Voto ELECTRÓNICO
PRUEBA PILOTO 2005 - CIUDAD DE BUENOS AIRES

PRUEBA PILOTO DE VOTO ELECTRÓNICO

Ciudad de Buenos Aires
23 de octubre de 2005

EXECUTIVE SUMMARY

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2005 E-VOTING PILOT PROJECT
FIRST EVALUATION REPORT
EXECUTIVE SUMMARY

This document outlines the main aspects of the assessment of the E-Voting Pilot that took place in the City of Buenos Aires on October 23rd 2005. The complete Report (in Spanish) can be found on our Website (www.buenosaires.gov.ar/dgelec).

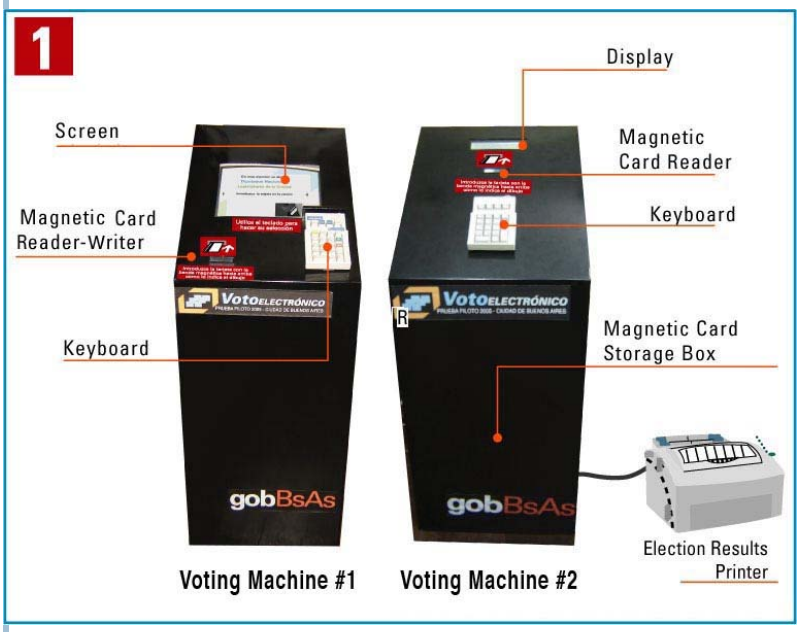
1. Introduction

- The E-Voting Pilot Project was launched on **October 23rd 2005** on occasion of 2005 Legislative Elections. The e-voting experience took place in 43 polling stations officially chosen for elections. Voters´ participation in the Pilot was non-compulsory. E-voters were asked to replicate the same election as in the real contest.
- The **goal** of the Project was to build several tools in order to evaluate and devise the technological option that best suits the social, demographic and institutional characteristics of the City of Buenos Aires.
- Because of its **technical complexity** (the design and implementation of both e-voting software and hardware were developed integrally by the Project's technical team) and the **experimental design**, the E-Voting Pilot conducted by the City's Office of Electoral Affairs constitutes an unprecedented experience within the country and the region.
- The Pilot Project was thought and planned as a **double test**: on the one hand, we aimed at testing four different technical options of electronic voting, and, on the other, we

sought to evaluate citizens´ behaviour and attitudes regarding the introduction of new technologies in the electoral process, specifically when casting a vote.

- The **four prototypes of electronic voting** built for the Pilot Project can be divided in two groups: two of them are Direct Recording Electronic systems (named REA and REV), and the other are two Optical Scan systems (named LOB and LOP).
- The software was developed by the Office of Electoral Affairs and is modular, open-source and flexible.
- In each polling station there were **four voting machines** –one of each functional prototype (all in all, we tested approximately 150 machines). Each voter participating in the Pilot was randomly assigned a different prototype and received some training on how to use the voting machine. Once the elector had cast her electronic vote, she was asked to answer a short survey aiming to get information about her experience interacting with the machine. A sample of voters also answered a long survey.
- The E-Voting Pilot Project required the participation of a coordinated group of people that had specific tasks to comply in order to assure the correct functioning of the Pilot. To do so, the Office of Electoral Affairs conducted an open recruitment process to cover the different positions on Election Day. 800 people were recruited and received training in order to fulfil the assigned tasks.

