

A Review: Automatic Identification and Data Collection and its Application in Manufacturing

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Abstract— This paper reviews the various Automatic Identification and Data Collection systems used in the field of manufacturing and allied activities to improve processes by reducing total time, improving quality and reducing human error significantly. The aim of this paper is to review the various ways in which Automatic Identification and Data Collection systems have significantly improved the performance of manufacturing and allied activities particularly by tracking multiple objects, their location and enabling in ease of product line tracking, product identification, improving productivity and ease in storage and retrieval.

Key words: AIDC, Automatic Storage and Retrieval, Product line tracking, Product Identification, Productivity

I. INTRODUCTION

Manufacturing is a complex task. It requires that the right materials arrive at the right station and receive the right process and that the manufacturing process itself is done correctly. Bar codes, RFID and vision systems have long been used in manufacturing to identify items or batches of items, direct processes and ensure product quality.

In some cases, AIDC aids in such seemingly simple tasks as ensuring that the right label goes on a product or that a box contains everything it should. In other cases, AIDC is put through such complex uses as packing an item through every workstation and recording every tool that performed an operation on it. This information can be used to quickly identify potential problems and correct them before they show up in the product. [1]

II. LITERATURE REVIEW

Manufacturing and allied activities such as supply chain in particular involve activities like Inventory management, tracking management, distribution and material processing management, Quality control and resource management and Safety. In order to increase accuracy and efficiency in all these activities, AIDC technologies are increasingly used over conventional ways to reduce errors and improvise entire operations.

Manufacturing and supply chain mgmt.	
Manufacturing	Warehousing
Inventory mgmt.	Picking mgmt.
Tracking mgmt.	Receiving mgmt.
Quality control mgmt.	Shipping mgmt.
Resource mgmt.	
Transportation	Retailing
Distribution mgmt.	Inventory mgmt.
Material processing mgmt.	Shelf-stock mgmt.
Safety mgmt.	Checkout mgmt.

Fig. 1: Manufacturing and Allied activities.

A. Automatic Identification and Data Collection (AIDC)

Used to identify and track items, automatic identification and data collection (also called AIDC, Auto ID, automatic

data capture and automatic data collection) is a family of technologies that identify, verify, record, communicate and store information on discrete, packaged or containerized items. Because the process is automated (rather than reliant on pen, paper and people), information is gathered quickly and accurately. The most common technologies used to identify and capture data are barcodes, handheld and fixed-position scanners and imagers, radio frequency identification (RFID) tags and readers, and voice recognition, weighing and cubing devices. Typical applications include receiving and put away, inventory picking, order fulfillment, determination of weight and volume, and tracking and tracing. [3]

B. Components of AIDC

The Automatic Identification Data Capture (AIDC) infrastructure is defined as a set of networked devices and software components which include:

- Devices - include various identification technologies such as RFID reader, RFID printer, barcode scanner, sensors, and Programmable Logic Controller (PLC) etc.
- Services - are software components that enabling the data preparation, capturing, and processing.

Essential components of an AIDC infrastructure are identified and illustrated in the above diagram. It contains the following components.

- Barcodes, Tags, and Sensors: The smallest units that are attached to an enterprise entity or resource to be identified.
- Device Controller or Edge Server: A device controller is used to manage and control identification hardware (Readers, Scanners, Sensors and other Manageable Devices), aggregate, pre-process and cache the identification information.
- Identification Network: The identification network is the infrastructure that connects all the hardware resources and enterprise information systems together.
- Enterprise Information Servers: Enterprise information server provides enterprise activities related data which can be used along with the identification information for business operations. It provides real-time, aggregated identification data and events to client applications. The Enterprise Information System provides interfaces so that the application can define, register and look up events. It also provides interfaces that the end application can register and lookup production information, business information, and transaction information that is associated with a particular identification data.

- Enterprise Application: Enterprise applications are functional modules that full fill certain enterprise activities. For example, a Warehouse Management System uses the data captured by the Edge Server to monitoring the inventory level; an Asset Management System uses the data to look up a particular asset; etc. [4]

