

Department of Industrial Design
The Ohio State University
380 Hopkins Hall
Columbus, Ohio 43210

Visible Language, 28:1
Susan King Roth, 48-67
©*Visible Language* 1994
Rhode Island School of Design
Providence, Rhode Island 02903



The Unconsidered Ballot: How Design Effects Voting Behavior

Susan King Roth

The voting ballot forms the visual interface between the voter and the political system. It must quickly and clearly communicate information to a diverse public engaged in decision-making activities. Given the importance of voting to a democratic system of government and the need for equal access to information displayed on the ballot, it is interesting that more research in this area has not been conducted. While a search of the literature and government documents reveals some studies on voting system standards related to performance and security, very little is available on ballot design or the interaction between the voter and various systems.

A preliminary study on the effect of ballot interface design on voting behavior, supported by a grant from The Ohio State University, was conducted in February of 1993 in cooperation with appropriate election officials. Subjects were videotaped while voting on either a mechanical lever or electronic voting machine displaying a ballot from the 1992 presidential election in an experimental situation approximating that found in the polling place. Significant problems related to human factors and the organization of information on the ballot have been identified that merit further examination.

Background

The right to vote is extended to all United States citizens eighteen years of age or older by the Constitution and its amendments. The voting age population is large and diverse, including all educational and economic levels and various ethnic groups. The design of voting systems requires careful consideration of the capabilities, characteristics and needs of the voting age public.

There are several different voting systems currently in use, ranging from punch cards to electronic voting machines. The ballot is the component of any voting system that displays information on candidates and issues and represents the visual interface between the election process and the voter. Information displayed must be legible, readable and easily understood in order to insure equal access to the political process and facilitate participation. In spite of the importance of voting system design, there is a lack of published research on the effect of ballot design on voting behavior or the interaction of voters with various systems.

A number of factors may contribute to this lack of research. Elections are held infrequently, and both equipment and ballot type (party-column vs. office-group ballot, for example) differ between states. Although federal law guarantees the right to vote, state and local election officials have control over the election process. Each state is divided into election districts or precincts and each district has a designated polling place. According to a 1990 Election Data Services summary report on voting equipment, there were 180,406 precincts in the United States within which approximately 121,000,000 people were registered to vote.¹

Voting equipment is developed and marketed competitively by private contractors who deal directly with state and/or local election officials responsible for selecting machines for purchase. The purchase of voting

equipment is especially competitive in metropolitan areas with large numbers of voters. While state and local officials may be thorough and responsible in their evaluation of alternate systems, they must choose from systems made available by contractors.

The federal government has published recommended engineering and performance standards for some voting systems, but detailed federal standards regarding ballot layout and equipment design are not mandated. A feasibility report generated in 1984 by a panel of the National Clearinghouse of the Federal Election Commission identified the “. . . need to look at related human engineering standards, panelists stated that neither the manufacturer of voting systems nor most state and local election offices pay much attention to how the voter interacts with the various voting devices. . . Panelists stressed that standards should encompass such matters with an emphasis on ballot design and format.”² In 1990 the Federal Election Commission published *Voting Systems Standards for Punchcard, Marksense and Direct Recording Electronic Voting Systems* as a result of an extensive project authorized by Congress to develop performance and security standards for these newer systems. Compliance with the standards is voluntary, however, and they contain general rather than specific information on ballot design and human engineering. In the section entitled “Ballot Printing or Display,” the document states “. . . the allocation of space and the type fonts used for each office, candidate and contest shall be uniform, and that no active voting position shall be perceived by the voter to be preferred to any other.”³ The document recommends that voting systems provide the maximum number of voting positions (at least 500) and consider requirements of the local jurisdiction, such as ballot rotation, state party voting, etc.

Details of the display of information on the ballot are the responsibility of state and local election officials. State codes may mandate minimum type size for candidate names or specify the width of ruled lines separating sections of the ballot, for example, but many state codes related to ballot format are based on the paper ballot system.⁴ Paper ballots are used primarily in smaller districts where counting ballots can still be done by hand; less than ten percent, or approximately 17,400 voting precincts nationwide, used paper ballots as of 1990.⁵

In the area of human engineering, Voting System Standards recommends reference to military standards found in the 1981 document *ML-STD-1472: Human Engineering Criteria for Military Systems, Equipment and Facilities*.⁶ This document contains anthropometric data listing human dimensions such as standing height, eye height, weight, etc.

Description of the study

A study on the effect of ballot design on voting behavior was conducted in cooperation with the Franklin County Board of Elections and the Elections Administration of the Ohio Secretary of State's Office, supported by a grant from The Ohio State University. Information gathered from this preliminary study is relevant to the voting process in other states and indicates the need for further research on the interaction between the voter and voting systems to insure equal access to the political process.

Nineteen subjects were videotaped while voting on either a mechanical lever or electronic voting machine displaying a ballot from the last presidential election (November 1992) in an experimental situation approximating that found in the polling place on voting machines provided by the Franklin County Board of Elections.

Voting equipment

The mechanical lever machine is operated by turning small metal levers positioned above or below selected candidates or issues. The ballot is printed on strips and inserted between metal brackets or frames in the appropriate position. (Ohio and about twenty-four other states⁷ require ballot rotation to insure that no candidate is favored by position.) Selections can be changed on mechanical lever machines by moving levers back into place before the final vote is recorded. All selections made for each area of the ballot on election day are displayed as small numbers on "candidate and question counters" at the back of the machine, which are later read aloud and recorded by hand by election officers at the polling place. Mechanical lever machines are common in metropolitan districts with large numbers of voters (*see figure 1*).

