# Modeling non-Expert Text Entry Speed on 12-Button Phone Keypads

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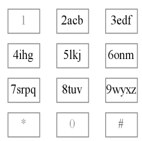
## Keypad Layouts

Traditional layout (used by Multitap, T9 and others)




Layout used by Less-Tap

## Phone Text Entry Techniques

**Multitap** (1.95 keystrokes per character)

press a key repeatedly until letter appears

**Less-Tap** (1.44 KSPC)

one keystroke for most frequent letters on each key…

**T9** (1.0072 KSPC)

possible interpretations of key sequence compared to words in dictionary

## Models and Text Entry

Models help developing new text entry methods. However, existing models predict only *expert* text entry rates. Since the notion of *expert text message user* is unrealistic, the existing models do not agree with experimental results for novices

### Existing Models:

#### Keystroke Level Model (Card et al. 1980)

– General (typing, mouse pointing, drawing etc.)

– Predicts *execution time* by accounting for times of different actions

key **press**, **pointing**, **homing**, **drawing**, **mental** preparation time, **system response** time, etc.

– Not specific enough – only a framework

#### Fitts' Law Based Model (Silfverberg et al. 2000)

– Two parts: *movement model*, based on Fitts' law, and a *linguistic model*

– Only for "experts"!

## Non-Motor Actions in Text Entry

– Re-reading phrase to be entered

– Figuring out next letter (spelling out word)

– Determining which button to press and how many times

– Deciding if *second* key press is required

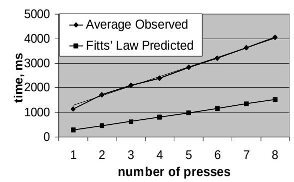
– If pressing key more than twice, keeping count of number of presses made

– [Verifying the result]

The following figure shows the Times for Various *Multiple* Presses in multipress methods and demonstrates the significance of considering cognitive components in a model.

**Figure1: Time for** Various ***Multiple*** **Presses in multipress methods**

Data obtained from novices [4]. Note the different slope, and the linearity beyond 2.




## New Movement Model (time to enter a character)

### Multi-press Input Methods

3 possible cases:

1 press ($N_1$ , $N_2$ = 0)

2 presses ($N_1$ = 1, $N_2$ = 0)

3 or more presses ($N_1$ = 1, $N_2$ > 0)

$$T_{char} = D_{init} + T_{Fitts} + N_1 \cdot (D_{repeat} + T_{repeat}) + N_2 \cdot (D_{count} + T_{repeat}) + [T_{timeout}]$$

### Predictive Input Methods

Since the presses of NEXT are rare (<1% of total), assume $D_{init}$ is the same as in multi-press methods

$$T_{char} = D_{init} + T_{Fitts}$$

## Completing and Verifying the Model

Combine the Movement Model with a Linguistic Model (letter digraph frequencies $p_{ij}$):

$$T_{char\_in\_corpus} = \Sigma\Sigma\, (p_{ij} \cdot T_{char\ ij})$$

Conversion to words per minute:

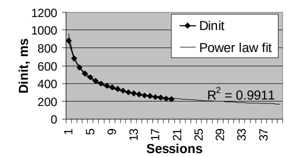
$$WPM = (1/T_{char\_in\_corpus}) \cdot (60/5)$$

Comparison with Experimental Data:

| Technique | Model by Card et al. [1] | Model by Silfverberg et al. [5] | Experiment 1 [2] | Experiment 2 [4] | New Model |
|---|---|---|---|---|---|
| *Multitap* | 18.35 | 22.3 | 7.98 | 7.15 | 6.97 |
| *Less-Tap* | 23.47 | 26.8 | | 7.82 | 8.01 |
| *T9* | 24.97 | 40.6 | 9.09 | | 10.07 |

## Learning Effect

Naturally, $D_{init}$ should decrease with learning. Based on results for *Multitap* in [3] (0.5 hrs per session, 20 sessions), we have compiled the following graph. Note that $D_{init}$ is still 200 ms after 15 hours.




## Summary

New predictive model for text entry speed on 12-button telephone keypads

– also predicts mental overhead

– values computed by the model are reasonably consistent with experimentally observed results

– can quite accurately predict performance of novice users

– potential prediction of learning

REFERENCES

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5. Silfverberg, M., MacKenzie, I. S., & Korhonen, P. (2000). Predicting text entry speeds on mobile phones. *Proceedings of the ACM Conference on Human Factors in Computing Systems – CHI 2000*, pp. 9-16. New York: ACM.