

SHARING AND IMPROVING PROJECT INFORMATION VIA DIGITAL PENS AND PAPER

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ABSTRACT

The collection of information on construction projects still continues to be a process rooted in traditional methods i.e. pen and paper. While the use of IT within the construction industry is becoming widespread as awareness increases, the full drawdown of benefits still leaves room for improvement. Many construction professionals insist on using traditional communication methods to collect and transfer project information. To leverage out these potential benefits, what is required is a process which still uses pen and paper as of its medium while at the same time facilitating the transformation of this information into a digital format, thus affording the organisation the opportunity to translate this information directly into digital project databases/applications. The uptake of a digital pen and paper based approach will allow construction organisations to become more deeply embedded in IT, whilst at the same time allowing the operative the opportunity to collect and transfer project information in a manner they are familiar with i.e. using a pen and paper

Keywords: digital pen, paper, project improvement

Introduction

Construction projects continue to become larger and more complex, and at the same time, the volume of information that passes through the project communication channels increases disproportionately. Management of this information has become a real challenge in itself (Bjork, 2002). Major construction projects continue to have difficulty capturing, storing and communicating information that has been collected.

The legal issues surrounding the construction industry and the inherent threat of claims for loss and expense means the risk in not managing and controlling project information becomes an area of serious concern for those involved in project documentation. Ownership of, and liability for, project information may also place restrictions on the nature and type of information that can and should be exchanged (Amor and Faraj, 2001).

As the culture of the construction industry begins to change and embrace technological solutions, construction organisations will begin to change their working practices and adopt and use newer technologies. The creation and management of project information requires systems and processes that provide all project participants with the ability to create and transfer information between project parties seamlessly and intuitively i.e. using a digital pen and paper. The exchange of information pre and during construction still relies on personal contact such as telephone, fax, and to a great extent, paper. Paper remains the major medium, with many contractors and clients alike still insisting on communicating in this traditional medium (Marsh and Flanagan, 2000).

The Underlying Power Of Pen And Paper

While the construction industry appears to be ideally suited to the electronic exchange of project information using Information Technology tools, the uptake of IT in the construction industry is low and lagging far behind other industries such as manufacturing (Gidado and Nichols, 2002). The quality of project information can be enhanced by using efficient IT systems and, although these systems are of benefit to some, many of the site processes still rely on the traditional methods (Gellatly et al., 2000).

This implies that many construction organisations and indeed construction projects are still paper-based. Most project information is still prepared and stored as “hard copy”, which is inherently difficult to access and often requires vast storage space. The traditional method of creation and storage is also time consuming and costly (Gidado and Nichols, 2002). People are comfortable with the “feel” of paper (Bowden, 2002a) and for some the idea of a paperless office is still a long way off. However, too much project information still exists locked in a paper environment, a fact which is highlighted in Figure 1 below.

Figure 1: Repositories of Corporate Knowledge (Xerox, 2002)

It is clear from the diagram that the emphasis of managing information needs to move away from managing paper-based documentation to managing the process electronically. Even this change in procedure may not be enough, because too little information exists in the correct environment - “the shared environment”. In today’s construction industry a mixture of methods is used for managing information (Bjork, 2002). This mixture of methods includes information produced using IT tools and also information which is created traditionally, “hand written or drawn” on paper: quite often this is the information which is of greatest importance.

Keeping track of paper based documentation, especially that which has been handwritten, requires a meticulous approach and one which would require a great deal of patience unless there was a process in place which undertook this task automatically. The solution, therefore, is a process which would still allow construction operatives to use pen and paper while at the same time turning this handwritten or drawn information into electronic format using the latest digital technology. Information taken down on the spur of the moment can be most useful when dealing with requests for information (RFI’s) or drawing sketches to send to the architect. This digital shift would undoubtedly speed up the transfer of paper based information and automatically file all handwritten or drawn information in a secure and shared electronic environment.