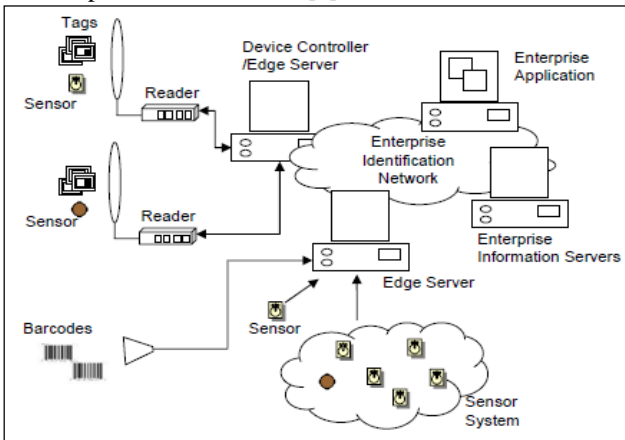


Fig. 2: AIDC components

C. Radio Frequency Identification (RFID)

Radio-frequency identification (RFID) is the wireless use of electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects. The tags contain electronically stored information. Some tags are powered by electromagnetic induction from magnetic fields produced near the reader. Some types collect energy from the interrogating radio waves and act as a passive transponder. Other types have a local power source such as a battery and may operate at hundreds of meters from the reader. Unlike a barcode, the tag does not necessarily need to be within line of sight of the reader and may be embedded in the tracked object. RFID is one method for Automatic Identification and Data Capture (AIDC). [5]



Fig. 3: RFID Components

At its most simple, a radio frequency identification (also called a transponder) and a reader (also called an interrogator). The tag is designed to be small and cheap – perhaps the size of a credit card or smaller – whilst the reader is more expensive and larger – typically around the size of a laptop computer. The RFID tag contains a small amount of memory for holding data, and whenever that tag comes into proximity with the RFID reader, the reader will detect the tag’s presence and can read the data from the tag. A real-world RFID application will typically make use of many RFID tags, which are attached to physical objects.

When one of these objects comes into proximity with the RFID reader, data from the associated tag can be read – this may be used to identify that specific object or to provide information about it. Similarly, real applications of RFID technology often make use of several RFID readers, so that the tagged objects can be identified in different locations. [6]

D. Barcode Technology

Barcode technology has become the most popular method of automatic identification in retail sales and in factory data collection. The barcode itself consists of a sequence of thick and narrow colored bars separated by thick and narrow spaces separating the bars. The pattern of bars and spaces is coded to represent alphanumeric characters. Barcode readers interpret the code by scanning and decoding the sequence of bars. The reader consists of scanner and decoder. The scanner emits a beam of light that is swept passed the barcode (either automatically or manually) and senses light reflection to distinguish between the bars and spaces. The light reflections are sensed by a photo detector that converts the spaces into an electrical signal and the bars into absence of an electrical signal. The width of the bars and spaces is indicated by the duration of the corresponding signals. The decoder analyses the pulse train to validate and interpret the corresponding data.

Certainly, a major reason for the acceptance of barcode is their widespread use in grocery markets and other retail stores. In 1973, the grocery industry adopted the Universal Product Code (UPC) as it is standard for items identification. This is a 10 digit barcode that uses 5 digits to identify the product and 5 digits to identify the manufacturer. The US Department of defence provided another major endorsement in 1982, by adopting a barcode standard (code 39) that must be applied by vendors on product cartons supplied to the various agencies of DoD. [7]



Fig 4: Code 39 Barcode

III. APPLICATIONS OF AIDC IN MANUFACTURING

A. RFID Based Automated Storage and Retrieval System

In modern manufacturing enterprise, auto ware house with Automated Storage and Retrieval System (ASRS) of Material Handling System (MHS) plays an important role by shifting the products and materials in this dynamically competitive world. ASRS is used in the places where large volume of loads needs to be shifted. The storage density is important due to the limited availability of space in production environment. The expensive damages to the load and also to the human can be avoided by centralized control of ASRS. So the ASRS is enhanced with RFID reader in Automated Storage and Retrieval System and RFID tags in the racks where control can be coordinated from PC. [9]

In order to improve the storage/retrieval efficiency of automated warehouse, robot technology is applied into the design of warehouses. Firstly, the RFID system is used to locate the target roughly and to obtain the attributes of the target. Then the vision mounted on the robot is used to recognize and locate the target precisely. Finally, the

teaching mode and remote mode are used flexibly to assist robot to grasp the target. The combination of these two modes can not only reduce the complexity of robot control, but also can make full use of the results of image processing. [10]

