

Ballot-Marking Errors in the First San Francisco Instant Runoff Election

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In March of 2002, San Francisco voters adopted Instant Runoff Voting (IRV) for their municipal elections by approving a ballot measure by a margin of 55% to 45%. After a series of logistical and political obstacles, IRV debuted in San Franciscan voting booths in November of 2004. This paper reviews the history of the San Francisco's first IRV election and analyzes the kind and frequency of ballot marking errors committed by its voters. Section 1 offers some background information on the IRV proposal and its implementation. Section 2 offers an analysis of the ballot-marking errors that were found and hypothesizes reasons for their occurrence. Lastly, Section 3 proposes some recommendations for improving San Francisco IRV election in the future.

1. Background

Prior to 2004, San Franciscans rarely elected all their local officials in one trip to the voting booth. Unlike most jurisdictions in the United States, the city and county of San Francisco require their officials to win with a majority of the vote, not a plurality; and with many offices facing three or more candidates, it was common for no candidate to exceed 50% in the general election. As a result, five weeks after each general election, San Francisco regularly holds a separate runoff election between the two candidates who received the most votes in the general election.

The runoff elections in San Francisco were plagued by high costs and lower turnouts. Of the 11 municipal elections between 1975 and 2003, only 1 did not need a subsequent runoff election¹. And of those remaining 10 runoff elections, 7 saw declines in turnout compared to the general election². Holding a separate December runoff also proved to be an expensive endeavor. The 2001 runoff election, for example, cost the city approximately \$29 per vote cast, for a total of about \$2 million³.

1.1 Legislation

On March 5, 2002, San Francisco voters eliminated the need for their runoff elections by approving Proposition A by a margin of 55.48% to 44.52%. The proposition amended the city and county charter to “provide for the election of the Mayor, Sheriff, District Attorney, City Attorney, Treasurer, Assessor-Recorder, Public Defender, and members of the Board of Supervisors using a ranked-choice, or ‘instant run-off,’ ballot”⁴. Instant runoff voting guarantees the winner receives a majority of support in a single election; the measure, therefore, streamlined the city’s costly two-stage runoff process with a single, cheaper, “instant-runoff” election.

Instant runoff voting, or IRV, works as follows. Each voter ranks the candidates on the ballot in order of preference, indicating his or her first choice, second choice, and so on. (For reasons explained below, San Francisco voters are restricted to ranking their first three choices). All the first choice votes are tallied. If any candidate receives a majority of the first choice votes, that candidate wins. If no candidate has a majority, the candidate with the fewest first-choice votes is eliminated and an “instant runoff” is held between the remaining candidates. Voters who ranked the losing candidate as their first choice will have their votes counted towards their second choice. This process of instant runoffs continues until a candidate has a majority of votes

and wins the election. Since the runoff process can be time-consuming, the San Francisco Department of Elections officially renamed the procedure “ranked choice voting,” so as not to raise expectations that the results would be made available “instantly.”

1.2 Implementation

Although the proposition passed, the path to implementation was not smooth. As an amendment to the city and county’s charter, Proposition A made San Francisco legally bound to implementing IRV in the next local election, which was scheduled for November 2003.

However, as that day edged closer, the city’s Department of Elections announced it was not ready to roll out the new system. IRV activists were outraged, and a legal battle ensued.

Although a judge chided the Department of Elections for incompetence, he ultimately sided with the city and IRV was postponed a year until November 2004⁵.

As the 2004 election drew closer, IRV’s future in San Francisco was still uncertain.

Comments from the chief of the city’s Elections Department, the president of the city’s Elections Commission, and the Mayor of San Francisco, all indicated that IRV might be delayed yet again.

The problem was that the city’s voting machine vendor, Election Systems and Software, had trouble securing federal certification for their source code and meeting certain conditions set by the judge⁶. Despite the difficulties, the federal certification was eventually granted, and the Secretary of State’s Voting Systems Panel gave the green light to IRV in time for the November races.

One of the concerns with implementing the new voting system was that the costs and logistics of procuring and training poll workers to operate new voting machines would prove too burdensome. To address this concern, the charter amendment triggered by the proposition specifically allowed the city to provide for ranking only three choices, if that is all their existing machines permitted.⁷ This allowed the Department of Elections to implement IRV with a small upgrade to their pre-existing Optech Eagles III-P precinct scanners and Optech IV-C central scanner without purchasing or training poll workers on entirely new equipment. The upgrade was provided by ES&S.

The San Francisco IRV ballot for a single office is laid out in three columns, each of which lists all the candidates for that post, to accommodate each voter's first, second, and third choices. A sample of the ballot used in the District 5 Board of Supervisor’s race, in which a crowded pool of 22 candidates competed, is found in Figure 1. The actual ballots had extra color tinting to distinguish the first, second, and third choices.