The electronic voting machine, also described as a Direct Recording Electronic (DRE) vote recorder, is a device that ". . . records votes by means of a ballot display provided with mechanical or electro-optical devices that can be actuated by the voter, that processes the data by means of a computer program and that records voting data and ballot images in internal memory devices."⁸ Votes are recorded for selected candidates and issues by "pressing touch-sensitive switches that are arrayed in 504 voting positions under the translucent ballot face."⁹ Selections made by voters may be changed by pressing the same button again to deactivate it and making a new selection. Final selections are recorded by pressing a large "Vote" button at the bottom of the machine. The electronic machines are gradually replacing mechanical lever machines in large election districts. They are smaller and lighter in weight than mechanical machines and are easily lowered for wheelchair-bound

Figure 1

The mechanical lever machine used in the study.

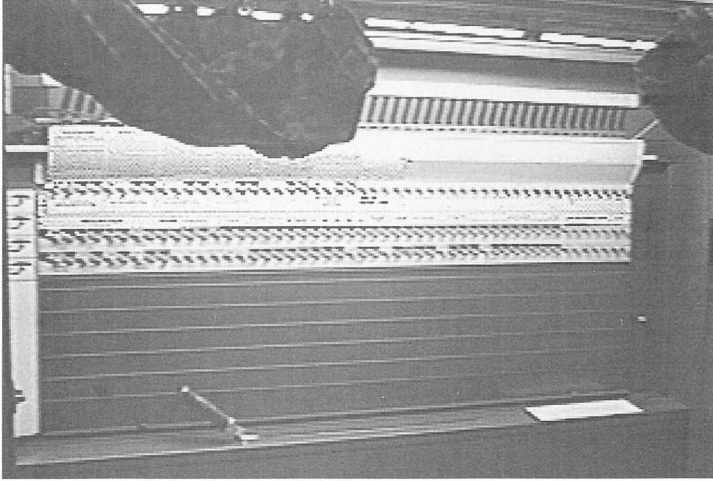
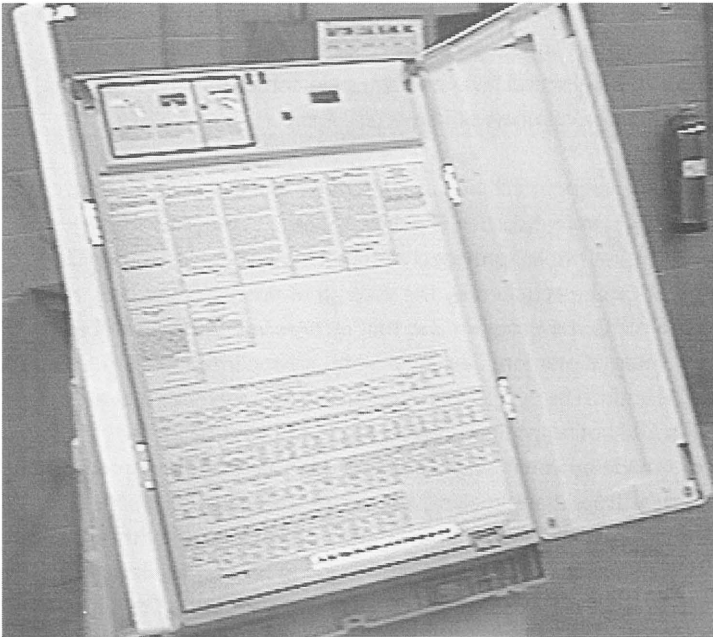


Figure 2

The electronic voting machine used in the study.



voters. Votes recorded on election day are tallied quickly and automatically by computer software programs. Electronic machines display an unobstructed ballot interface on a single sheet of paper—unlike the mechanical lever machine, there are no metal frames to hold ballot strips and no levers. The ballot for the electronic machine used in the study is generated by proprietary computer software and printed on a plotter (see figure 2).

Subjects

Nineteen subjects ranging from 18 to over 75 years of age were selected at random. Nine, or 47 percent, were over age 65. They included members of minority (African-American) and ethnic groups (Vietnamese and Indian) and a large percentage of female subjects. Older subjects were located through a metropolitan senior center with a diverse population of daytime visitors. Educational levels ranged from less than twelve years to over two years of college education. Nine of nineteen subjects (47 percent) reported an educational level at or below 12th grade.

Research procedure

Subjects were instructed to vote as they would normally and were limited to five minutes due to the Ohio state regulation that restricts voting to five minutes when lines are long at the polling place. (Ballots created for the general election in November of 1992 contained several presidential/vice presidential candidates including Bush/Quayle, Clinton/Gore and Perot/Stockdale, as well as numerous state and local issues.)

Voting activities were recorded by a stationary camcorder positioned behind the subject and directed at the ballot. It was explained to subjects at the outset that selections made on the ballot were not relevant to the study and would remain confidential, as would the identity of participants. The camcorder was relatively unobtrusive since it operated automatically in the background. Research assistants were available to answer questions about use of the equipment, as would be the case with poll workers in the polling place. This environment was intended to duplicate the natural situation as much as possible and avoid inhibiting subject activities.

Written questionnaires were administered in a separate room after voting was completed to gather information on age, sex, previous voting experience and other data such as whether subjects wore glasses (for close or distant vision). Specific questions were included to gather information pertaining to legibility and comprehension and open-ended questions included to solicit subject opinion on the voting process just

completed. An informal group discussion afterwards with all subjects present elicited additional comments.

