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is the impact of the technologies on IT and business?

Few would doubt the tremendous impact that information technology (IT) has had, and continues to have, on business effectiveness and profitability. Developments in information processing capability, information storage and data communications continue to fuel and shape our IT infrastructure world-wide. An important, and growing part of this beneficial and often radical impact is attributable to automatic identification and data capture (AIDC).

Although less recognised as a sector of IT than its processing, data base and communication counterparts, the significance and importance of AIDC within the IT arena is undeniable and its visibility as an IT discipline is rising. Hitherto AIDC has been regarded as a seemingly disparate range of technologies visible in important but varied applications such as retail barcoding, magnetic stripe credit cards and ticketing, and, more recently, applications using smart cards.



Radical and revolutionary

AIDC is now being seen as a radical and revolutionary data carrier and identifier discipline with principles and practice that can be applied to virtually every sector of industry, commerce and services where data is handled and needs exist to track and trace individuals, materials and equipment. Without AIDC, IT is incomplete.

Those unfamiliar with AIDC have only to look at the role and advantages of a retail barcode system to appreciate the potential that it can provide for other areas of application. Checkout scanning of a barcode symbol takes less than half a second.

To key in the same data manually may take three seconds or so. This therefore represents a six to ten fold improvement in the speed of data entry. In addition to speed advantage, accuracy is also better with barcode entry compared with manual keying of data. Manual keying is generally considered to exhibit an error rate of perhaps 1 in 300 whereas an error in barcode data entry is generally better than 1 in 3 million.

It is not too difficult to imagine the delays that would arise at a retail checkout without barcode scanning. In addition to time and accuracy advantages, barcoding can be seen to provide other distinct benefits at the retail checkout. It allows, for example, rapid itemised listing and pricing of goods, the barcode data providing a key to this information stored elsewhere in an information management database.



Supply chain logistics

This further allows information to be maintained on stock and numbers of items sold, for example. The same principles of item identification and process support is used elsewhere in supply chain logistics, manufacturing, business management and a variety of other areas of application and with data carriers other than barcode symbols.

In viewing AIDC as a discipline substantially devoted to satisfying data carrier, transfer and identification requirements its relevance to other IT disciplines – data structures, data storage, data processing and data communications – can be readily appreciated.

The data so carried invariably enters an information management system. It is therefore important that data carrier systems can be interfaced effectively with such systems, and that the data structures, communication format and other features concerning the data are compatible and can be embraced by both information handling and communication software and hardware.

Standards serve to support this objective and are an essential consideration in applying AIDC technologies and proprietary products.

This guide seeks to assist readers in gaining a broad but useful perspective on AIDC, its attributes and benefits when effectively applied.



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the technologies are used

Virtually every sector of industry, commerce and services has potential for the effective application of automatic identification and data capture (AIDC) technologies. The majority of applications are based on a few generic foundations, as listed below.



Tracking and Traceability

These are applications where data is encoded into a suitable carrier for the purposes of tracking items and / or achieving traceability of items within an identifiable life cycle of activities or processes. Typically, traceability relates to items passing through and being influenced by supply chain processes. Where items in supply chains are identified using suitable AIDC data carriers the opportunity exists for improving the efficiency and effectiveness of the supply chain processes. In-house tracking applications using AIDC data carriers include document and asset tracking.

Tracking and traceability capabilities support a range of associated applications including:

- Inventory and warehouse management
- Shipping and distribution management
- A range of other supply chain logistical operations including rapid response and proof of delivery activities

Coupled with the capabilities presented by escort information (see below), further potential is provided for enhancing supply chain logistics and service support.

Escort information

This covers applications in which information is required to be carried, in the form of portable data files, with items of various kinds, such as manufacturing sub-assemblies, containers, pallets, packages, instruments and equipment, to provide item and process specific information immediately the data carrier is read.

For example, in manufacturing escort information may be used to set up machining centres for item specific machining. On instruments, escort information may be used for calibration and or service type functions. Chemical containers may use such escort information to provide item-resident hazard handling information.

The escort concept extends to person and service-based applications where portable data files are used to carry various items of information, such as personal details (name, address, contact information and so forth), driving licence renewal details, exhibition badge information, medical histories and prescription details and software updates to name but a few.



Product and item identification

These are applications where it is simply necessary to identify products, items and / or their structure or condition for quality assurance, security, safety, maintenance and intelligence purposes. This category of applications embraces the use of feature extraction technologies such as vision and chemical 'signature' systems. The information so gathered could also be used for track and traceability purposes.

Transaction and services support

This is a range of applications where the data carried is used to support a financial or product transaction or support a service such as travel ticketing, recreational services, payment services, baggage reconciliation and vending machine services.