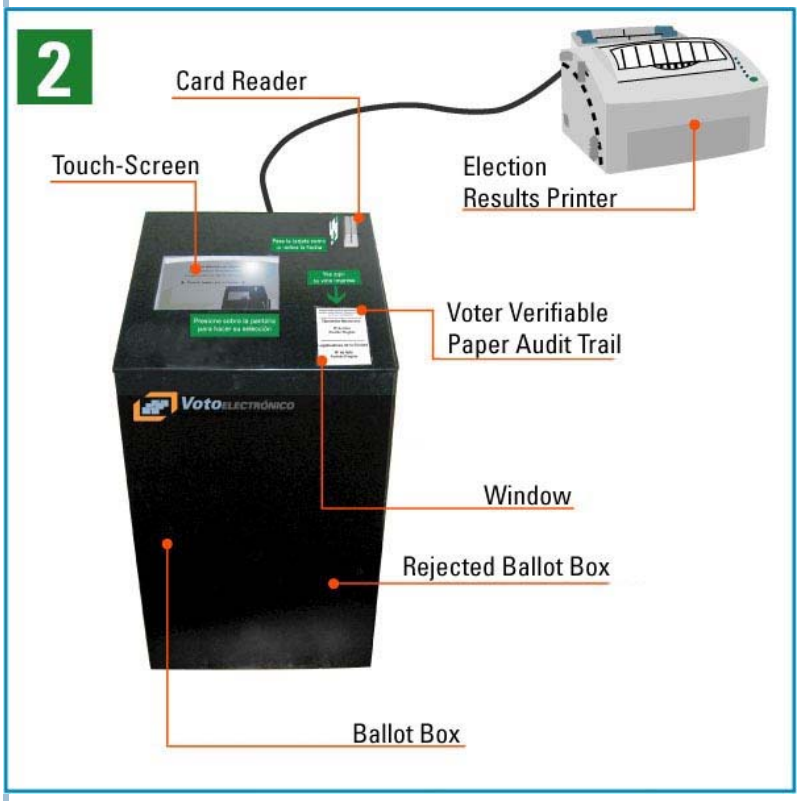
Prototype # 1 (named REA)



Prototype 1
Digital, Keypad

The voter inserts a smartcard into the first machine. Scrolls over party labels and selects a party lists using a numeric keypad. A special button on the keyboard allows voters to cast a blank vote.

Prototype # 2 (named REV)

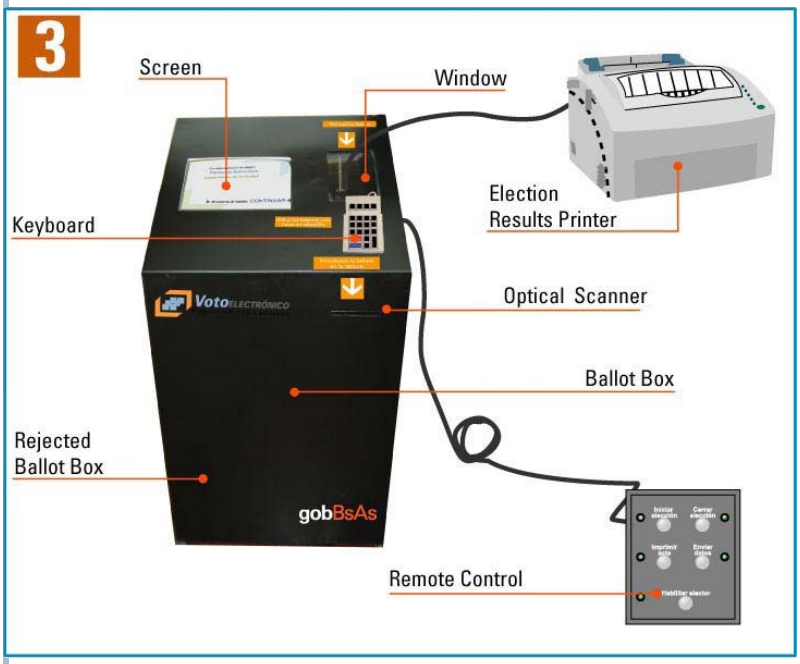


Prototype 2
Digital, Touch Screen

The voter swipes a smartcard in order to start the voting process. Using a touch-screen device the voter scrolls over party labels and selects a party list.

To cast a blank vote, the voter must search the blank ballot randomly placed among other party labels.

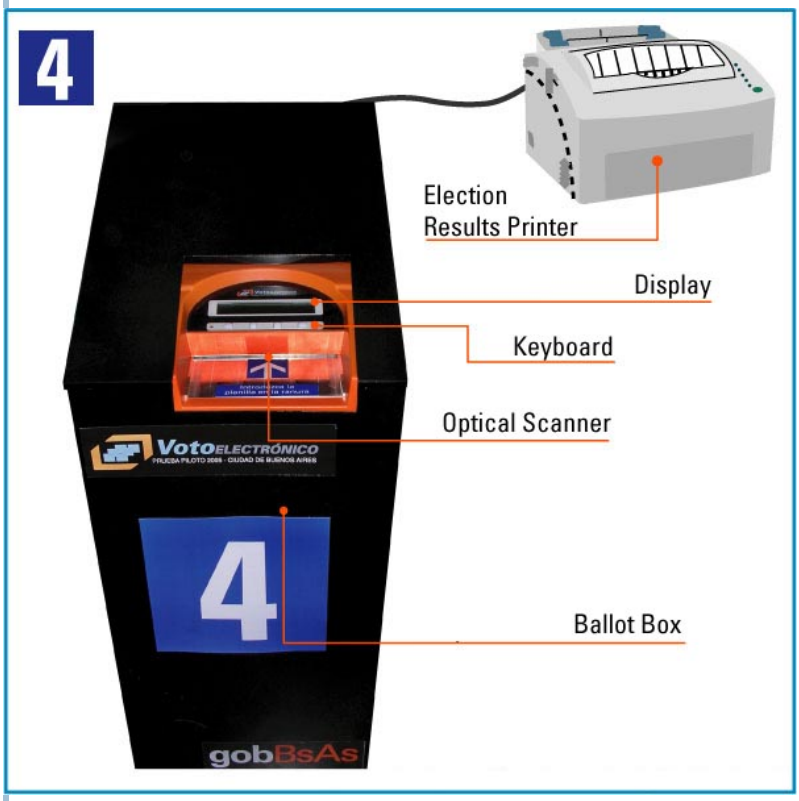
Prototype # 3 (named LOB)



