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CONSULTING

Electoral pilot scheme technical evaluation

South Bucks District Council

June 2007

Introduction

This report is presented to the Electoral Commission to inform the statutory evaluation of the electoral pilot scheme in South Bucks District Council (SBDC) at the elections on 3 May 2007.

The Electoral Commission is required to submit its evaluation report to the Secretary of State and any of the local authorities involved in the pilot scheme, and those local authorities are required to publish the evaluation report within three months of the election. This report is the technical evaluation report presented to the Commission on 25 June 2007 to inform their statutory evaluation.

In preparing this report, Ovum has drawn on its own observation and assessment of the pilot scheme, as well as on the views expressed to us by a number of other stakeholders. We would particularly like to thank the Returning Officer, and the electoral services department of SBDC for their assistance in undertaking this evaluation and for supplying us with the information and data to support the technical evaluation.

Pilot objectives

In response to the October 2006 electoral pilot scheme prospectus, SBDC submitted an application to pilot a series of innovations and changes to electoral procedures, including:

- Telephone based voting
- Internet based voting
- Electronic Counting of manually cast ballots

This report evaluates the e-Counting component, where the primary objective was to reduce the time taken in completing the count on election night.

A second, but equally important objective, relates to the availability of manpower for the count. It has proved increasingly difficult for the council to find sufficient (suitable) employees to undertake the count. South Bucks estimate that to do a full manual count would require some 120 staff, a real challenge when the total workforce is only 150 and many of those are in manual rather than clerical roles.

It is therefore not unusual for those undertaking the count to have also been manning the polling stations during the day. These individuals would therefore have probably been up since 5.00am on polling day and then worked a full 24 hour day. As a result some staff would decide on the day that they were too tired to do the count (they could not be forced as their participation was voluntary) creating further staffing issues. Tired staff were also prone to make errors in counting creating an additional workload.

Measures of success

Based on previous election experience South Bucks estimated that with a manual count the final result would have been declared some time after 5.00am on the Friday morning. With e-Counting it was hoped that the count would be completed by 2.30am. The ability to conduct the count with a much reduced workforce was also a key measure

Pilot scheme technical description

South Bucks is the only local authority in 2007 that piloted both e-Voting and e-Counting solutions. The e-Voting component offered both Internet and telephone (IVR) voting. The e-Counting solution used image recognition technology to scan all non-electronic votes. The South Bucks election covers both district and parish contests.

The solution procured by South Bucks District Council (SBDC) from ES&S (the only supplier to respond to the ITT from SBDC) was to use 3 commercial scanners to scan the manually cast ballots and then merge those results with those from the electronic voting system to provide the full result for the District and Parish elections.

The details of South Bucks District Council's application included piloting the following:

- Internet and telephone voting options for electors with voting permitted in the 12 days prior to the election and up to the close of the polls on 3 May 2007
- Electronic counting of all manually submitted ballots, whether at the polling station on the day of the election or in advance.
- Electronic postal vote management and matching, incorporating new legislative requirements for postal vote identifiers and marked register of postal voters (note that this evaluation report does not specifically address this aspect since it is linked to new legislative requirements, and is not defined as part of the pilot-only aspects of the scheme)
- The Electronic Count was planned to be conducted immediately following the close of poll on Thursday 3 May 2007.

The focus of South Bucks District Council's pilot scheme was very much biased towards the electronic voting part of the solution and both they and their chosen supplier (ES&S) were far less focused on the electronic counting component of the pilot. The primary purpose for South Bucks to introduce electronic counting was to use an electronic counting system that would efficiently and accurately record and count ballot papers for both district and parish elections on 3 May 2007 with a much reduced number of council personnel required to complete the count. The requirement was for a fully auditable solution that incorporated the requirements of the Electoral Administration Act 2006.

The innovations included in the electronic counting part of the scheme were:

- Redesign of the ballot paper, to include a barcode printed on the reverse of the ballot paper, in addition to ballot paper numbers. In addition the ballot paper had a grey line printed in the top left corner to confirm authenticity of the ballot paper. There were also two sizes of ballot paper (A4 and A5), size being determined by the number of candidates.
- An electronic counting software solution that captured ballot images and provided a complete solution from verification through to the final result. It had the capability to perform an automatic adjudication of all scanned ballot papers, whilst providing facilities for manual adjudication for any paper that was unclear or outside of the standard rule set.
- Ability to incorporate the ballots from the Internet and telephone voting option.
- A two stage manual adjudication process to allow council staff, as they would in a manual count, to adjudicate on blank and overvote ballots as well as ballots where the system had detected a mark

on the paper which was not actually a mark of a voter's intention. Only those ballots that required the Returning Officer to adjudicate were passed to the second stage.

- Doubtful ballot papers were adjudicated in front of candidates and agents as usual, and the system provided the facility for recounts
- Provision of hardware, including commercial off-the-shelf scanners, PCs running Windows XP, and a server running Windows 2003 (including back-up equipment for contingency)
- Projected displays for the delivery of information to onlookers, and to facilitate observation of adjudication.

e-counting of postal ballot papers

Although postal ballots were scanned prior to the count in order to fulfil the requirement for signature and date-of-birth verification, all postal ballots were then rescanned at the count itself for vote recording purposes. Such postal ballots would be the first to be processed at the count.

Full e-counting of all ballots papers returned from polling stations

Following the close of poll, all ballot boxes were moved to the count venue, a sound stage at Pinewood Studios. This was the first time that South Bucks had conducted the count at a single location, in the past two separate locations had been used. A full e-counting system was provided, incorporating 3 scanners, PCs and server to scan all returned ballot papers.

The key stages of the count – registration, scanning, verification, first and second level adjudication of doubtful ballot papers and the final count – were performed electronically using the e-counting local area networked system.

Changes to the ballot paper to facilitate e-counting

Ballot papers were provided for electronic scanning in various sizes according to the number of candidates. The counterfoil provision had been removed through the provisions of the Electoral Administration Act 2006. Ballots were "loose leaf" in style with no binding or stapling, thus avoiding the potential for damaged ballots seen in other pilots.

The reverse of the paper included details of the contest, the ballot paper number, and a corresponding barcode. The barcode provided a unique identifier, containing details of the Event, Election and Contest, as well as the reference of that distinct ballot paper within that election contest. The system can, in this way, assign ballots to a given election contest, and reject duplicate ballots.

The solution supplied by ES&S allowed for A4 and A5 ballots to be counted concurrently. Therefore all ballots regardless of paper size were placed in a single ballot box and voters were asked not to fold their ballots (almost all complied with this request) and SBDC had purchased new ballot boxes for this election the design of which encouraged the non-folding of ballots.