Access control

Applications in this area include controlled access to premises and to systems such as computers and telecommunication networks. The AIDC data carrier or feature extraction technology provides the key for authorised access.

Sortation

This covers tasks requiring or likely to benefit from automatic or semi-automatic sorting of items, such as packages on warehouse or loading conveyors, manufacturing components in automated production units, and waste discrimination.

Automation support

The identification of locations and items may be used to automate or semi-automate processes in which items or materials are moved, such as in-house picking and put-away systems and automated vehicle navigation support.



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Accuracy

Accuracy here refers to the effectiveness with which data is captured. It is generally measured in relation to error rates and performance compared with errors associated with manual keying of data or with manual paper-based data handling.

Performances will vary according to the technology used, the effectiveness with which it is applied and the quality assurance procedures that are used. Higher levels of performance can generally be expected of data encoding technologies, such as barcoding, magnetic stripe, smart card and radio frequency identification, compared with feature extraction technologies such as vision capture techniques and speech recognition.

However, accuracy beyond manual handing of data can usually be expected, particularly where lengthy, repetitious gathering of data is involved. The gains achievable through greater accuracy are reductions in the time, effort and associated costs of checking, identifying and dealing with the consequences of errors.

Speed and Immediacy of Data

Where data encoding technologies are concerned speed of data transfer can be substantially greater than can be achieved through manual keying. Tens, hundreds and even thousands of characters of data can often be read or transferred between the source carrier device and reader in less than a second, depending on the technology concerned.

In addition to fast transfer AIDC data carriers can often be read whilst moving, and often at high speed. Fixed position barcode scanners, for example, can reliably capture data from barcode symbols on packages travelling on conveyers at several hundred feet per minute.

Fast capture and direct transfer of data to the host information management system, without manual intervention, provides immediacy of data, with associated benefits in the speed of turn-around of transactions or process actions, such as up-to-the-minute inventory. Where portable data collection devices are used, radio frequency data communication (RFDC) links can allow direct transfer of data to the host as soon as it is captured.

Economics

Where effectively applied, AIDC usually yields significant economic gains and fast return on investment, often together with less quantifiable gains such as customer satisfaction and confidence. One of the reasons why barcoding has been so successful in retail applications has been through its use in providing very low cost identification of packages and products. This has allowed items to be efficiently and effectively handled and tracked throughout the distribution chain to final checkout, with significant economic savings over systems without such support.

Many of the data carriers (barcodes, magnetic stripes, radio frequency transponders) used in AIDC systems are low or relatively low in cost. In some cases – with barcodes for example – data carriers are disposable and others, particularly read/write devices, are reusable, thus yielding potential for further economic benefit. The latter may be more expensive than disposable carriers but reuse can often amortise the initial cost over a number of uses.

Versatility

Versatility, coupled with convenience, characterises the range of technologies encompassed by AIDC. Whatever the data capture and/or identification requirements it is usually possible, within reason, to derive a suitable solution. The wide-ranging and often complementary attributes of AIDC technologies and systems products provide the foundation for achieving this versatility.

Each of these areas of benefit relate to technology or product attributes and therefore provide a useful first-line set of considerations in selecting technology to satisfy application needs.



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Analysis of data-handling processes is a significant key to identifying appropriate applications and to establishing the requirements that have to be fulfilled in realising an effective AIDC approach.

This includes data structuring, the type or types of AIDC technology to use, system and associated technology requirements, and economic and people-based needs that have to be satisfied.

As far as the technologies are concerned, a foundation for selection may be developed from a consideration of technological attributes, and how they relate to requirements, without going into too much technical detail on how these attributes are manifest. However, this may not obviate the need for more detailed technical considerations when moving to the specification, implementation and maintenance of a practical system.



Efficient solutions

In many situations AIDC is key to providing highly efficient solutions for a wide range of carrier and data collection needs, particularly where there is a requirement to identify items, individuals, data, events and locations.

By considering the main areas of application for AIDC the set of questions, presented here, has been structured to assist in determining the potential for applying automatic identification in small to medium enterprises (SMEs).

The number of checks registered in the tick-boxes will provide an initial indication of the potential for applying AIDC.

Management of Information

- ' Do you have problems and errors in handling information?
- ' Is re-keying of data a common occurrence within your company?
- ' Do you have many keying errors?
- ' Is management information readily available?
- ' Is the management information accurate?
- ' Do you encounter difficulties in tracking documents and sources of information?

- ' Are aspects of your data handling slow and frustrating?
- ' Do you encounter customer problems because of errors in information or speed in responding to customer requests?

Where responses to such questions indicate difficulties the prospect may exist for using AIDC.

