


Koester Performance Research

## Enhancing Efficiency for People who Use Switch Scanning

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## 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

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## 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

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## Part 1

- Review switch scanning and its challenges

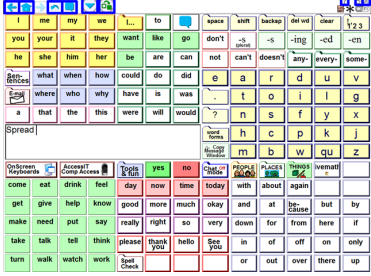
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## Single-switch Scanning

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



“Spread your envelopes out...”

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## Single-switch Scanning Example

- Baseline, subject 004:
  - Excellent switch control
  - Excellent command of layout
  - High satisfaction
  - But text entry rate (TER) surprisingly slow

TER (wpm)	1.23
Selection Errors (%)	3.61%
Timing Errors (%)	13.21%

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## 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, 1<sup>st</sup> 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

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Conceptual Step	Procedure
1. Identify problems with current switch activation	Run single-, double-, and triple-hit Switch tests in Compass. Observe errors or difficulties in activating switch, and note number of extra hits reported by Compass test. Revise switch type or location if switch activation is not consistent.
2. Gauge adequacy of current scan delay	Use results from Switch Test and the recommended scan delay and 1" open delay. (Note: the recommended scan delay is calculated as the single-hit switch-press time multiplied by 1.5.)
3. Identify problems with using switch to make scanning selections.	Run a Compass Scan Test that reflects current letter layout and settings. Note error counts in resulting report. A complementary approach is to ask user to enter text with their scanning system. Record video or make careful observations to count and classify scanning errors.
4. Accommodate any problems identified in Step 3.	Error reduction is the first focus if scanning errors exceed 25% of correct selections. Figure 3 illustrates some changes that can be considered, such as slower scan delay, manual initiation, additional dead time, or clearer scan pattern.
5. Assess success of accommodations in Step 4.	Re-measure scanning errors as in Step 3. Ideally, get scanning errors down below 25%.
6. When scanning errors are roughly below 25%, identify enhancements for efficiency.	First, establish fastest timing parameters that allow low error rate. These will come from Step 3, but may have been adjusted during the error reduction Step 4. Then, try to reduce scan steps at minimal extra cost. Consider the following, where applicable: Group organization - put letters in preferred group first - rely on letters in preferred group until word has been completed - ensure that other groups serve a useful purpose; else remove them Language features - identify first syllables - use 3 to 6 words in the list - provide enough time to search the list, e.g., with either post-selection time or manual initiation Letter layout: use frequency-based layout, unless strong reason to do otherwise <b>SCANNING</b> - make sure it's readable, with orderly progression - consider manual initiation only if errors are a problem or layout is unfamiliar - set loop count to 1; higher loop counts are generally not a good idea Dead time - identify any sources of dead time (flicker, message window, post-selection delay) - if possible, is there a good reason for it? - if not, eliminate Scanning Model Software (SMS) software simulates impact of these, but is not mandatory Timing parameters - letter layout - manual/auto hit - loop count - reduction in scanning errors

Manual steps. Fairly complicated. From Koester & Simpson, 2014. *Journal of Rehabilitation Research and Development*, 51(6): 995-1012.

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## Part 2

- Demo of Scanning Wizard software

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## 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

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## 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

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## Part 3

- What do the data mean?

