The research of construction common product coding system

Nai-Hsin Pan
Associate professor, department of construction engineering,
National Yunlin University of Science and Technology
pannh@yuntech.edu.tw

ABSTRACT: Automatic data identification (Auto ID) technology such as bar code has grown rapidly in various industries. However, the focus of these applications has primarily been limited to the internal operations of a few larger companies. One of the major barriers to adopt modern Auto ID technologies in the construction industry is the lack of a construction common product code (CCPCS). The main objective of this research is to investigate the problems created by inadequate CCPCS and to create a suggested framework for data transfer. This could result in improving the communication of information between different components of the construction process by using new Auto ID technologies in the construction industry. A key component to achieving a solution is the development of CCPCS and which will have sufficient robustness to accommodate a wide variety of existing Auto ID technologies and to accommodate newer systems which appearing.

Keywords: construction; AUTO ID; materials management; standard coding

1. INTRODUCTION

Auto ID has grown rapidly in various industries. Especially, bar coding is one of the technologies which have already been implemented successfully in many industries. During the last couple of years, a small number of construction companies have also started to implement AUTO ID technologies for a limited number of applications. The focus of these applications has primarily been limited to the internal operations of a few larger companies. This means that the benefits of the new technology are confined within the operations of the company itself and information transfer from outside the company still tends to involve the manual recording and remanufacturing of information for use within the company. One of the major barriers to adoption of modern automated industry-wide data collection in the construction industry is the lack of a uniform construction industry standard for information transfer. Other industries, such as the grocery industry, have faced similar problems but have developed industry-wide solutions. As a result, virtually all products in the grocery industry originating from various suppliers can be identified by scanning the bar coding label at any supermarket in the country. The main objective of this research is to investigate the problems created by inadequate uniform information transfer standards and to create a suggested framework for data transfer. This could result in improving the communication of information between different components of the construction process by using new AUTO ID technologies in the construction industry. A key component to achieve a solution is the development of an industry-wide standard for information transfer of external" data and which will have sufficient robustness to accommodate a wide variety of existing AUTO ID technologies and to accommodate newer systems which are appearing. An organizational framework which could be utilized in moving toward the development of a set of AUTO ID standards for construction is suggested with a heavy emphasis in utilizing the extensive efforts already put forty in similar developments in other industries. Materials and components management is the primary focus of this study although the results would be applicable across the construction system of planning, design, construction and operation.

2. VALUE OF CONSTRUCTION CCPCS

When a company considers implementing new AUTO ID technologies for any reason, the company generally decides whether the application fields are limited to internal use or extended to external use. If the system is just for internal use, the company will set up their own system and probably develop the internal standards for the company itself. However, there are more difficult information-communication problems if it is intended to interface with an external system. An industry standard only plays a **recommended** role for internal use while it plays a **necessary** role for external use.

During past the several years, as some new AUTO ID technologies have been coming into wider use, it is becoming impossible to limit the capabilities of AUTO ID system to internal applications only (Pan, 1996). Many companies in the automobile industry, the grocery industry or the electronic industry have already extended the capabilities of AUTO ID to external systems. External systems are used to communicate between companies or other entities, rather than just internally.

Prior to computer systems, there was less formality in how products were identified. Typically, verbal and written communications, including purchase orders, used product descriptions. When descriptions became too long and cumbersome, catalog" or "art" numbers were assigned (Marilyn, 1989).

As computer systems came into common use, individual manufacturers, distributors, and end customers often set up their internal computer systems using unique methods of identification. The manufacturers, distributors, and end customer would set up stock" numbers. Thus, each company in the distribution channel could be using different numbers or format variation for the same product. The result is a tower of Babel,"(Scan Tech, 1985) with translation often done by order entry and/or receiving clerks from product descriptions or foreign numbers" on purchase orders and product packages. After translating the description or the foreign number" of the product to the company internal number, the translation is often recorded on another piece of paper and key entered into a computer system.

Now that electronic data interchange (EDI) is becoming prevalent, business is increasingly aware of the cost and complexity created by the multiple numbering systems. The principle of EDI is that trading partners computers talk to each other via telephone lines, transmitting routine transactions like purchase orders, acknowledgments, and invoices without human intervention. For such communications, computers require exact product identifications in order to understand each other.