Prototype 3
Optical, Two Ballots

On the first screen shown to the voter, she is asked to insert a ballot paper or press the CONTINUE button to cast a blank vote. There is a ballot for each party. She inserts two ballot papers, one for National Deputies and one for local Legislators.

Prototype # 4 (named LOP)



Prototype 4
Optical, Mark, Single Ballot

The voter browses the party lists in a booklet and marks its preference on the paper ballot. An optical device scans the ballot. Order of lists based on Party Number, with blank vote placed last in the ballot. Failure to mark is not considered a blank vote

2. General results

- The decision adopted by the technical team of the Project to develop e-voting prototypes that use an **open source software** turned out to be very successful. We must take into account that the use of open source software for the development of specific drivers (such as the magnetic card reader-writer used in REA prototype) made our work more complex since, in many occasions, we had to develop our own drivers. However, this circumstance did not attempt against the success of the Project, assuring once again the feasibility of developing technical systems of this type. In the future, the use of an open source platform will let the government implement **ICT programmes** without licence payment and favouring independence and software audit.
- Another conclusion that stems from the e-voting experience is the importance of **voter-verified audit trails** to the whole election process. Keeping physical evidence of votes allowed us to make an evaluation of the electronic voting system by matching physical evidence of votes with the machine's electronic registry. This evaluation was made in the presence of several non-governmental organizations.
- The **communication strategy** implemented for the E-voting Pilot proved to be very effective. The most successful initiative consisted of an invitation letter sent to all the electors that, on October 23rd, were assigned to one of the 43 polling stations selected for the Pilot. In this letter, they were informed about the characteristics of the e-voting experience and encouraged them to participate. According to the survey data, the letter was the main channel by which electors heard about the Pilot and decided to participate. High participation of voters also highlighted citizenship's interest in taking part of the policy decision-making process, especially in one that has to do with the means by which our representatives are elected.
- The **training** received by electors on the use of voting machines was considered "Good" or "Very good" by 96% of voters. An even higher percentage (98.7%) answered the same when they were asked about the quality of the service given by the Pilot's personnel. When discriminating data by prototype, age, sex, or educational level, the voters´ perception about the training and service received do not show significant differences.
- When asked about the **changes** they consider should be made to the E-Voting Pilot, 41% of voters answered that there should not be any change at all. Among those who did consider the implementation of some changes, 22.10% of suggestions had to do with improvements in the graphic design of machines´ screens, ballots and additional

material used to identify candidates and party lists, since this last task proved to be quite difficult for electors. Furthermore, many people mentioned the need for solving the technical errors occurred in many voting machines. Changes that had to do with hardware devices summed up to 7.6% of answers. 3.5% of voters showed concern towards the training process and the use of voting machines by the elderly, handicapped and low socio-economic voters. As regards this last issue, they claim that vote accessibility should be improved.

3. Participation

- In the 43 polling stations where the Pilot took place, the experience reached a high level of participation. **14,806 voters** from the City of Buenos Aires cast their votes by electronic means.
- **Prototype 2** (REV) reached the **highest level of participation** (34%), while voter participation in prototype 4 (LOP) was considerably lower than in the rest (9%). However, we must take into account that prototype 4 was only installed in 21 of the 43 polling places.
- **Women participation** in the Pilot slightly prevailed over men's: 54 % of participants were female and 46% were male.
- 44% of the voters that participated in the Pilot were **more than 50 years old**, while those aged between 30 and 49 years old reached 37%. Population statistics of the City of Buenos Aires account that 36.6% of the people is more than 50 years old, and those between 30 and 49 years old represent 41.9% of the City's population[1]. This difference shows that in the Pilot there was a slightly lower representation of the population under 30 years old.
- Participation was greater among electors with a **higher level of education**. The group with the highest level of education (incomplete or complete university studies) accounts for 58% of the total number of participants. Inside this group, those with "complete high school studies" and "complete university studies" had the highest level of participation, with 24% and 29% respectively. According to the demographic statistics of the City of Buenos Aires, the population with "complete high school studies" represents 21.5% of

[1] This data was drawn from the National Population Census 2001. City of Buenos Aires.

the City's total. The percentage rises to 27.6%[2] for citizens with "complete university studies". This data shows that there are no significant differences between the characteristics of the population that participated in the Pilot and the demographic statistics of the City. However, there is an important contrast between the 58% of electors with a high level of education that participated in the e-voting experience and the 44% of the population living in the city of Buenos Aires which stands under the same category.