With the new ballots printed and the machines upgraded, instant runoff voting premiered in San Francisco on November 2, 2004. Seven of the city’s eleven districts used the voting method that day to elect their representatives on the Board of Supervisors, San Francisco’s equivalent of a city council. When the Department of Elections tallied the first-choice votes that evening, in three of the seven races a candidate received an outright majority of the first-choice votes and was declared the winner that night. However, when the Department of Elections returned the next day to perform the instant runoffs for the remaining four races, a computer glitch caused the vote tallying software to fail. The problem was blamed on higher-than-expected voter turnout. Three days later the problem was fixed, the instant runoffs were performed, and the remaining winners were declared without a subsequent glitch.

OFFICIAL BALLOT / BALOTA OFICIAL / 正式選票
CONSOLIDATED GENERAL ELECTION / ELECCIONES GENERALES CONSOLIDADAS / 聯合普選
CITY AND COUNTY OF SAN FRANCISCO / CIUDAD Y CONDADO DE SAN FRANCISCO / 三藩市市縣
NOVEMBER 2, 2004 / 2 DE NOVIEMBRE DE 2004 / 2004年11月2日

SUPERVISORIAL DISTRICT 5

INSTRUCTIONS TO VOTERS: Mark your first choice in the first column by completing the arrow pointing to your choice, as shown in the picture. To indicate a second choice, select a different candidate in the second column. To indicate a third choice, select a different candidate in the third column. To vote for a qualified write-in candidate, write the person's name on the blank line provided and complete the arrow.

INSTRUCCIONES PARA LOS ELECTORES: Para marcar su primera opción en la primera columna, complete la flecha que apunta hacia su selección, tal como se indica en la imagen. Para indicar una segunda opción, seleccione un candidato distinto en la segunda columna. Para indicar una tercera opción, seleccione un candidato distinto en la tercera columna. Para votar por un candidato calificado no listado, escriba el nombre de la persona en el espacio en blanco provisto, y complete la flecha.

選民指南: 在第一列中標記你的第一個選擇，將指向你的選擇的箭頭畫線連接起來，如圖所示。標記第二個選擇時，在第二列中選擇一位不同的候選人。標記第三個選擇時，在第三列中選擇一位不同的候選人。投票合格寫入候選人時，在提供的空位上填寫此人的姓名，並將箭頭畫線連接起來。

MEMBER, BOARD OF SUPERVISORS / MIEMBRO, CONSEJO DE SUPERVISORES / 市參議員		
DISTRICT 5 - DISTRITO 5 - 第 5 選區		
VOTE YOUR FIRST, SECOND AND THIRD CHOICES / VOTE POR SU PRIMERA, SEGUNDA Y TERCERA SELECCIÓN / 投票你的第一、第二和第三選擇		
FIRST CHOICE PRIMERA SELECCIÓN 第一選擇	SECOND CHOICE SEGUNDA SELECCIÓN 第二選擇	THIRD CHOICE TERCERA SELECCIÓN 第三選擇

