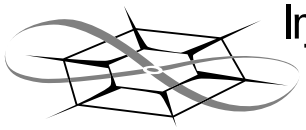
The University of Kansas



Information and Telecommunication Technology Center

Technical Report

# First-Time Usability Testing for Bluetooth-Enabled Devices

Jim Juola and Drew Voegele

ITTC-FY2005-TR-35580-02

July 2004

Project Sponsor:
Bluetooth Special Interest Group

# Abstract

We conducted several surveys of college students' usage patterns and familiarity with popular devices used in telecommunications and computer applications, such as desktop computers, laptops, mobile phones, hand-help devices, digital cameras, and digital headsets. In addition, we conducted a first-time use study of Bluetooth-enabled devices. In the study, 48 undergraduate participants each worked with three pairs of devices that were presented just as they would appear "out of the box." They were assigned a different task to complete with each pair, including transfering calendar entries, pictures, and personal contact information between devices using Bluetooth wireless technology. Although the subjects were generally unfamiliar with both the specific devices used and Bluetooth in general, most tasks were completed within an arbitrary 40-min limit, and the average task completion time was about 15 min. There were notable differences between specific devices and device pairings in objective behavioral measures as well as in subjective impressions of usability. Both objective and subjective measures resulted in recommendations for changes and standardization in device design and features.

# Contents

# 1 Introduction

The initial phase of the current set of studies was concerned with determining the interoperability of a large sample of Bluetooth-enabled telecommunications and computer devices. Within this set, some devices and pairs were found to be more-or-less easy to use, readily accepted Bluetooth connectivity, and facilitated rapid transfer of information from one device to the other. Other devices and pairings showed consistent or intermittent failures that made their use difficult or impossible for our test team. In the second phase of the current research, some devices were selected for inclusion in first-time use tests with naive participants. Devices that proved difficult to use and pairs that performed relatively poorly in the interoperability tests were specifically excluded from the first-time use testing. The goal of the research was to measure success rate, efficiency of operation, and subjective impressions of specific devices and pairs by people unfamiliar with Bluetooth wireless technology.

To begin the second phase of the research, over 100 college students were given a survey that assessed their usage patterns and reported levels of expertise with common computer and telecommunications equipment. The survey data confirmed that while the average undergraduate is quite familiar with devices such as desktop computers and mobile phones, and quite capable of using e-mail and other telecommunications software, they are relatively unfamiliar and naive with respect to local wireless communications systems such as Bluetooth. The survey also confirmed that there are wide variations in device usage patterns and technological expertise within the undergraduate student community.

A different sample of 48 undergraduates was then selected for the first-time use study. They were each given six different devices, one pair at a time, and asked to turn them on, attempt to establish a Bluetooth connection between them, and execute a simple transfer of information task using the Bluetooth connection. Their attempts were monitored and recorded, as were the times for successful connection and task completion. They then filled out surveys of their impressions of the usability of each device and their performance in the Bluetooth transfer task. Just as the initial surveys showed that there are large differences among individuals in terms of their familiarity and expertise with device technology, the first-time use research showed large differences between objective and subjective measures of device usability and pair communications. These results are reported in the following sections of this report, along with a conclusion that makes recommendations for how device designs might be standardized for maximum usability. Suggestions are also made for how Bluetooth technology could be implemented in a standard way in such devices to promote the usability and acceptance of wireless communications.

# 2 Initial Survey

The following survey was given to 127 undergraduate students at the University of Kansas at the beginning of the spring semester, 2004. The sample included 92 students enrolled in a lower-level psychology class and 35 students enrolled in an introductory course in engineering.

## 2.1 Questionnaire: Please respond to each of the items below to the best of your ability.

1. Below is a list of electronic devices available on the market today. For each one, check ( ✔ ) the appropriate box to indicate the frequency that you most typically have used each such device over the past six months.