4. External actors

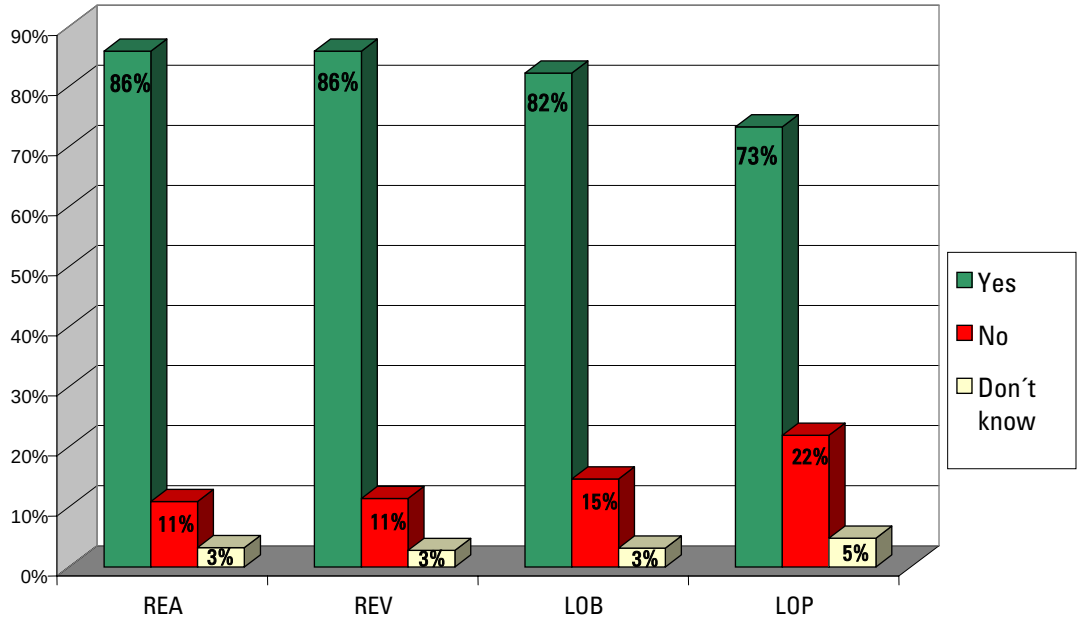
- The participation of a wide group of **external actors** (non governmental organizations; experts in electoral processes, political rights and new technologies; as well as international observers) has enriched the evaluation process carried out after the Pilot election.
- Even though only a few **non governmental organizations** in Argentina are specialized in electronic voting, these actors evidence a profound and increasing interest in this topic.
- The observation of the E-Voting Pilot carried out by **international experts** has been a key input for the external evaluation system, showing the importance of mechanisms of international cooperation in topics as new and as complex as the incorporation of new technologies of information and communication to the electoral process.

5. Voters´ opinions towards electronic voting

- After casting their electronic vote, 84% of the surveyed electors claimed that **they would like real elections to be carried out under electronic voting.**

[2] Data based on the Permanent Home Survey 2004, City of Buenos Aires. In this case, the distribution of the population by the maximum level of education obtained was taken from the population over 25 years old.

Question: "Would you like to use this voting system in a real election?"



- The answers given to these questions by **prototype 4 (LOP) voters** differed significantly from the rest. Although the majority of voters would like to use this voting system in a real election (73.2%), positive responses given by electors who tested the other three prototypes reached higher positive responses (an average of 84.6%). When discriminating data by **sex and age**, we did not find significant differences regarding voter's desire to use electronic voting machines in a real election.
- There is a slightly **negative relationship** between the level of education[3] of electors and their desire to use an electronic voting system in a real election. This means that while the level of education increases, the desire to use an e-voting system decreases. In effect, among groups of voters with the highest level of education (82.3%) and those with the lowest level (89.2%) the difference between positive answers reaches 7 points.
- Survey data shows a **positive attitude of electors towards the possibility of introducing an electronic voting system**, independently of which of the four prototypes they had tested in the Pilot. 43.6% of the surveyed electors agreed with changing the manual voting system for an electronic one. Moreover, a 32.5% said that they "fully agree" with changing the actual voting system.