Vote for One Vote por Uno 請選一名	Vote for One - Must be different than your first choice Vote por Uno - Debers ser diferente de su primera selección 請選一名 / 必須與第一個選擇不同	Vote for One - Must be different than your first and second choices Vote por Uno - Debers ser diferente de su primera y segunda selección 請選一名 / 必須與第一個選擇和第一個選擇不同
ROSS MIRKARIMI 羅斯·莫卡里密 District Attorney Investigator 地方檢察官辦公室調查員	ROSS MIRKARIMI 羅斯·莫卡里密 District Attorney Investigator 地方檢察官辦公室調查員	ROSS MIRKARIMI 羅斯·莫卡里密 District Attorney Investigator 地方檢察官辦公室調查員
MICHAEL E. O'CONNOR 麥克·奧康諾 Small Business Owner 小企業業主	MICHAEL E. O'CONNOR 麥克·奧康諾 Small Business Owner 小企業業主	MICHAEL E. O'CONNOR 麥克·奧康諾 Small Business Owner 小企業業主
PHILLIP HOUSE 菲利浦·豪斯	PHILLIP HOUSE 菲利浦·豪斯	PHILLIP HOUSE 菲利浦·豪斯
ROBERT HAALAND 羅拔·瓦蘭德 Labor Housing Organizer 勞工房屋組織者	ROBERT HAALAND 羅拔·瓦蘭德 Labor Housing Organizer 勞工房屋組織者	ROBERT HAALAND 羅拔·瓦蘭德 Labor Housing Organizer 勞工房屋組織者
EMMETT GILMAN 埃美特·吉爾曼 Attorney 律師	EMMETT GILMAN 埃美特·吉爾曼 Attorney 律師	EMMETT GILMAN 埃美特·吉爾曼 Attorney 律師
JULIAN DAVIS 朱利安·戴維斯 Doctor 醫生	JULIAN DAVIS 朱利安·戴維斯 Doctor 醫生	JULIAN DAVIS 朱利安·戴維斯 Doctor 醫生
LISA FELDSTEIN 麗莎·費爾德斯坦 Community Housing Executive 社區住房組織主任	LISA FELDSTEIN 麗莎·費爾德斯坦 Community Housing Executive 社區住房組織主任	LISA FELDSTEIN 麗莎·費爾德斯坦 Community Housing Executive 社區住房組織主任
SUSAN C. KING 蘇珊·C·金 Non-Profit Fundraising Director 非牟利籌款主任	SUSAN C. KING 蘇珊·C·金 Non-Profit Fundraising Director 非牟利籌款主任	SUSAN C. KING 蘇珊·C·金 Non-Profit Fundraising Director 非牟利籌款主任
DAN KALB 丹·卡爾布 Director of Normative Policy 政策規範總監	DAN KALB 丹·卡爾布 Director of Normative Policy 政策規範總監	DAN KALB 丹·卡爾布 Director of Normative Policy 政策規範總監
TYS SNIFFEN 泰斯·斯尼芬 Small Business Owner 小企業業主	TYS SNIFFEN 泰斯·斯尼芬 Small Business Owner 小企業業主	TYS SNIFFEN 泰斯·斯尼芬 Small Business Owner 小企業業主
FRANCIS SOMSEL 法蘭西斯·桑姆塞爾 Business Development Consultant 商業發展顧問	FRANCIS SOMSEL 法蘭西斯·桑姆塞爾 Business Development Consultant 商業發展顧問	FRANCIS SOMSEL 法蘭西斯·桑姆塞爾 Business Development Consultant 商業發展顧問
JIM SIEGEL 吉姆·西格爾 Small Business Owner 小企業業主	JIM SIEGEL 吉姆·西格爾 Small Business Owner 小企業業主	JIM SIEGEL 吉姆·西格爾 Small Business Owner 小企業業主
PHOENIX STREETS 菲尼克斯·斯特里茨 Deputy Public Defender 助理公共辯護律師	PHOENIX STREETS 菲尼克斯·斯特里茨 Deputy Public Defender 助理公共辯護律師	PHOENIX STREETS 菲尼克斯·斯特里茨 Deputy Public Defender 助理公共辯護律師
ANDREW SULLIVAN 安德魯·沙利文 Internal Service Executive 內部服務總監	ANDREW SULLIVAN 安德魯·沙利文 Internal Service Executive 內部服務總監	ANDREW SULLIVAN 安德魯·沙利文 Internal Service Executive 內部服務總監
PATRICK M. CIOCCA 帕特里克·M·奇歐卡 Attorney 律師	PATRICK M. CIOCCA 帕特里克·M·奇歐卡 Attorney 律師	PATRICK M. CIOCCA 帕特里克·M·奇歐卡 Attorney 律師
BRETT WHEELER 布勒特·維勒 Professor 教授	BRETT WHEELER 布勒特·維勒 Professor 教授	BRETT WHEELER 布勒特·維勒 Professor 教授
VIVIAN WILDER 維維安·維爾德 Consumer Advisor 消費者權益顧問	VIVIAN WILDER 維維安·維爾德 Consumer Advisor 消費者權益顧問	VIVIAN WILDER 維維安·維爾德 Consumer Advisor 消費者權益顧問
NICK WAUGH 尼克·沃克 Labor Rights Advisor 勞工權利顧問	NICK WAUGH 尼克·沃克 Labor Rights Advisor 勞工權利顧問	NICK WAUGH 尼克·沃克 Labor Rights Advisor 勞工權利顧問
ROB ANDERSON 羅拔·安德森 Districer 區議員	ROB ANDERSON 羅拔·安德森 Districer 區議員	ROB ANDERSON 羅拔·安德森 Districer 區議員
H. BROWN H·布朗	H. BROWN H·布朗	H. BROWN H·布朗
JOSEPH BLUE 約瑟夫·布魯 Loan Consultant 貸款顧問	JOSEPH BLUE 約瑟夫·布魯 Loan Consultant 貸款顧問	JOSEPH BLUE 約瑟夫·布魯 Loan Consultant 貸款顧問
BILL BARNES 比爾·巴爾內斯 District Supervisor's Representative 市參議員議員代表	BILL BARNES 比爾·巴爾內斯 District Supervisor's Representative 市參議員議員代表	BILL BARNES 比爾·巴爾內斯 District Supervisor's Representative 市參議員議員代表
WRITE-IN / ESCRIBEN / 寫入	WRITE-IN / ESCRIBEN / 寫入	WRITE-IN / ESCRIBEN / 寫入

38-R4-D5-1

RCV
Dist. 5
Front

Figure 1. Sample IRV Ballot for District 5 Supervisor Race

2. Ballot-Marking Errors

According to the San Francisco Poll Worker Manual, the upgraded Optech Eagles were programmed to reject, or “spit back,” a ballot under four distinct conditions⁸. If the voter voted for two candidates in the same column, commonly known as an *overvote*, the Eagle would reject the ballot and generate the error message “Over-voted Ballot.” If the voter did not vote in exactly one or two columns, also known as an *undervote*, the machine would print the message “Unvoted Choice.” When a voter left a ballot entirely blank—committed an undervote in all three columns—the message would be “Un-voted Blank Ballot”. Lastly, the voter would receive the message “Candidate in more than one choice” if he or she had voted for the same candidate in multiple columns, an act which we’ll refer to as a *redundant vote*.