Estimated Frequency of Use – Past 6 Months

| | Never<br>1 | A few times a month<br>2 | About every week<br>3 | A few times a week<br>4 | Most days<br>5 | Some time every day<br>6 | Every day for hours<br>7 |
|---|---|---|---|---|---|---|---|
| Desktop | | | | | | | |
| Laptop | | | | | | | |
| Mobile phone | | | | | | | |
| Head set | | | | | | | |
| Hand-held device (PDA) | | | | | | | |
| Printer | | | | | | | |
| Digital camera | | | | | | | |
| Portable music player | | | | | | | |
| Human inter-face device (mouse, key-board, etc.) | | | | | | | |

***For the devices above that you have used the most, please indicate by placing a check mark ( ✔) in one of the boxes on the following scales to indicate your best response to each item.***

2. I am familiar with the design, technology, and some details of the hardware involved.

I have no idea I have a general idea I know a lot about

of how they work | of how they work | the products' technology

1 2 3 4 5 6 7

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |

3. I am familiar with the interface that controls the devices that I use most often.

I have no idea how to use them | I understand some of the interfaces | I am very familiar with them

1 2 3 4 5 6 7

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |

4. I am familiar with the software that controls the devices that I use most often.

I have no idea how it works | I understand some of the software | I could write it myself

1 2 3 4 5 6 7

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |

5. I have an understanding of wireless technology in general

I have no idea how it works | I understand the important principles | I have a deep understanding of several wireless technologies

1 2 3 4 5 6 7

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |

6. I am familiar with Bluetooth technology

I have no idea how it works | I know what it's used for, but not how it works | I am very familiar with how it works

1 2 3 4 5 6 7

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |

7. Are you familiar with Bluetooth technology, and what is your understanding of how well it works?

Never heard of it | I believe that it works sometimes | I believe that it works very well

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| | | | | | | |

8. Below is a list of functions available for technical devices available on the market today. For each one, check the appropriate box to indicate the frequency that you typically have engaged in each activity over the past six months.

Estimated Frequency of Use – Past 6 Months

| | Never | A few times a month | About every week | A few times a week | Most days | Some time every day | Every day for hours |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Programming | | | | | | | |
| Game playing | | | | | | | |
| e-mail | | | | | | | |
| e-chat rooms | | | | | | | |
| Mobile phone calls | | | | | | | |
| Printing | | | | | | | |
| Digital photography | | | | | | | |
| Portable/digital Music playing | | | | | | | |
| Instant messaging | | | | | | | |
| Downloading programs | | | | | | | |
| Downloading music | | | | | | | |
| Send/receive text messages | | | | | | | |

## 2.2 Initial survey results:

The mean values of the responses for each item were determined for students in the psychology class and for those in the engineering class separately. It was decided to use a

two-tailed *t*-test with a conservative *p*-value of .01 to test for differences between mean responses for the two student groups. Significant differences are marked with an asterisk (*) and the higher values are indicated in bold in the table below.

| | Mean response for Psychology students | Mean response for Engineering students | t-value |
|---|---|---|---|
| 1. Usage frequency | | | |
| Desktop | 5.3 | **6.6** | 7.1 |
| Laptop | 3.2 | 3.0 | <1 |
| Mobile phone | **5.8** | 4.7 | 2.64* |
| Headset | 2.6 | 3.2 | <1 |
| Handheld device | 1.7 | 1.8 | <1 |
| Printer | 3.9 | **5.0** | 4.04* |
| Digital camera | 1.9 | 2.3 | <1 |
| Portable music player | 3.5 | 3.1 | <1 |
| Human interface device | 5.8 | **6.7** | 7.04* |
| 2. Familiarity ratings | | | |
| Hardware | 4.1 | **5.1** | 3.24* |
| Interface | 4.5 | 4.9 | 1.27 |
| Software | 4.0 | 4.6 | 2.21 |
| Wireless technology | 3.7 | 4.3 | 2.29 |
| Bluetooth technology | 1.4 | **3.4** | 6.24* |
| How well it works | 1.4 | **3.9** | 7.52* |