The official mark was a printed grey line in the top left corner of the paper. The system is designed to check this mark is both present and valid. If not, the vote would not be counted. In tests after the election (SBDC would not release any ballots during the election) it was found that this mark could be scanned on a simple home scanner but it was not possible to verify whether that scanned ballot would have been accepted by the system.

All district ballot papers were white, and parish ballot papers were yellow. As will be seen later in this report there seemed to be a higher incidence of ballots being rejected amongst those from the parish elections suggesting that the paper colour made it harder for the scanner to identify the voter's marks.

Management of the pilot scheme

Project management

In essence the project was managed under PRINCE principles although this was not on a formal basis. The Project Manager on the supplier side is a certified project manager (Institute of Project Management Professionals).

The pilot was run as a single project with ultimate responsibility for its management being taken by the supplier. In part this was probably due to the lack of experience of this type of solution by the South Bucks lead, the Electoral Services Officer.

On the face of it in the run up to the actual count the project appeared to be well managed with regular weekly meetings between ES&S and South Bucks throughout the run up to the setting up and initialisation of the voting system.

The night of the count (3 May) was a disappointment from a project management perspective as the ES&S Project Manager chose to base himself in Rushmoor – another pilot scheme for which ES&S were the supplier - rather than at South Bucks, despite Rushmoor having an e-voting pilot with only minor impact on the count.

When problems started to arise with the production of results the lack of the Project Manager's presence was a contributing issue as there was no one taking an overall role in deciding the best course of action. The ES&S Project Manager finally arrived at Pinewood Studios, Iver Heath, where the count was taking place, at 3.00am on the morning of Friday 4 May.

In hindsight there should have been an overall Project Manager for the count, probably from the Local Authority as they have the count process expertise, leaving the ES&S Project Manager to manage the technology component of the count. Had, as was the case with all of the other e-counting pilots, SBDC only been piloting the counting process then this would have been the case. However they were also piloting e-voting and had a single team covering both voting and counting with a strong bias towards the voting side. It is also imperative, certainly whilst this is at a pilot stage, that when a supplier is providing a Project Manager they are dedicated to a single Authority and not split between more than one.

Training

The only e-counting training required was for those Council staff who were to undertake the adjudication. The training was provided by ES&S following the acceptance testing. Hands-on training was undertaken by ES&S on-site with the relevant South Bucks staff and no training material was provided to them.

The training was adequate since the staff clearly understood what was required of them on the night, but with hindsight some issues arose in the process on the night that could of perhaps been addressed through training (or changes to the process) and would have been identified had SBDC run a full scale dummy election as part of the training acceptance process.

Relationship management

Prior to the count South Bucks and ES&S seemed to have a good relationship. Since this was the first pilot scheme conducted in the district, the Council were reliant upon ES&S giving them advice on the way they should address the process to ensure a successful outcome.

ES&S have used contractors for some parts of the (e-counting) solution but these were not involved directly with South Bucks.

The supplier was very involved and took the lead on most of the decision making. Prior to ES&S arriving in the UK there were regular weekly project meetings and these continued and became more frequent in the final run-up to the election. No real or perceived conflict of interest was seen in this relationship between supplier and Local Authority. However, the ES&S Project Manager was managing two clients simultaneously and this became an issue on the night when things started to go wrong and he was in the wrong location for South Bucks.

An issue arose with the printing of the ballot papers due in part to the decision by the selected printer to subcontract the work to a third party who then proved to be unable to meet the required quality. ES&S spent a great deal of time with the printer ensuring the ballot papers were readable by the scanner, in effect scanning every ballot as it was printed to ensure it was acceptable to the scanner.

There is a contract between the Council and the Supplier based on the response to a formal bid process. Of the suppliers on the DCA Framework only ES&S submitted a bid for this pilot scheme, leaving South Bucks with no choice of supplier for the pilot. There is nothing, however, to suggest that the contract was neither unsuitable nor insufficient

South Bucks created their own Statement of Requirements. However, there was limited technical evaluation undertaken as part of this, since this was considered to have been done by the DCA.

Justification for such a view taken by SBDC (and other Councils involved in the pilot) can be drawn in part from the ministerial statement which announced the pilots declared:

To support those pilots that will be utilising electronic services, we have undertaken a rigorous procurement exercise and have established a framework of suitable suppliers for the piloting authorities to use.[1]

“Rigorous procurement exercise” and “suitable suppliers” strongly suggest that detailed evaluation, perhaps even testing or accreditation, was part of this process. The approach of the councils to their suppliers suggests they took it in this spirit.

It is therefore unsurprising that the councils relied very much on their suppliers to deliver a managed service, meeting the requirements detailed in the DCA SOR (Statement of Requirements) and further scoped by their joint PID (project initiation document) and respective supplier contracts. Council officers seemed to take it for granted that those requirements had been understood and would be delivered. Meetings were concerned more with logistics – who would be doing what, when – than with the functionality and capacity of the pilot systems, which were assumed to be adequate, tested and proven.

[1] House of Commons, Hansard, Ministerial Statements for 29 January 2007 (pt0001) http://www.publications.parliament.uk/pa/cm200607/cmhansrd/cm070129/wmstext/70129m0001.htm#0701295000003

South Bucks also had a major focus on the e-Voting part of the pilot and the e-counting component was seen to be a minor part of the process and therefore needed less attention.

South Bucks did not undertake a rigorous technical evaluation of the electronic counting solutions offered by ES&S. Indeed the solution was only seen for the first time at the acceptance test (conducted on 18 April 2007). Had such an evaluation been undertaken then the desire to have the system deliver results of completed counts whilst still counting other contests might have been identified and addressed ahead of the actual count.

As part of the DCA Security Audit, the Auditor (Security & Standards Consultancy Ltd), requested that South Bucks and ES&S draw up a document that clearly defined responsibilities between the two parties. Prior to his request no such document had been considered leading to the potential for critical aspects of the election (voting and/or counting) to fail because each party thought the other party was responsible for it.

Process management

On the night of the count ballot boxes were delivered to the count centre from the polling station, or in the case of the postal ballots from SBDC's offices where the envelopes had been opened, the voters credentials checked and ballots placed in specific ballot boxes relating to the contest (as would have been the case had the ballot been cast at a polling station).

The ballot boxes were received by SBDC staff and logged in with a "header" page created containing details of the number of ballots for each contest that should be in the box (taken from information supplied by the presiding officer at the polling station).