Ballot design, legibility and readability

Legibility is a term that appears often in the psychology, design and engineering literature. Reynolds uses the term to “encompass all factors in typography and layout which may influence the ease, speed and accuracy with which information can be read.”¹⁰ According to McCormick and Sanders it is defined as “The attribute of alphanumeric characters that makes it possible for each one to be identifiable from the others. This depends on such features as stroke width, form of characters, contrast and illumination.”¹¹ Readability, a related concept, is the quality that describes the “recognition of the information content of material”¹² when the individual letters are arranged in words and sentences. Legibility and readability are greatly effected by spacing between lines, characters and words, width of margins, etc. Because the communication of written information also depends on the perceptual abilities of the viewer, visual acuity effects legibility. Visual acuity is the term used to describe the “ability of the eyes to differentiate between the detailed features of what we see, such as reading the fine print in an insurance contract . . .”¹³ Tests of visual acuity include measurements of the smallest feature that the eye can detect. Visual acuity declines naturally with age. “Aging affects many aspects of visual function but the changes are primarily physiological and anatomical . . . in any of these changes there is a loss of sensory function that results in a decrement in performance as a person ages.”¹⁴

Type size affects legibility. Type size is primarily measured in points, and the point system is based on the measure of the type “body,” which is the block supporting the raised letterform in metal type. Because the point system is based on body size rather than size of the actual letter, various type styles of the same point size appear to be different. This is due to the “x-height” or height of the lowercase “x” used as a standard of measurement (*see figure 3*).

As Zachrisson states “The x-height of a letter varies considerably. There are some types which have a larger design in 10 point than others in 12 point, etc. It follows that the typographic measurement is not an exact one as far as the design goes . . .”¹⁵

Appropriate type size is related to viewing distance and the perceptual abilities of the reader. With older voters, the need for greater illumination and larger type size is increased. The American Association of Retired Persons notes in *Truth About Aging: Guidelines for Accurate Communications*

Figure 3

Text set in 10 point Helvetica type. Helvetica has a larger x-height and therefore appears larger.

Text set in 10 point Times type. Times has a smaller x-height and therefore appears smaller.

An example of 10 point text set in two type styles with differing x-heights.

“By age 65, virtually every person will suffer some loss in ability to focus, to resolve images, to discern colors and to adapt to light. Over sixty percent of those considered visually impaired are older persons.”¹⁶ Sorg states that older subjects prefer text type set in either 14 point capital letters or 12 point upper and lower case type.¹⁷

Type size in Ohio is mandated at 12 points for candidate names listed on the ballot. This is within the range of legible type sizes for adults as determined by a number of research studies.¹⁸ Type size in other areas, including the “Questions and Issues” section containing the greatest amount of text, is not mandated and in practice type may be reduced to fit the space available. In the ballot study, one subject over 65 years of age who voted for very few items on the ballot stated during the informal discussion that the type was “too small and some people may have difficulty reading it.” Other subjects mentioned the size of type and their need to get “really close” to read it. Whether this was due to type size or to a lack of visual acuity attributable to age or uncorrected vision is not known. It should be noted that thirteen out of nineteen subjects (68 percent) wore glasses and eight of the thirteen needed glasses for “close” vision according to answers they provided on the questionnaire.

A comparison of “Issues” text displayed on the electronic and mechanical voting machines (*figures 4.1 and 4.2*) reveals that text on the electronic ballot is set with more space between lines, making it somewhat easier to read than text on the mechanical lever ballot that is set with no extra line space. Design of the mechanical lever machine restricts the depth of space available for Issues text due to the position of metal frames that hold the ballot strips in place, while the electronic ballot permits Issues text to occupy more space. There is also greater letterspacing on the electronic ballot, reflecting the method of production (a plotter). Text in

2 PROPOSED CONSTITUTIONAL AMENDMENT
To amend Article V of the Ohio Constitution by the
addition of new sections 8 and 9 as follows:

Section 8: No person shall hold the office of United States Senator from Ohio for a period longer than two successive terms of six years. No person shall hold the office of United States Representative from Ohio for a period longer than four successive terms of two years. Terms shall be considered successive unless separated by a period of four or more years. Only terms beginning on or after January 1, 1993 shall be considered in determining an individual's eligibility to hold office.

Section 9: In determining the eligibility of an individual to hold an office in accordance with this article, (A) Time spent in an office in fulfillment of a term to which another person was first elected shall not be considered provided that a period of at least four years passed between the time, if any, in which the individual previously held that office, and the time the individual is elected or appointed to fulfill the unexpired term; and (B) A person who is elected to an office in a regularly scheduled general election and resigns prior to the completion of the term for which he or she was elected, shall be considered to have served the full term in that office.

If adopted by a majority of electors voting on this amendment, each provision of this amendment shall be deemed severable from the others, and a finding that a provision is invalid shall not affect the other provisions.

(Proposed by initiative petition)

A majority yes vote is necessary for passage.

SHALL THE PROPOSED AMENDMENT BE ADOPTED?

YES ----->

YES

NO ----->

NO

2

PROPOSED CONSTITUTIONAL AMENDMENT

To amend Article V of the Ohio Constitution by the addition of new sections 8 and 9 as follows:

Section 8: No person shall hold the office of United States Senator from Ohio for a period longer than two successive terms of six years. No person shall hold the office of United States Representative from Ohio for a period longer than four successive terms of two years. Terms shall be considered successive unless separated by a period of four or more years. Only terms beginning on or after January 1, 1993 shall be considered in determining an individual's eligibility to hold office.

Section 9: In determining the eligibility of an individual to hold an office in accordance with this article. (A) Time spent in an office in fulfillment of a term to which another person was first elected shall not be considered provided that a period of at least four years passed between the time, if any, in which the individual previously held that office, and the time the individual is elected or appointed to fulfill the unexpired term; and (B) A person who is elected to an office in a regularly scheduled general election and resigns prior to the completion of the term for which he or she was elected, shall be considered to have served the full term in that office.

If adopted by a majority of electors voting on this amendment, each provision of this amendment shall be deemed severable from the others, and a finding that a provision is invalid shall not affect the other provisions.

(Proposed By Initiative Petition)

Figure 5

Section of the electronic voting machine ballot used in the study (actual size of text area: 26 x 24 inches).