3. Function frequency

| | Mean response for Psychology students | Mean response for Engineering students | t-value |
|---|---|---|---|
| Programming | 1.4 | **4.7** | 12.52* |
| Game playing | 3.0 | 3.5 | 1.19 |
| e-mail | 5.3 | **6.1** | 4.33* |
| e-chat | 1.3 | **2.9** | 4.55* |
| Mobile phone calls | **5.7** | 4.4 | 3.03* |
| Printing | 4.2 | **5.2** | 3.65* |
| Digital photography | 2.0 | **2.8** | 2.73* |
| Portable music playing | 3.6 | 3.8 | <1 |
| Instant messaging | 3.4 | **4.6** | 2.82* |
| Downloading programs | 2.4 | **4.4** | 6.44* |
| Downloading music | 2.7 | **3.9** | 2.90* |
| Send/receive text messages | 2.9 | 3.4 | 1.30 |

## 2.3 Survey Conclusions

In summary, engineering students make more use of desktop computers (but not laptops), printers, and human interface devices, whereas psychology students make more use of mobile phones. Engineering students are more familiar with device design, technology, and hardware, and are more familiar with and have more faith in Bluetooth technology than do psychology students. Finally, engineering students spend more time writing and downloading programs, using e-mail, printing, taking digital photographs, and downloading music, whereas psychology students spend more time talking on mobile phones.

# 3 First-time use study

## 3.1 Devices selected for first-time usability study.

Of all the devices made available for interoperability testing, a small subset was chosen for usability testing based on two criteria: (1) they represented the most commonly used devices enabled with Bluetooth technology, and (2) they were judged to be easy to use by the interoperability testing team and succeeded quickly and easily in making Bluetooth connections with other devices in the first phase of the current study. The actual devices chosen for usability testing are listed below:

| Hand-held devices: | Mobile phones: |
|---|---|
| MP1 (dual-device) | MP3 |
| HH2 | MP6 |
| HH4 | MP4 |
| HH5 | MP2 |
| **Head sets:** | **PCs: Integrated and Adapters:** |
| HS1 | PC1 |
| HS8 | PC2 |
| HS9 | |
| HS7 | |

## 3.2 Device pairs and tasks selected for usability study.

The pairings chosen were reflective of the pairs that most likely would be used by consumers in ordinary situations for wireless communication. This resulted in the six pair types shown in the table below. The task assigned to each pair was similarly chosen to represent common uses for wireless technology with the devices in each pair.

| Device pair | Task |
|---|---|
| Mobile phone - headset | Place a call to a land line and talk with the headset |

| | |
|---|---|
| Mobile phone - mobile phone | Create a calendar entry on one phone (name, date, time, purpose) and send it to the other phone |
| Mobile phone - PC | Locate a specific picture on the phone and send it to the PC |
| Mobile phone - hand held | Create a contact entry on the phone (name, phone no. and e-mail address) and send it to the hand held |
| Hand help - PC | Locate a specific picture on the hand held and send it to the PC |
| Hand held - hand held | Create a contact entry on one hand held and send it to the other |

## 3.3 Participants and Procedure

Participants were 48 University of Kansas student volunteers, 24 selected from undergraduate psychology classes, and 24 from undergraduate engineering classes. They were randomly assigned to two groups with the constraint that each group was made up of half engineering and half psychology students. Each person filled in several questionnaires and was given three pairs of devices and tasks to accomplish. A limit of 40 minutes was given for each task.