The ballot boxes were then taken to a holding area where they could be opened in full view of all observers and the ballots placed in a box along with the header sheet. These boxes were then taken to table where they were logged in to the e-counting system (by ES&S staff) and allocated to one of the 3 scanners. The box was then placed on a rack (one for each scanner) prior to being scanned.

Scanning operators (again ES&S) took the boxes off the rack and scanned the ballots in the box, checking that the total number of ballots scanned (plus any ballots that were unscannable for whatever reason) equalled the total number of ballots expected in the box. Unscannable ballots (or those that required rescanning for whatever reason) were sorted by the scanner into a separate output tray on the scanner. Those that could not be scanned were placed in a plastic folder in the box so they could be manually processed.

Once a box had been scanned to was then taken to a table (ES&S Staff) where the tally between the number of ballots scanned (including those requiring manual entry) and the number expected was checked again, following which (assuming they tallied) the box was released for adjudication. If they did not tally then the box was returned for rescanning. On count night some issues were encountered with the postal votes where ballots from different contests had ended up in the same box during the sorting/verification process at SBDC's offices, but his was identified at the count and resolved quickly.

Ballot boxes awaiting adjudication were placed on racks and then taken off by the adjudication teams (SBDC staff) and first level adjudication undertaken. In addition, any ballots that required manual entry were processed at this stage. A flaw in the overall process was that all ballot boxes were placed on the

adjudication racks irrespective of whether there were any adjudications or manual entries required. This made the apparent scale of the adjudication process look much greater than it really was.

Once adjudicated the ballot boxes were then placed in a storage area awaiting result declaration, or Returning Office adjudication prior to result declaration. The RO had a screen visible to the observers. Candidates and Agents and was able to call up ballots for adjudication on a contest by contest basis.

Risk and contingency management

In their Project Initiation Document (PID) South Bucks had included a risk assessment section. However, much of this was related to the e-voting rather than the electronic counting part of the process.

The following contingency procedures were considered for the pilot scheme:

- Manual procedures: In the event of a failure of the count South Bucks had a provision to abandon the electronic count and revert to a manual count the next day.
- Redundant servers: ES&S had redundant servers available should they be required. Indeed, a software problem arose because a server ordered by ES&S for the count was delivered (by Dell) late leaving only a couple of days for it to be built and thus there was insufficient time for it to be fully tested.
- Redundant communication links: These were not required as there was no external interface for the system. The e-Ballot Box data from the e-Voting system was transferred via a CD.
- Spare equipment: No spare equipment was available. Instead ES&S arranged for an engineer from the scanner supplier to be on hand for the evening. In hindsight an additional spare scanner would have been useful, as one of the scanners failed and could not be repaired quickly thus reducing the throughput by one third for a small period of time.
- Backup power supply: The servers had backup power, but the rest of the equipment did not, although the location (a film studio) did have a backup supply available should it be have been required.

There were no other availability issues, other than a scanner failing, and none of the other contingencies mentioned above were required in the event.

Testing approaches

The Authority conducted an acceptance test which involved the processing of 12,000 paper ballots prepared by SBDC and ES&S staff as part of the acceptance test process. The manual ballots in the test replicated the electronic ballot voting pattern as a means of ensuring that the electronic voting process was accurate. The system passed this with no problem. The issue with this test, however, was that it did not identify the problem of the system not being designed to easily allow the announcement of results whilst the count was still in progress.

No independent tests were conducted on the e-counting side of the pilot, but there is nothing to suggest this would have identified any issues. It would have been prudent to have undertaken more extensive verification of the role performed by the official mark on the manual ballot papers and checked to ensure it was indeed as secure (regarding copying) as ES&S claimed.

Test material for the acceptance test was prepared by the supplier. The material supplied replicated the material that would be used for the actual election.

The acceptance test was not observed by external evaluators due to the day being changed at the last minute. Also much of the Acceptance Test focussed on the e-voting part of the Pilot rather than the e-counting element.

It is our understanding that no candidates or agents were present at (or invited to) the test, although on 12 March a presentation was delivered by ES&S for councillors and agents. This presentation did not constitute a formal demonstration as there was no working system available for the e-counting solution at that time.

Technology

Hardware and technical layout

From a systems architecture perspective the solution was divided into two discrete components – scanning/adjudication and results consolidation - with no physical or wireless connection between each component, the "air gap" being a DCA requirement to ensure the highest level of security for the count.

Scanning and adjudication was the largest component of the system, and comprised 9 PCs connected to a common server plus the three scanning machines. The scanners were owned by ES&S and only used for the count.

Results consolidation was handled by a standalone laptop which took a CD containing XML files from both the e-voting system and the e-counting system and merged the results to create the final results of the election

New ballot boxes were used which encouraged the non-folding of ballot papers. Standard commercial scanners (Axiome Alpha Hem3310) were used in conjunction with ES&S's own image recognition software. The use of these scanners reflected the DCA's preference for e-counting pilot schemes which investigated the feasibility of using commercially available hardware. The scanners selected also had dual output hoppers so that ballots that were rejected or required rescanning (following a machine jam for instance) could be identified and rescanned without the need for the whole batch to be rescanned.

Hardware

The full inventory of hardware for the count was as follows:

Scanning Control Server – Dell Power Edge SC1430 Server
(Primary)Serial# JMVLW2J (42742209691)
(Backup)Serial# HPVLW2J (38570043547)
Scanning Control Switch – Dell Power Connect 2716 Serial# JC10581
Scanning Control Workstation – Poseidon 150 Serial# M900004894
Batch Balancing Workstation – Poseidon 151 Serial# M900004899

Scanners: Axiome Hemera Model 3310 firmware version 3.12.10
Scanner 1: Serial# 00504304
Scanner 2: Serial# 00505248
Scanner 1: Serial# 00504305
Scanner Workstation PCs – HP Compaq dx2250 Microtower w/ 1GB Ethernet NIC
Workstation 1: Serial# 80045-595-896-003
Workstation 2: Serial# 80045-595-896-057
Workstation 3: Serial# 80045-595-896-129

