HP Ergonomics R&D Program
Workstation Ergonomics: Current Research Results from Hewlett Packard

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Cynthia Purvis, Co-Director, Ergo R&D Program Office
Hewlett-Packard Company, Office of Strategy & Technology
Neck and shoulder pain among computer users has reached startling proportions

- According to research funded by governments around the world, it is clear that neck and shoulder discomfort among computer users has reached startling proportions

  - Wahstrom et al. (2004) found that 58% of women and 31% of men reported pain in their neck or between their shoulder blades
  - Brandt et al. (2004) found that among both genders 36% reported neck pain
  - Gerr et al. (2002) found that 34% reported neck/shoulder pain and stiffness—60 times greater than the reported incidence of carpal tunnel syndrome
Moreover, 50%-90% report eye and vision discomfort

- Research indicates 50-90% of computer users report eye and vision discomfort such as eye strain, dry eyes, eye irritation and blurred vision (Sheedy, et al., 2003; Yan, et al., 2008)

- The HP Ergonomics R&D Team responds to these alarming rates by funding over a decade of pioneering research to better understand the influence of computer monitor placement on neck posture, visual fatigue and perceived comfort
Workstation Ergonomics MYTHS

MYTH! One set up fits all people

MYTH! One set up fits all tasks

MYTH! One set up is comfortable for all body parts at all times

MYTH! “Set it and forget it” (especially in terms of displays)
Let your comfort be your guide

– You do your best when you’re not hurting
– Listen to your body & keep adjusting
  • Move, move, move
    – Upright to reclined
    – Seated to standing
  • Breathe, breathe, breathe
  • Blink, blink, blink
  • Take frequent short breaks
– Exercise, Exercise, Exercise
  • Especially in the neck and shoulder area
THE MARKETPLACE FOR COMFORT

THE CURRENT UNCOMFORTABLE CUSTOMER EXPERIENCE

“THE TURTLE”
Don’t Be a Turtle!
(forward leaning posture)

What field observations showed computer users are doing most of the time
(Dowell, et al., 2001)
NOT! “Turtle necking” (neck craning)
Pay attention to your posture & any discomfort in your:

- Eyes
- Neck
- Shoulders
- Hands
- Arms
- Back
Computer users are doing “The Turtle” at all stages of life.

“The eyes lead the body”
Dr. Jim Sheedy, Director, Vision Performance Institute

K-5 and university turtles

“The eyes always win”
Eileen Vollowitz, Physical Therapist

desktop & notebook turtles

multifocal lens wearing turtles
Computer users are getting older

– By 2012 the US labor force is projected to have a median age of 41.4 years
  • In 2011, 78 million baby boomers in the US turn 65
  • 12% of the US population is now 65 or older

– Near the age of 40 human eyes begin to lose the ability to focus on close targets (presbyopia)
  • Multi-focal or progressive addition lenses (PALs) are often prescribed to correct for presbyopia
Two Field Observation Studies Regarding Display Placement for Multifocal Lens Wearers

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Objectives

• **Study 1:** To assess display support preferences of older computer users wearing progressive addition lenses (PAL)

• **Study 2:** To compare the display placement needs of multifocal lens wearers and young eyed (pre-presbyopic) adults
Field Study #1

- 10 participants
  - 4 men & 6 women
  - Age: 45-64
  - All Progressive Addition Lens (PAL) wearers

- 5 display conditions:
  - Notebook, Riser, Arm, HP “Dual Hinge” Display, HP “Column” Display

- All conditions except notebook included an external keyboard and mouse

- Participants experienced each display condition for 1 week
  - Measurements and surveys completed W-F of that week
Field Study #1
Bottom Line

– PAL wearers exhibited a preference to position the screen low

– The Arm and HP Advantage Monitors (dual-hinge design) received the highest preference rankings
  • Allow the greatest range of adjustability, particularly low

– Notebook Riser Accessory is not an appropriate solution for PAL wearers
  • Riser had the lowest preference rankings
  • Riser removed by 3 participants
  • More neck discomfort with Riser over all
  • Resulted in the smallest arc angles (12.5 ArcMin)
    – Display height and viewing distance are correlated
Field Study #2

- 47 participants (29 M, 18 F)
  - 24 pre-presbyopes (mean age 31.2)
  - 23 presbyopes (mean age 54.3)

- All participants received an 18.5” widescreen display mounted on a display arm
  - Notebook users received a mouse and keyboard in addition to the display

- Participants experienced the display for 4 consecutive work days (M-Th)
  - Measurements taken W-Th morning and afternoon
  - Displays moved out of position after each morning measurement
Field Study #2

Bottom Line

– Multifocal wearers selected a significantly lower display placement than pre-presbyopes
  • Lower screen height
  • Higher eye/screen angle
  • Higher screen tilt
– No differences in preferred viewing distance
– No difference in arc angle

