Automating the Collection of Data for Line Management and Polling Place Capacity

Charles Stewart III
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... Democracy Fund and the Hewlett Foundation for supporting the Local Election Administrator Survey

*None of whom bears responsibility for our results.
Waiting Times at Ballot Boxes Draw Scrutiny

BY JEREMY W. FETES
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WASHINGTON — With studies suggesting that long lines at the polls cost Democrats hundreds of thousands of votes in November, party leaders are beginning a push to make voting and voter registration easier, setting up a likely new conflict with Republicans over a deeply polarizing issue.

White House officials have told Congressional leaders that the president plans to press for action on Capitol Hill, and Democrats say they expect him to highlight the issue in his State of the Union address next week. Democrats in the House and Senate have already introduced bills that would require states to provide online voter registration and allow at least 15 days of early voting, among other things.

Fourteen states are also considering whether to expand early voting, including the battlegrounds of Florida, Ohio and Virginia, according to FairVote, a nonprofit group that advocates electoral change. Florida, New York, Texas and Washington are looking at whether to ease registration and establish preregistration for 16- and 17-year-olds.

Several recent polls and studies suggest that long waiting times in some places depressed turnout in 2012 and that lines were longest in cities, where Democrats outnumber Republicans. In a New York Times/CBS News poll taken shortly after Election Day, 18 percent of Democrats said they waited at least a half-hour to vote, compared with 11 percent of independents and 9 percent of Republicans.
Source: 2012 Survey of the Performance of American Elections, conducted by Charles Stewart III of M.I.T.
Waiting to Vote

Charles Stewart III and Stephen Ansolabehere

ABSTRACT
We review evidence that long lines waiting to vote in the 2012 presidential election were costly and disproportionately appeared in certain regions of the country, in cities, and among minority voters. We argue that the field of queuing theory helps to frame thinking about polling place lines. Because addressing the problem of long lines requires precise data about polling place dynamics, we conclude by suggesting new approaches to research that are necessary to identify the most effective cure for long lines.

Waiting in line to vote is the most visible sign of administrative friction of managing elections. The visibility of long lines makes them a convenient symbol for those who seek to improve election administration. However, absent comprehensive, reliable information about lines—where they occur, who endures them, and strategies to mitigate them—it is easy to fail at the problem without making much progress. In this article, we lay the groundwork with some evidence about where long lines occur and what is thought to cause them. We emphasize four points:

First, long lines are costly.
Second, long lines are not universal.
Third, the field of queuing theory helps frame thinking about polling place lines.
Fourth, new approaches to empirical research in polling places are needed to identify the most effective cures for long lines.

THE COSTS OF LINES
Long lines present three categories of problems in American elections: they discourage voting, lower voter confidence, and impose economic costs on voters.

First, long lines discourage some from voting. Responses to the 2012 Voting and Registration Supplement (VRS) of the Current Population Survey suggest that over 500,000 eligible voters failed to vote because of a list of polling place problems that include long lines—inconvenient hours or polling place location, or lines too long.

Second, long lines reduce voter confidence in elections. Responses to the Survey of the Performance of American Elections (SPAE) suggest that...
And by the way, we have to fix that.
# Survey of Local Election Officials

Charles Stewart  
MIT  
December 3,

<table>
<thead>
<tr>
<th>Reason</th>
<th>All</th>
<th>Smaller Jurisdictions</th>
<th>Larger Jurisdictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Too many people showed up at the same time</td>
<td>56.6%</td>
<td>56.9%</td>
<td>53.8%</td>
</tr>
<tr>
<td>2. Overly long/complicated ballots</td>
<td>35.8%</td>
<td>34.4%</td>
<td>50.0%</td>
</tr>
<tr>
<td>3. People in wrong precinct</td>
<td>21.2%</td>
<td>22.1%</td>
<td>11.5%</td>
</tr>
<tr>
<td>4. Inadequate space @ polling place</td>
<td>16.9%</td>
<td>16.7%</td>
<td>19.2%</td>
</tr>
<tr>
<td>5. Registration problems</td>
<td>13.9%</td>
<td>14.5%</td>
<td>7.7%</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Insufficient # of poll books</td>
<td>7.6%</td>
<td>6.9%</td>
<td>15.4%</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Not enough early voting days</td>
<td>7.3%</td>
<td>6.5%</td>
<td>15.4%</td>
</tr>
</tbody>
</table>
Thousands of service-related businesses across the country deal with similar challenges each day. General knowledge about how to meet these location-specific challenges is well known in the fields of industrial engineering and management science. The challenge is marrying more completely these common management tools with the election process.  

\[ W = \frac{\sum_{j=1}^{k} \frac{\lambda_j}{\mu_j - \lambda_j}}{\sum_{j=1}^{k} r_j} \]

\[ L = \lambda W \]
The Elbow

![Graph showing the impact of different check-in line configurations on turnout]

- **1 check-in line**: The turnout remains relatively stable throughout the range of turnouts shown.
- **2 check-in lines**: The turnout shows a significant increase in the number of people waiting in line, especially as the turnout increases beyond 1000.