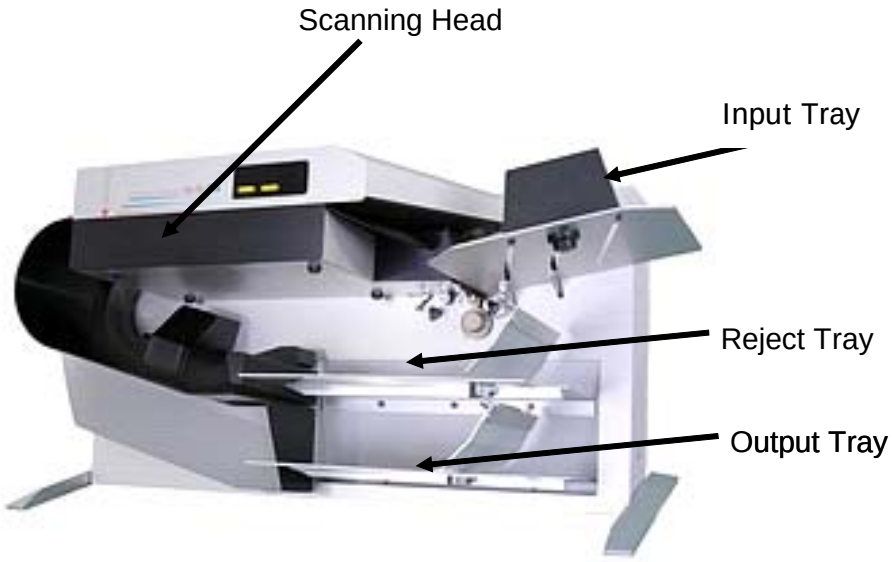
Image Deciphering and Adjudication Server – Dell PE2900 Xeon 5160 3.0GHz/4MB 1333FSB
Serial# TH7WD-6JBD2MB6DK-W3CYX-K2670X12-51821

Adjudication Workstations – HP Compaq dx2250 Microtower w/ barcode hand scanners
Workstation 1: Serial# 80045-595-896-131
Workstation 2: Serial# 80045-595-896-133
Workstation 3: Serial# 80045-595-896-172
Workstation 4: Serial# 80045-595-896-179

Barcode Scanners – Metrologic MS9540 Voyager CG
Scanner 1: Serial# 8607021815
Scanner 2: Serial# 8607021708
Scanner 3: Serial# 8607021772
Scanner 4: Serial# 8607021037

eBallot Box Decryption Workstation (South Bucks Primary)
Compaq nc6320 Serial# CNU7060VD2
eBallot Box Decryption Workstation (South Bucks Secondary)
Compaq nc6320 Serial# CNU7060WX6

IRC Workstation (South Bucks)
Dell Latitude D600, Windows XP Pro SP2, Serial# CN-03U652-48643-37M-4604



Process operation

The core processes for the count were (in order) as follows:

Ballot Box registration (SBDC Staff)

1. Ballot boxes were received from the polling stations (or in the case of postal ballots from the SBDC offices) and assigned a number to denote the district contest and where there was more than one polling station the polling station
2. A paper based ballot box header record was created showing the ballot box number and the number of ballots contained in it, based on the information provided by the presiding officer

3. Ballot boxes were then taken to an area for sorting and the contents transferred to a box where the ballots would remain for the remainder of the process.

Scanning (ES&S Staff)

1. The sorted ballot box was taken to the scanning supervisor who entered the box into the system, assigned it to a specific scanner and entered the total number of ballots expected in the box.
2. The box was then placed on the rack associated with its allocated scanner to await scanning. Ballots from different polling stations but for the same contest could be and were assigned to different scanners for scanning.
3. Boxes were selected (at random) from the racks by the scanner operators and the contents (or part for larger batches) placed in a "shaker" device to ensure all of the ballots were aligned correctly. It would have been better if this aligning process had been conducted in two planes to ensure where there were mixed size ballots from the same box they were aligned along 2 common edges not just one.
4. The aligned batches were then placed in the input hopper of the scanner, the scanner was activated and the ballots scanned
5. In theory A4 and A5 ballots could be scanned together in the same batch, but due to some operational issues the scanner operators took the decision to sort the two different sizes of paper and scan them separately leading to a reduction in the speed of the scanning process.
6. Ballots that could not be scanned were diverted to a separate output hopper on the scanner and rescanned. Likewise in the event of a machine jam then unscanned ballots in the machine at the time of the scan were also diverted to this hopper. This meant that in the event of any issue with the scanning process it was not necessary to rescan the whole batch.
7. Once the batch had been scanned the operator placed the scanned ballots back in the box. Any ballots that could not be scanned were placed in a plastic wallet so that they could easily be identified for manual entry
8. The completed ballot box was then passed for verification
9. The operator then selected a new box to scan

Verification (ES&S Staff)

1. The completed ballot box was taken for verification.
2. The operator ran the 'Verification' report from the application. This was run on a Ward/Parish basis.
3. The application displayed the number of successfully scanned ballot papers, together with the numbers entered at registration for each polling station within that ward/parish.
4. The count manager wrote the number of successfully and unsuccessfully scanned ballots on the control sheet.
5. If there were no discrepancy between the figures the batch status was set to 'Verified' and the batch was placed in the rack awaiting adjudication'. If there was a discrepancy the batch was resubmitted for scanning
6. Another batch was brought for verification and the process repeated from the selection of the Ward/Parish.

1st Level Adjudication (SBDC Staff)

1. The adjudication team (2 per screen) selected a ballot box from the pick list of available boxes on their screen and located the box on the rack
2. Having located the box the team then (if there were any ballots in the box requiring manual entry) entered the Manual Entry screen
3. Using a handheld scanner they scanned the bar code on the reverse of the ballot paper. This the bought up a blank ballot paper on the screen.
4. Using the paper based ballot the Adjudication team then entered the voters selection on the screen. Once completed the ballot was saved.
5. Once all of the manual entry ballots were processed the operators then went to the Adjudication screen for the contest. Ballots requiring adjudication were then displayed sequentially on the screen for processing.
6. There were 4 options available to the Adjudicators, namely
    a. Blank ballot
    b. Too many votes
    c. Voter intentions unclear – pass to RO for Adjudication
    d. Voter intention clear but the scanner had picked up some "noise" on the ballot paper when scanning which had confused the image recognition software, the elector had placed their mark in the wrong place on the screen or only part of the ballot had been scanned. In this case the Adjudicators would manually "correct" the image on the screen. If necessary they would locate the paper ballot from the box and inspect the original to verify what the voters' intentions were. If there was any doubt they would pass it to the RO for adjudication
7. Two operators were used to aid transparency in the process and to guard against operator error and an incorrect adjudication.
8. Once the batch had been completed the box was placed in a storage area awaiting the declaration of the result (it needed to be accessible in case the result was contested) and subsequent transfer back to SBDC's offices for storage.

Returning Officer Adjudication (SBDC Staff)

The process for Returning Officer adjudication was as above except that the process took place in front of the candidates, agents and other observers, the ballot in question being displayed on a large screen. In addition the options above the RO could also reject a ballot as being "spoiled".