[3] For the purpose of this document, we organized the variable *educational level* into four categories: Educational level 1, Educational level 2, Educational level 3, and Educational level 4. Educational level 1 groups voters with no studies, incomplete and complete primary school studies. Educational level 2 includes voters with incomplete and complete secondary school studies. Educational level 3 includes voters who finished their tertiary studies and have not completed their education yet. Finally, Educational level 4 considers those who at least have started a career ay university.

Percentage of voters that agreed on replacing the ballot voting system for an electronic one

	REA	REV	LOB	LOP	Average	Total
Fully disagree	3,8%	3,8%	4,0%	5,4%	4,2%	3,9%
Disagree	6,1%	6,7%	7,2%	5,3%	6,3%	6,5%
Neither agree nor disagree	11,0%	12,2%	11,2%	16,6%	12,7%	11,9%
Agree	46,1%	44,0%	46,7%	37,4%	43,6%	45,0%
Fully agree	32,6%	32,6%	30,3%	34,8%	32,6%	32,1%
Do not know	0,4%	0,7%	0,6%	0,5%	0,6%	0,6%
Total	100%	100%	100%	100%	100%	100%

- When asked about how they felt about replacing the traditional voting system for an electronic one, voters´ answers did reveal some **differences in relation to their age.** Electors over 50 years old and between 30 and 49 years old "agreed" or "fully agreed" with replacing the system in **79% and 78%** (respectively) of cases. In contrast, electors under 29 years old "agreed" or "fully agreed" on replacing the system only in **69%** of cases.
- When discriminating data by **sex**, we found that male voters are slightly more prone than women to accept the replacing of the traditional voting system by an electronic one.
- When discriminating data by **level of education**, we found the same negative relationship we mentioned before between level of education and desire to replace the traditional voting system for an electronic one. Electors belonging to the group with the lowest level of education agreed on replacing the actual voting system in 81% of the cases. On the contrary, in groups with a higher level, positive responses accounted for 76.93.
- 95.7% of the voters claimed that **the instructions received for the use of the voting machines had helped them to cast their vote correctly**[4]. The majority of voters (80.6%) rejected the idea that the whole voting process had too many steps. 91.5% of voters considered that they would not need to ask for help every time they use the

[4] This percentage was calculated without discriminating data by prototypes.

machines. Moreover, on average, 50.5% said that the use of electronic machines was "easy" or "very easy" in 32.2% of cases.

- When discriminating data by the **four different prototypes**, we found that 67.4% of voters using prototype #4 (LOP) believe that most citizens will learn how to use the electronic voting machine, reaching the highest percentage of answers among all prototypes. Voters using prototype 1 (REA) answered in the same way in 40.8% of cases. However, when asked about the need of assistance in order to use the machine, the highest percentage of positive answers is also found among voters using prototype 4 (15.5%). This situation might be related to the malfunctioning of this prototype during the Pilot.
- As regards the **difficulties** found when using the voting machines, there appears to be a difference between optical scanning prototypes (LOB and LOP) and direct electronic registering ones (REA and REV). While **85.5%** of voters that tested REA and REV considered that the use of the machines was "easy" or "very easy", this percentage is 5 points lower among voters who tested optical scan systems.
- Gender has **no significant impact** on opinions related to the interaction the voting machines.
- On the contrary, when discriminating data between the different **age** cohorts we do obtain some relevant differences regarding opinions about the interaction with machines. 11.4% of voters aged 50 years + considers that they will need help every time they use an electronic voting system; whereas voters under 30 years old answered in the same way in a 4.7% percentage of the cases. Something similar happens when they were asked about how difficult the use of the voting machines was for them. 4.1% of voters over 50 years old think that the electronic voting system was "hard" or "very hard" to use, while young voters (under 30) answered in the same way in 1.7% of the cases.
- The analysis of responses according to the **different levels of education** shows important differences. The percentage of positive responses decreases as the level of education increases. 76.9% of voters that belong to the group with the lowest level of education said the majority of electors will be able to learn how to use the electronic voting system. This percentage decreases to a 67.4% among group 2 voters, to a 58.5% for group 3, and to a 56.4% for group 4 (highest level of education). In spite of this, questions about difficulties in using the machines do not present important differences between age groups.

- **Confidence** on the functioning of the electronic voting system is one of the most important aspects to evaluate. This variable was **operationalized by two different questions**. The first one has to do with how much electors trust in the way they cast their vote. The second one has more to do with voters´ perception as regards the effective and correct registration of their votes. In this sense, the first question tries to point out an objective aspect about confidence on the system while the second one aims to asses a subjective aspect about confidence.
- Almost every surveyed elector (92.51%) considers that the electronic voting system they tested **can be trusted**. As regards confidence in the correct and safe registry of votes, 57% of the surveyed electors thought that the system was "safe", and 15.6% thought it was "very safe". 8.4% answered it was "unsafe" and for a 3.2% it was "very unsafe".