**Avg. wait (min.)**

- The average wait time for a single check-in line remains constant up to a certain point, after which it significantly increases.
- With two check-in lines, the wait time remains relatively low across the range of turnouts.

**Turnout**

- The x-axis represents the number of turnouts, ranging from 0 to 2000.
- The y-axis represents the average wait time in minutes, ranging from 0 to 50.

**Legend**

- **Blue line**: 1 check-in line
- **Red line**: 2 check-in lines
List of Queueing Theory Software

This page gives a list of queueing theory software. The list was compiled by Dr. Myron Hlynka of the University of Windsor, who welcomes any additions to the list. His e-mail address is hlynka@uwindsor.ca.

The URL of this page is http://www2.uwindsor.ca/~hlynka/qsoft.html

Last updated: June 10, 2014.

1. Octave-Forge - Extra packages for GNU Octave (added June 10, 2014)
   http://octave.sourceforge.net/qequeueing/index.html
2. Java Modelling Tools (added June 10, 2014)
   http://inst.sourceforge.net/
3. Solutions to Queueing Systems (added June 10, 2014)
   http://queueing-systems.ens-lyon.fr/
4. Queueing Theory Calculator. (confirmed February 28, 2014)
   http://www.supositorio.com/queue/calculator.html
   http://www.religiousmath.com/Queueing Calculator.html
6. Call Center calculator and several others. (confirmed Feb. 28, 2014)
   http://www.ertificate.com/calculator/
7. Communications Engineering: Queueing Simulation demo (A few comments).
   http://gencva.net/?page_id=3585SimpleQueueing
   Demo: http://demos.gwce.net/SimpleQueueing/SimpleQueueingTimeGraph.html

Queueing Theory Calculator

1. Choose the queueing model.
   - M/M/C: Single queue, C servers.
   - M/M/Inf: At least one server per customer.
   - M/M/C/K: Queue can only hold customers.

2. Input all the values required.
   - Arrival and Service rates
     - Number of Servers
     - Arrival rate
     - Service rate

- Calculate
Election Toolkit

Election administrators face many challenges planning for and running elections. This website offers tools based on the expertise of election administrators, business managers, and social science researchers that can help election administrators plan and conduct elections.

Our goal is to demonstrate what is possible with such tools. The Election Management Toolkit is an open access place where technologies can be shared and improved. We launch this site with three key tools developed. We encourage you to use these tools and give us (and the developers) feedback on them.

Calculators

- **Line Optimization and Poll Worker Management**
  Developer: Stephen Graves
  This tool uses queuing theory to calculate the minimal number of service stations at a process step in a polling place so as to satisfy a service target on maximum waiting times.

- **Poll Worker and Machine Optimization**
  Developer: Aaron Bruess
  An easy-to-use calculator that takes basic information about a precinct and reports the number of check-in poll books and voting machines needed to keep lines short during a presidential election.

- **Line Optimization**
  Developer: Mark Pelczeroki
  This simulation gives an idea of potential voter wait times for if you have estimates of projected turnout, average time to vote with your ballot and equipment, and average time required to check-in each voter.

Enter data

Each input category is restricted to the stated range.

- **Arrival rate (voters per hour)**
  - 115
  - [1,10000]

- **Average time to vote (minutes per voter)**
  - 0.5
  - [0,100]

- **Number of voting stations**
  - 1
  - [1,2,3,...100]

- **Maximum wait-time target (seconds)**
  - 900
  - [1,1000]

- **Service level (%)**
  - 95
  - [1,99.9]

Results

Figures will appear below after Calculate is pressed.

- **Average wait time (seconds per voter)**
  - 690

- **Percent of voters that wait longer than the target**
  - 27

- **Number of voting stations required to meet service level**
  - 2

- **Wait time reduction from an additional station (seconds per voter)**
  - 681

[Calculate]
[Finish Using Tool]
Enter data

Each input category is restricted to the stated range.

- Arrival rate (voters per hour): 115 (1,10000)
- Average time to vote (minutes per voter): 0.5 (0,100)
- Number of voting stations: 1 (1,2,3,...100)
- Maximum wait-time target (seconds): 900 (1,1000)
- Service level (%): 95 (1,99.9)

Results

Figures will appear below after Calculate is pressed

- Average wait time (seconds per voter): 690
- Percent of voters that wait longer than the target: 27
- Number of voting stations required to meet service level: 2
- Wait time reduction from an additional station (seconds per voter): 681
Enter data

Each input category is restricted to the stated range.

Arrival rate (voters per hour)
115 [1,10000]

Average time to vote (minutes per voter)
0.5 [0,100]

Number of voting stations
1 [1,2,3,...100]

Maximum wait-time target (seconds)
900 [1,1000]

Service level (%)
95 [1,99.9]

Results

Figures will appear below after Calculate is pressed

Average wait time (seconds per voter)
690

Percent of voters that wait longer than the target
27

Number of voting stations required to meet service level
2

Wait time reduction from an additional station (seconds per voter)
681

Calculate

Finish Using Tool
How do we gather the data we need to feed to the resource allocation toolkit?
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- When do people arrive?
- When do they leave?