<p>#1 PROPOSED CONSTITUTIONAL AMENDMENT</p> <p>A AMENDMENT PROPOSED IN ARTICLE 16, SECTION 3 OF THE CONSTITUTION OF THE STATE OF OHIO, TO BE SUBMITTED TO THE ELECTORS IN THE GENERAL ELECTION OF NOVEMBER 3, 1993.</p> <p>Article 16, Section 3 of the Constitution of the State of Ohio, reads as follows:</p> <p>"At the general election to be held in the year one thousand nine hundred and thirty-two and in each twentieth year thereafter, the question: 'Shall there be a convention to revise, alter, or amend the constitution,' shall be submitted to the electors of the state; and in case a majority of the electors, voting for and against the calling of a convention, shall decide in favor of a convention, the general assembly, at its next session, shall provide, by law, for the election of delegates, and the assembling of such convention, as is provided in the preceding section; but no amendment of this constitution, agreed upon by any convention assembled in pursuance of this article, shall take effect until the same shall have been submitted to the electors of the state, and adopted by a majority of those voting thereon."</p> <p>A majority yes vote is necessary for passage.</p> <p>SHALL THERE BE A CONVENTION TO REVISE, ALTER, OR AMEND THE CONSTITUTION OF THE STATE OF OHIO?</p> <p>YES -----> <input type="checkbox"/> YES</p> <p>NO -----> <input type="checkbox"/> NO</p>	<p>#2 PROPOSED CONSTITUTIONAL AMENDMENT</p> <p>To amend Article V of the Ohio Constitution by the addition of new sections 8 and 9 as follows:</p> <p>Section 8: No person shall hold the office of United States Senator from Ohio for a period longer than two successive terms of six years. No person shall hold the office of United States Representative from Ohio for a period longer than four successive terms of two years. Terms shall be considered successive unless separated by a period of four or more years. Only terms beginning on or after January 1, 1993 shall be considered in determining an individual's eligibility to hold office.</p> <p>Section 9: In determining the eligibility of an individual to hold an office in accordance with this article, (A) Time spent in an office in fulfillment of a term to which another person was first elected shall not be considered provided that a period of at least four years passed between the time, if any, in which the individual previously held that office, and the time the individual is elected or appointed to fulfill the unexpired term; and (B) A person who is elected to an office in a regularly scheduled general election and resigns prior to the completion of the term for which he or she was elected, shall be considered to have served the full term in that office.</p> <p>If adopted by a majority of electors voting on this amendment, each provision of this amendment shall be deemed severable from the others, and a finding that a provision is invalid shall not affect the other provisions.</p> <p>(Proposed by Initiative Petition)</p> <p>A majority yes vote is necessary for passage.</p> <p>SHALL THE PROPOSED AMENDMENT BE ADOPTED?</p> <p>YES -----> <input type="checkbox"/> YES</p> <p>NO -----> <input type="checkbox"/> NO</p>	<p>#3 PROPOSED CONSTITUTIONAL AMENDMENT</p> <p>To amend Article II, Section 2 of the Ohio Constitution by the addition of the following paragraph:</p> <p>No person shall hold the office of State Senator for a period longer than two successive terms of four years. No person shall hold the office of State Representative for a period longer than four successive terms of two years. Terms shall be considered successive unless separated by a period of four or more years. Only terms beginning on or after January 1, 1993 shall be considered in determining an individual's eligibility to hold office.</p> <p>In determining the eligibility of an individual to hold an office in accordance with this article, (A) Time spent in an office in fulfillment of a term to which another person was first elected shall not be considered provided that a period of at least four years passed between the time, if any, in which the individual previously held that office, and the time the individual is elected or appointed to fulfill the unexpired term; and (B) A person who is elected to an office in a regularly scheduled general election and resigns prior to the completion of the term for which he or she was elected, shall be considered to have served the full term in that office.</p> <p>If adopted by a majority of electors voting on this amendment, each provision of this amendment shall be deemed severable from the others, and a finding that a provision is invalid shall not affect the other provisions.</p> <p>(Proposed by Initiative Petition)</p> <p>A majority yes vote is necessary for passage.</p> <p>SHALL THE PROPOSED AMENDMENT BE ADOPTED?</p> <p>YES -----> <input type="checkbox"/> YES</p> <p>NO -----> <input type="checkbox"/> NO</p>								
<p>#51 PROPOSED TAX LEVY</p> <p>HILLIARD CITY SCHOOL DISTRICT</p> <p>A Majority Affirmative Vote is Necessary for Passage</p> <p>An additional tax for the benefit of the Hilliard City School District for the purpose of CURRENT EXPENSES</p> <p>at a rate not exceeding four and nine-tenths (4.9) mills for each one dollar of valuation, which amounts to forty-nine cents (49¢) for each one hundred dollars of valuation, for a continuing period of time.</p> <p>FOR The Tax Levy -----> <input type="checkbox"/> YES</p> <p>AGAINST The Tax Levy -----> <input type="checkbox"/> NO</p>										
<p>PRESIDENT AND VICE PRESIDENT OF THE UNITED STATES</p> <p>A Vote for President is a vote for Vice President and the presidential electors representing each.</p> <p>(Vote not more than ONE)</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%; border: 1px solid black; padding: 2px;"> President and Vice President GEORGE BUSH and DAN QUAYLE <small>Republican</small> </td> <td style="width: 25%; border: 1px solid black; padding: 2px;"> President and Vice President BILL CLINTON and AL GORE <small>Democratic</small> </td> <td style="width: 25%; border: 1px solid black; padding: 2px;"> President and Vice President LINDA B. FULANI and MARIA ELIZABETH MUNOZ </td> <td style="width: 25%; border: 1px solid black; padding: 2px;"> President and Vice President JOHN HAGELIN and VINTON TOMPKINS </td> </tr> <tr> <td style="width: 25%; border: 1px solid black; padding: 2px;"> President and Vice President LYNDON H. LAROUCHE, JR. and JAMES L. BEVEL </td> <td style="width: 25%; border: 1px solid black; padding: 2px;"> President and Vice President ANDRE MARROU and NANCY LORD </td> <td colspan="2"></td> </tr> </table>			President and Vice President GEORGE BUSH and DAN QUAYLE <small>Republican</small>	President and Vice President BILL CLINTON and AL GORE <small>Democratic</small>	President and Vice President LINDA B. FULANI and MARIA ELIZABETH MUNOZ	President and Vice President JOHN HAGELIN and VINTON TOMPKINS	President and Vice President LYNDON H. LAROUCHE, JR. and JAMES L. BEVEL	President and Vice President ANDRE MARROU and NANCY LORD		
President and Vice President GEORGE BUSH and DAN QUAYLE <small>Republican</small>	President and Vice President BILL CLINTON and AL GORE <small>Democratic</small>	President and Vice President LINDA B. FULANI and MARIA ELIZABETH MUNOZ	President and Vice President JOHN HAGELIN and VINTON TOMPKINS							
President and Vice President LYNDON H. LAROUCHE, JR. and JAMES L. BEVEL	President and Vice President ANDRE MARROU and NANCY LORD									
<p>REPRESENTATIVE TO CONGRESS (15th District)</p> <p>(Vote for not more than ONE)</p>	<p>STATE SENATOR (16th District)</p> <p>(Vote for not more than ONE)</p>	<p>STATE REPRESENTATIVE (29th District)</p> <p>(Vote for not more than ONE)</p>	<p>COUNTY COMMISSIONER (Full Term Commencing 1-2-93)</p> <p>(Vote for not more than ONE)</p>	<p>COUNTY COMMISSIONER (Full Term Commencing 1-3-93)</p> <p>(Vote for not more than ONE)</p>						
<p>DEBORAH PRYCE <input type="checkbox"/> LINDA REIDELBACH <input checked="" type="checkbox"/></p> <p><small>Republican</small> <small>Democrat</small></p>	<p>BONNIE MICHAEL <input type="checkbox"/></p> <p><small>Democrat</small></p>	<p>KEVIN L. SHOEMAKER <input checked="" type="checkbox"/></p> <p><small>Democrat</small></p>	<p>HUGH DEMOSS <input checked="" type="checkbox"/></p> <p><small>Democrat</small></p>	<p>MARYELLEN O'SHAUGHNESSY <input checked="" type="checkbox"/></p> <p><small>Democrat</small></p>						
<p>RICHARD CORDRAY <input checked="" type="checkbox"/> WRITE-IN <input type="checkbox"/></p> <p><small>Democrat</small></p>	<p>EUGENE WATTS <input type="checkbox"/></p> <p><small>Republican</small></p>	<p>WILLIAM SCHUCK <input checked="" type="checkbox"/></p> <p><small>Republican</small></p>	<p>ARLENE SHOEMAKER <input checked="" type="checkbox"/></p> <p><small>Republican</small></p>	<p>DOROTHY TEATER <input checked="" type="checkbox"/></p> <p><small>Republican</small></p>						
<p>COUNTY ENGINEER (Vote for ONE)</p>	<p>CORONER (Vote for not more than ONE)</p>	<p>STATE BOARD OF EDUCATION (6th District)</p> <p>(Vote for not more than ONE)</p>	<p>CHIEF JUSTICE OF THE SUPREME COURT (Full Term Commencing 1-1-93)</p> <p>(Vote for not more than ONE)</p>							
<p>JOHN CIRIOLE <input checked="" type="checkbox"/></p> <p><small>Republican</small></p>	<p>WILLIAM R. ADRIEN <input checked="" type="checkbox"/> MICHAEL M. ALEXANDER <input checked="" type="checkbox"/></p> <p><small>Republican</small> <small>Democrat</small></p>	<p>PATRICIA SMITH <input checked="" type="checkbox"/> MARIE S. PFEIFFER <input checked="" type="checkbox"/></p> <p><small>Democrat</small> <small>Democrat</small></p>	<p>SUE ANN NORTON <input checked="" type="checkbox"/> THOMAS J. MOYER <input checked="" type="checkbox"/></p> <p><small>Democrat</small> <small>Democrat</small></p>	<p>ROBERT H. GORMAN <input checked="" type="checkbox"/> J. ROSS HAFFEY <input checked="" type="checkbox"/></p> <p><small>Democrat</small> <small>Democrat</small></p>						

