Learning Objectives

- Apply 3 principles that govern successful use of scanning systems
- Use Scanning Wizard to help configure scanning systems for switch user
- Analyze a scanning interface for 5 factors that affect user performance
- Configure a scanning interface to meet user needs and maximize text entry rate

Overview

- Review switch scanning and its challenges
- Demo of Scanning Wizard software
- What do the data mean?
- Case examples for analyzing and enhancing scanning configuration for single-switch users

Part 1

- Review switch scanning and its challenges

Single-switch Scanning

- Allows people to independently use a computer or AAC device with just a single switch

“Spread your envelopes out…”

<table>
<thead>
<tr>
<th>Single-switch Scanning Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline, subject 004:</td>
</tr>
<tr>
<td>• Excellent switch control</td>
</tr>
<tr>
<td>• Excellent command of layout</td>
</tr>
<tr>
<td>• High satisfaction</td>
</tr>
<tr>
<td>• But text entry rate (TER) surprisingly slow</td>
</tr>
<tr>
<td>TER (wpm)</td>
</tr>
<tr>
<td>Selection Errors (%)</td>
</tr>
<tr>
<td>Timing Errors (%)</td>
</tr>
</tbody>
</table>
Switch Scanning Challenge

- Remains an important option for some users
- Speed is slow
- Text entry rate (TER):
  - *Very* fast user, with no impairments, may achieve 7 or 8 wpm
  - 1 wpm or less is not uncommon
  - Limited data for two-switch scanning: 1.3 wpm

What affects TER?

- In general terms:
  - User strengths and limitations
  - System setup
  - Relationship (“fit”) between user and system

Some User and Fit Factors that Influence TER

- Ability to control switch (or switches)
  - Speed
  - Consistency
  - Precision
- Familiarity with layout (where everything is)
- Effective strategies (best way to select what you want)
- Errors
  - Selection and timing
  - Goal is to select what you want, on the first opportunity
  - Etc. (not an exhaustive list!)

System Factors that Influence TER

- Switch characteristics: type, location
- Timing parameters: scan delay, 1st-item delay
- Item layout & organization: based on frequency of use
- Scan pattern: manual vs auto initiation, loop count
- Language features: word prediction, fixed words, abbreviations, semantic compaction
- Dead time
- Most of these factors affect two-switch scanning, too

How do we adjust all those factors to best match a user’s needs?

- This is the problem we are trying to solve.
- First approach:
  - Mostly manual process
  - Effective (average TER improvement was 120%)
  - Time-consuming, not very practical
- Revised approach
  - Guided software wizard
  - scanningwizard.com
  - < 20 minutes to run in usability tests

Basic method in both approaches is the same:

1. Analyze switch activation
   - measure response time & errors
2. Analyze scanning selections
   - measure text entry rate
   - count & classify scanning errors
3. Determine settings that will reduce scanning errors
4. Determine settings that will enhance efficiency
Scanning Wizard Software

- The method works, but can we make it easier and more efficient to use in the real world?
- Build all of the data collection and decision points into one piece of software that walks you through the process
- Provides specific recommendations for scanning settings that best meet the user’s needs

Demo of Scanning Wizard

- https://scanningwizard.com
- Switch Test
  - Can user activate switch quickly and reliably?
  - What is the matching scan speed setting?
- Scan Test
  - Can user make accurate and efficient selections from a scanning grid?
- Final Recommendations

Part 2

- Demo of Scanning Wizard software

Part 3

- What do the data mean?

Scanning Wizard Switch Test

- Difficulty Score summarizes how well the current switch setup meets the user’s needs (green/yellow/red zones)
- Data help diagnose problems with switch:
  - Slow activation
  - Slow release
  - Slow recovery
  - High variability
  - Extra hits
- Report suggests ways to reduce problems

Switch Test: Green zone example

Your Difficulty Score: 2.22
Your score is in the Low Difficulty zone.

What does my score mean?
Your score is an estimate of how well the current switch setup meets your needs. It combines indicators of speed, consistency, and precision into one overall score. A higher score suggests greater difficulty with using the switch, while a lower score indicates lower difficulty.

Your Difficulty Score of 2.22 suggests that your use of the current switch setup is appropriate for effective use of single-switch scanning. We recommend that you continue on to the Scan Test. Consider reviewing the Recommendations for Improvement section below before moving on to the Scan Test.

Switch Test: Red zone example

Your Difficulty Score: 22.77
Your score is in the High Difficulty zone.

Your Difficulty Score indicates that the current switch setup may not allow effective use of single-switch scanning.

