spaces 90 to locate container holders 40 loaded with containers 42 near to inventory stations 50. When inventory system 10 is operational, one or more container holders 40 may be moved from an initial storage space 74 or other location to drift spaces 90 to wait until needed or requested by a particular inventory station 50. Then, when the supply of

containers 42 at a particular inventory station 50 is exhausted, a container holder 40 waiting in a drift space 90 may be moved to the relevant inventory station 50. By positioning stocked container holders 40 in drift spaces 90, certain embodiments of inventory system 10 may reduce the amount of time required to deliver a new container holder 40 to depleted inventory stations 50 and increase the number of retrieval requests 160 and/or other operation requests 60 that each inventory station 50 can process over a given period of time.

[0080] FIG. 5, in particular, shows an overhead view of a specific embodiment of inventory system 10 in fulfilling an example container request 260. As noted above, container request 260 is an operation request 60 used in certain embodiments of inventory system 10 to request delivery of containers 42 to a particular inventory station 50. In particular embodiments, container request 260 may represent an instruction, message, or notification sent by the relevant inventory station 50 to management module 15 indicating that the supply of containers 42 at the relevant inventory station 50 has been exhausted and/or requesting additional containers 42 be delivered to the relevant inventory station 50. Management module 15 responds to container requests 260 by instructing a mobile drive unit 20 to transport a container holder 40 to the requesting inventory station 50. To limit the amount of time required to deliver another container holder 40 to inventory station 50, management module 15 may select a container holder 40 waiting in a drift space 90 relatively near to inventory stations 50 to fulfill the container request 260.

[0081] More specifically, at an appropriate time during operation of inventory system 10, management module 15 may select one or more container holders 40 to drift until management module 15 receives its next container request 260. For example, in particular embodiments, when inventory system 10 initially starts up, management module 15 may select one or more mobile drive units 20 and one or more container holders 40 and instruct a selected mobile drive unit 20 to move a selected container holder 40 to each active inventory station 50. Management module 15 may also have one or more container holders 40 transported to drift spaces 90. Workspace 70 may be configured so that drift spaces 90 are located relatively close to inventory stations 50 and, in particular embodiments, closer than many or all of storage spaces 76. In the illustrated example, inventory stations 50a-c are initially active, and operation begins with container holders 40 (shown in FIG. 5 as container holders 40x-z) positioned next to each inventory station 50 currently active.

[0082] While inventory system 10 is positioning container holders 40 near inventory stations 50 or at an appropriate point in time before or after positioning such container holders 40, inventory system 10 may also move one or more container holders 40 to drift spaces 90. For example, management module 15 may select one or more mobile drive units 20 and one or more container holders 40 and instruct the selected mobile drive units 20 to move the selected container holders 40 to drift spaces 90. In the illustrated example, management module 15 selects mobile drive units 20a-c and container holders 40a-c and instructs mobile drive units 20a-c to move container holders 40a-c to drift spaces 90a-c, respectively (as shown by arrows 502a-c and 504a-c). In particular embodiments, the selected mobile drive units 20 may then undock from the drifted container holders 40 and move away to begin completing other tasks.

[0083] Once the selected mobile drive units **20** and container holders **40** are positioned in drift spaces **90**, inventory system **10** can begin to respond to container requests **260** using container holders **40** waiting in drift spaces **90**. As noted above, container requests **260** request delivery of additional containers **42** to a particular inventory station **50**. Depending on the configuration of inventory system **10**, container requests **260** may be transmitted by an inventory station **50** (or its operator) when the requesting inventory station **50** becomes active, the supply of containers **42** at the requesting inventory station **50** is exhausted, and/or any other event occurs prompting a need for additional containers at the requesting inventory station **50**. In the illustrated example, after mobile drive units **20**a-c have moved container holders **40**a-c to drift spaces **90**a-c, management module **15** receives a first container request **260**a from inventory station **50**d indicating that inventory station **50**d has been activated.