Only the Returning Officer process PCs could access the Returning Officer adjudication queue and this queue could only be accessed through the Returning Officer's secure access credentials.

Once all of the ballots had been adjudicated for a contest then the result could be declared. This then highlighted the fact that the ES&S solution could not achieve this process quickly and easily as it was only expecting to this once all of the adjudications had been completed.

Paper Ballot Conversion

The scanning process created a separate EML format file for each ballot paper. Once the ballots had been adjudicated the system then needed to merge the individual EML Ballot Documents (files) into one EML document (file) so that they could be consolidated into the results database with the eVoting ballots more quickly, and the final results could then be calculated.

On the night it was the server, built only days before the election and not tested in a live environment, that proved to be a problem, resulting in a corrupt XML file being created.

Results Consolidation

Results consolidation was handled by a standalone laptop which took a CD containing XML files from both the e-voting system and the e-counting system and merged the results to create the final results of the election. Results for all contests were thus produced simultaneously.

The results were then printed out and handed to the Returning Officer to be announced. This part of the solution lacked the ability to easily calculate the results from one contest whilst others were still being counted because the software was designed to handle all contests at once rather than allow the creation of separate XML files for each contest, leading to frustration on the night as manual intervention was required (prior to finding a problem with the server) to try and announce results of completed contests.

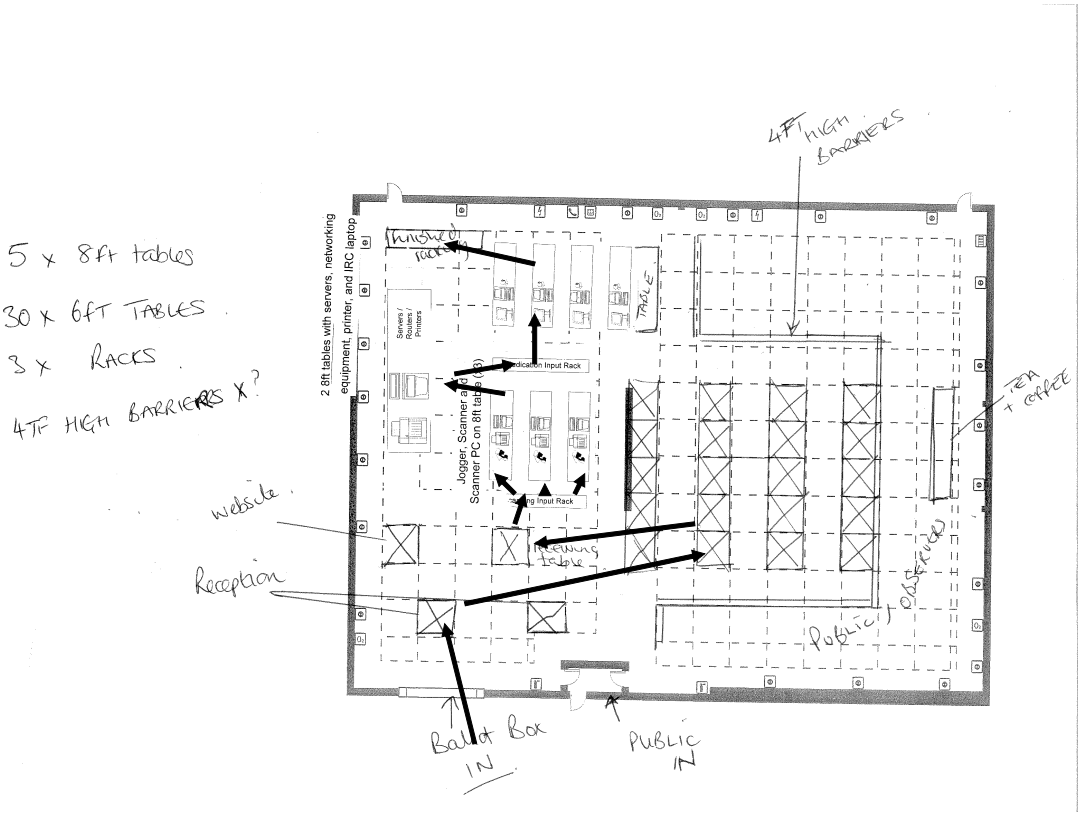
The system undertook the counting of some 21,000 ballots that had been cast either in polling stations or by post across the District and Parish Council elections. The results from the scanned ballots were merged with the results of the e-voting pilot to create the results for each contest.

The solution appeared to be scalable with there simply being the need to add more scanners and more adjudication stations as the size of the electoral population increased. Each additional scanner requires two additional staff. Similarly each additional adjudication station requires two additional staff. There is no reason for these staff not to be suitably trained council employees.

The Council staff seemed to like the technology and thought it straightforward to operate. On the night the scanners were operated by ES&S staff but this was not seen as being essential. There did not appear to be a user manual that staff could refer to. In part this was due to the system being new and not yet being sold as commercial offering for operation without ES&S presence. Such a manual would not be difficult to create, however.

Electronic counting

The diagram below shows the flow of the process for the count. The main failings in this process were that multiple ballot boxes from the same contest were not scanned together leading to partially counted contests and thus major delays in the results process. Had the process concentrated on completing the counting of all ballots in a contest as quickly as possible the overall time for the count would have been much reduced. In addition the adjudicators did not know which ballot boxes could be adjudicated and which still awaited reconciliation or some other action, again causing delays. Ballot boxes that required neither adjudication nor manual entry of ballots were also stored along side those that did require action making it appear that many more ballot boxes required intervention than was actually the case.



The ballot papers were either A5 or A4 depending on the number of candidates for each election. A5 size paper was used for 6 or less candidates. The A4 size was used for more than 6 candidates, and depending on whether there were more or less than 9 candidates, this determined the spacing of the information on the ballot paper.

The official mark was on the front of the ballot paper, and on the reverse a single barcode and a reference number. The barcode was unique to the ballot paper and contained details of the contest, the polling station and the sequence number for the ballot paper but no other information. The official mark and barcode were checked as part of the scanning process.

Despite the use of new ballot boxes which encouraged the non-folding of ballot papers, some voters insisted on folding their ballots and these had to be unfolded before scanning causing minor delays

Software

The software for image recognition was ES&S's own software. Unlike standard Optical Mark Recognition (OMR) software, which tends to be restrictive in both the style and location of the mark for assessment, the ES&S software scanned the whole ballot paper and then processed it as a single image, using a large library of potential styles and sizes of voter marks ("X" and check marks) to validate the ballot.