## 3.4 Test Groups

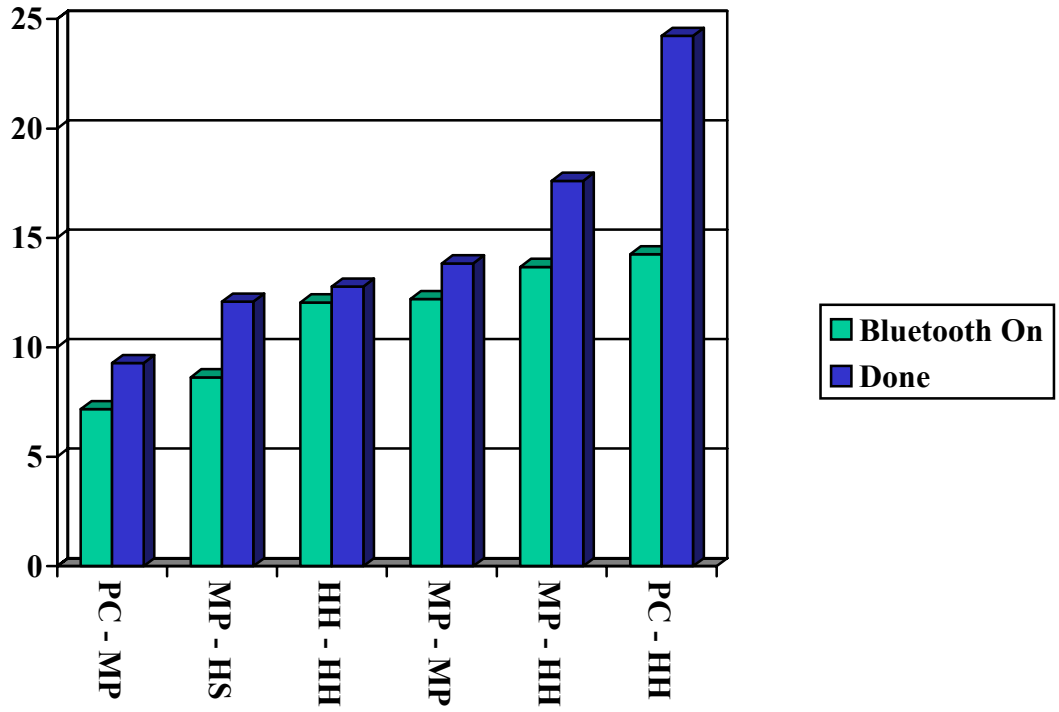
| *Group 1* | *Group 2* |
|---|---|
| HH - PC (picture transfer) | MP - HS (talk via HS) |
| MP - HH (contact transfer) | MP - PC (picture transfer) |
| MP - MP (calendar entry transfer) | HH - HH (contact transfer) |

Thus, each participant performed three different tasks requiring a different type of information transfer using Bluetooth technology, using a total of six different devices. For the contact and calendar entry transfer tasks, a written description was provided that had to be entered into one of the devices by hand before it could be transferred to the other device. The experimenter recorded the times to turn on the devices, the time to achieve a Bluetooth connection, and the time to complete the task. Other obvious behaviours, such as referring to the manuals or looking for information on help menus were also recorded. When each pair was completed, a questionnaire was administered and an additional questionnaire was given at the end of the third task.

