Unsuitable for sustained keyboard work:

- 70° acute elbow angle will increase upper limb fatigue and nerve compression.

Unsuitable for sustained keyboard work:

- Fingers cannot rest on keys
- ~90° elbow angle
- Wrist extension

Ideal for sustained keyboard work:

- Fingers can rest on keys
- >90° elbow angle
- Wrist neutral
Cornell/Honeywell Study
(Hedge et al., Ergonomics, 1999)

Before and after study of keyboard systems.

Desk group

Tray group

Tilt down group

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Control Group Wrist Extension

Test Group Wrist Extension

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Cornell/Honeywell Study (Hedge et al., 1999)

- Conventional Tray
- Tilt down system

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Cornell/Honeywell Study: Reported discomfort (Hedge et al., Ergonomics 1999)

- Control group
- PT Test group

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Keyboard Slope and Wrist Extension (Simoneau et al., 1999)

- 10 female Ss typed on keyboard at different slope angles.
- Wrist extension decreased 1° for every 2° decrease in keyboard angle.
- Optimal wrist position was when the keyboard tilted down in a range between 7-15°.
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Keyboard Position

• Lowered, negative-tilt tray for neutral wrist posture.

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Encourage Neutral Posture

Preferred viewing angle, distance and monitor height

Relaxed, balanced neck
Relaxed, supported shoulders
Supported, lordotic back
Open knees, ankles
Open elbow

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Indoor Air Quality Problems

• 1 in 3 workers may be in a “sick” building.
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**Office Indoor Air Quality Concerns**

- Combustion gases (COx, NOx, SOx)
- Volatile organics (VOCs, MVOCs)
- Particulates/fibers (ETS, SMF, Asbestos)
- Biogenic particles (bacteria, fungal spores, allergens)
- Thermal conditions

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**Breathing Zone Filtration**

- Energy efficiency: not all office air needs to be treated, only that in the breathing zone.
- Thermal comfort: eliminating ‘dead zones’ improves thermal comfort conditions.
- Personal control: most HVAC systems have only crude control mechanisms.

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**Cornell Study: Statistics Canada**

(Hedge et al., Indoor Air, 1993)
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**BZF and Perceived Environment Conditions**

(Hedge et al., *Indoor Air*, 1993)

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**BZF and PIAQ Effects on Productivity**

(Hedge et al., *Indoor Air*, 1993)

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**BZF and SBS symptoms**

(Hedge et al., *Indoor Air*, 1993)
Slide 25

**BZF and SBS Effects on Productivity**

(Hedge et al., *Indoor Air*, 1993)

- DRY EYES
- IRITATED, SORE EYES
- TIRED, STRAINED EYES
- STUFFY NOSE
- RUNNY NOSE
- LETHARGY

0 10 20 30 40 50 60 70 80 90 100

Pre-control

Post-control

Pre-BZF

Post-BZF

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**Benefits of BZF**

- BZF provides continuous, controllable, clean air to each employee.
- BZF compliments HVAC performance and improves air mixing in cubicles.
- BZF protects employees against transient air pollutants.
- BZF reconfigures with "office churn".
- BZF improves IAQ and reduces SBS complaints.
- BZF improves productivity.

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**Office Lighting Issues**

- **Computer Vision Syndrome** is the #1 complaint of computerized office workers.
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Lighting and Eyestrain: Sources of Glare

- Overhead lights
- Task lights
- Windows
- Reflective sources (clothing, paper)
- Computer screen

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Computer Use and Eye Symptoms

(Hedge et al., ASHRAE Proc., 1991)

Men
Women

(Hrs. computer use)

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Office Lighting Systems
Slide 31

**Indirect vs. Direct Lighting**

- The eye doesn't see illuminance!

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**Cornell Lighting Study: Xerox Facility**

(Hedge et al., *Ergonomics*, 1995)

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**Open-office K-12 Lighting**

(Hedge et al., *Ergonomics*, 1998)
Cornell/Xerox: Lighting Changes
(Hedge et al., Ergonomics, 1995)

K12 lens
Parabolic
Lensed-indirect

Parabolic Gloom!
(Hedge et al., Ergonomics, 1995)

Private Offices
Open-Plan Offices

Lensed-Indirect Lighting
(Hedge et al., Ergonomics, 1995)

• Overwhelming preference for indirect lighting.
• % reporting daily work-related health complaints twice as great with direct PB lighting.

Lighting Preferences

Prefer LIL
Prefer PBL
Group
Two-Component Lighting Study

Pre-Installation Offices
- Interior office
- Perimeter office

Office Photometrics
- Distribution of evening light levels in the office space.
Cubicle Offices

- Individually controllable wall-sconce indirect fixture on side panel and on each mullion between cubicles.
- Desktop-adjustable, asymmetric task light.

Lighting Quality Ratings

- Direct
- 2-component

Reactions to 2-component Lighting
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Opinions of 2-component Lighting

- Room is less hectic
- Less spotty
- Office looks brighter
- Like new lighting
- Other looks nice
- Like using lighting control

% Agree

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Dual-component Lighting

- Worker reaction to the use of dual-component lighting systems is very positive.
- Workers require training.

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Cornell Glare Filter Study

(Hedge et al., HFES Proc., 1996)
Reactions to Health Symptoms

(Hedge et al., HFES Proc., 1996)

% response

Lethargy
Tired eyes
Trouble focusing eyes
Itching/watering eyes
Dry eye
Headache

Survey 1
Survey 2
Survey 3

Good Ergonomics is Great Economics

• Ergonomics is always a benefit.
• Ignorance of ergonomics is the cost!

Cornell University Ergonomics Web
http://ergo.human.cornell.edu