both cases is smaller than that used for candidate names elsewhere on the ballot.

The presentation of information on the ballot appeared to influence voting order, which is the sequence or pattern of selections made. The electronic ballot (*see figure 5*) produced greater voter response and a more orderly pattern of voting than the mechanical lever ballot.

When using the electronic ballot, the majority of subjects started at the upper left corner and voted across each row before moving down and proceeding again from left to right in a regular pattern, ending at the lower right corner. This produced a sequence that began with Issue 1 and ended with candidates for Judge of the Court of Common Pleas. The electronic voting machine used in the study displayed flashing red lights which appeared in each area on the ballot containing candidates or issues. Making a selection terminated the light's flashing, leaving a steady red light indicating that activity in the area had been completed. One subject mentioned that the flashing lights prompted her to continue voting and kept her from "getting lost." Another felt the flashing red lights contributed to the tension and pressure to vote quickly, but seven out of ten subjects (70 percent) using this machine found the flashing lights "very useful" or "useful" as recorded on the questionnaire.

In terms of voting order, eight of ten subjects (80 percent) using the electronic machine began with the Issues section, one initiated activity in the candidate section and one appeared to vote randomly. By contrast, only three out of nine subjects (33.3 percent) using the mechanical lever machine began with the Issues section and 44 percent initiated voting with the presidential candidate position below the Issues section and the remaining subjects voted in a random pattern. In terms of voting speed, subjects spent about one minute less (an average of 2 minutes, 54 seconds) voting on the mechanical lever machine than those using the electronic machine (3 minutes, 59 seconds).

Visibility and human factors

While type size and ballot layout were identified at the outset as factors to be examined in the preliminary study, equal access to information was an unexpected but significant problem on the mechanical lever machine. The Issues section of the ballot was positioned far above eye level for some subjects.