Capacity to handle goods

- ' Do you encounter problems or inefficiencies in tracking goods internally?
- ' Do you encounter problems or inefficiencies in organising customer orders?
- ' Are you part of a supply chain in which the demands for more efficient handling of goods is being demanded?
- ' Are you sufficiently competitive in dealing with goods?
- ' Do you encounter problems or inefficiencies in delivering orders?
- ' Are you being required to barcode or apply AIDC in respect of your goods?
- ' Do you have the potential to handle more goods, but feel constrained by the staffing implications?

AIDC can often allow you to handle more volume of goods and enhance the efficiency with which the goods are handled.

Throughput

Is the throughput of business, goods, manufacturing processes, services or information made difficult or slow due to errors in information or inefficient data handling?

- ' Do you have an effective system for tracking customer orders?
- ' Do you have an effective and efficient system for managing processes?
- ' Do you see potential for increasing throughput, but feel constrained due to staffing implications?

AIDC can often allow increased throughput with savings in time and without increase in staffing.

Inventory Space

- ' Is your goods handling constrained by the space available?
- ' Are you having to spend more on space than you feel is justified?
- ' Is the space available for handling goods efficiently organised to allow

effective and efficient storage and retrieval?

- ' Do you have difficulties in tracking items within the space available?
- AIDC may help you to carry less stock, and therefore require less space for storage. AIDC may also allow better organisation of stock and more efficient handling.

Personnel

- ' Do you have a need to introduce or enhance time and attendance monitoring?
- ' Is manual data entry a significant feature in your business?
- ' Do you have a need to formally link jobs to individuals?
- ' Do you have problems in tracking and managing manual processes within your company?

AIDC may help you to reduce personnel for manual data entry and handling of goods, freeing them to be gainfully employed elsewhere.

Reliability

- ' Do you have a need to reduce errors in data or information used within your business or provided for customers?
- ' Are errors arising within the goods handling or service activities of your company that are causing concern?
- ' Do you see any opportunities for improving reliability of data-gathering activities within the company?

AIDC invariably provides scope for reducing errors in data or information handling.

Security

- ' Do you have a need for personal identification of employees within the company or for the services they provide?
- ' Do you have a need to introduce or improve controlled access to secure or hazardous areas?
- ' Do you have problems of theft or misappropriation of goods?
- ' Do you have a need to introduce or improve controlled access to information and/or computer-based information management systems?
- ' Do you have a need to introduce or improve the security of goods delivery?
- ' Do you have a need to introduce or improve a proof-of-delivery service?

AIDC can often provide scope for improving access control, and reduce losses due to theft and proof of delivery.

Transportation

- ' Do you have problems in tracking and managing transportation?
- ' Do you have information-based problems in organising the flow of goods to distribution?
- ' Do you have difficulties in maintaining service and maintenance histories on vehicles?
- ' Do you have problems in tracking and recovering pallets and containers?
- ' Do you have information-based difficulties or inefficiencies in loading and unloading goods to and from goods-carrying vehicles?

AIDC can often provide the basis for better management of transportation and distribution through better data handling.



Sortation

- ' Do you encounter bottlenecks, difficulties or inefficiencies in sorting goods or items?
- ' Do you encounter stockpiling problems due to sorting difficulties?
- ' Do you need to introduce a means of identifying and sorting goods on conveyors?
- ' Do you have a need for improving a process or processes for sorting goods, items or materials within a manufacturing, supply or service activity?

AIDC can offer the possibility to sort goods automatically and avoid bottlenecks and stockpiling.

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should you use the technologies?

The following eight-step approach may be helpful in getting started with AIDC

- 1 Gain an appreciation of the basic principles and technologies of AIDC.
- 2 Gain an appreciation of the scope and opportunities for applying AIDC.
- 3 Identify, through process assessment, opportunities within your company.
- 4 Identify needs for open systems development and numbering, including attention to EAN.UCC numbering system and support standards for data carriers.
- 5 Identify relevant standards that are necessary or can assist in defining effective solutions.
- 6 Develop or acquire expertise within your company to prioritise opportunities and determine feasibility and economic justification for using AIDC.
- 7 Select suppliers.
- 8 Develop or acquire expertise to apply and use AIDC systems.

Step 1

The principles of AIDC are, in essence, quite simple – to acquire data for use in computer based processing, in ways that are automatic, accurate, fast and flexible and involve a degree of identification, be it of items, data or people. The foundations on which these principles are based are soundly rooted in information, coding and pattern recognition theory, but may be transparent to the potential user when seeking to gain a practical business perspective on the applicability and benefits to be gained from AIDC.