<table>
<thead>
<tr>
<th>Measure</th>
<th>Pre-Presbyope Mean (Range)</th>
<th>Multifocal Mean (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display Height</td>
<td>11.82&quot; (7.0-16.6&quot;)</td>
<td>8.85&quot; (5.4-14.6&quot;)</td>
</tr>
<tr>
<td>Screen Tilt Angle</td>
<td>9.6° (-3° to 22°)</td>
<td>16.4° (2° to 34°)</td>
</tr>
<tr>
<td>Eye/Screen Angle</td>
<td>13.7° (2° to 26°)</td>
<td>21.4° (7° to 34°)</td>
</tr>
<tr>
<td>Viewing Distance</td>
<td>25.8&quot; (16.5-40.25&quot;)</td>
<td>26.4&quot; (20.1-38.6&quot;)</td>
</tr>
<tr>
<td>Arc Angle</td>
<td>14.6 min (7.4-25.4)</td>
<td>14.8 min (8.4-25.4)</td>
</tr>
</tbody>
</table>
Field Study #2
Bottom Line

- Average arc angle for both groups is below the minimum recommended by ANSI HFES 100 2007 and ISO 9241-303
  - Only 30% of the participant observations subtended the suggested minimum 16 minutes of arc
  - Only 5% met or exceeded the recommended 20 minutes of arc

<table>
<thead>
<tr>
<th>Group</th>
<th>Text Size (mm)</th>
<th>Arc Angle (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Range</td>
</tr>
<tr>
<td>PP</td>
<td>2.70</td>
<td>2.0 - 3.8</td>
</tr>
<tr>
<td>MF</td>
<td>2.85</td>
<td>2.0 - 4.8</td>
</tr>
</tbody>
</table>

Research indicates 50-90% of computer users report eye & vision discomfort
HP Ergonomics R&D Program
Office
Display Placement Recommendations
Study #2 Results
“Young-eyed” adults compared to multifocal wearers

Users who wear multifocal lens (bifocals, trifocals or progressive addition lenses) view the display ~3” lower and with ~6.8° more tilt (on average) than users with “young” eyes (pre-presbyopes)
Ergo R&D Monitor Adjustability Recommendations
High/low for “young eyed” pre-presbyopes

How High = Upper edge of active screen area at highest point of display adjustment
How Low = Bottom edge of active screen area at lowest point of display adjustment
Ergo R&D Monitor Adjustability Recommendations
High/low for multifocal wearers
HP Ergo R&D Program Office
Display Placement Recommendations

- **How High?**
  - Upper edge of active screen area at highest point of display adjustment
  - 15.8" (39.7 cm)
- **How Low?**
  - Bottom edge of active screen area at lowest point of display adjustment
  - 2.6" (6.6 cm)
- **How Close?**
  - Zero is aligned with home row
  - 5.0" (12.7 cm)
- **How Far?**
  - Zero is aligned with home row
  - 15.8" (40.1 cm)

**Best**
- 50.8 cm
- 3.3 cm
- 12.7 cm
- 40.1 cm

**Good**
- 44.7 cm
- 6.6 cm
- 20.1 cm
- 33 cm

HP Confidential
Notebooks locked at CLOSE/LOW placement

Where the eyes go, the body will follow
Notebook with Riser:
VERY HIGH to TOO-FAR & LOW

Study #1 results:
Riser resulted in the smallest arc angles & least preferred by multifocal wearers
HP Ergonomics R&D Program Office

What HP is teaching customers of all ages
"Revolutionizing how we view monitors"

- HP research findings challenge the conventional “eye-level” rule of thumb
- This position may better suit employees with “young” eyes
- Positioning the top of the display at eye level may cause awkward neck posture for multifocal wearers.
- Multifocal wearers often prefer their monitor set very low, because they can view content through the lower portion of their lenses.
DISCOMFORT CAN INTERRUPT CONCENTRATION AND DISTRACT STUDENTS FROM LEARNING

Computers designed for adults are often used in schools and placed on fixed-height tables or used with chairs that are not adjustable.

AFTER LONG PERIODS AT THE COMPUTER SOME CHILDREN MAY COMPLAIN OF ACHING NECK, SHOULDERS, HANDS OR BACK AND THAT THEIR EYES ARE TIRED.
LEARNING DISTRACTION:

ROUNDED TURTLE BACK
LEARNING DISTRACTION:
ROUNDED TURTLE BACK

A fixed-height monitor placed too high, too far away or with small text can lead to students sitting uncomfortably with rounded backs, hunched shoulders and extended necks.
THE HP SOLUTION: HP ADVANTAGE MONITORS

The unique dual-hinge design of the HP Advantage LCD Monitors offers a wide range of height adjustments, including placement close to the desk for young students.

STUDENTS OF ALL AGES CAN SIT BACK AND FIND MONITOR POSITIONS THAT ARE COMFORTABLE FOR THEIR EYES, NECKS, SHOULDERS AND BACKS.

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HP poster available to all elementary schools free of charge

Don't be a Turtle!

Sit back & get comfortable
Thanks for listening. Any questions?