ES&S Applications

The application list for ES&S is a combination of modules from their normal application library and some developed specifically for use in UK elections. Some applications had been used in live elections before this, others had not been used in live elections previously. All version numbers in the list below were those used for the election.

IRC v1.0.128
Adjudication v1.0.26
BallotReceiptService v1.0.26
BallotRecognition v1.0.26
BallotDisplay v1.0.26
CleanupService v1.0.26
ContestReport v1.0.26
ControlPanel v1.0.26
EMLWriter.exe v1.0.26
SettingsEditor v1.0.26
StatusDisplay v1.0.26
UserManager v1.0.26

Reliant Applications

ScanTerminal v1.0.0.36
BallotHandler v167
BatchController v167

3rd Party Products

Microsoft Windows Server/2003 SBE
Microsoft MSDE 2000 SP4
Microsoft .NET Framework 2.0
Mitek QuickStrokes SDK 3.3
Oracle 10g Database 10.2.0
Oracle 10g Application Server 10.1.2
Red Hat Linux Enterprise v4
Ubuntu v6.10
Apache Webserver 2.0.52
Tomcat Servlet Container 5.5
Aspose Barcode.NET v2.2.2.0
Ubuntu 7.04
Ruby v1.8.4
Ruby on Rails v1.2.1
Steel Bank Common Lisp v1.0
Firefox v2.0.0.3
Sun JRE 1.4
Struts 1.2
EJB 2.1

Official Mark

The official mark was a diagonal grey mark in the top left hand corner of the ballot. In addition there were two black circles, top right and bottom left on the front of the ballot, used for scanner aligning.

It was claimed that the official mark could not be copied, however using a standard scanner on photo setting it was possible to create a copy including the official mark. Unfortunately because the ballot papers were not available until after the election it was not possible to prove whether the scanned ballot would go through the reader. It should also be noted that the test ballots used for the acceptance test

were printed by ES&S on a standard printer making the true security of the official mark difficult to establish.

EML

Each scanned ballot was created as a unique EML file. EML version 4 message 460 was used. EML was seen by ES&S as the natural choice for this application as it offered interchangeability, easy 3rd party integration if required and is an approved industry standard. The ballot definitions file was created using EML message 410 was used by the system to input the ballot definitions

Security and fraud

As stated previously, the focus of SBDC and ES&S throughout the run up to and the actual election was around the e-voting component and this was equally the case with regard to security. That is not to say however that they glossed over the need for ensuring the count was undertaken in a secure environment with access to restricted areas tightly controlled. Indeed with hindsight the RO believes the restrictions on access at the count were probably too onerous and helped to create a level of frustration on the night amongst candidates and agents as they could not easily see what was happening.

DCA QA Audit

Ovum was present at the DCA's QA audit of the technical system, undertaken on 17 April and this was the first on-site audit conducted by that DCA contractor.

The DCA auditor considered e-counting pilots to have less specifically technical issues to address than e-voting and therefore much of the focus of the audit was on the e-voting aspect of the study. The primary concern of the auditor relating to the count seemed to be around physical security and threat of subversive action by individuals keen to disrupt the count process and how data for records would be protected or backed up etc.

On the whole, the audit was judged to be thorough, raising concerns where required and the major focus seemed to be getting ES&S to provide concrete evidence to support responses obtained prior to the audit by telephone.

The key issue from the DCA auditor's perspective for e-counting in South Bucks was that of physical configuration, for example, the placement of electrics within the hall, how data for records would be protected or backed up etc.

The main points raised by the DCA auditor for closer attention included having more robust documentation of all processes such as zeroing the system, contingency planning etc; secure placing of servers; a password policy; training count staff to be vigilant and to police the count area; ensuring a clean PC policy, with no unused applications visible to users or observers on the PC monitors; also making sure users logged off the desktop if they need to leave their seat for any reason.

All of the DCA audit recommendations were incorporated into the planning by South Bucks and ES&S for the count.

System security

The system was stand-alone and isolated, with no connections to external networks, and as such there was no threat to the confidentiality of the information being scanned or stored. In addition all equipment used on the night for the handling of data was either created specifically for the occasion and/or had undergone a full and extensive virus check prior to the election and count night.

All of the equipment used was located well away from public access to avoid malicious or accidental interference by members of the public.

Scanner and adjudicator operators had to log on with unique user identifications and passwords.

Standard Microsoft user controls were used to control access to the various components of the system.

Data storage

The EML files and the converted XML files were held on dedicated “clean” computers. These were either brand new computers or computers that had been completely reformatted for the SBDC election. After the election all of the computers underwent an extensive data removal process and were cleaned to military specification (overwriting with zeros seven times). Copies of the data were burnt to CD and stored by SBDC in the same way that paper ballots are stored.

Count security

For each ballot box the number of ballots expected in the box, as defined by the poll clerk, was recorded on a batch header document which then accompanied the ballot box through the process.

After scanning, the number of ballots actually scanned (plus unscannable ballots) was reconciled with the batch header to ensure accuracy.

Only SBDC approved personnel were allowed in the actual count area. All others attending the count (observers, press, candidates and agents) had to stay outside the count area and behind barriers. With hindsight the RO felt this was excessive and he should have allowed the observers greater visibility of the scanning process and initial adjudication.

Prior to the count commencing, a zero report was produced showing all candidates to have zero votes against their names. A copy of this report is available.

At the polling station and during transit to Pinewood no special security measures were put in place as result of the electronic count. Ballot boxes were under the control of SBDC staff at the polling station and in transit to the count. At the count the ballot boxes were kept behind the barriers and opened in view of the candidates, agents and other observers.

The scanning machines were located in the centre of the count area some distance from any non-SBDC approved attendees.

The results were printed out and handed to the RO to be announced

All of the computers were password protected and were clean machines created specifically for the election. After the election they were to be completely erased to US military standards. Election data from the count was copied to CD and these were passed to SBDC for retention along with the paper ballots.

The system did not need to be connected to the Internet other than for the e-voting system to download the electronic ballot box. In any event, Pinewood wanted to charge several thousand pounds for Internet access. Therefore, the process used required the e-Ballot box which contained the votes cast electronically at the election to be accessed at SBDC’s offices, then copied to CD and bought in a secure box to the count so they could be combine with the paper ballots. Further details of this process may be found in the corresponding technical report on electronic voting for the South Bucks pilot scheme. No

penetration testing of the electronic counting solution was carried out as it was not required due to the isolated nature of the solution.