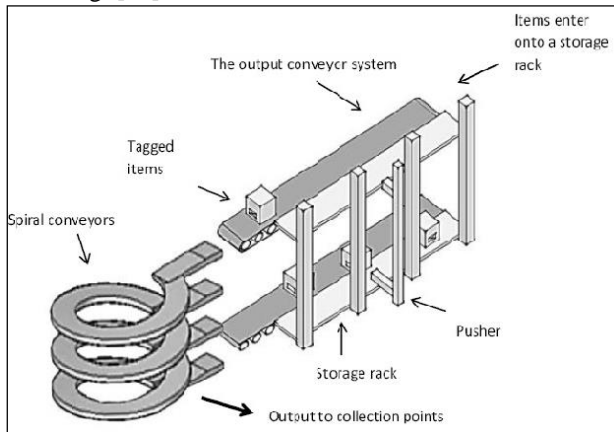


Fig 5: Automated Storage and Retrieval System

B. Production Line Tracking in a Pharmaceutical Plant using RFID

Pierrel-Ospedali is an Italian pharmaceutical company whose medical solution products are highly regulated by the government. One step in the manufacturing process requires that these products be sterilized for a period of time at over 120 degrees C. This process must be carefully controlled and documented. If there is any doubt that the sterilization process was not reliable, then full batches of bottles have to be trashed. Bottles enter the oven (autoclave) mounted on very large steel racks. Each rack is tagged with a transponder so that a rack ID number and time/date stamp can be automatically collected at the beginning and end of the process as the rack travels through the autoclave on a conveyor. Prior to installing this system, this information was collected manually allowing for human error to creep in. RFID tags can withstand the harsh environment and high temperature of the autoclave, whereas a bar code label never could. The automation system ensures the delivery of accurate and complete records for government agencies, plus it has freed up 2 to 3 employees in the operation. [12]

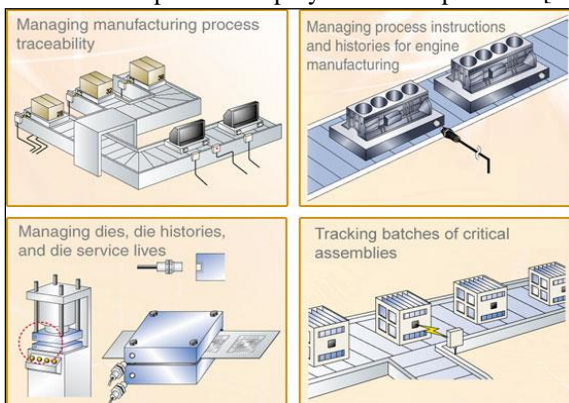


Fig 6: Product tracking examples using RFID

C. RFID Improves Chip Manufacturers Yields

A number of semiconductor companies, like Motorola, SGS Thomson, and Wacker, use RFID in their clean rooms to gain control, improve quality and operator efficiency, and increase equipment use. The need to keep everything

antiseptically clean makes the use of RFID ideal, since no hands are needed for accurate data capture. Losses and production downtime are very costly in the semiconductor industry. For instance, the production per week can be as high as 200 million chips, so any interruption or misprocessing means significant lost revenue. In a fab clean room there can be as many as 800 locations where a wafer carrier is moved from one step to the next. On occasion, wafers do get lost by getting attached to the wrong lot. By IDing wafer carriers with an RFID tag, accuracy in processing is greatly improved. In this application, both wafer carriers (cassettes) and employees have RFID tags (that they wear on their wrists under the "bunny suits"). At every step, both the employee's ID number and the carrier's ID number are read and verified by the host system to ensure that the correct process is followed. The production process for each lot is managed by the host system that keeps track of wafer lot, equipment, recipe, and operator. If there is not a match, then a warning signal emits and the equipment cannot be started until the correct lot is in place. Prior to automation, this tracking had to be done by operators who scanned bar codes or keyed-in ID numbers and access codes. The system also monitors the use of equipment to detect bottlenecks or inefficiencies. [12]

D. Product Identification using UID two-dimensional bar code

Thermal-transfer printing is widely used to print nameplate identification labels on-demand with serial number information and/or UL/CSA regulatory content. Synthetic label materials ensure the durability of the image and the label's longevity. Most products and components that require a UID two-dimensional bar code to comply with U.S. Department of Defense lifetime identification requirements can be successfully labeled using thermal-transfer printers and media. Thermal-transfer printing also meets many lifetime marking requirements in the aerospace, automotive, electronics and other industries. [14]

IV. CONCLUSION

In this paper we have discussed AIDC technologies such as RFID and Barcodes and their applications in Manufacturing, various ways in which Automatic Identification and Data Collection systems have significantly improved the performance of manufacturing and allied activities particularly by tracking multiple objects, their location and enabling in ease of product line tracking, product identification, improving productivity and ease in storage and retrieval.

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