Current Information Process

Construction site processes can be improved by more effective storage and timely communication of information (Marsh and Flanagan, 2000). Many processes (see table i) use pre-formatted worksheets as a means of data collection and transmission. These worksheets still have to be physically completed and processed in that they have to be re-typed or scanned back into a project database.

The complex process of collecting and recording site information can be further hindered if the main contractor or site manager has to disseminate paper based documentation from a number of different organisations (Vidogah and Ndekugri, 1998). A Request for Information (RFI) for example could take the following route before approval:

Step 1: RFI is hand written by the sub-contractor

Step 2: The RFI is then faxed to the general contractor

Step 3: The RFI may be re-written and then faxed to the architect

Step 4: The architect may pass the RFI to a consultant for review who in turn:

Step 5: Maypass on the RFI to a sub-consultant

Step 6: The response is formulated and sent back to the consultant for review

Step 7: This is then faxed back to the architect

Step 8: Assuming there is no further clarification needed the architect faxes back the RFI to the general contractor

Step 9: On final approval the contractor passes the RFI to the originator of the RFI

Table 1: Site information processes

This nine-step RFI approach is time consuming and is a process with inherent traps where information could become lost, misplaced or misinterpreted, a fact which will ultimately cause conflict and delay on construction projects. Construction site managers spend almost 70% of their time dealing with and generating project information (Bowden, 2002h). Efficient site personnel who are able to access and create accurate information will make better use of their project resources. Before this can be achieved however some site process re-engineering will need to take place which should examine which processes can be automated and streamlined resulting in overall improvements to the creation and management of paper based construction site information.

Current Methods of Collecting Site Information

With the demise of geographical boundaries within the construction industry, the mobility of operatives increases as does the distance from their home base office. Many construction operatives waste valuable time because data has to be captured manually and then transferred back to the office in a physical manner and manually keyed back into an organisation's IT system (ICE, 2004). Now however, there is technology in place that allows the paper based construction operative the opportunity to turn handwritten and drawn sketches into digital, electronic format using an old style method, "pen and paper" which adopts and uses the same technology as other mobile communication tools. Put simply, construction operatives have the ability to operate, create, transfer and share information based on a paper format, electronically.

The Concept of Digital Pen And Paper

Much information is created and stored on paper and therefore others who may wish to use this information are often deprived of the chance to do so. In effect, there is a knowledge gap between available knowledge, such as that in a database and manually created knowledge, which has been created using pen and paper. To bridge this knowledge gap a process is required whereby handwritten knowledge can be sent and stored electronically. This process is made possible with Anoto digital paper.

We all know how to use pen and paper: what is different with Anoto paper is that the paper itself is printed with a unique pattern of dots. The digital pen, through the use of an on-board camera, picks up which dots have been overwritten and is able to send the image to an identified recipient as it has been written or drawn on the digital paper. The information can be routed direct from the pen to a computer, or by using mobile phones connected via the internet, to a PC anywhere in the world. The digital paper can be printed as stand-alone paper applications where form designs are super-imposed onto the paper. The operative then completes the form in the usual manner. The advantage is that the information is being transferred back to the office as soon as the box is ticked, for example, whereas in the past this information would have had to be physically transported. Further development will bring more functionality. It is now possible (see Figure 2) to turn the handwritten information into digital format and import this information direct into software packages and databases such as Excel, Access or DB2.

Figure 2: The integration of handwriting recognition with software packages (www.Sysnet.co.uk)

Typical construction site processes such as snagging (the detection and reporting of defects), site inspections and requests for information can be fully automated using the traditional method of collection i.e. pen and paper. Using digital pen and paper to control some manual processes brings obvious benefits: the main one being that of time-saving. The time it takes to go through the nine step process of creating an RFI, such as that described above could be dramatically reduced by automating the process using digital pen and paper. Manual and physical steps such as faxing, transporting and distributing information are eliminated from the process.