[0084] In response to a container request **260**, management module **15** may instruct an appropriate mobile drive unit **20** to deliver a container holder **40** from a drift space **90** to the requesting inventory station **50**. If more than one container holder **40** are waiting in drift spaces **90**, management module **15** selects one of the waiting container holders **40** to fulfill the received container request **260**. Management module **15** may select the appropriate container holder **40** based on the length of time the selected contain holder **40** has been waiting in its drift space **90**, the number of containers the selected container holder **40** stores, a distance between the requesting inventory station **50** and the drift space **90** in which the selected container holder **40** is waiting, and/or any other suitable considerations or factors. For example, in FIG. **5**, management module **15** manages the drifted container holders **40** waiting in drift spaces **90** in a first-in/first-out manner, with the container holder **40** that has been waiting for the longest amount of time being selected to fulfill received container requests **260**. As a result, management module **15** selects container holder **40**a to fulfill container request **260**a.

[0085] After selecting a drifted container holder **40** to fulfill a received container request **260**, management module **15** may instruct a particular mobile drive unit **20** to transport the drifted container holder **40** to the requesting inventory station **50**. For example, in FIG. **5**, management module **15** instructs mobile drive unit **20**d to move container holder **40**a to the requesting inventory station **50**, inventory station **50**d. The relevant mobile drive unit **20** may then move to and dock with the drifted container holder **40** and transport the drifted container holder **40** to the requesting inventory station **50**. Thus, in the illustrated example, mobile drive unit **20**d moves to container holder **40**a and transports container holder **40**a to inventory station **50**d to fulfill first container request **260**a (as shown by arrows **506** and **508**, respectively).

[0086] In particular embodiments, management module **15** may replace container holders **40** that are released from drift spaces **90** to fulfill container requests **260**. Specifically, management module **15** may select a container holder **40** from a storage space **76**, a station where container holders **40** are loaded with containers **42**, or any other location in inventory system **10** and dispatch a mobile drive unit **20** to move that container holder **40** to the vacated drift space **90**. For example, in FIG. **5**, management module **15** instructs mobile drive unit **20**e to retrieve container holder **40**d and move container holder **40**d to the drift space **90** vacated by container holder **40**a (as shown by arrows **510** and **512**, respectively).

[0087] As a result, in particular embodiments, inventory system **10** may maintain a continually-restocked supply of container holders **40** in drift spaces **90** and may be able to fulfill multiple container requests **260** using container holders **40** waiting in drift spaces **90**. To illustrate, FIG. **5** also shows management module **15** receiving a second container request **260**b from inventory station **50**b after fulfilling first container request **260**a. Second container request **260**b indicates, for example, that inventory station **50**c has exhausted the supply of containers **42** stored by container holder **40**z initially positioned next to inventory station **50**c. In response to second container request **260**b, management module **15** selects a container holder **40** (container holder **40**b in FIG. **5**) and instructs a particular mobile drive unit **20** (mobile drive unit **20**f in FIG. **5**) to move to and dock with the drifted container holder **40** (as shown by arrow **514**). Additionally, management module **15** may also instruct a mobile drive unit **20** (not shown in FIG. **5**) docked to the exhausted container holder **40** (container holder **40**z in FIG. **5**) to move the exhausted container holder **40** away from the requesting inventory station **50** (as shown by arrow **516**) so that the transporting mobile drive unit **20** can then position the drifted container holder **40** next to the requesting inventory station **50** (as shown by arrow **518**).

[0088] Thus, as FIG. **5** illustrates, drift spaces **90** can also be used to drift container holders **40**, inventory holders **30**, or other components of inventory system **10** when the final destination of the relevant component is not yet determined. This may allow inventory system **10** to position components such as container holders **40** and inventory holders **30** relatively near to several potential destinations prior to a need or use arising for the relevant component at a particular one of the destinations.

[0089] FIG. **6** is a flowchart illustrating example operation of the embodiment of inventory system **10** shown in FIG. **5**. In particular, FIG. **6** illustrates the operation of inventory system **10** in fulfilling container requests **260** received by management module **15**. The steps illustrated in FIG. **6** may be combined, modified, or deleted where appropriate, and additional steps may also be added to the flowchart. Additionally, the illustrated steps may be performed in any suitable order.