"After voting, I felt sure that my vote was correctly registered"

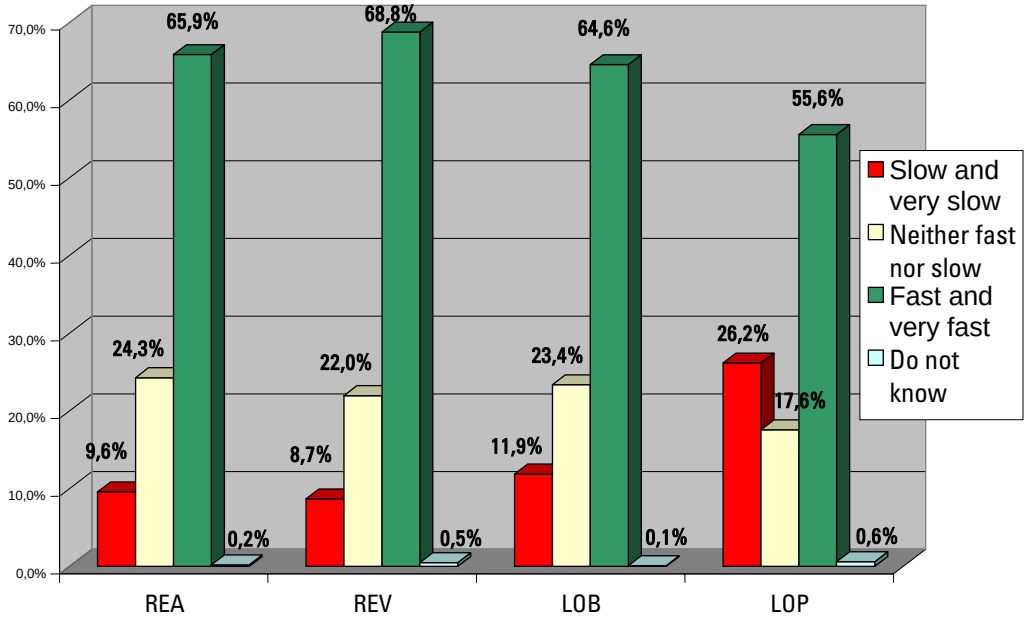
I´m sure I did not	2,4%
I think I did not	4,0%
I think I did	34,4%
I´m sure I did	58,4%
I do not know	0,8%
Total	100%

- Survey data discriminated by prototypes shows that the **objective measure of confidence** does not vary by prototype machine. In contrast, the **confidence on the safe and the correct registry of votes** (subjective aspect of confidence) was higher for voters using prototypes 1, 2, and 3. On average, 93.4% of the surveyed electors answered that they "thought to be" or they "were sure to be" confident on the correct registry of their vote. In the case of the voters that used prototype 4, the percentage decreases to 84.5%.
- The level of confidence on the electronic voting system is **higher for adult voters than for young voters**. In 9.44% of cases, voters over 50 years old believe that the registry of their vote is "unsafe" or "very unsafe", while 77.28% think it is "safe" or "very safe". Voters between 30 and 49 years old answered in 72.05% of the cases that it is "safe" or "very safe". On the contrary, voters below 30 years old answered they found the vote

registry to be "unsafe" or "very unsafe" in 14.02% of the cases, and "safe" or "very safe" in 62.24% of the cases.

- When discriminating data about confidence on the electronic voting system by **sex**, we found no significant differences in the answers given by the surveyed electors.
- Electors with lower **level of education** have the highest levels of confidence on the way they their votes were registered (81.5%). Voters belonging to group 4 (highest level of education), answered they had confidence on it in 69.9% of the cases. Groups 2 and 3 shows average levels of confidence (74.8% and 72.2% respectively). Confidence on the safe and correct registry of votes has no apparent significant relationship with the level of education of voters. Groups 2 and 3 reached the higher levels of confidence (94.6% and 93.8% respectively) than voters belonging to groups with the highest and the lowest level of education.
- A majority of the surveyed voters think that **the voting process was fast enough** (50.63%). When analysing this data by voting machine, we observe that the lowest percentage of electors who considered the voting process to be fast enough (41.6%) corresponds to those who tested prototype 4 (LOP), while the highest percentage (53%) corresponds to electors that tested prototype 2 (REV).

"In your opinion, the electronic voting system was…"(by prototype)



- The functioning of voting machines was considered "slow" by a 10% of voters. Opinions about prototype 4 differ from the rest as 18.42% of the surveyed voters using this prototype considered it "slow." **The fastest prototype, according to voters´ opinion, was prototype 2** with 68.9% of the responses, followed by prototype 1 with 65.9%, and prototype 3 with 64.6%.
- There are no significant differences in opinions about how fast voting machines registered their votes among electors belonging to the different **age and sex** groups.
- The **level of education** of electors has no apparent impact on their perception about machines´ speed to register votes. Group 4 (highest level of education) has the highest percentage of people who considered that the voting process was "slow" or "very slow" (13.3%). On the contrary, group 1 has the highest percentage of people who considered the voting process to be "fast" or "very fast" (72.3%).
- The qualitative evaluation of the Pilot (consisting of an ethnographic observation conducted in the 43 polling stations) shows that there is a direct relationship between the feeling of privacy and intimacy the elector experiments when casting his vote inside the polling booth and the secrecy of that vote. From this we can conclude that the **design and layout of the polling booth** plays an important role in the confidence the elector has on the voting system.