Figure 3: Time and Resource Savings Possible Using Digital Pen and Paper Technology (www.sysnet.co.uk)

Other benefits of adopting digital pen and paper can be listed as follows (Figure 4):

Figure 4: The benefits of adopting Anoto digital pen and paper technology

The concept has been steadily gaining momentum and the key aspect of this revolutionary technology is that while making information transfer more efficient, if implemented and designed to match current working procedures, there will be no disruptive changes to the current working procedures of the construction organisation. Construction information will still be reported and signed-off on paper although the process will become wholly electronic and automatically logged in a project database.

No pattern of dots is repeated which means that every single page of digital paper is unique. This allows the technology to know exactly what page of paper has just been written upon. On each page of the digital paper there are areas called pidgets, which can be used to initiate an action from the digital pen. For example a tick in the “send box to the bottom right of the page (Figure 5) will inform the digital pen to transfer all the information collected to the correct recipient via the appropriate method. As each page of digital paper is unique the information from the digital pen can be passed to a specific application that has been designed to process the information. When the information is received, it is processed to create an image of the digital paper or transfer to other functionality that has been added to that particular application.

Hand Writing Recognition

Handwritten Character Recognition (HWR) makes it possible to convert cursive handwritten text into digital characters (Floren, 2002). Every pen stroke is recorded as a sequence of 2D sample points, which can be regarded as digital ink that will be used for recognition. The trajectories described

by the pen strokes are processed by the LEGAL recognition engine to produce several possible candidates for each handwritten character or word, which are then ranked according to the configuration of the recognition engine.

The key to reliable handwriting recognition is to restrict the recogniser as much as possible (Sommerville et al., 2004). This entails specifying as far as possible what the writing is expected to be or what the words will be i.e. the construction of a robust lexicon. For example, if a project number consists of two capital letters, a dash and five numbers e.g. AB-12345 the user can instruct the recogniser to expect this form of data entry. The more information the user has, the further the user can restrict the scope of the recogniser.

The integration of HWR software with existing software packages will totally revolutionise the way in which paper information is captured and transferred. The ability to turn handwritten information directly into digital format and into project databases will prove to be the ultimate benefit. In simple terms it will provide “the ability to operate, create, transfer and share information in a paper format electronically” (Sommerville and Craig, 2004).

Information can quite often be the key to the success of a project. Many site issues, including snagging (defects), need to be resolved quickly and efficiently to avoid dispute and more importantly, cost overrun.

Case Study: Construction Site Snagging Application

During project execution, quality plays a major role in facilitating or hindering successful results. An underpinning to the goal of construction quality is real time information flow to and from the construction site to the many varied construction contractors. To carry out their job function properly the timing and transfer of information is critical to both the individual’s and the project’s success. The snagging system in Figure 5 has been developed and designed over a 10 month period and is in use within the UK construction market. Snagging information is recorded by the operative on a specially designed digital paper application: the system can be adopted for use by all construction organisations on all construction projects.

The snagging (defects) data collected is then transferred directly into a web-based database where all issuing, actioning and approving of the snags identified is carried out. The database also holds an individual image of the digital paper which takes away the need for scanning and filing paper documents. Handwriting recognition software automatically creates digital characters from the pen strokes on the paper and populates the database accordingly. The system brings with it traceability and accountability features along with built in security mechanisms, although the main benefit however is that of time saving. Manual and physical steps such as faxing, printing, transporting and distributing paper information are effectively eliminated from the snagging process (Sommerville and Craig, 2004).

The system also interacts seamlessly with other database options such as Excel and Access (Figure 5) and the digital paper application is heavily customisable which basically means the fields and terminology on the digital paper application can be changed to suite the individual situation. The digital paper solution will undoubtedly speed up the snagging transfer and dissemination processes. Within the wider picture, the examination of other construction site-based paper processes will identify which processes can be re-engineered and automated which will result in major improvements to the management of paper-based construction information.