Note that the term “undervote” in the context of an IRV ballot conflates two different types of blank columns. Because the rules in San Francisco do not *require* a voter to rank their second and third choices, a ballot containing only a first choice or only a first and second choice is a normal, expected, routine occurrence. In contrast, a ballot on which an undervote *precedes* a valid vote is more likely to be a mistake. This second, more erroneous class of undervotes will be referred to as *skipped votes*.

If we consider that each column of the ballot could contain one of three types of votes—a valid vote for a single candidate, an overvote, or an undervote—then there are 27 different valid/overvote/undervote combinations we could expect to see on ballots from this election. The tables in the Appendix show the frequency of each of these combinations in the San Francisco election. The data was extracted from a ballot image listing currently posted on the San Francisco Department of Elections website⁹. To illustrate how one should read a ballot combination in the Appendix tables, the “VUO” ballots are those which contain a valid vote in the first column, a blank second column, and an overvote in the third column. Table SF contains that data for all of San Francisco and Tables D1, D2, D3, D5, D7, D9, and D11 show that data for the similarly numbered supervisor districts.

The tables also refer to percentages of *correct* and *incorrect* ballots. A ballot is deemed “correct” if it does not contain overvotes or skipped votes; otherwise it is “incorrect.” Thus, there are only four types of correct ballots: VVV, VVU, VUU, and UUU. The number of candidates and the winner’s percentage of first choices in the district tables are listed to give some idea of the competitiveness of each contest. The average number of valid votes per ballot offers an indication of how often voters chose to rank beyond their first choice, and therefore, some indication of how well they understood the system generally. The demographic data was gathered from the 2000 Census and will be discussed in Section 2.4.¹⁰

To offer one point of reference before delving into the numbers in more detail, consider that the State of California found the residual vote rate in San Francisco County in the 2000 presidential election, when the same optical scan machines were in use, to be 1.3%.¹¹ Finally, note that the vote tallies provided in the Appendix are still considered “preliminary” by the Department of Elections. The department is still processing absentee and provisional ballots and the ballot image listing is being update almost daily. Nevertheless, the final results are unlikely to differ much from those that are presented in this paper.

2.1 Redundant Votes

Marking the same candidate in multiple columns was an error that many observers expected voters to make. At voter-education sessions run by the Elections Department, a frequent question was whether it would help a candidate to vote for them more than once.¹² To address this potential problem, the machines were programmed with the “Candidate in more than one choice” message previously described, and the ballots themselves instructed voters to choose a different candidate in each column.¹³ The scenario was also addressed in the “Frequently Asked Questions” and the “Ranked Choice Voting: A Guide for Candidates” published by the Department of Elections.¹⁴

As anticipated, on the day after the election there were some reports from poll workers of voters making this very mistake.¹⁵ However, an inspection of the ballot image listing provided by the Department of Elections surprisingly shows no such redundant votes—absolutely zero. As confirmed by the department, the reason no candidate appeared in more than one column on the listing is that the machines were deliberately programmed to record them as undervotes. So, for example, a ballot that had three valid votes for the same candidate was written to the listing as VUU; and a ballot which had the same candidate marked in the first two columns and a different candidate in the third column is listed as VUV. This practice does not affect the final tally—redundant votes are supposed to be passed over just like undervotes—however, it is a poor design decision for reasons laid out in Section 3.

2.2 Overvotes

With all the discussion of how the new voting would allow you to vote for multiple candidates, and with ballot instructions asking voters to mark their top three choices, one would expect a relatively high rate of voters mistakenly voting for their multiple choices in a single column, and therefore a higher rate of overvoting. Indeed, as shown in Table SF in the Appendix, 0.85% of the ballots in the election contained an overvote. This is quite high for the Optech Eagle III-P precinct-based optical scan machines. In the 2002 gubernatorial election in Florida, the state’s Division of Elections found these same machines to allow for only a .05% rate of overvoting¹⁶. The comparison isn’t perfect, however. Unlike the gubernatorial contest, which was the first race on the ballot, the Board of Supervisors election was found at the end of a long series of races and propositions, when voters were arguably more fatigued and paying less attention.

Closer inspection of the data in Table SF seems to reveal something curious: overvotes are only followed by undervotes, never valid votes or other overvotes. Again, like the handling of redundant votes, this turns out to be a deliberate feature. The Optech Eagles were intentionally programmed to record every ranking following an overvote as an undervote, regardless of the actual markings on the ballot. This is consistent with the IRV charter amendment, which states that, upon reaching an overvoted column, the ballot is deemed “exhausted” and no more ranking on that ballot should be considered. So, for example, a ballot that is actually OVV will be written to the listing as OUU.