- Electors are inclined to think about **machines as innocuous objects** that can be manipulated by men. Thus, as transparency relies more on this aspect than in technology, its utilization is welcomed.
- The **analogies** made by electors in order to understand new machines in relation to others that they already know are diverse: money expending machines, personal computers, etc. However, in practice, the way in which these analogies are useful to understand the functioning of voting machines is limited. This indicates that a definitive implementation of an electronic voting system must include a progressive (re)socialization of electors in the use of new technologies.
- The ethnographic observation of electors´ behavior also confirms that in spite of some technical faults found in voting machines, **positive expressions towards the use of an electronic voting system prevailed**. In this sense, voters that participated in the E-Voting Pilot expressed their satisfaction with electronic voting and claimed that this voting system was much easier to use than they had imagined. **Prototypes 1 (REA) and 2 (REV)** were the most accepted machines among electors.

6. Voters' evaluation of the functioning of each specific voting machine

Prototype # 1 (REA)

- 50 percent of REA voters felt it **was easy to find their preferred candidates on the screen.** 31 percent said it was both easy and handy. Only 12 percent of the voters that tested this prototype disagreed with the statement "Searching for the candidate list on a screen is both easy and practical", while 7 percent emphatically agreed on it.
- When asked about their opinion about the use of the **magnetic card** as a means for registering and recording their choice, 76 percent of REA´s voters expressed they were sure about not having found problems in extracting the card from the machine. An 89 percent of the respondents perceived the card as an adequate means for voting.
- We can conclude that the evaluation made by voters about the different **devices** that make up the REA prototype (magnetic card, keyboard, and screen) is generally positive.
- Voters with higher **levels of education** were more skeptical in relation to the usability of the screen in REA. While 5.1 percent of the group with educational level 1 (complete primary education) thought that finding candidates on the screen was not easy or handy. The share of this answer increases to a 26 percent when comparing it to those

answering in the same way within the group of the highest level of education (university graduates).

- Difficulties found by voters when **extracting the magnetic card** from the machine were different according to the level of education. 18, 6 percent of voters with a low educational level claimed that they had problems of this sort. This number decreases to 8.4 percent within the group with the highest level of education.

Prototype # 2 (REV)

- 50 percent of REV voters said that **finding their preferred candidates on the screen was both easy and handy**.
- 27 percent of REV voters believe that the **touch-screen** is an easy mechanism for finding and choosing candidates. 67 percent of them claimed to be *sure* about it.
- 69 per cent of the voters claimed *to be sure* that the printer device functioned agilely and without any difficulties. 23 percent *believed* it worked that way. On the contrary, 5 percent *believed* it wasn't agile and 3% *was very certain* about such statement. When asked if the voter-verified audit trail was perceived as a guarantee for the correct registering of the vote, 58% *was sure* it was that way and 31% *believed* so.
- When discriminating answers according to **age**, we found no significant difference.

Prototype # 3 (LOB)

- **Voters' opinions about prototype LOB are highly positive**, both from the standpoint of hardware devices (scanning the ballots and using the keyboard) and software (interaction with the screen). Introducing the ballot in the optical scanning device was considered *very easy* by the 20 percent of voters; whereas 65 percent thought it was *easy*. At the same time, 93 percent did not find any difficulties in introducing the ballots.
- **Confirming the selection** using the keyboard was found *useful* by 78 percent of voters. 19% *believed* it was this way, though having some doubts about it. 82 percent of respondents claimed that they were able to **verify** that the ballot on the screen corresponded to the one introduced into the scanner. Only 3 percent said the opposite. Discriminating data by age or level of education does not reveal any significant difference.

Prototype #4 (LOP)

- 49% of the respondents answered that they *were certain* about **having found their list of preference easily**, and 18% *believe* it was easy. For 56% of the voters, lists were found more easily in the selection ballots than in the booklet.
- 5 out of 10 of respondents *were sure* about the fact that the **selection ballot** is a handy mean for voting, 18% *believes* so, while 15% *thinks* it is not handy and 12% *was sure* about the fact that it is not handy at all.
- The **introduction of the selection ballot in the optical scanning device** was found easy by 38% of the voters. However, 35% was sure about the fact that it was a difficult task.