[0090] Operation begins in the described example with management module **15** positioning one or more container holders **40** in drift spaces **90**, as shown by steps **600**-**608**. In particular, management module **15** selects one or more container holders **40** and one or more mobile drive units **20** to transport the selected container holders **40** to drift spaces **90** at step **600**. At step **602**, management module **15** instructs the selected mobile drive units **20** to move to storage spaces **76** or other locations in which the selected container holders **40** are initially stored. At step **604**, the selected mobile drive units **20** then move to and dock with the selected container holders **40**.

[0091] At step **606**, management module **15** instructs the selected mobile drive units **20** to move the selected container holders **40** to drift spaces **90**. Each selected mobile drive unit **20** then moves a selected container holder **40** to a drift space **90** at step **608**. In particular embodiments, the selected mobile drive units **20** may then undock and move away from the selected container holders **40**, leaving the selected container holders **40** in drift spaces **90**.

[0092] At step **610**, the selected mobile drive units **20** subsequently wait in drift spaces **90** for a trigger event to occur. In particular embodiments, the trigger event relates to or is triggered by a need for containers **42** arising at a particular

inventory station **50**. For example, in the described embodiment, inventory stations **50** transmit container requests **260** to management module **15** to request delivery of containers **42** and/or to indicate their supply of containers **42** is exhausted. As a result, management module **15** determines, at step **612**, whether management module **15** has received a container request **260**. If not, operation returns to step **610** and the drifted container holders **40** continue to wait in drift spaces **90**.

[0093] In response to determining it has received a container request **260**, management module **15** selects, at step **614**, one of the plurality of container holders **40** waiting in drift spaces **90** to fulfill the received container request **260**. As noted above, management module **15** may select a container holder **40** to fulfill the received container request **260** based on any appropriate considerations or criteria. In particular embodiments, management module **15** selects the container holder **40** that has been waiting in drift spaces **90** for the longest period of time.

[0094] After selecting a particular container holder **40** to fulfill the received container request **260**, management module **15** instructs a mobile drive unit **20** to move to and dock with the drifted container holder **40** at step **616** (e.g., by transmitting a task request **62** identifying the relevant drift space **90** and/or its location). In response, the selected mobile drive unit **20** moves to and docks with the drifted container holder **40** at step **618**. At step **620**, management module **15** instructs the selected mobile drive unit **20** to move the drifted container holder **40** to the requesting inventory station **50**. The selected mobile drive unit **20** then moves the drifted container holder **40** from the drift space **90** in which that container holder **40** is waiting to the requesting inventory station **50** at step **622**.

[0095] In particular embodiments, inventory system **10** may replace the released container holder **40** by moving another container holder **40** into drift spaces **90**. This is illustrated in FIG. **6** in steps **624-632**. In particular, management module **15** selects a replacement container holder **40** and a mobile drive unit **20** to transport the replacement container holder at step **624**. As explained above, management module **15** may select a replacement container holder **40** and a mobile drive unit **20** to transport the replacement container holder **40** based on any appropriate characteristics or considerations. At step **626**, management module **15** instructs the selected mobile drive unit **20** to move to the replacement container holder **40**. The selected mobile drive unit **20** moves to and docks with the replacement container holder **40** at step **628**.

[0096] At step **630**, management module **15** instructs the selected mobile drive unit **20** to move the replacement container holder **40** to the vacated drift space **90** (or another available drift space **90**). At step **632**, the selected mobile drive unit **20** moves the replacement container holder **40** to the vacated drift space **90**. The replacement container holder **40** may then wait in the relevant drift space **90** until a trigger event associated with the replacement container holder **40** occurs (e.g., receipt of a container request **260** after the replacement container holder **40** has been in its drift space **90** longer than any other drifted container holders **40**). Operation of inventory system **10** in responding to the received container request **260** may then end as shown in FIG. **6**.

[0097] Although the present invention has been described with several embodiments, a myriad of changes, variations, alterations, transformations, and modifications may be suggested to one skilled in the art, and it is intended that the present invention encompass such changes, variations, alterations, transformations, and modifications as fall within the scope of the appended claims.