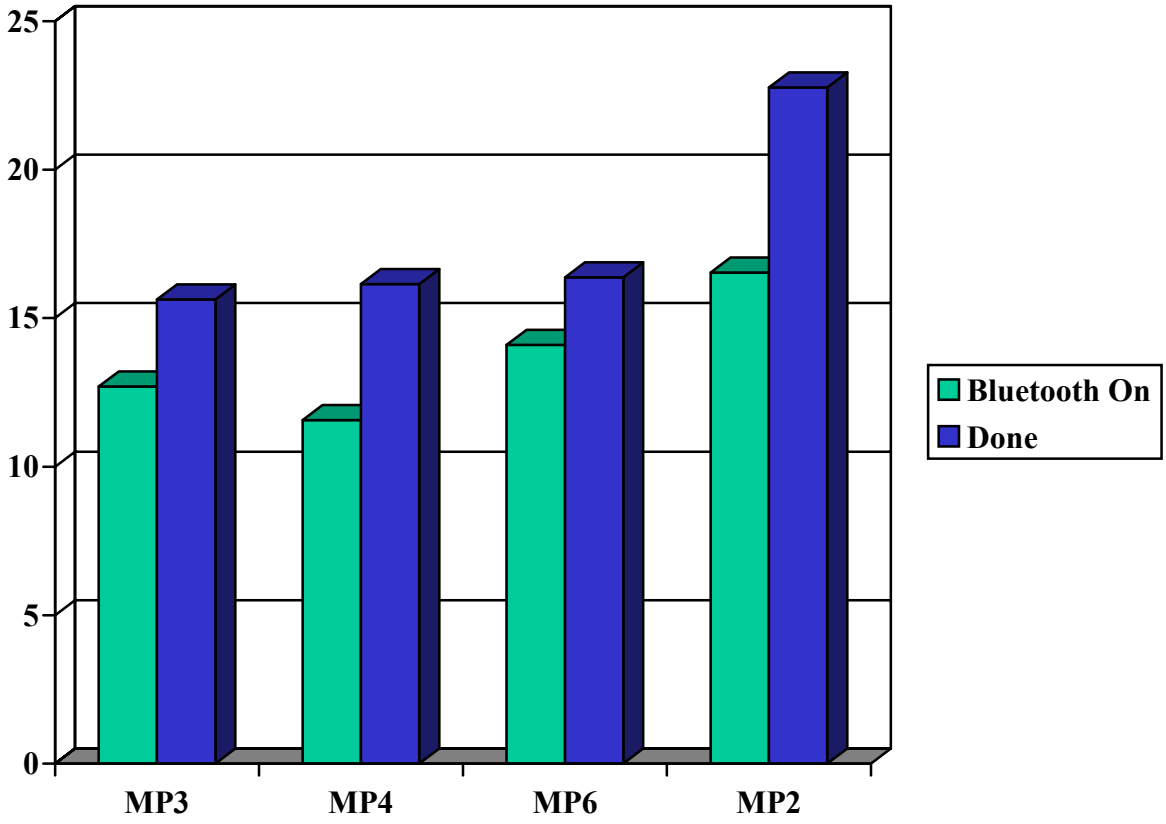
# 4 Results

The main objective measures were the times recorded to achieve a Bluetooth connection between each pair of devices, and the times needed to complete the task successfully. In addition, the number of failures (out of 24 individuals) to complete the task within the arbitrary limit of 40 min was recorded. The median times in min and sec and the number of failures are shown in the table below, and the times are plotted on the graph on the next page.