The impact of bar code applications has also been recognized by many industrial sectors. The most familiar example is the UPC system, universally used in the grocery products industry and becoming widely used in other retail areas.

Whereas the focus in internal systems is building in the flexibility to work with existing systems for material control, labor accounting, and others, the UPC experience shows us that the game in external systems is the development of industry standards.

It is easy to see why this is so. Consider the example of the customer who has decided to extend his internal data collection system to incorporate data from his suppliers so that he can quickly get control of materials once he receives them. He will want certain key information like product identification described on a label or other identifying medium attached to the product in a format which can be accurately, conveniently and uniformly read on the jobsite. This information could be in bar coded or other forms. The format of the label may be somewhat arbitrarily decided.

Consider the situation of the supplier who has dozens, hundreds or thousands of customers who wish to have coded information supplied with the product. If only a small percentage of them demanded this service and they all wanted different product identification formats this would be a major problem for the supplier and could soon result in a totally unworkable situation.

These kinds of problems are leading supplier and users in major industry groups to band together to standardize product numbers. Some of the active industry groups include AIAG (automotive), LOGMARS (DOD), UCC (retail, grocery, electric).

The concept that all trading partners in a distribution channel should use the same identification for a unique product is now widely accepted by most industries. This standard identification be used in both paper and electronic communications is also widely accepted. Such standard identification allows for dramatic improvement in efficiency and accuracy in manufacturer, distributor, and end customer operations. This standard identification could be categorized into two types of numbering system based on the characteristics. One is branded product identification number, Uniform Product Code (UPC) is the typical example maintained by Uniform Code Council in industries. The other is the concept of CCPCS, Standardized Product Identification Numbers (SPIN) is the typical example which is maintained by Industry Bar Code Alliance (IBCA). Those two types of numbering concept will be discussed later.

3. BASIC STRUCTURE OF CONSTRUCTION CCPCS

CCPCS permit buyers to specify material components regardless of vendor. Common numbering schemes also facilitate the transfer of materials information between designer or owner and the construction contractor. However, to assign a unique material or components identification using the CCPCS concept is more difficult than the previous methods. A commodity code scheme results in the assignment of unique numbers to items. The number assignment process is complicated when a large number of factors can be varied to create many combinations of specification parameters. Also, it is more difficult for the architect or designer to refer to the new assigned unique material identification number instead of traditional material description.

However, the concept of a CCPCS could make a specified item or building product to be recognized uniformly by all parties involved in the construction operation (e.g. supplier, contractor, designer/architect) by using a unique number. Based on the description above, from the basic construction material identification standpoint, using the method of CCPCS will be more suitable than the method of BPIN at the present time.

Using the CCPCS concept could provide a uniform approach to develop an construction materials information classification system for basic construction items.

Any references to "codes", "coding structure", or "numbering system" are meant to be completely symbology-independent. This means we are only referring to numbers

(and in some cases, letters too) that are used to identify or describe something and which are a convenient format for the computer.

No matter what types of different information will be required to be exchanged among parties, data transfer in the construction process could be categorized into two major groups:

- **Object Identification (Primary Information);**
- **Application Identification (Secondary Information).**

The two information groups will be examined in detail in the following sections.

3. 1 Object Identification:

Object identification in CCPCS would generally be of a long-term nature. Included in this class could be organizational units such as client, design firm, manufacturing company, or other organizational unit involved in the construction process. Another type of information could be item identification. This identification would be related to the object and does not change when the object identification is used by different organizations. An example of object identification can be seen by examining the UPC basic coding.

This research will focus on the construction material/building component identification as a module because construction material cost occupies 50% of the total project cost. Also, from the viewpoint of Material Management, material is the primary information needed to be identified. The standardization for code structure of product identification is one of the most complex parts in industry-wide standardization. Construction material tracking and management can involve literally millions of different items from a vast array of manufacturers and suppliers. For example, distinctions can be made about the physical scale of objects whose data are stored and exchanged. Relevant classes include data about regional objects or systems, data at the (building) project level, data at the level of the individual unit or object, data at the level of complex components or object parts(doors, walls, bathrooms), and data at the level of individual components such as beams, pipes, bath tubs, and nails. When they are ordered, shipped, delivered to jobsite, it is necessary to make sure that these items conform to what was specified. To solve this problem, there is a need to establish uniform procedures for vendor product identification. Of particular concern is determining which products (if any) should be identified with a uniform commodity code. If a commodity code approach is used the product identification must use the same identifying number for generic class, regardless of manufacturer. Using the concept of CCPCS, an example of a suggested data structure for pipe is shown in the Table 1.