What is claimed is:

1. A method for fulfilling requests in an inventory system, comprising:

receiving a request indicating an activity to be completed;

selecting, from a plurality of holders, a holder to fulfill the request;

selecting, from a plurality of inventory stations, at least one inventory station at which to fulfill the request, wherein each of the plurality of inventory stations is associated with a queue comprising a plurality of queue spaces;

moving the selected holder from a first location to a second location remote from the selected inventory station;

determining that a trigger event has occurred; and

in response to determining that the trigger event has occurred, moving the selected holder from the second location to a queue space of a queue associated with the selected inventory station.

2. The method of claim **1**, wherein moving the selected holder from the first location to the second location comprises:

determining that a threshold number of queue spaces in a queue associated with the selected inventory station are already assigned to holders; and

in response to determining that the threshold number of queue spaces are already assigned, moving the selected holder from the first location to the second location remote from the selected inventory station.

3. The method of claim **2**, wherein determining that the trigger event has occurred comprises determining that one or more of the queue spaces in the queue associated with the selected inventory station are no longer assigned to a holder.

4. The method of claim **1**, wherein moving the selected holder from the first location to the second location comprises:

determining that a threshold number of queue spaces in a queue associated with the selected inventory station are already occupied by holders; and

in response to determining that the threshold number of queue spaces are already occupied, moving the selected holder from the first location to the second location remote from the selected inventory station.

5. The method of claim **4**, wherein determining that the trigger event has occurred comprises determining that one or more of the queue spaces in the queue associated with the selected inventory station are no longer occupied.

6. The method of claim **1**, wherein moving the selected holder from the first location to the second location comprises:

transmitting information identifying a location of the selected holder to a mobile drive unit;

moving the mobile drive unit to the location of the selected holder;

coupling the mobile drive unit to the selected holder; and

moving the mobile drive unit and the selected holder from the location of the selected holder to the second location.

7. The method of claim **1**, further comprising selecting, from a plurality of mobile drive units, a mobile drive unit to move the selected holder, and wherein moving the selected holder from a first location to a second location comprises moving the selected holder from a first location to a second location with the selected mobile drive unit.

8. The method of claim **1**, wherein the holder comprises an inventory holder operable to store inventory items.

9. The method of claim **1**, wherein determining that the trigger event has occurred comprises determining that a particular inventory holder has moved into the queue.

10. The method of claim **1**, wherein determining that the trigger event has occurred comprises determining that multiple inventory holders associated with a particular order have moved into the queue.

11. The method of claim **1**, wherein moving the selected holder from the first location to the second location comprises:

selecting one of a plurality of predetermined locations reserved for drifting; and

moving the selected holder from the first location to the selected location.

12. The method of claim **1**, wherein moving the selected holder from the first location to the second location comprises:

selecting one of a plurality of unoccupied locations in a workspace; and

moving the selected holder from the first location to the selected location.

13. The method of claim **1**, further comprising selecting the second location based on a distance between the second location and the first location.

14. The method of claim **1**, further comprising selecting the second location based on a distance between the second location and the selected inventory station.

15. The method of claim **1**, further comprising selecting the second location based on a length of a path from the first point to the queue through the second point.

16. The method of claim **1**, further comprising:

receiving a second request indicating an activity to be completed;

selecting a second holder to fulfill the second request;

selecting a second inventory station at which to fulfill the request;

moving the second selected holder from a third location to the second location;

determining that a second trigger event has occurred; and

in response to determining that the second trigger event has occurred, moving the second selected holder from the second location to a queue space of a queue associated with the second selected inventory station.

17. A system for storing inventory items, comprising:

a plurality of holders operable to store objects;

a plurality of inventory stations, wherein each of the plurality of inventory stations is associated with a queue comprising a plurality of queue spaces; and

a management module operable to:

receive a request indicating an activity to be completed;

select, from a plurality of holders, a holder to fulfill the request;

select, from a plurality of inventory stations, at least one inventory station at which to fulfill the request;

instruct a mobile drive unit to move the selected holder from a first location to a second location remote from the selected inventory station;

determine that a trigger event has occurred; and

in response to determining that the trigger event has occurred, instruct the mobile drive unit to move the

selected holder from the second location to a queue space of a queue associated with the selected inventory station.