Some female subjects were observed to stand several inches below the Issues text on the ballot. The height of the top of the Issues insert was 67

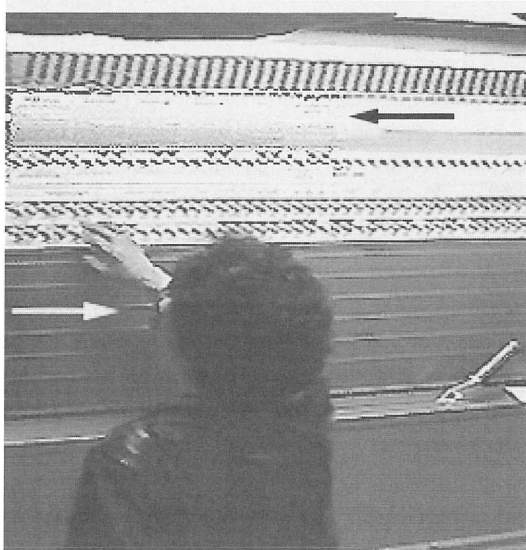
Figure 6

Subject who commented, "I did not see any issues." Black arrow indicates the display height of Issues text on the mechanical lever ballot and white arrow indicates eye level of the subject.



Figure 7

A second subject relative to display height of Issues text on the mechanical lever ballot. Black arrow indicates the display height of text and white arrow indicates eye level of the subject.



inches. A review of published anthropometric data obtained by measuring and recording human dimensions provides a context for examining this finding. Anthropometric data are often organized into the 5th, 50th and 95th percentiles, with the majority of the population falling within the 50th percentile. The five percent at the bottom and top represent smaller and larger dimensions respectively. According to Woodson, Tillman and Tillman, male eye height in the 50th percentile is 64.7 inches and female eye height is 60.3 inches.¹⁹ The eye height of adult males in the 5th percentile is 60.8 inches, while females in this percentile have an eye height of 57.3 inches. Eye height is even lower for females over 70 years of age — only 50.8 inches. This is significantly less than the display height of the Issues text on the mechanical lever machine.

In addition to gender and age, ethnic group also influences height. Woodson, Tillman and Tillman cite studies of Chinese, Filipino, Thai and Vietnamese males that produced an average standing height of 63.14 to 65.51 inches.²⁰ Given the “rule of thumb” for determining eye height when only standing height is known (e.g., eye height is approximately 5.2 inches lower than standing height for males) the eye height for men in these groups would range from 57.94 to 60.31 inches—similar to the range for US females and males in the 5th percentile. It can be assumed that the eye height of females from these ethnic groups would be less than that of males due to gender differences. In the ballot study a young female subject of Asian origin (who was observed on tape to be at the low end of the height range) was asked to describe the first four ballot issues in her own words on the questionnaire. She responded: “I did not notice any ‘questions and issues.’ I only vote for candidates . . .” Figure 6 is a single frame taken from the videotape of this subject engaged in voting activities, and demonstrates the difference between eye level and the display height of the “Issues” section on the ballot. Figure 7, a single frame taken from the videotape of another subject, demonstrates that the problem of display height is not unique. In fact, of the four subjects who did not vote on the Issues, every one was at the low end of the range for height. All four subjects were female; one was of Asian heritage and a member of the youngest age group while three were elderly African-Americans.

Women outnumber men in the elderly population and many have a lower standing height. Metropolitan districts with large numbers of voters (districts that often use mechanical lever machines) may also contain members of various ethnic groups. These two groups—elderly women and voters of ethnic origin—may be represented disproportionately in the 5th percentile for height. According to Kroemer, “If one designs, for

example, to fit persons between the 5th and 95th percentile, one knows that this design will fit the central ninety percent, but it is too large for five percent and too small for another five percent of the intended user population.”²¹

Interestingly, subjects of lower height as determined by viewing the tapes did not mention any problem related to display height when responding to open questions on the questionnaire. Informally, a few mentioned in a follow-up conversation that the Issues were “too high” on the mechanical lever machine. The reason this relevant information was not mentioned on the questionnaire is unknown. It is possible that subjects did not consider display height to be a problem with design of the ballot but a personal problem. Donald Norman makes the observation that people who have been studied while making errors with the operation of machinery, word processors or other designed objects “. . . feel guilty and either try to hide the error or blame themselves for ‘stupidity’ or ‘clumsiness’. . . I point out that the design is faulty and that others make the same mistake . . . Still, if the task appears simple or trivial, then people blame themselves.”²²

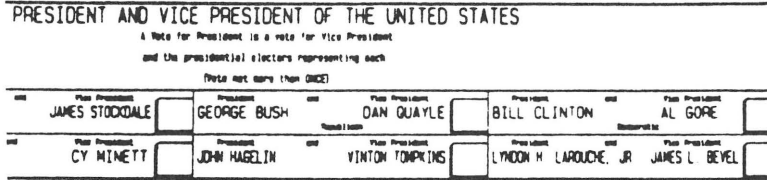
As stated before, four out of nine subjects (44 percent) assigned to the mechanical lever machine in the ballot study did not vote at all in the Issues section of the ballot, while only one of ten subjects (10 percent) using the electronic voting machine, which displays text at a lower height, did not vote in this section. This suggests that information displayed on the mechanical lever machine at a height above eye level for some subjects may decrease response.

Ambiguity and the display of information

Another significant finding in the study was the fact that information displayed on the “Presidential/Vice Presidential Candidate” section of the ballot on the electronic voting machine was ambiguous so that it was not always clear which name was associated with the corresponding button. Such ambiguity could be avoided by reorganizing the display of information on this section of the ballot based on a consideration of principles of visual perception and effective information design.