Where data encoding is being considered a variety of needs have to be specified as a basis for selecting appropriate technology. Such needs include:

- The type of data to be encoded - numeric, alphanumeric, ASCII, graphic, code-book etc.
- The quantity of data to be encoded, usually expressed in bytes, including indications of licence plate or portable data file usage.
- The density of data, if required to be incorporated into an area of a component, product label, packaging etc.
- The structure of the data – fields of data required, numbering requirements and, as appropriate data and application identifiers.
- Numbering requirements for open and closed proposed applications.
- The needs for read-only or read/write capability.
- Longevity of data requirements and environment to be encountered by encoded data.
- Security and data integrity requirements.
- Necessary and useful standards, including numbering and coding standards.
- Reading requirements, including distance, speed and integrity.
- Cost constraints.

These needs will assist in selecting appropriate technology.

Technology determining needs will include:

- Source of features to be accommodated – object, individual, event or property.
- Nature and complexity of features to be obtained.
- The speed and integrity of features to be extracted.
- The manifest form of data to be achieved - presence or absence of an object, defects detection, verbal to computer usable data, human readable to computer usable data.
- Environment and time demands of data collection process.

Step 2

The scope for applying AIDC is considerable with opportunities arising in virtually every sector of industry, commerce and services in which data is gathered for use in computer-based systems. Typically these areas of application include:

- Personal identification, security and access control
- Safety and personnel tracking
- Time and attendance
- Document tracking and control
- Financial services support
- Goods receiving management
- Inventory control, pick and place support and warehouse management
- Manufacturing work in progress, shop floor data collection and quality assurance
- Asset tracking, equipment, components and tool management
- Condition monitoring support
- Identification, distribution and security of traded goods
- Retail product management
- Continuous process manufacturing
- Library systems
- Hotel, Leisure and entertainment management

Step 3

Identifying opportunities within your own company requires consideration of existing and planned processes with a view to seeing how improvements can be achieved or radical changes introduced to exploit the benefits offered by AIDC. These actions require a profound knowledge of processes, their control and the ability to determine the implications of making a change through the introduction of new technology. There is also a requirement to assess the savings and improvements that can be achieved through applying new technology.



Step 4

Where needs and opportunities are identified for open systems applications it is likely to require consideration of numbering systems for the purposes of item identification. Some closed applications may also require similar consideration. In these situations it is



important to consider the legally protected, standard approach to numbering. The international system of numbering enables any company, actively registered with EAN.UCC, to identify its products, services or locations with unique 13-digit numbers, that can be incorporated into data carriers such as barcodes, and read throughout the supply chain adopting the scheme. Barcodes, supported by EAN.UCC standards, have been used extensively in establishing supply chain strategies that cover consumer, traded units and shipment data needs, with benefits to manufacturers, distributors, wholesalers and retailers.



Step 5

In pursuing applications for AIDC it is important to establish whether standards exist that are relevant to the application and/or the technologies being considered. Where, for example, the EAN.UCC international numbering system is to be used with barcode carriers it would be sensible to use the EAN.UCC barcode standards, with the attendant advantages that they offer in respect of data and application identifiers. Where other data carriers are being considered, numbering systems may be readily applied, but the need exists to identify support standards for the carriers, such as AIM Symbology Specifications.

Step 6

Despite the radical nature of AIDC and the expectation of fast return on investment it is imperative that judgements to invest are based on sound technological and economic justifications. This stage requires a profound understanding of the process requirements and technology, together with sound proposals covering all aspects of systems application, including interface requirements, software, materials and ownership requirements, education and training needs, and maintenance commitments. Costs need to be considered against expected savings and benefits, where necessary expressed against discounted cash flows.

Technological justification should consider the influence that change will have on other system processes to which the improved or new process links and the operational issues, human and otherwise, that invariably arise when new technology is introduced.

Step 7

In selecting AIDC suppliers or support services it is important to establish their capability to handle your requirements. A series of questions directed at a number of suppliers may help establish suitability. These questions may be structured to determine experience in handling particular technologies, systems solutions, software development (custom and modification), host connections and integration (PC-LAN, WIN NT, AS/400, UNIX, for example). You may also wish to know their experience of handling applications in your sector of industry, commerce or services and knowledge of your business.

Step 8

Applying AIDC effectively requires attention to the needs of implementation and use. While the expectation of trouble free operation may be realistic there are needs for ensuring effective integration into existing systems, quality assurance and maintenance. This requires appropriate understanding of systems, the assurance that those implementing the system are able to do so effectively and that users have sufficient training to use and maintain the technology that is introduced. Pilot initiatives may help in gaining confidence in the use of AIDC.

Depending on familiarity and experience of AIDC, various sources of support and advice are available to assist newcomers in getting started, including training on applying and using AIDC technologies.