18. The system of claim **17**, wherein the management module is further operable to instruct the mobile drive unit to move the selected holder from a first location to a second location by:

determining that a threshold number of queue spaces in a queue associated with the selected inventory station are already assigned to holders; and

in response to determining that the threshold number of queue spaces are already assigned, instructing the mobile drive unit to move the selected holder from the first location to the second location remote from the selected inventory station.

19. The system of claim **18**, wherein the management module is operable to determine that the trigger event has occurred by determining that one or more of the queue spaces in the queue associated with the selected inventory station are no longer assigned to a holder.

20. The system of claim **17**, wherein the management module is further operable to instruct the mobile drive unit to move the selected holder from a first location to a second location by:

determining that a threshold number of queue spaces in a queue associated with the selected inventory station are already occupied by holders; and

in response to determining that the threshold number of queue spaces are already occupied, instructing the mobile drive unit to move the selected holder from the first location to the second location remote from the selected inventory station.

21. The system of claim **20**, wherein the management module is further operable to determine that the trigger event has occurred by determining that one or more of the queue spaces in the queue associated with the selected inventory station are no longer occupied.

22. The system of claim **17**, wherein the management module is further operable to instruct the mobile drive unit to move the selected holder from a first location to a second location by:

transmitting information identifying a location of the selected holder to the mobile drive unit;

moving the mobile drive unit to the location of the selected holder;

coupling the mobile drive unit to the selected holder; and

moving the mobile drive unit and the selected holder from the location of the selected holder to the second location.

23. The system of claim **17**, wherein the mobile drive unit comprises one of a plurality of mobile drive units operable to move the holders, and wherein the management module is further operable to select the mobile drive unit to move the selected holder, from the plurality of mobile drive units.

24. The system of claim **17**, wherein the holders comprise inventory holders operable to store inventory items.

25. The system of claim **17**, wherein the management module is further operable to determine that the trigger event has occurred by determining that a second inventory holder has moved into the queue.

26. The system of claim **17**, wherein the management module is further operable to instruct a mobile drive unit to move the selected holder from the first location to the second location by:

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selecting one of a plurality of predetermined locations reserved for drifting; and

instructing a mobile drive unit to move the selected holder from the first location to the selected location.

27. The system of claim 17, wherein the management module is further operable to instruct a mobile drive unit to move the selected holder from the first location to the second location by:

selecting one of a plurality of unoccupied locations in a workspace; and

instructing a mobile drive unit to move the selected holder from the first location to the selected location.

28. The system of claim 17, wherein the management module is operable to select the second location based on a distance between the second location and the first location.

29. The system of claim 17, wherein the management module is operable to select the second location based on a distance between the second location and the selected inventory station.

30. The system of claim 17, wherein the management module is operable to select the second location based on a length of a path from the first point to the queue through the second point.

31. The system of claim 17, wherein the management module is further operable to:

receive a second request indicating an activity to be completed;

select a second holder to fulfill the second request;

select a second inventory station at which to fulfill the request;

instruct a second mobile drive unit to move the second selected holder from a third location to the second location;

determine that a second trigger event has occurred; and

in response to determining that the second trigger event has occurred, instruct the second mobile drive unit to move the second selected holder from the second location to a queue space of a queue associated with the second selected inventory station.

32. A computer-program product stored on a computer-readable medium, the computer program comprising code operable, when executed, to:

receive a request indicating an activity to be completed;

select, from a plurality of holders, a holder to fulfill the request;

select, from a plurality of inventory stations, at least one inventory station at which to fulfill the request, wherein each of the plurality of inventory stations is associated with a queue comprising a plurality of queue spaces;

instruct a mobile drive unit to move the selected holder from a first location to a second location remote from the selected inventory station;

determine that a trigger event has occurred; and

in response to determining that the trigger event has occurred, instruct the mobile drive unit to move the selected holder from the second location to a queue space of a queue associated with the selected inventory station.