Prototypes REA, REV, LOB, and LOP

- The information coming from **machines´ logs** allows us to analyze the impact that the **screen's design** (in the case of REA and REV) had on electoral behavior. Prototype REA had all the lists available for National Deputies in two consecutive screens. Approximately 30% of voters consulted only the first one. For Local Legislators, options were distributed across 3 consecutive screens. The percentage of REA electors that visualized only one screen of Local Legislators is higher than in the former electoral choice (39.2%). When selecting local legislators, 24.3% of the voters visualized 3 screens and the residual 18% visualized 4 screens or more. This means that they visualized the three screens and then moved back to the previous one or forward to the first screen.
- The REV prototype had its candidates´ lists for National Deputies distributed across 3 **screens**, while the lists for Local Legislators were distributed across 4 screens. In the first electoral category, 32.2% of voters visualized only one screen; 26.8 percent went through 2 screens, and 17.1% went through 3 screens. In the Local Legislators selection, 29.9% of electors visualized only one screen; 20.3% visualized 2 screens; 18.8% 3 screens, and 9.6% 4 screens.
- Another important conclusion that can be drawn from the logs of the voting machines is that **voters did not look at the candidates presented by each party** before deciding their vote: 9 out of 10 voters did not visualize other lists apart from the one they finally voted for (in both categories and prototypes).
- Regarding the statistics about the **length of the electronic voting process**, the analysis shows that in the moments with the highest voter affluence, the average voting time decreases. Furthermore, we can conclude that the variables that exert a positive

influence on the total duration of the voting process are: the number of total vote cancels; the number of screens available, and the candidates´ lists which are visualized by each elector. As these three factors increase, so does the length of the voting process.

- Excluding LOP from the analysis, according to a comparison between median voting times, the prototype with the **minimum voting time** is REV (87 seconds), followed by REA (90 seconds), rendering LOB with the maximum voting time (112 seconds).
- As the voter's **educational level** increases, voting time decreases. On the other hand, data dispersion for lower educational levels is higher.
- Data also shows that the option of **canceling the vote** once the voter has selected all the electoral choices has been scarcely used. Partial cancels (for National Deputies only or for local legislators only), in contrast, reached much higher levels, especially in the case of LOB.

7. Evaluation of the technical performance of the electronic voting prototypes

Prototype #1 (REA)

- This prototype had a **correct performance**, given that the 43 machines did function during the election. Total registered votes in this prototype were 3,910, representing an average of 91 votes per machine.
- The main failure of this prototype was the product of an **error in the application** and/or the communication established between the application and the magnetic card reader-writer. This mistake was responsible for the iterated blocking of that device, resulting in the restart of the equipment each time it happened. Once the equipment was restarted, the correct functioning of the device was reestablished.

Prototype # 2 (REV)

- We can conclude that REV was the **most efficient and stable prototype**. 4,537 votes were registered in the 43 machines available, resulting in an average of 106 votes per unit.
- The main problem found in this prototype was the **existence of invalid magnetic cards**. Lab analysis conducted after the Pilot led us to discard the hypothesis of an existing problem with the devise itself. On the contrary, it demonstrated that it was the result of some errors in magnetic cards, due to physical deficiencies (scratches, problems with

the magnetic stripe) or due to deficiencies with the quality of the recording of entry codes developed during the pre-vote phase. This problem was not that significant because it was finally solved with the replacement of the defective magnetic card.

Prototype # 3 (LOB)

- Of the 43 machines available for the Pilot, only 41 could be used because 2 of them had serious flaws and had to be left aside. In spite of that initial decrease in the number of machines, LOB registered **3,709 votes**, with an average of 90 votes per unit.
- The maximum number of errors that occurred in LOB were generated by the **scanner** and the **ballot displacement device**. Both devices were specifically designed for the E-Voting Pilot thus, their manufacturing and integration were handmade.
- The low quality of **ballots** (paper, ink and size) conditioned the stable behavior of this prototype. This means that the provision of high quality printed materials might represent a solution.

Prototype # 4 (LOP)

- LOP was the most **unstable** prototype. Out of the 21 machines distributed in the different voting places, 6 had serious flaws that couldn't be fixed, and hence, stopped functioning.
- The most frequent problem associated with the 15 working machines had to do with the **introduction of the selected ballots into the scanner**.
- The total number of **votes** registered in this prototype was 957. Since the number of votes per machine heavily fluctuated, it is hard to estimate a vote average per unit.
- One of the reasons that explain why this prototype was more unstable than the rest is that it had many aspects to calibrate. These calibrations have to do with the configuration and design of the ballot; with adjusts in the application's communication with the driver developed for the device; with the adjustment of the scanner's sensors, and with the quality and density of the paper used for the ballots.

- Taking all these aspects into account, one of the failures found in all prototypes was that the **USB front ports** were not of a good quality. The pressure exerted when connecting/disconnecting something to the USB front port frequently caused its breaking down.
- Another problem found in all prototypes was the over-heating of the machines´ cabinets: this deficiency may have aggravated other problems found in each prototype. Lab tests

conducted later demonstrated that a refrigeration system can improve the machine's performance.