# Chapter 1.19
# Assessing Human Mobile Computing Performance by Fitts' Law

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## ABSTRACT

*This chapter describes the interdependence between locomotion while walking and human input performance in mobile Human-Computer-Interaction (HCI). For the analysis of the interdependence, appropriate performance measures, for example, subjective workload ratings or error rate, have to be applied. The way in which Fitts' law can enhance the analysis is explained. In an experiment with n=18 participants, the general indices of performance (bits per second) were measured while standing and walking with constant speed (2, 3.5, 5 km/h). Results show a significant increase of the error rate and a significant decrease of the index of performance for increased walking speed. Subsequent regression analyses allow quantitative estimation of these effects. The results show a division of the interdependence in two parts, based on the difficulty of the input task; they define threshold values for accuracy of user input. These values can be applied for the implementation and design of future Graphical User Interfaces (GUI) for mobile devices.*

## INTRODUCTION

Flexibility, variability, and mobility are topics of growing importance for today's society. This trend affects work with modern IT-systems (Goth, 1999): There is a growing availability and market for portable and mobile devices. They facilitate ubiquitous information access throughout customers' visits, while traveling, wandering through a production plant, or for working at home offices. It is expected that the market share of telecommuting and according devices for information access will increase. IT-developers and providers share this optimistic estimation of the growth potential (Business Week, 2006). They assume that today's mobile computers already have a market share of 40% (Microsoft, 2006). This requires special information infrastructures and personal mobile devices.

Common portable and mobile devices are notebooks, tablet-PCs, personal digital assistants (PDA), and so-called smartphones, which are cellular phones with enhanced functionality. For applications while standing or on the move (walking), when no tables or horizontal racks are available, weight and size issues are most relevant. They reduce the available devices to small, lightweight PDAs and smartphones.

PDAs and especially smartphones often rely on direct keypad input. Keypads allow a fast selection of a limited number of special functions. However, this is hardly sufficient for a more complex interaction. In that case, a point-and-click procedure is applied, which requires special touch-sensitive screens and pens for HCI and a WIMP-metaphor (windows, icons, menus, and pointer) is implemented (well known from most desktop systems) for the graphical user interface (GUI). Required training is reduced and most users can instantly use the device. Text input is facilitated by a miniaturized (virtual) keyboard or handwriting recognition. The keyboard solution displays a miniaturized QWERTY-keyboard and keys are selected by pointing and clicking. Handwriting recognition requires a stable position of the base for a precise text input. In both cases, pointing and pointing accuracy are essential.

Most of today's GUIs of mobile devices are simply adapted from stationary desktop systems. Characteristics of mobile use and their effects have not been considered (Berteksen & Nielsen, 2000; Crowley et al., 2000; Danesh et al., 2001; Dunlop & Brewster, 2002; Lumsden & Brewster, 2003; York & Pendharkar, 2004). However, effects of mobility on input performance are likely because of various reasons. First, walking itself causes distracting movements and forces on the arm and hand system. This leads to reduced input performance. Second, pointing and moving are two concurrent tasks, both of which require attention and processing resources. As a matter of fact, performance in either of the two tasks is reduced. This can be observed when users either stop when working with a mobile device or quit working with the device.

These observations show an overall need for the inclusion of general ergonomic findings, results, and models to optimize HCI and the according GUI on the move. As a first step, valid measures have to be analyzed in order to quantify input performance under different mobile conditions. They must be sensitive enough to detect even small effects. Based on these measures, subsequent analyses will give more detailed recommendations for the design of the GUI. This way a real mobile use can be achieved.

## ASSESSING INPUT PERFORMANCE OF MOBILE DEVICES

Using computers on the move is a combination of walking and HCI. There are several reasons to assume interdependences between both. The extent of these interdependences varies with the degree of mobility. For quantifying it is necessary to identify and measure HCI performance correctly. There are different methods for doing

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