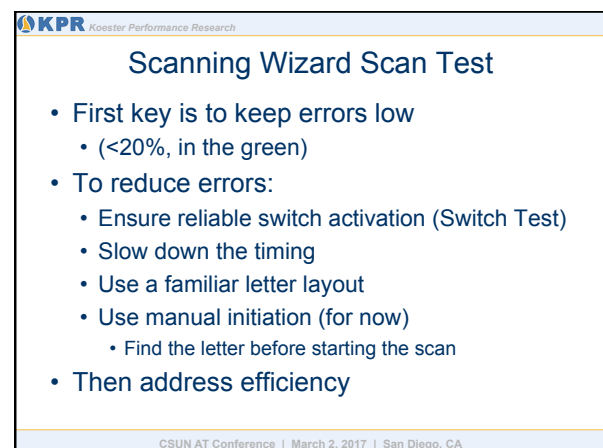
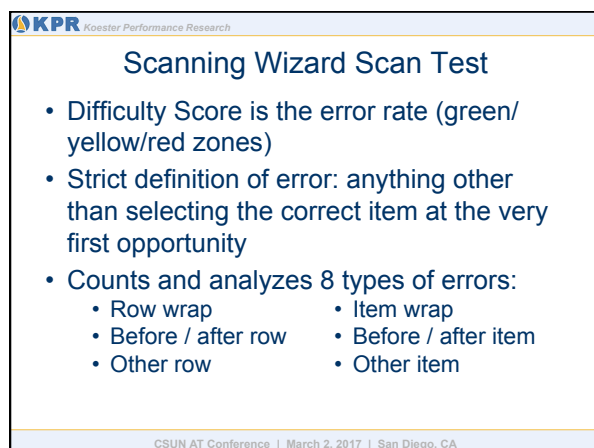
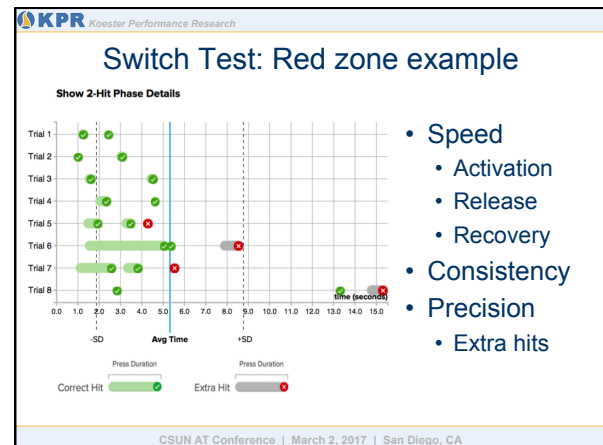
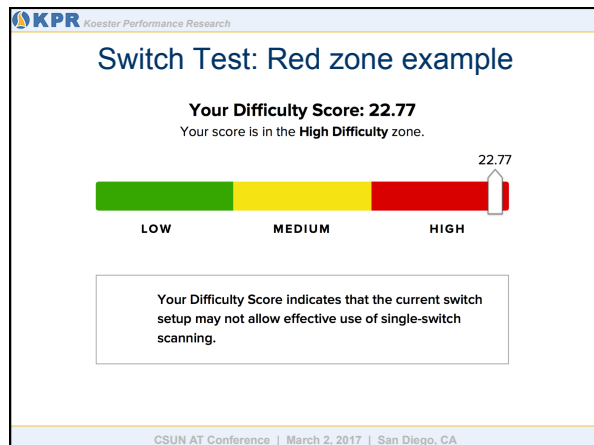
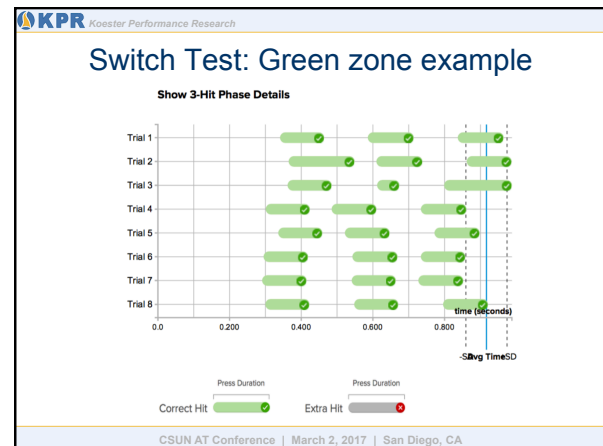
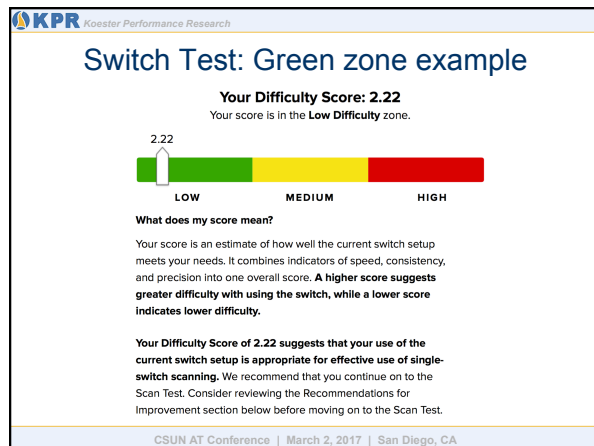
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## Scanning Wizard Switch Test