Impact on the counting process

Electronic counting set-up

Three scanners were used on the night. In reality a fourth scanner would have been both useful to allow faster throughput and also to act as a backup should (as was the case) a scanner fail.

There were two operators per scanner both supplied by ES&S.

Ballots were allocated randomly to scanners and the Parish and District ballot papers were mixed. This caused issues when district and parish elections being voted for at the same polling station used different paper sizes and consequently there was a mix of A4 and A5 ballots in the same ballot box. The use of the "jogging" machines (used to shake the papers so that they would align with each other) was ineffective as the ballots were only jogged in one direction, and so remained unaligned in the other direction. As a result the scanner operators decided (without reference to either a senior ES&S or SBDC member of staff) to sort the ballots, and this resulted in a delay in the scanning process which delayed the whole process. In future it would probably be best to use a single size of ballot paper to avoid this issue.

Ballots that had been submitted by post were, in some cases, damaged by the automated letter opener and these had to be manually processed in the same way as other rejected ballots. This involved scanning the barcode on the ballot paper and then using the software to allow the voters intentions to be recorded.

The scanners were located well away from the observers. Indeed with hindsight they were too far away from the observers leading to additional frustration on the evening as agents and candidates could not observe what was taking place.

The only contingency in the event of failure was the option to switch to a manual count.

Count process

A dry run was undertaken as part of the acceptance test but because a different and untested server was used at the count itself, the software fault encountered on the night did not arise at the test and so was unforeseen. In an attempt to ensure that everything ran perfectly on the night ES&S decided to order and build a new, faster, server for the count. This server only arrived on the Monday, due to late delivery by Dell, before the count and left no time to actually test it prior to it being deployed at the count. Had it been tested then the software version incompatibility issue would have been identified and could have been corrected.

Also at the dry run, no attempt was made to declare results until all ballots were counted, again failing to highlight a major issue on the night.

The first polling station ballot box arrived at Pinewood at 10.25pm; the postal ballot boxes arrived slightly earlier. The final ballot paper was scanned at about 3.00am. Had the three machines been operating properly and there had been no need to manually separate A4 and A5 ballots then the scanning should have taken a little over 2 hours to complete. With attention to process (ie ensuring

ballot boxes from the same contest were counted together) then the whole count could have been completed much more quickly and the first results (software permitting) could have been announced around midnight.

Because of the technology issues no timesaving occurred. There is a clear potential for significant time saving in the future assuming working technology and better attention to the process flow.

With regard to bottlenecks in the process, there were two. One caused by the scanner operators' decision to sort A5 and A4 ballots to stop the scanner jamming. This could possibly have been avoided if the ballots had been "jogged" in two directions to align a common corner rather than edge. The other bottleneck related to the adjudication process where there were boxes on the racks apparently awaiting adjudication that could not be processed by the adjudicator as they were still awaiting release from the verification stage. The problem also looked more serious than it was as boxes that required no adjudication were being stacked with those that required attention, but the "clean" boxes were not listed on the adjudicators' terminal as being available to process and therefore simply stayed there until the end of the count when there were no more boxes to adjudicate. Had these boxes been cleared earlier then (subject to the software being capable) results of contests could have been declared

The system did not process any false positives as far as it was possible to tell, although no manual verification of the e-Counting took place. ES&S and SBDC jointly felt unnecessary as the test had been 100% accurate. Likewise no rescanning of batches was required.

The peak scanning rate based on the machine specification for A4 ballots was 120 ballots per minute and for A5 ballots 125 ballots per minute. With 3 machines the throughput should of between 360 and 375 per minute. In terms of overall scanning 21955 ballots took about 5 hours to scan giving a mean scanning rate of 24.39 ballots per minute per machine. However for much of the time only 2 scanners were being used and because of the sorting process the scanners were not operating continuously.

The only delays due to unscannable ballots were down to the damaged postal ballots that had been cut by the envelope opener. This was anticipated before the count and consideration should be given to action which could be taken in the future to avoid such damage.

No recounts were requested for any of the contests. The Returning Officer saw this in part as a sign of acceptance by the candidates and agents of the technology.

No results were displayed electronically. The results were generated as reports which were printed out and handed to the Returning Officer.

The only interaction with the candidates and agents were the adjudication of ballots referred to the Returning Officer. These were displayed on a large screen in front of the interested parties. There were no issues raised by any parties regarding this form of adjudication and having both observed a traditional count and also in discussion with the RO it was clearly preferable to the usual process where all of the interested parties are trying to crowd around the Returning Officer as he examined the ballots.

Despite promises at the outset, there was no electronic display of the count progress on the night further adding to frustration amongst those not directly involved (candidates, observers and agents) in the count who struggled to understand what was going on.

The count started at about 10.25pm and the last ballot box was scanned and through first stage adjudication by about 3.15am the next morning which was quicker than would have been the case for a traditional count. Had the scanner operators not spent time sorting ballot papers by size prior to

scanning then the process would have been completed even earlier. The count was then suspended so that the software issue could be resolved and the RO adjudications commenced at 10.00am on the Friday morning with the last result declared shortly after midday.

Completing the count earlier than in the past was seen by an additional benefit to the main aim of introducing electronic counting, namely the need for far fewer staff. It was unfortunate that the time benefit was not achieved due to the software fault, especially as the candidates and agents had high expectations in this regard.

Adjudications

88.2% of all ballots counted were successfully read at the first pass. 6.6% of all adjudications (or 0.8% of all ballots cast) were passed to the Returning officer for adjudication. Thus 93.4% of the ballots passed for adjudication were address by the first stage adjudication process with only a small number of ballots passed to the RO for adjudication.

From the scanned ballots the total number of “spoilt” ballots is 242 ballots:

- 1 of the “spoilt” ballots was from a discernible voter ID
- 28 of the “spoilt” ballots were ballots that were “over voted”
- 213 of the remaining “spoilt” ballots were either “true blank” ballots, or ballots where the voter intent was unable to be determined

Analysis of the adjudications by ward show that there were more issues in reading ballots from parish elections where the paper was yellow and especially in those where the ballot paper was A4 and had more than 9 candidates. Consideration to this should be given in the future, especially with regard to the colour of the paper. In this case it may have been better to have reversed the colours so that the white paper was used in the Parish elections as these were the ones that the higher number of candidates.