Like the machines’ treatment of redundant votes, its failure to record valid votes and overvotes after an initial overvote is disconcerting. The determination of which votes to ignore is a decision that should only be made by the tallying software, not the optical scan machine itself. The machine should be confined to producing an accurate textual transcription of the physical ballots, be those ballots valid or invalid. This point is elaborated on in the recommendations found in Section 3.

A comparison of the overvote rates across districts shows a somewhat significant variation. The rate reaches a low of .41% in District 3 and a high of 1.33% in District 5. This variation seems to be somewhat correlated with the number of candidates on the ballot in each district. This connection, if valid, would make sense: the greater the number of candidates on the

ballot, the more likely a voter will want to rank multiple candidates, and therefore, the more likely they will mistakenly rank those multiple candidates in a single column.

2.3 Undervotes

Far more common than overvotes were undervotes. In fact, nearly a third of all ballots cast in the election contained at least one blank column. However, the use of the term “undervote” in this context is unconventional and slightly deceptive. Unlike its implication in plurality races, an undervote on the ranked-choice ballot does not mean that the voter abstained from or even overlooked the race. As discussed in Section 2, in IRV a voter can just rank a first choice, or just a first and second choice, and leave the remaining columns blank while still having their say in the contest. Thus, a high undervote rate in this election is anticipated.

One of the more common types of ballot combinations with undervotes was the entirely blank ballot. A total of 17028, or 7.85% of all ballots cast in the election were entirely blank. While this would be a very high rate of non-participation in a statewide race, for a municipal race located at the end of a ballot, and for one which coincided with a presidential election, it was not unexpectedly high.

A comparison of the blank ballot rate in this IRV Supervisor election with the plurality Supervisor election in 2000, which also coincided with a presidential election, will be instructive. As shown in the Appendix, the residual vote rate for the Board of Supervisors races in 2000 was 16.81% for the entire city, ranging from 10.74% in District 7 to 29.15% in District 2. Making the conservative assumption that the Optech Eagles, which were also in use in 2000, allowed no more than a 1% overvote rate, then the bulk of those residual votes can be chalked up to undervotes. In other words, the data suggest that roll-off in the Board of Supervisor races declined significantly from 2000 to 2004.

The decline in roll-off is even more impressive given the high turnout for the presidential race. The higher the turnout for a presidential election, the greater the likelihood that voters care only about voting for president, and therefore the more likely they are to abstain from local contests. Yet, in spite of the high turnout for the close presidential race in 2004—the highest turnout since 1968—voters were apparently much less likely to abstain from the IRV municipal election compared to the plurality election in 2000.¹⁷ Nevertheless, one might still expect that the Supervisor districts with the greatest presidential turnout had the highest rate of blank ballots. Unfortunately, that hypothesis will have to remain untested until that data is released by the Department of Elections in the coming weeks.

Turning our attention to skipped votes, we can see from the Appendix that they occurred at a rate of 1.08% across the entire city. They ranged from a low of .81% in District 5 to a high of 1.6% in District 11. One thing to keep in mind is that a higher rate of skips may actually be the result of more redundant voting that’s being recorded as undervotes on the ballot image listing. There may be demographic explanations for the variation in skipped votes that will be discussed in the Section 2.4.

2.4 Demographic Trends

One of the concerns voiced by critics of instant-runoff voting was that the added complexity of the ranked-choice ballot would reduce turnout and confuse voters, particularly first-time voters and those who spoke limited English.¹⁸ To address potential voter confusion, the Department of Elections spent \$776,000 on voter education efforts to introduce IRV to San Franciscans. These efforts included a citywide mailing of educational brochures in three languages, an interactive Web site where visitors could practice ranked-choice voting, and an advertising campaign on the back of city buses.¹⁹ The department also organized a team of community groups to host demonstrations and tutorials of the new voting system to San Francisco residents, particularly those in low-income and minority areas.²⁰

To analyze how low-income and language minorities fared, the demographic data found in the Appendix will be useful. Looking at Asian-Americans, there is no strong evidence that they committed more voting errors than others. On the contrary, of the three districts where Asians make up more than 40% of the population—districts 1, 3, and 11—two have a rate of correct ballot rates that is above the citywide rate. As for their understanding of IRV, two of those three districts (not the same two) have an average number of valid votes per ballot that exceeds the city’s average. Furthermore, voters who marked the leading Asian candidates in those districts—Lillian Sing in District 1, Eugene Wong in District 3, and Myrna Lim in District 11—as their first choice all have an above-average number of average votes per ballot.

Although Asian-Americans appear to have fared well, Hispanics may have faced greater difficulty. The two districts with the largest Hispanic populations—Districts 9 and 11—have the two highest rates of incorrect ballot in the city. These two districts also have the two lowest per capita incomes amongst the districts studied. The data show that the high incorrect ballot rate in these districts is driven mostly by a high frequency of skipped votes. (Though, as mentioned before, the high percentage of skipped votes may actually reflect a high rate of redundant voting.) Despite these relatively high error rates in Districts 9 and 11, the IRV ballot does not appear to have dissuaded voters from participating; both districts had below average rates of blank ballots.