- 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

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## 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

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## Scan Test example

Test	Switch	Difficulty Score	Text Entry Rate	Item Accuracy, %
1	With ring	Green (15.8)	0.95 wpm	90%
2	Without ring	Red (76.5)	0.59 wpm	81%

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

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## Scan Test example: the “cost” of errors (switch without ring)

Time (ms)

Total Test Time Actual vs Optimal

Your Time: 5:43

Optimal Time for These Settings: 3:03

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

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## 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.

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## 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

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## 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

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## 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

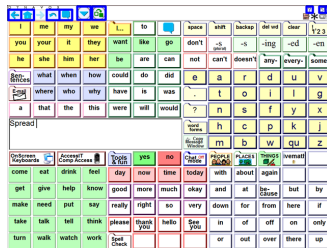
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## Part 4

- 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

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## M004 Baseline & Key SW Recs

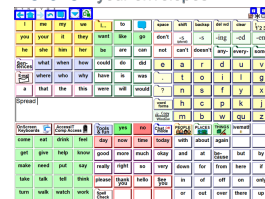


- Extra Delay: change 0.27 to 0
- Letter Layout: frequency
- Dead Time: reduce
- Word Pred: List on top, enough search time
- Char Pred: don't use
- Letters + WP block: move to 1<sup>st</sup> position, use row-col scan

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## M004's Layout Before and After:

Before: 'your envelopes'



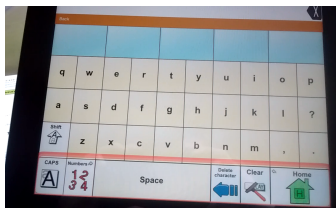
After: 'will also respect'



136% improvement in text entry rate.

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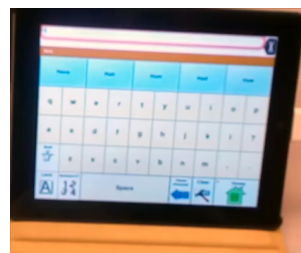
## R006 Baseline & Key SW Recs



- 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

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## R006 Baseline: AutoTap delay


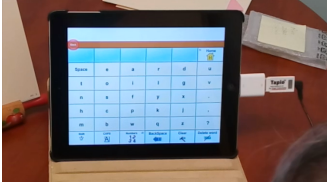


- Dead Time: reduce
  - Function rows in top positions
  - AutoTap adds post-selection delay

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## R006's Layout Before and After:

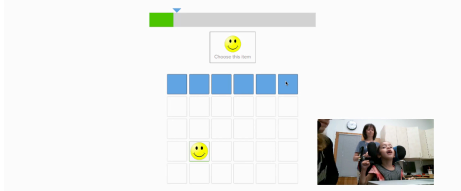
Before:  After: "Your health" 

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

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## 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

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## 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!

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## Other Ways to Measure Switch Hit Time

- Compass software ([kpronline.com](http://kpronline.com))
- SSPT software ([aacinstitute.org](http://aacinstitute.org))

## Other Ways to Measure Scan Performance

- Compass software ([kpronline.com](http://kpronline.com))
- Paper, pencil, video camera

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## Acknowledgements

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

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## 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](http://scanningwizard.com)
- Email [hkh@kpronline.com](mailto:hkh@kpronline.com) for more info or with comments, suggestions, etc.

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