Figure 5: Digital paper snagging application and its interaction with a web-based database (www.sysnet.co.uk)

Conclusion

The whole communication process in the construction industry is, in reality, heavily biased towards paper, and construction projects themselves still rely on faxed copies of sketches etc to keep the construction project moving. Although the use and awareness of IT has increased, many construction organisations still operate and perform tasks in traditional ways.

This paper has examined the creation of information in a paper context and has also examined current construction site information processes. A possible solution to the paper problem has been put forward which uses wireless technology to communicate. The creation of information, however, is still the responsibility of the construction operative. This information created traditionally is often not made available to others, which effectively means the creators of such information are not sharing their knowledge with other construction industry operatives.

The emergence of digital pen and 32 paper technology is beginning to open new avenues and opportunities, although further research and development work is required in order to maximise its potential. If implemented correctly, the knowledge gap that exists between current paper processes and IT systems could be resolved at the tick of a box.

Construction organisations that do not embrace this new digital pen and paper technology are in grave danger of being left behind. If traditional methods of working are to embrace technology, the technology must first embrace tradition.

References

- Amor, R. & Faraj, I. (2001). Misconceptions about integrated project databases. *Electronic Journal of Information Technology*, Vol.6, pp57-66.
<http://www.itcon.org/2000/3/paper.htm>.
- Bjork, B. (2002) *The Impact of Electronic Document Management on Construction Information Management*. In proceedings of CIBW78 conference 2002, The Aarhus School of Architecture, 12- 14 June, Denmark.
- Bowden, S. (2002) *Construction Site Information Needs*. Amp; London,
http://www.cire.org.uk/Resources_Case_Studies_IT_On_A_Construction_Site.html
- Bowden, S. (2002h) *Mobile Technology Construction Software*, Arup, London,
http://www.cire.org.uk/Resources_Case_Studies_IT_On_A_Construction_Site.html
- Florén, J. (2002), *Measuring the cost and value of Anoto functionality implementations compared to PDA implementations*, Anoto Functionality

- Publications, Sweden. 2002. http://www.anoto.com/?url=/publications/paper_printingdocumentation/
- Gellatly, GM. Burtwistle, P. and Baldwin, AN. (2000) *Groupware the key to successful partnering: a case study*, Proceedings of Institution of Civil Engineers, pp119-123, London.
- Gidado, KI. and Nichols, M. (2002) *The Current State of Use of Electronic Document Management System by UK Architectural Practices*. In electronic proceedings of the 2nd International Conference on Decision Making in Urban and Civil Engineering, London.
- ICE (Institution of Civil Engineers) (2004) *Mobile Communications and Hand Held Devices Briefing Sheet*. Institution of Civil Engineers (ICE), London, <http://www.ice.org.uk/knowledge/downloads/information.asp>
- Marsh, L. and Flanagan, R. (2000) Measuring the benefits of information technology in construction. *Journal of Engineering Construction and Architectural Management*. Vol.7, pp423-435, Loughborough.
- Sommerville, J. and Craig, N. (2004) *Information Processing Using a Digital Pen and Paper*. International Conference on Construction Information Technology, Managing Projects through Innovation & IT Solutions, pp217-224, Langkawi, Malaysia.
- Sommerville, J. Craig, N. and Ohlstenius, O. (2004) *Handwriting Recognition: Improving the Effectiveness of Construction Project Information*, 4th International Post Graduate Research Conference (IPRC 2004): Salford University. 1st - 2nd April 2004, Vol i. 274 - 283
- Vidogah, W. and Ndekugri, I. (1998) A Review of the Role of Information Technology in Construction Claims Management, *Journal of Computers in Industry*, Vol. 36, pp. -85, Elsevier Science. Xerox, (2002) *Convergent Document Technology an IT manager's Guide*, <http://www.istart.co.uk/index/DOCC199/FI49o7>