To gauge how San Francisco voters felt about the new voting system, and to see how those feelings broke across racial and ethnic lines, the Chinese American Voter Education Committee (CAVEC), commissioned an exit poll. According to the poll, 69% of voters liked the new voting system, including 82% of Latinos and 72% of Asians. When asked if they found it easy to use, 74% of Latinos found it easy to use, compared to 14% who found it difficult. Among Asians, the split was 59% to 27%.

The results of the poll are curious, because they’re completely at variance with what the data suggest: that Hispanics experienced more problems correctly completing their ballot than Asians. In fact Asians, by all indications, were less likely than the average voter to make mistakes and more likely to use all their rankings. Perhaps the explanation is that certain community groups, such as CAVEC, succeeded in heightening awareness about the new voting system amongst the Asian community. It could be argued that this increased anxiety about the system, which was reflected in the poll, made Asian voters more likely to educate themselves about the process in advance and kept them “on their toes” while in the voting booth.

2.5 Poll Worker Responses to Errors

The day after the election, newspaper reports documented some irregularities in how undervotes were addressed by poll workers. In particular, some voters who only marked their first choice or their first two choices were wrongly instructed by poll workers that they must vote for three.²¹ Other poll workers put ballots with less than three votes in a special bin with the provisional ballots instead of pressing the override button. Apparently, these workers mistakenly thought that the “Unvoted Choice” message from the Eagle meant the ballot would be completely invalid if submitted in that condition.

Perhaps one of the reasons for this misunderstanding lies in the San Francisco Poll Worker Manual. According to the manual, if the Eagle generates any of the four error messages, including the “Unvoted Choice” message, the poll worker must do the following (the bold-face emphasis appears in the manual):

1. Read the message on the Eagle tape to the voter (or let the voter read the message).
2. Ask the voter if this is what he or she had intended.
 - ✓ If YES: Once you are sure the voter understands that **the Eagle will accept the ballot as a vote for no candidate**, press the #3 key.
 - ✓ If NO: Send the voter to the ballot-issuing clerk to have the ballot card spoiled and a replacement card issued.²²

These instructions, the words in bold in particular, are incorrect. In reality, neither the “Unvoted Choice” message, nor the “Candidate in more than once choice” message, nor even the “Over-voted Ballot” message necessarily mean that the ballot will be counted “for *no* candidate.” These instructions could be partially to blame for the poll worker confusion.

3. Recommendations

It is understood that this was the first time IRV was used in San Francisco and mistakes were bound to be made. Nevertheless, the above analysis suggests some ways in which San Francisco can improve its IRV elections for the future.

3.1 Enhanced Poll Worker Training

Clearly, the passage detailing how the poll worker should respond to error messages should be replaced with more accurate language. Moreover, the scenario of a voter voting for less than three candidates was an anticipated one that should have been covered explicitly in poll worker training sessions. If it was not, it should be in the future.

3.2 Continued Voter Outreach and Education

The Department of Elections should continue its voter education campaign and outreach to the community. The evidence suggests that the Hispanic and low-income voters in particular may have made more mistakes in the voting booth, despite the fact that Hispanics didn’t express that frustration in the exit polls. Remember, too, that there are four other San Francisco districts that have yet to try the system.

3.3 “Dumber” Optical Scanning

As mentioned in Sections 2.1 and 2.2, it was a poor decision to program the optical scanners to not record redundant votes and votes that follow overvotes. If a candidate is marked in multiple columns, the optical scanner should record precisely that. If a valid vote was made after an

overvote, the ballot image should reflect that as well. Ideally, the machine wouldn't even record an overvote; instead it would record all the candidates that were marked in that column. In other words, the only job of the optical scanner should be to, as accurately as possible, convert a physical ballot into digital text form and let the tallying software do the rest. There are three principle reasons for this.

First, there is a trust issue. The more preprocessing and control logic built into the optical scan machine, the greater the chance that there are mistakes or bugs in that logic that could eventually lead to incorrect tallies. Yes, similar mistakes could be made in the tallying software; but the difference is that the ballot image listing can be posted online for many others to inspect and analyze. If there were a bug in the tallying software that generated incorrect results from the ballot image listing, there is a much greater likelihood that someone would detect it. Therefore, if the scanner can leave some logic to the tallying software, it should.

Second, there is a research issue. By eliminating information from the ballot image listing, it detracts from researchers abilities to study how people are voting, what mistakes they are making, and why. For instance, an overvote followed by two valid votes is probably a mistake, but three consecutive overvotes is more likely an intentional protest. But currently, both voting combinations are recorded as OUU, thus making it impossible for a researcher examining the listing to make that distinction.

Lastly, there is a design issue. By adding logic to the optical scanners specific to the counting rules governing this first San Francisco election, without further modification, the machines are unusable should the city alter those rules in the future. Or should another city want an IRV election under slightly different rules, they could not simply procure the same upgrade.