Scanning Wizard Scan Test

• Difficulty Score is the error rate (green/yellow/red zones)
• Strict definition of error: anything other than selecting the correct item at the very first opportunity
• Counts and analyzes 8 types of errors:
  • Row wrap
  • Before / after row
  • Other row
  • Item wrap
  • Before / after item
  • Other item
  • Speed
  • Activation
  • Release
  • Recovery
  • Consistency
  • Precision
  • Extra hits

First key is to keep errors low
• (~20%, in the green)
To reduce errors:
• Ensure reliable switch activation (Switch Test)
• Slow down the timing
• Use a familiar letter layout
• Use manual initiation (for now)
  • Find the letter before starting the scan
Then address efficiency
Scan Test example

- First scanning assessment for adult with CP (typing is tiring, slow, and creates tension)
- Two Scan Tests
  - First uses a ring to keep switch positioned in palm
  - Second without ring

Scan Test example

- Good ability to use single-switch scanning
- Ring-mounted switch gives best performance

<table>
<thead>
<tr>
<th>Test</th>
<th>Switch</th>
<th>Difficulty Score</th>
<th>Text Entry Rate</th>
<th>Item Accuracy, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>With ring</td>
<td>Green (15.8)</td>
<td>0.95 wpm</td>
<td>90%</td>
</tr>
<tr>
<td>2</td>
<td>Without ring</td>
<td>Red (76.5)</td>
<td>0.59 wpm</td>
<td>81%</td>
</tr>
</tbody>
</table>

Scan Test example: the “cost” of errors

- Timing errors: e.g., not selecting a row, selecting the wrong row, not selecting a letter
- These errors almost double the time required

Final Recommendations

- Based on Switch and Scan data
- Recommendations for 18 settings
- Principles:
  - Appropriate switch & location
  - Goldilocks scan speed and timing
  - Scanning errors are costly! Minimize!
  - Put most frequently used things in closest spot
  - Use word prediction only if adequate search time
  - Principles aren’t new; help applying them is.

Data-specific Recommendations

- Switch setup
- Scan Timing
  - Scan Time and Extra Delay
  - Scan Initiation: Auto or Manual
- Loop Count: 1 or 2
- Keyboard Layout: Frequency-based or familiar
- Main idea is to reduce scanning errors first, then consider efficiency

General-guideline Recommendations

- Reduce Dead Time (unnecessary time)
- Prediction Features
  - 3 to 6 word list, on or near top of its group
  - Preserve adequate search time (about 1 s)
- Scan Pattern
  - Use simple row-column where possible
  - If using blocks, put Letters + WP block first
- Core Words: use if already have and like
  - Applying these may require analysis and judgment
Some Rules-of-thumb for Settings

- Base timing parameters on switch hit time
- Provide time for user to use prediction effectively (i.e., to select from the list on the first scan)
- Put Letters+prediction group first; stay there once selected until word is done
- Character prediction not useful, typically
- Set loop count to 1
- Use manual initiation only if necessary
- Reduce errors, then increase efficiency

Part 4

- Case examples
  - Long-time users of single-switch scanning
    - M004: Dynavox with Scanning WordPower
    - R006: TouchChat iOS
  - Emerging switch users
    - V007: Scanning Wizard smiley face task

M004 Baseline & Key SW Recs

- Extra Delay: change 0.27 to 0
- Letter Layout: frequency
- Dead Time: reduce
- Word Pred: List on top, enough search time
- Char Pred: don’t use
- Letters + WP block: move to 1st position, use row-col scan

M004’s Layout Before and After:

Before: ‘your envelopes’

After: ‘will also respect’

136% improvement in text entry rate.

R006 Baseline & Key SW Recs

- Scan Rate: change 1.9 to 1.4
- Letter Layout: change qwerty to frequency
- Dead Time: reduce
  - Function rows in top positions
  - AutoTap adds post-selection delay
- Word Pred: enough search time
- Scan Pattern: use simple row-col scan

R006 Baseline: AutoTap delay

- Dead Time: reduce
  - Function rows in top positions
  - AutoTap adds post-selection delay
R006's Layout Before and After:

Before:

After: "Your health"

System did not allow for all changes to be made. But, still a 55% improvement in text entry rate.

V007: emerging switch user

• First experience with row-column scanning (typically uses linear scan)
• Challenges with switch operation
• Scanning Wizard for assessing and tracking progress

Scanning Wizard Limitations

• It's not identical to user's own system
  • But we have found high correlation between SW scores and "real life" scanning
• Not intended to address issues such as appropriate language representation
• Provides limited help in actually making the changes on the user's system
  • We can help with that!

Other Ways to Measure Switch Hit Time

• Compass software (kpronline.com)
• SSPT software (aacinstitute.org)

Other Ways to Measure Scan Performance

• Compass software (kpronline.com)
• Paper, pencil, video camera

Acknowledgements

• Scanning Wizard research & development is supported by:
  • National Institutes of Health

To participate in Scanning Wizard project:

• Field study
  • How many people are currently working with a person who uses one- or two-switch scanning?
• Survey
  • scanningwizard.com
• Email hhk@kpronline.com for more info or with comments, suggestions, etc.