For example, the paper ballot on the electronic machine contains areas of text divided by lines of varying width, with drawn square “buttons” placed over the 504 voting positions on the underlying electronic grid. Buttons on the electronic ballot were ambiguously positioned relative to candidate names. In one ballot rotation, the name of George Bush was positioned in close proximity to the right of one button and the name of

Figure 8



Partial view of the Presidential/Vice Presidential Candidate section from the electronic voting machine ballot in one of its rotations (November 1992). Note the position of drawn buttons equidistant between the names of opposing presidential/vice presidential candidates.

James Stockdale (Vice Presidential Candidate for H. Ross Perot) was located equally close to the same button on the left side with a thin line separating candidate boxes. A similar situation applied to the positioning of Presidential Candidate “Bill Clinton” and “Dan Quale” (George Bush’s Vice Presidential Candidate) and H. Ross Perot and Nancy Lord (Andre Marrou’s Vice Presidential Candidate).

This ambiguous presentation of visual information probably did not favor any particular candidate in this case, but the potential for confusion and error exists (see figure 8). Three of the subjects participating in the ballot study mentioned this on the written questionnaire. One stated, “The square next to Clinton’s name was for the other candidate to the left. The square for Clinton was to the right.” Another responded “It seemed that the buttons were closer to the adjoining candidate. I tend to vote by president’s name, but the correct button was closer to the vice president’s name.” Perceptually, there is a tendency to group visual elements that appear close together or in proximity. One of the rules of visual perception established by the Gestalt school of psychology concerns grouping by proximity. “The Law of Proximity states that the relative closeness of some units to each other as compared to others at a greater distance will cause the closer elements to be seen together as a new entity.”²³

Comprehension and “plain English”

Issues appearing on the ballot may be written in language that is unfamiliar or confusing to voters. Suggestions for the use of “plain English” in government documents have been made in the past. For example, in 1978 President Carter signed an executive order requiring that contracts generated by executive agencies must be “as simple and clear as possible, written in plain English and understandable to those who must comply

with it.”²⁴ Some effort in this area was continued by the Reagan administration. Broadbent²⁵ indicates that informational materials may be most effectively posed in the active, affirmative mode, while the passive, negative mode, should be avoided. Some subjects stated that issues were hard to understand or confusing. One subject felt a need to be sure when voting for or against an issue, stating that in the area of ballot issues, the “wording has a lot of negatives.” The use of “plain English” on the ballot is especially important for voters with lower literacy or education levels and for those for whom English is a second language.

Significance of the study

Approximately one-half to three-quarters of the total voting age population votes in presidential elections. The ballot provides the visual interface between the voting system and the voter. It would not be an overstatement to suggest that factors that interfere with reading or comprehension of information on the ballot could have a significant impact on the voting process, perhaps leading to inaccurate election results or discouraging voter participation.

According to *Vital Statistics on American Politics*, 68 percent of the voting age population over 65 reported voting, compared to 33 percent of the 18-20 year old population,²⁶ making clear the need to present information with consideration of the special characteristics of older voters. As the elderly population grows in the future, design that includes this segment of the public will become even more important. Koncelik, examining the changing composition of the population and the impact this will have on design practice, notes: “In America, our current proportion of those over 65 is at 12.5 percent and is estimated to increase to 20 percent to 25 percent between 2030 and 2050.”²⁷

Summary observations

Factors related to characteristics of the entire voting age population, including the elderly, women and certain ethnic groups, needs careful consideration during the design and evaluation of voting systems.

Effective visual organization and the clarity of information displayed on the ballot are important criteria for any voting system and design guidelines for election officials should address these concerns beyond the generalized recommendations that now exist. Attention to type size, type style and text setting that is legible and easily read by all members of the voting age population is important. Rules addressing the appropriate placement of candidate names with corresponding buttons and the correct display height of ballot text should be included in these guide-

lines. If necessary, state codes that mandate ballot format should be updated to include newer voting systems and a sensitivity to the needs of special populations. And there should be a renewed effort to further simplify and standardize ballot language at the national level, to insure use of written language that is comprehensible and familiar to the greatest number of voters.

Local and state election officials responsible for purchasing voting systems and creating ballots for each election are forced to work within constraints dictated by available equipment. The Federal Election Commission's 1990 *Voting System Standards* addresses this issue by suggesting that designers of newer systems follow recommended standards found in *ML-STD-1472: Human Engineering Design Criteria for Military Systems, Equipment and Facilities* with reference to visual displays, anthropometric data, etc. However, since anthropometric data in *ML-STD-1472* is derived from U.S. Army, Marine, Navy and Airforce men and Army and Airforce women, it is possible that men and women over age 65 and many of those within the 5th percentile in the general population may not be included in this select group (no age was specified in the data). Data found in *ML-STD-1472* lists the standing eye height of three groups in the 5th percentile of those measured as 59.5 inches and 59.9 inches for male "ground troupes" and "aviators," respectively, and 55.5 inches for "women" with no occupation specified.²⁸

The authors of *Voting System Standards* further suggest that designers of voting systems extend the criteria found in this military source to accommodate special users and conform with the spirit of the Voting Accessibility for the Elderly and Handicapped Act of 1984.²⁹ The intent of this act as written is to "improve access for handicapped and elderly individuals to registration facilities and polling places for Federal elections."³⁰ In addition to physical access, members of these groups are to be given *access to instructions printed in large type* that are conspicuously displayed at each facility and provided with information on absentee voting. Although the intent of the Act is to improve access to the voting process for the handicapped and the elderly (those 65 years of age or older), it does not specifically address accessibility to printed information displayed on the voting ballot.³⁰

More complete information on the human use of voting systems based on a large representative sample of the voting age population, including those in the 5th percentile for height and those over 65 years of age, would provide a strong foundation for designing and evaluating voting systems that insure equal access to the democratic process for all voters.