33. The computer-program product of claim 32, wherein the code is further operable to instruct the mobile drive unit to move the selected holder from a first location to a second location by:

determining that a threshold number of queue spaces in a queue associated with the selected inventory station are already assigned to holders; and

in response to determining that the threshold number of queue spaces are already assigned, instructing the mobile drive unit to move the selected holder from the first location to the second location remote from the selected inventory station.

34. The computer-program product of claim 33, wherein the code is further operable to determine that the trigger event has occurred by determining that one or more of the queue spaces in the queue associated with the selected inventory station are no longer assigned to a holder.

35. The computer-program product of claim 32, wherein the code is further operable to instruct the mobile drive unit to move the selected holder from a first location to a second location by:

determining that a threshold number of queue spaces in a queue associated with the selected inventory station are already occupied by holders; and

in response to determining that the threshold number of queue spaces are already occupied, instructing the mobile drive unit to move the selected holder from the first location to the second location remote from the selected inventory station.

36. The computer-program product of claim 35, wherein the code is further operable to determine that the trigger event has occurred by determining that one or more of the queue spaces in the queue associated with the selected inventory station are no longer occupied.

37. The computer-program product of claim 36, wherein the code is further operable to instruct the mobile drive unit to move the selected holder from a first location to a second location by:

transmitting information identifying a location of the selected holder to the mobile drive unit;

instruct the mobile drive unit to move to the location of the selected holder;

instruct the mobile drive unit to couple to the selected holder; and

instruct the mobile drive unit to move the selected holder from the location of the selected holder to the second location.

38. The computer-program product of claim 32, wherein the mobile drive unit comprises one of a plurality of mobile drive units operable to move the holders, and wherein the code is further operable to select the mobile drive unit to move the selected holder from the plurality of mobile drive units.

39. The computer-program product of claim 32, wherein the code is operable to determine that the trigger event has occurred by determining that a second inventory holder has moved into the queue.

40. The computer-program product of claim 32, wherein the code is operable to instruct the mobile drive unit to move the selected holder from the first location to the second location by:

selecting one of a plurality of predetermined locations reserved for drifting; and

instructing the mobile drive unit moving the selected holder from the first location to the selected location.

41. The computer-program product of claim 32, wherein the code is operable to instruct the mobile drive unit to move the selected holder from the first location to the second location by:

selecting one of a plurality of unoccupied locations in a workspace; and

instructing the mobile drive unit to move the selected holder from the first location to the selected location.

42. The computer-program product of claim **32**, wherein the code is further operable to select the second location based on a distance between the second location and the first location.

43. The computer-program product of claim **32**, wherein the code is further operable to select the second location based on a distance between the second location and the selected inventory station.

44. The computer-program product of claim **32**, wherein the code is further operable to select the second location based on a length of a path from the first point to the queue through the second point.

45. The computer-program product of claim **32**, wherein the code is further operable to:

receive a second request indicating an activity to be completed;

select a second holder to fulfill the second request;

select a second inventory station at which to fulfill the request;

instruct a second mobile drive unit to move the second selected holder from a third location to the second location;

determine that a second trigger event has occurred; and

in response to determining that the second trigger event has occurred, instruct the second mobile drive unit to move the second selected holder from the second location to a queue space of a queue associated with the second selected inventory station.

46. A system for retrieving inventory items within an inventory system, comprising:

means for receiving a request indicating an activity to be completed;

means for selecting, from a plurality of holders, a holder to fulfill the request;

means for selecting, from a plurality of inventory stations, a least one inventory station at which to fulfill the request, wherein each of the plurality of inventory stations is associated with a queue comprising a plurality of queue spaces;

means for moving the selected holder from a first location to a second location remote from the selected inventory station;

means for determining that a trigger event has occurred; and

means for in response to determining that the trigger event has occurred, moving the selected holder from the second location to a queue space of a queue associated with the selected inventory station.

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