Cost and value for money

Item	Quantity	Item Price	Total Price	Item Description
Election management system	N/A	N/A	N/A	
Election adjudication system	Included	Included	Included	
Scanning software	N/A	N/A	N/A	
Digital Central Scanner (Includes Scanner, Start-Up Kit, Dust Cover, and Adjudication Software)	3	£13,550.00	£40,650	
Ballot Joggers	3	£106.75	£320	For alignment of the ballots
Installation Digital Central Scanner	3	£1,200.00	£3,600	
Computers	7	£950.00	£6,650	Not in original costings
Servers	2	£1,200.00	£2,400	Not in original costings
Pre-election end-to-end trial	Included	Included	Included	
Results and statistics generation	1	£8,515.00	£8,515	Includes Software for accumulation and presentation of results from the e-count channels
Total			**£62,135**	

The total cost to South Bucks for just the e-counting technology component was £62,135.00. This was higher than the original quote (£52,871.75) due to the addition of 2 Ballot Joggers, 7 Computers and 2 Servers not included in the original costing. It would appear that these changes to the costs were made without due reference to staff at South Bucks. The costs of the computer equipment would also seem to be very high, appears to be something approaching list price, for just one night's usage and given that these capital items have been retained by ES&S. In addition there was a charge of £4,775.00 for ES&S staff provided on the night.

In addition to these costs are Project Management costs which need to be considered. In total ES&S charged South Bucks £195,513, for Project Management, development and training (including the £4775 mentioned above), but this covered both the e-counting and e-voting components and it no breakdown of the separate costs have been provided, although the majority of non-specific costs will probably have been associated with the e-voting component which was much more involved and took place over a longer period of time.

It should also be noted that the Project Management costs have increased from £159,825 shown in the original quote, again with no discussion or agreement with South Bucks. It would seem that ES&S have treated the pilot as a time and materials style procurement rather than a fixed price one, although their proposal appears not to mention this. Given the issues that arose on the night of the count it might have been reasonable for ES&S to actually make a downward adjustment to the cost rather than an increase.

None of the hardware was already owned by the authority or is now owned by the authority as a result of the pilot. ES&S in effect rented the equipment to South Bucks for the Pilot, and whilst it is

understood that the scanners cost about £45,000 each to purchase the overall cost of the provision of the hardware for the count seems to be rather high.

None of these costs would be avoided were SBDC to conduct an exercise like this again as no capital equipment was procured by or on behalf of the Council. SBDC did buy new ballot boxes for this election (to discourage folding of ballot papers) and these will be available for future elections.

Adding an additional scanner would have increased the costs but provided an additional throughput, and also the comfort of having sufficient scanners to continue the count at a reasonable speed when one failed.

Staff were available for a manual recount of a single contest if it had been required. If the whole election had had to revert to a manual count then it would have taken place the next day and the Council would have used its own staff.

The council already scanned for signature verification and these were not the same scanners used by ES&S for the count. Work would be required to allow the dual role use of these scanners, in particular the software used for the various processes would have to be able to work on a common scanner platform.

Had South Bucks undertaken the count manually, rather than embark upon the Pilot, then the key cost would have been payment to staff to do the count and they estimate that cost to of been £6800. The Pilot therefore cost considerably more than a manual count but against that needs to be considered the primary issue for South Bucks in that they find it very difficult indeed to source sufficient staff to undertake the count in a reasonable period of time.

Conclusions and findings

Conclusions

Ovum's conclusions in relation to the electoral pilot scheme in South Bucks District Council are as follows:

The technology facilitated the count, and led to fewer staff being required: The Council successfully conducted the count using the technology solution from ES&S and critical to the council this was achieved with far fewer staff than required for a manual count, even when one takes into account that outside of a pliot environment the Council would of needed to supply staff to fulfil the roles undertaken on the night by ES&S staff. The software problem delayed the results declaration but did not prevent it.

There was no apparent increase in impersonation or other offences or malpractice through the use of the electronic counting solution.

Cost saving was not a primary motive in SBDC conducting the pilot.

Learning and Issues arising

The pilot was seen as a successful event: Whilst it is fair to say the South Bucks e-Counting pilot did not proceed exactly as planned, it should not be seen as a failure and the Chief Executive of the authority is at pains to stress that he does not see as such. Whilst the announcement of the results was delayed, and the hope of declaring results earlier than previously with a manual system were clearly not met, the result was determined using the e-counting option and there were no recounts called or challenges to results. The clear (and primary) benefit to the Authority was the ability to conduct the count with a much reduced number of council employees, even allowing for the potential substitution in future counts of ES&S staff with Council staff.

Electronic counting is seen by the Local Authority as the way forward: Speaking with the Chief Executive of the Council after the election he was very clear that he saw that e-counting was the way forward for future elections, especially for the smaller authorities such as his own who simply do not have sufficient suitable and willing staff to undertake a count of this scale manually, especially if that requires the count to be done on the night of the election. General elections are perhaps less of an issue because there is only the one contest making it less complex.

Improvements to workflow and consistency of project management need to be addressed: Setting aside the software problem that was the primary cause of the delay and the omission (in the original DCA Statement of Requirement) of the inability to declare results whilst other contests were still being counted, there were two primary issues with the South Bucks pilot.

First, the workflow (from the arrival of the ballot box to the completed counting and adjudication of the contents of the box) for the count did not follow the established procedure of a manual count where each contest is counted in total and the result declared before the next contest is counted, albeit there may be multiple workstreams and thus multiple counts in progress at the same time. At this election there was no effort to ensure ballot boxes were counted in some order to speed up the results

declaration process or to identify those contests where all ballots had been counted and thus the results could be declared, subject to any RO adjudications.

Second there was no specific overall Project Manager (for either ES&S or South Bucks) for the count taking control of the process on the night. Whilst ES&S had taken on Project Management responsibility for the technical side of the count (albeit that their PM was absent on the night at Rushmoor) the count is a process in itself and required its own management.

SBDC needed to be more involved in all aspects of the pilot: Clearly SBDC were responsible for the count and took that role seriously but as much of the process was being conducted by ES&S staff they were somewhat remote from the process (which was also new to them) and understanding what was happening. This lack of management and consequently information then had a knock on effect in that there was poor communication between the Council and the candidates and agents as to what was going on, both before and after problems arose.

Problems encountered were not insurmountable: It has to borne in mind that this was a pilot exercise and by their very nature pilots are intended to identify issues and develop best practice. None of the problems encountered by South Bucks could not be rectified in future electronic counting exercises and the technology supplied by ES&S delivered an accurate outcome that all interested parties are happy with.

Untried and untested aspects of a technical solution must be avoided at all costs: South Bucks also placed most of their emphasis on the electronic voting component of the pilot as this was seen as being of much greater risk to the success of the election. This perhaps led to some of the issues experienced not being identified prior to the night, but it would not have addressed the major issue of the software failure on an untried and untested server.