Considering the significance of issues raised, it is hoped that this preliminary study will encourage further research. As Landgraf notes "The first step toward creating products that provide a valuable benefit to users is understanding performance needs from the users' perspective. Until we understand what the user considers valuable in a product, we will only be speculating . . . what needs exist."³¹ An article titled Inclusion by Design in a recent issue of *I.D. Magazine*, part of a report submitted to President Clinton by a team of leading designers, called for a review of design in government with consideration of the diversity of the US population. "Government can take the lead by using inclusive design principles to promote and encourage civic and political participation. The materials government uses to interact with the people should not be hard for the ordinary citizen to read, use or understand."³² One specific suggestion was that designers and government work together to "apply a new initiative in public information design to such projects as . . . modernizing and redesigning voting machines." There is a clear need to do so, and it is hoped that issues raised by this preliminary study will be addressed by any future effort in this direction.

Susan King Roth is associate professor of visual communication design in the Department of Industrial Design at The Ohio State University. She has a BFA from The Cooper Union for the Advancement of Science and Art and an MA from The Ohio State University. Formerly Director of Graphics for the New York City Parks, Recreation and Cultural Affairs Administration, she practiced design and taught at The School of the Art Institute of Chicago before joining the design faculty at The Ohio State University. She has been involved in design research since 1988. She is co-founder and co-director of the Center for Interdisciplinary Studies in Art and Design at OSU and is a consulting editor of the *Journal of Visual Literacy*.

References

- 1 Election Data Services, Inc. 1990. *Voting Equipment Summary Report*. Washington, DC, 1.
- 2 National Clearinghouse on Election Administration of the Federal Election Commission. 1984. *A Report to the Congress on the Development of Voluntary Engineering and Procedural Performance Standards for Voting Systems*, 21.
- 3 Federal Election Commission. 1990. *Voting Systems Standards*. Performance and Test Standards for Punchcard, Marksense, and Direct Recording Electronic Voting Systems. Washington, DC: Government Printing Office, 24, 3 .2.2.6.
- 4 Penelope Bonsall, Director of the National Clearinghouse on Election Administration, The Federal Election Commission. March 1992, telephone conversation.
- 5 Election Data Services, Inc. 1990. *Voting Equipment Summary Report*. Washington, DC, 1.
- 6 Federal Election Commission. 1990. *Voting Systems Standards*, Appendix D, D-6.
- 7 Federal Election Commission. 1991. *Technical Report 2*. Fast Facts on State Registration and Election Procedures. Washington, DC (draft, no pagination).
- 8 Federal Election Commission. 1990. *Voting Systems Standards*, 3, 1.3.3.
- 9 ECRI. 1988. *An Election Administrator's Guide to Computerized Voting Systems*. Plymouth Meeting, PA, 2, S-1.
- 10 Reynolds, Linda. 1984. *The Legibility of Printed Scientific and Technical Information*. Information Design Easterby and Zwaga, eds. Chichester: Wiley and Sons, Ltd., 187.
- 11 McCormick, E. and Sanders. 1982. *Human Factors in Engineering and Design*. Fifth Edition. New York: McGraw-Hill, 89.
- 12 McCormick and Sanders, *Human Factors in Engineering and Design*, 98.
- 13 McCormick and Sanders, *Human Factors in Engineering and Design*, 64.
- 14 Pitts, Donald G. 1982. *The Effects of Aging on Selected Visual Functions: Dark Adaptation, Visual Acuity, Stereopsis, and Brightness Contrast*. Modern Aging Research. New York: Alan R. Liss, Inc. 2,131.
- 15 Zachrisson, Bror. 1965. *Studies in the Legibility of Printed Text*. Stockholm: Almqvist and Wiksell, 201.
- 16 American Association of Retired Persons. 1986. *Truth About Aging. Guidelines for Accurate Communications*. Washington, DC: AARP, 25.
- 17 Sorg, Judith. 1985. An Exploratory Study of Type Face, Type Size and Color Paper Preferences Among Older Adults. Thesis, Pennsylvania State University.
- 18 Zachrisson, Bror, *Studies in the Legibility of Printed Text*, 40.
- 19 Woodson, W., Tillman, B. and Tillman, P. 1992. *Human Factors Design Handbook*. Second Edition. New York: McGraw-Hill, Inc., 556.
- 20 Woodson, W., Tillman, B. and Tillman, P. 1992. *Human Factors Design Handbook*. Second Edition. New York: McGraw-Hill, Inc., 577.
- 21 Kroemer, Karl. 1987. Engineering Anthropometry. *Handbook of Human Factors*. Gavriel Salvendy, ed. New York: John Wiley and Sons, 2.5,166.
- 22 Norman, Donald. 1988. *The Design of Everyday Things*. New York: Doubleday, 34-35.
- 23 Thiel, Philip. 1981. *Visual Awareness and Design*. Seattle: University of Washington Press, 158-59.
- 24 Bowen, Duffy & Steinberg. 1986. Plain Language Laws. *Visible Language*, 20:2.
- 25 Broadbent (1977), cited in McCormick, Ernest, and Sanders, Mark, *Human Factors in Engineering and Design*, 98.
- 26 *Vital Statistics on American Politics*. Washington, DC: Congressional Quarterly Press, 1992.
- 27 Koncelik, Joseph A. 1993. Design , Aging, Ethics and the Law. Paper presented at The Ohio State University, Columbus, OH.
- 28 U.S. Government/Department of Defense. 1981. *ML-STD-1472: Military Standard; Human Engineering Design Criteria for Military Systems, Equipment and Facilities*, 127.
- 29 Federal Election Commission. 1990. *Voting Systems Standards*, Appendix D, D-6.
- 30 1986. Public Law 98-435: Voting Accessibility for the Elderly and Handicapped Act. United States Statutes at Large, 1984. Vol. 98:2, 1678. Washington, DC: United States Government Printing Office.
- 31 Landgraf, M. 1992. User-Centered Design. *Innovation*, 18.
- 32 Pearlman, C., Sorkin, M., and Woodard, S. 1993. Inclusion by Design. *I.D. Magazine*, March/April, 61.