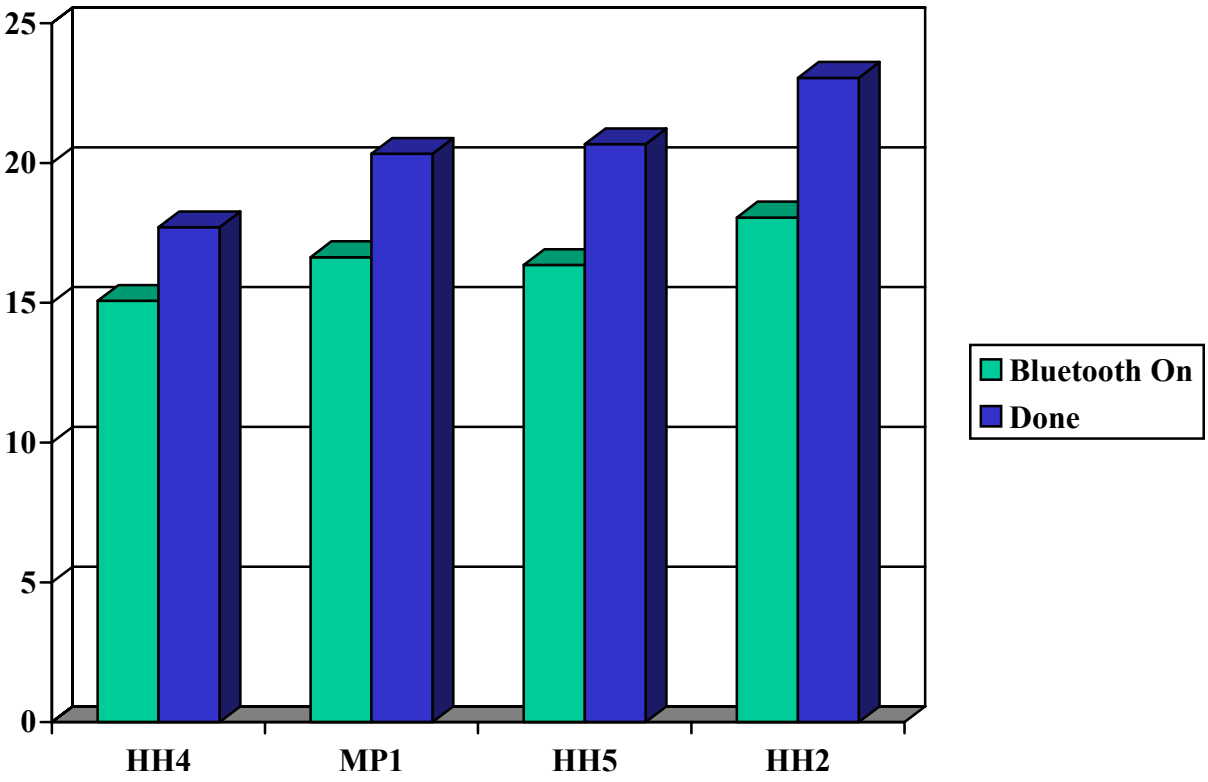
| *Device Type Pair* | *Time to Connect* | *Time to complete* | *No. of failures* |
|---|---|---|---|
| Mobile phone - PC (picture) | 7:10 | 9:17 | 4 |
| Mobile phone – headset (talk) | 8:38 | 12:05 | 5 |
| Hand held - hand held (contact) | 12:03 | 12:46 | 0 |
| Mobile phone - mobile phone (calendar) | 12:12 | 13:50 | 2 |
| Mobile phone - hand held (contact) | 13:40 | 17:36 | 4 |
| Hand held – PC (picture) | 14:15 | 24:14 | 7 |