For example, what if San Francisco decides to start counting valid votes that follow overvotes? Or what if the city wants to try equal-ranking instant runoff voting, where multiple candidates can be marked in a single column? Then recording these as overvotes would not be sufficient. Or what if another city were to adopt a cumulative voting system, where each voter is given three votes to proportion however they like across candidates, e.g. three votes on one candidate, two votes on one and one vote on another, etc.? Now redundant votes would be of significance. But the larger point is that no one knows what system any given jurisdiction may adopt in the future, so to as great a degree as possible, the machines should not be biased towards any particular one.

In communication system design, this principle is sometimes referred to as the end-to-end argument. It dictates that maximum flexibility of design is obtained when intelligence in a system should be placed at the end points, not in the communications network. In the case of the voting process, the relevant end point is the software which tallies the votes, and the communication medium is the optical scan machine, which communicates physical ballots into digital text.

In short, the optical scanner would be better if it were *dumber*—if it made no assumptions and implemented no biases in favor of any particular system. The ballot image listing should be just that, a text version of the ballots, not interpreted or pre-processed in any way. That would improve verifiability, flexibility, and research.

Appendix: Ballot Statistics

Table SF: San Francisco IRV Ballot Statistics

	# Ballots	% Ballots		
Total	216928	100.00%		
VVV	136449	62.90%	Average Valid Votes Per Ballot:	2.28
VVO	169	0.08%	Percentage Correct Ballots:	98.12%
VVU	20988	9.68%	Percentage Incorrect Ballots:	1.88%
VOV	0	0.00%	Percentage Ballots with Overvotes:	0.85%
VOO	0	0.00%	Percentage Ballots with Undervotes:	37.02%
VOU	458	0.21%	Percentage Ballots with Skips:	1.08%
VUV	1439	0.66%	Residual Vote Rate in 2000:	16.81%
VUO	62	0.03%		
VUU	38385	17.69%		
OVV	0	0.00%		
OVO	0	0.00%		
OVU	0	0.00%		
OOV	0	0.00%		
OOO	0	0.00%		
OOU	0	0.00%		
OUV	0	0.00%		
OUO	0	0.00%		
OUU	1100	0.51%		
UVV	105	0.05%		
UVO	5	0.00%		
UVU	414	0.19%		
UOV	0	0.00%		
UOO	0	0.00%		
UOU	33	0.02%		
UUV	277	0.13%		
UUO	16	0.01%		
UUU	17028	7.85%		

<p>Legend V = Valid Vote O = Overvote U = Undervote</p>
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Table D1: Supervisor District 1 IRV Ballot Statistics

	# Ballots	% Ballots		
Total	29786	100.00%		
VVV	19622	65.88%	Number of Candidates:	7
VVO	15	0.05%	Winner's Percentage of First Choices:	41.09%
VVU	2975	9.99%		
VOU	61	0.20%	Average Valid Votes Per Ballot:	2.37
VUV	200	0.67%	Percentage Correct Ballots:	98.37%
VUO	1	0.00%	Percentage Incorrect Ballots:	1.63%
VUU	5061	16.99%	Percentage Ballots with Overvotes:	0.71%
OUU	126	0.42%	Percentage Ballots with Undervotes:	34.07%
UVV	13	0.04%	Percentage Ballots with Skips:	0.95%
UVO	1	0.00%	Percentage Blank Ballots in 2000:	0.141271192
UVU	31	0.10%		
UOU	1	0.00%	Per Capita Income:	\$31,594.00
UUV	31	0.10%	Percentage Hispanic:	5%
UOU	5	0.02%	Percentage Asian:	43%
UUU	1643	5.52%		

Table D2: Supervisor District 2 IRV Ballot Statistics

	# Ballots	% Ballots		
Total	37796	100.00%		
VVV	18568	49.13%	Number of Candidates:	5
VVO	13	0.03%	Winner's Percentage of First Choices:	61.25%
VVU	3600	9.52%		
VOU	72	0.19%	Average Valid Votes Per Ballot:	1.96
VUV	209	0.55%	Percentage Correct Ballots:	98.65%
VUO	6	0.02%	Percentage Incorrect Ballots:	1.35%
VUU	10648	28.17%	Percentage Ballots with Overvotes:	0.45%
OUU	73	0.19%	Percentage Ballots with Undervotes:	50.84%
UVV	17	0.04%	Percentage Ballots with Skips:	0.93%
UVO	1	0.00%		
UVU	79	0.21%	Per Capita Income:	\$75,877.00
UOU	3	0.01%	Percentage Hispanic:	4%
UUV	36	0.10%	Percentage Asian:	13%
UOU	2	0.01%		
UUU	4469	11.82%		