The concept of a CCPCS could make a specified item or building product recognized by all parties involved in construction operations (e.g. supplier, contractor, designer/architect). The construction industry does involve the metal industry or pipe industry but the building items in the construction process come from many different fields. The current concept of a CCPCS is for the identification of similar products (e.g. pipe made of carbon and pipe made of stainless steel.). Therefore, construction industry standards should also be able to identify different items during the construction process(e.g. door, wall, pipe, form, glazing, equipment, etc.).

3. 1. 1 Package Level Identification

The concept of the coding structure described above is used for the identification of a single item class. However, it would be very unusual that just a single product class or material would arrive on the job site as a single unit. Most of the items for the construction job arrive on the construction site as packages, shipping containers or bulk deliveries. Some of these packages or containers may contain a mix of different kinds of items. Sometimes, it is not suitable or efficient (e.g. time-consuming) to open every package or containers to check what the contents are. Thus, after defining the single item unit and assigning a product number according some established guidelines, it is necessary to also consider the packaging configuration. A packaging configuration is one unique hierarchical method of packing a product. Other industries (e.g. Retail industry and automotive industry) have faced the same problems. Manufacturers, distributors, and end customers typically deal with multiple levels of packaging of the same items. For example, a distributor may buy a full shipping container or even a full pallet of an item. He may break the container to sell intermediate containers or individuals consumer units to an end customer. When the transaction is recorded, either by key entry or using a bar code scanner, it is critical that the correct number of customer units be identified. Therefore, to identify higher levels of packaging (above the consumer unit) within a product packaging hierarchy, the packaging indicator concept was created. The **Package Identifier** will be 1 digit or 2 digits which are used to identify various levels of packaging and for defining the quantity contained within the package such as:

- Unit Pack: A pack contains standard or non-standard quantity of like items.
- Mixed Item Pack: A pack contains items with different product numbers.
- Multiple Pack: A pack containing smaller packages(sub packs) of items.

3. 1. 2 For example:

PI	**Base Standard Product ID Number**									
	1	2	3	4	5	6	7	8	9	10
1	0	1	5	1	7	0	1	0	5	4	0

3. 1. 3 PIPE.... PA

In this example, the leading PI of 1 is used to identify the next level of packaging, above the item unit. Standardized PI with specific meanings have been adopted by some industries and companies. The construction industry could benefit by following similar recommendations and develop a standard suitable to the construction industry. The recommendations from UCC(1992) publications could be referred to as one of the resources.

3. 2 Application Identification:

Using the construction operation on the jobsite as a starting point, in addition to the objects or items needed to be identified, there are other data which are related to the activities(e.g. accounting, purchasing, shipping, delivery, etc.) and parties involved(e.g. addresses, phone number). Thus in addition to the product identification there is also information about products like shipping date, manufacturers name, weight, quantity shipped, etc., and a construction industry standard for automated data transfer must also provide a capacity to include this **secondary information** somewhere in the process. For example, when the materials/products are ordered by the field office, they are then shipped to the job. The field office not only must identify the products themselves and whether they are in fact the products ordered but also need to know the quantities of particular shipments and the linkage to job management and accounting operations. The field and central offices will retrieve files of related purchase orders to check information of material and component receipts against items and quantities required and ordered. As a result there are at least two other packets of secondary information the field office needs to know. First, the information attached with the product/material must either supply the **purchase order number or a link to this information which may be in a computerized database for larger contractors or filed information for smaller contractors.** It could help the field office to efficiently retrieve the files of purchase orders which may be particularly extensive in a complex project. Second, it also should include the information regarding the **quantity of the item included in the particular shipment**. This also would help the field office check the shipped product quantity against orders to determine whether this matches the information in the purchase order. This would be an especially important process in which automated data-processing technologies could make an important contribution. The example described above represents one of the possible applications.

3. 2. 1 Dates

Some products need to be identified with specific critical dates, such as production date, packaging date, warranty date, shipping date. In bar code application, the decision regarding whether to bar code dates depends on the importance of the information or the frequency with which such data may need to be collected by the manufacturers, supplier, or user.