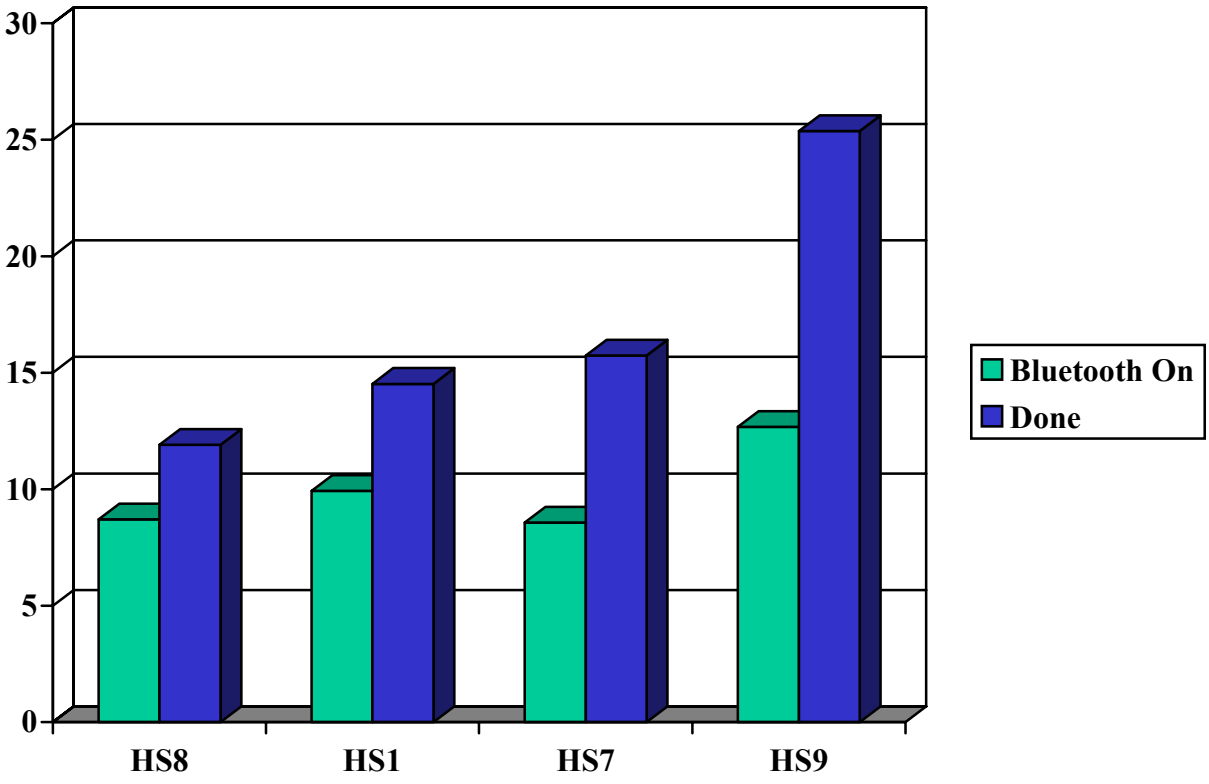

**Median times (min) to connect via Bluetooth and to complete the transfer task**



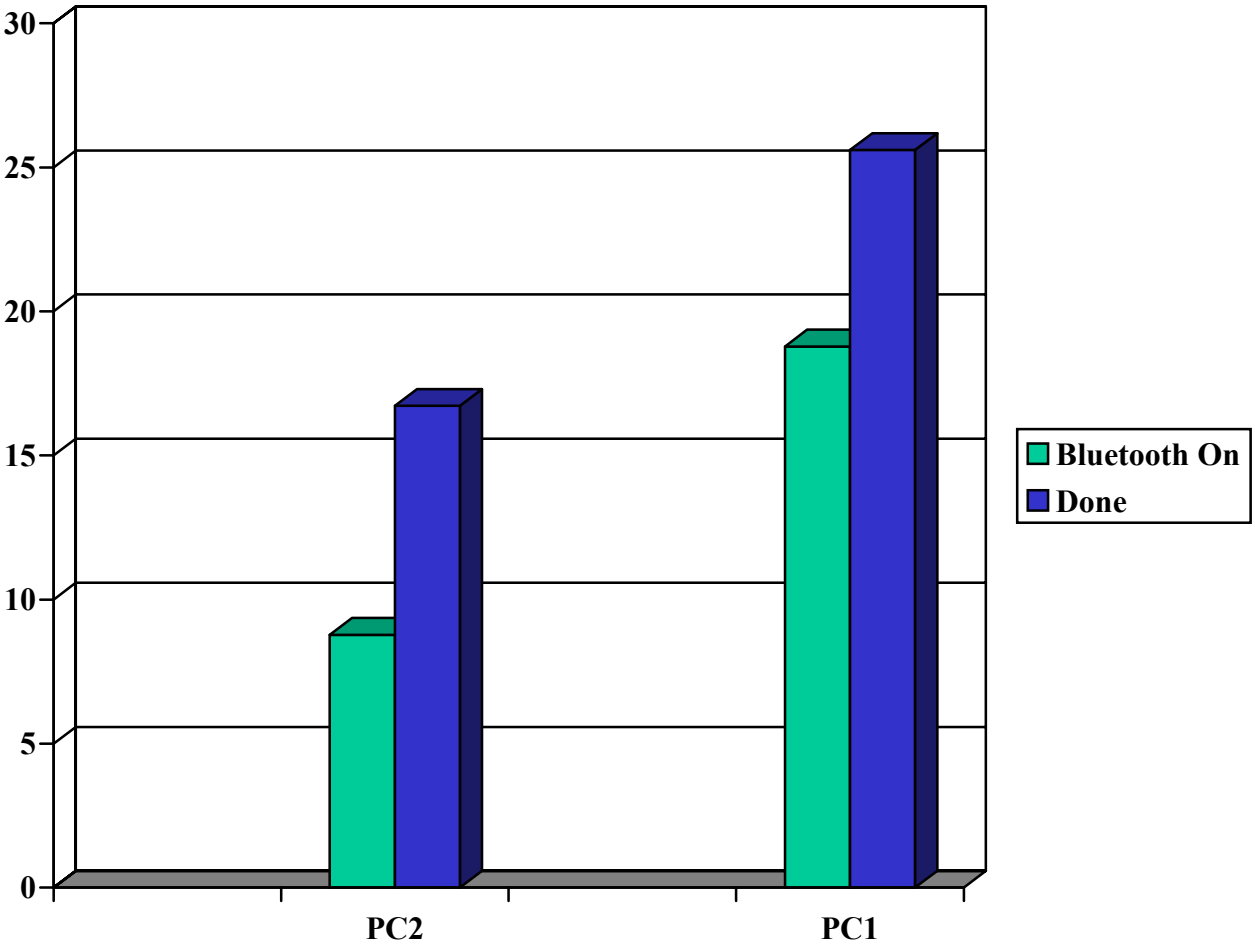

**Mean connection and completion times for mobile phones**




**Mean connection and completion times for hand held devices**




**Mean connection and completion times for headsets**




**Mean connection and completion times for PCs**

## 4.1 Subjective rating scales.

In addition to the objective measurements of Bluetooth connection and task completion times, questionnaires were administered after each task and at the end of the third task. These questionnaires asked for ratings, on a one to five scale, of satisfaction with the devices and with the Bluetooth communication system. These data are presented in tables below.

## 4.2 Summary of Subjective Measurements of User Satisfaction

*1 = disagree strongly; 5 = agree strongly*

| | |
|---|---|
| 1. I enjoyed working with the devices | 4.10 |
| 2. I enjoyed trying to get Bluetooth to work | 3.81 |
| 3. I was impressed with the wireless technology | 4.08 |

4. I was distressed with the difficulty of getting things to work 2.77
5. I would like to use Bluetooth technology at home 4.00

## 4.3 Subjective Ratings of Usability

*1 = impossible; 7 = very easy, worked on the first try*

| Device | Alone | In a pair |
|---|---|---|
| PC1 | 4.9 | 3.5 |
| PC2 | 5.6 | 5.2 |
| MP1 (dual device) | 4.6 | 4.4 |
| HH2 | 5.0 | 4.0 |
| HH4 | 5.4 | 4.5 |
| HH5 | 5.2 | 4.9 |
| MP3 | 5.5 | 4.8 |
| MP6 | 5.2 | 5.1 |