Table D3: Supervisor District 3 IRV Ballot Statistics

	# Ballots	% Ballots		
Total	27393	100.00%		
VVV	15903	58.05%	Number of Candidates:	4
VVO	10	0.04%	Winner's Percentage of First-Choices:	62.55%
VVU	2339	8.54%		
VOU	48	0.18%	Average Valid Votes Per Ballot:	2.17
VUV	188	0.69%	Percentage Correct Ballots:	98.51%
VUO	2	0.01%	Percentage Incorrect Ballots:	1.49%
VUU	6611	24.13%	Percentage Ballots with Overvotes:	0.41%
OOU	49	0.18%	Percentage Ballots with Undervotes:	41.91%
UVV	14	0.05%	Percentage Ballots with Skips:	1.10%
UVO	0	0.00%		
UVU	46	0.17%	Per Capita Income:	\$37,597.00
UOU	3	0.01%	Percentage Hispanic:	4%
UUV	48	0.18%	Percentage Asian:	47%
UO	1	0.00%		
UUU	2131	7.78%		

Table D5: Supervisor District 5 IRV Ballot Statistics

	# Ballots	% Ballots		
Total	38243	100.00%		
VVV	28277	73.94%	Number of Candidates:	22
VVO	38	0.10%	Winner's Percentage of First-Choices:	28.40%
VVU	2317	6.06%		
VOU	98	0.26%	Average Valid Votes Per Ballot:	2.44
VUV	142	0.37%	Percentage Correct Ballots:	97.97%
VUO	17	0.04%	Percentage Incorrect Ballots:	2.03%
VUU	3395	8.88%	Percentage Ballots with Overvotes:	1.33%
OOU	333	0.87%	Percentage Ballots with Undervotes:	25.96%
UVV	19	0.05%	Percentage Ballots with Skips:	0.81%
UVO	1	0.00%		
UVU	69	0.18%	Per Capita Income:	\$36,248.00
UOU	16	0.04%	Percentage Hispanic:	7%
UUV	40	0.10%	Percentage Asian:	17%
UO	4	0.01%		
UUU	3477	9.09%		

Table D7: Supervisor District 7 IRV Ballot Statistics

	# Ballots	% Ballots		
Total	33818	100.00%		
VVV	21749	64.31%	Number of Candidates:	13
VVO	35	0.10%	Winner's Percentage of First-Choices:	33.23%
VVU	3795	11.22%		
VOU	59	0.17%	Average Valid Votes Per Ballot:	2.32
VUV	226	0.67%	Percentage Correct Ballots:	98.10%
VUO	9	0.03%	Percentage Incorrect Ballots:	1.90%
VUU	4860	14.37%	Percentage Ballots with Overvotes:	0.93%
OUU	206	0.61%	Percentage Ballots with Undervotes:	35.58%
UVV	15	0.04%	Percentage Ballots with Skips:	1.02%
UVO	1	0.00%		
UVU	53	0.16%	Per Capita Income:	\$39,829.00
UOU	4	0.01%	Percentage Hispanic:	8%
UUV	36	0.11%	Percentage Asian:	32%
UOU	0	0.00%		
UUU	2770	8.19%		

Table D9: Supervisor District 9 IRV Ballot Statistics

	# Ballots	% Ballots		
Total	25517	100.00%		
VVV	16018	62.77%	Number of Candidates:	6
VVO	23	0.09%	Winner's Percentage of First-Choices:	50.73%
VVU	4002	15.68%		
VOU	59	0.23%	Average Valid Votes Per Ballot:	2.37
VUV	230	0.90%	Percentage Correct Ballots:	97.66%
VUO	14	0.05%	Percentage Incorrect Ballots:	2.34%
VUU	3771	14.78%	Percentage Ballots with Overvotes:	0.94%
OUU	142	0.56%	Percentage Ballots with Undervotes:	37.14%
UVV	9	0.04%	Percentage Ballots with Skips:	1.46%
UVO	0	0.00%		
UVU	70	0.27%	Per Capita Income:	\$21,423.00
UOU	1	0.00%	Percentage Hispanic:	43%
UUV	46	0.18%	Percentage Asian:	23%
UOU	2	0.01%		
UUU	1130	4.43%		

Table D11: Supervisor District 11 IRV Ballot Statistics

	# Ballots	% Ballots		
Total	24375	100.00%		
VVV	16312	66.92%	Number of Candidates:	8
VVO	35	0.14%	Winner's Percentage of First-Choices:	32.24%
VVU	1960	8.04%		
VOU	61	0.25%	Average Valid Votes Per Ballot:	2.37
VUV	244	1.00%	Percentage Correct Ballots:	97.31%
VUO	13	0.05%	Percentage Incorrect Ballots:	2.69%
VUU	4039	16.57%	Percentage Ballots with Overvotes:	1.18%
OUU	171	0.70%	Percentage Ballots with Undervotes:	32.94%
UVV	18	0.07%	Percentage Ballots with Skips:	1.60%
UVO	1	0.00%		
UVU	66	0.27%	Per Capita Income:	\$19,176.00
UOU	5	0.02%	Percentage Hispanic:	26%
UUV	40	0.16%	Percentage Asian:	46%
UOO	2	0.01%		
UUU	1408	5.78%		

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