Some examples of the use of bar code labeled dates include:

1. The manufacturer, supplier, or user may wish to scan shipments to ensure that old and expired materials are not shipped for use.
2. The manufacturer, supplier, or user may wish to scan inventory to discard old material, or their computer systems may be programmed to create warnings of inventory nearing obsolescence.

Computer systems may be programmed to automatically find the oldest material in stock and identify its location as order picking documents are printed, to ensure first-in/first-out.

3. 2. 2 Serial Number

Commodity ID number is defined as “primary” product identification and serial numbers are defined as one form of “secondary” product identification. Serial numbers are identification codes assigned to specific product units. Typically, serial numbering is used for relatively expensive products versus less expensive or highly dispersed products. Examples may be an air handler unit or air conditioner vs. a load of two by fours. More and more manufacturers, in many industries, are bar code labeling serial numbers to gain the advantages of more efficient data entry and more complete and accurate information. Such benefits need not be limited to manufacturers. In construction, serial numbers could be attached to some expensive equipment, or prefabricated building components. This would aid the construction company in tracking inventory. Inspectors can keep track of warranty date, and quality. End users can keep records of service, or performance. This number could be for external use.

4. CONCLUSION

1. The primary technological barrier in effectively adopting AUTO ID technologies in construction is the lack of industry-wide information transfer standards for encoding and transferring information.
2. The complex nature of construction and the vast number of items which go into construction creates severe difficulties in developing an all-encompassing information identification system.
3. It is concluded that the use of a data identifier along with permanent identification numbers for all participate would provide the most effective solution.
4. Construction Information can be classifies as internal or external, primary or secondary and so forth. It is only mandatory that external information could be industry standardized although standardization of other information could encourage the development of a supporting software industry which could increase accuracy and reduce costs.

5. Some sections of the construction industry, such as the piping industry, are developing coding schemes. However, unless these efforts are integrated into an industry-wide standard there will still be difficulties in introducing AUTO ID procedures for on-site construction management.
6. Due to large investments made in developing standards in other industries, construction could realize significant time and cost savings by utilizing the experience gained in the related areas.

REFERENCES

[1] Bell Lansford C. and Stukhart George (1987), "Costs And Benefits Of Materials Management Systems", Journal of Construction Engineering and Management, ASCE, Nov., 1987.211-220

[2] Forger Gary J. (1990)" Auto. ID & EDI: Hotline To Productivity", Modern Material Handling, February 1990, 56-58

[3] Lisse Stephen D. (1993), "Japanese Industrial Standards For The Construction Industry", ASTM Standardization News, February 1993, New York, 57-63

[4] Sherry Marilyn S. (1989) "Industry Standards and Uses of Auto ID", Scan-Tech 89 Proceedings, AIM, 15-17

[5] Pan, N. H.(1996)."Automatic data processing technologies and industry-wide information transfer standard in construction," Ph.D. Dissertation of Civil Engineering, SUNY at Buffalo.

[6] The Construction Industry Institute (CII) (1987) "Project Materials Management Handbook" A Report By The Construction Industry Institute Materials Management Task Force

Table 1: Recommended Data Fields for Process Pipe Data Tables

Data Field	Definition
Specification Standard For Material (Metallurgy)	ASTM or API Standard (i.e., ASTM A106, API 5L or ASTM A53, etc.)
Grade	Grade within the specification standard (i.e., ASTM A53 grade B or C or A106 grade A, B, or C, etc.)
Processing History	Pipe can be seamless or welded (EFW-electron fusion welded or SAW- submerged arc welded or ERW-electro resistance welded)
Size	The nominal outside diameter of the pipe (NPS)
Wall Thickness or Schedule	The thickness of the pipe (OD - ID)
Other	The pipe could be coated and wrapped, cement lined, galvanized, ordered with beveled ends or double random lengths.
Metallurgy Description For Material	Usually when specifying pipe, a broad description of the pipe metallurgy is given such as carbon steel, stainless steel, 1 1/4 Chrome, 2 1/2 Chrome, low temp, carbon steel, etc.

Notes:

1.) The metallurgy description, specification standard, grade and class make up the pipe metallurgy. It is suggested that the commodity code number group the pipe by the metallurgy description, then spec. standard, grade, class, processing history, wall thickness and then size.

Using the concept of a CCPCS, requirements of Specifications, and other specified attributes for the different items could lead to a uniform coding for the specified construction items.