| MP4 | 4.5 | 4.6 |
| MP2 | 4.3 | 4.2 |
| HS1 | 3.7 | 4.2 |
| HS8 | 4.7 | 5.0 |
| HS9 | 5.2 | 3.7 |
| HS7 | 5.2 | 4.7 |

## 4.4 User Suggestions

In addition to the rating scales, open-ended questions were asked of the participants about how the devices themselves or the Bluetooth features might be improved to facilitate usability. The main suggestions and comments are summarized below.

Bluetooth:

- Try to locate and correct causes of occasional unexplained failures
- Standardize menus, icons, locations, and terminology across devices
- Make the radio on/off setting apparent or turn it on automatically when sending

Hand helds:

- Emphasize similarity to Windows
- Make stylus and its use more obvious

PCs:

- PC2 sometimes seems to corrupt transmitted data
- PC1 should have all Bluetooth options available in the wizard
- Received files should be immediately accessible

# 5 Conclusions

- Engineering and psychology undergraduates represent a population of future Bluetooth users, and they also represent a range of expertise and experience with technology.
- First-time users of various devices can usually achieve a Bluetooth connection and complete a simple transfer task within about 15 minutes, although there is considerable variation between both users and devices are some notable failures.
- The users generally express favorably attitudes toward the devices and Bluetooth technology and would be willing to use them at home.
- There is room for improvements in device design, software, and implementation of Bluetooth technology.