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**Ergonomics Programs for  
Schools:  
Challenges and Opportunities**

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With thanks to Kathryn Laeser, Shawn Oates,  
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**Presentation Content**


- ☐ Computer use in schools
- ☐ Children and computer use - issues  
+ research evidence
- ☐ Implications and future action



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**Conceptual Framework**


- ☐ Latency
  - ⊗ Mass computerization of the office in the 1980s is associated with the MSD issues in the 1990's
  - ⊗ Mass computerization of the schools in the 1990's ...?
- ☐ Children as small adults (biomechanically)
- ☐ Lifelong habits
  - ⊗ Learning good posture and work habits requires the same effort as learning poor posture and work habits.
- ☐ Healthful computer use
  - ⊗ Promote healthful ways of working with computers.



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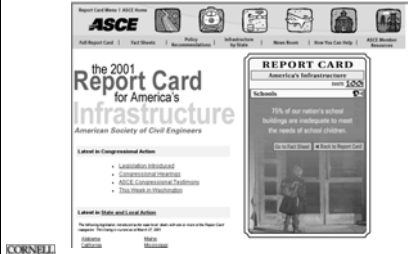
**U.S . Schools 2001**

- ❑ ~45 million students attend schools.
- ❑ ~ 86,000 public schools.
- ❑ The number of students is growing, up 9% since 1990.
- ❑ The Department of Education estimates that 2,400 new schools will be needed by 2003.
- ❑ Average age of the nation's schools is 42 years.
- ❑ Schools welcome computers in an attempt to raise performance.
- ❑ School technology plans focus on the technology. Ergonomics is seldom on the 'radar screen'.



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**U.S. Schools Report**  
(American Society of Civil Engineers, 2001)



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**U.S. Schools Repairs Report:  
D- Grade**


- ❑ 75% of schools need repairs.
- ❑ Total budget need = \$268 billion.
- ❑ Average repairs per school = \$2.2 million (\$3,800 per student).
- ❑ Where considered, ergonomics is seen as another cost.



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**Computers in Schools**

- ❑ Rapid proliferation of computers.
- ❑ Computer use in schools inevitably is increasing.
- ❑ Goal of ubiquitous computing.
- ❑ Competing budget constraints.
  - ⊗ Primary focus on hardware and networking.
  - ⊗ Secondary focus on software and curriculum.
- ❑ Teaching training/technology integration lags.
- ❑ Laptops increasingly favored over desktops. Physical ergonomic issues seldom considered.
- ❑ Computer ergonomics is a lifelong skill (Larson, 1999).
- ❑ Tomorrow's workers are in today's schools.



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**Research Issues and Studies**


- ❑ Risk Factors and Exposure
- ❑ Ergonomic Design Research
- ❑ Ergonomics Information Research
- ❑ Ergonomics Programs Research

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**Computers in Schools**  
(Coley, ETS, Policy Information Center, 1999)

- ❑ 98% of all schools own computers
- ❑ 4.4 million computers in classrooms
- ❑ Current average student-to-computer ratio:
  - ⊗ 10:1 (range 6:1 – Florida, Wyoming, Alaska, North Dakota to 16:1 – Louisiana), down from 125:1 in 1984.
  - ⊗ 11:1 – Elementary schools
  - ⊗ 9.7:1 – Junior High
  - ⊗ 8.4:1 – Senior High



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**Computers in Schools**  
(Coley, ETS, Policy Information Center, 1999)

- ☐ 85% of schools have multi-media computers (MMC) [Keyboard + mouse]
- ☐ Current average student-to-MMC ratio is 24:1 (range 9:1 – Florida to 63:1 – Louisiana).
- ☐ US Dept. Education currently recommends a ratio of 5:1

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**School Computers use by Children**  
(Coley, ETS, Policy Information Center, 1999)

- ☐ Daily computer use in schools:
  - ⊗ 4<sup>th</sup> grade – 9%
  - ⊗ 8<sup>th</sup> grade – 10%
  - ⊗ 12<sup>th</sup> grade – 19%
- ☐ Computer integration into the curriculum (work, games)
- ☐ Internet access
  - ⊗ 1998 - 51% schools
  - ⊗ 1999 - 89% schools
- ☐ One computer per desk policies

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**Computers use by Children**  
(AOL & Roper Starch, 1999)

- ☐ Computers in schools and homes.
- ☐ 1-3 hours per day computer use and growing.
- ☐ 63% of 9-17 year olds prefer web surfing to watching TV.
- ☐ Average on-line days per week:
  - ⊗ 9-11 years old - 3 days/week
  - ⊗ 15-17 years old - 5 days/week
- ☐ Internet:
  - ⊗ Rookies average 6.6 hours/week
  - ⊗ Experienced users (>3 years) average 10.5 hours/week

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**Computer Use by Children**  
(AOL Canada, 1999)

- ☐ ~ 5 million children <12 years old use the Internet
- ☐ By 2002, ~20 million children <12 years old will be using the Internet

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**Lifelong Computer Use**  
(Berenter, Greenhouse & Webster, + Fortino Group, 1999)

- ☐ Survey of 162 children 9-12 years, 6,000 children 10-17 years old.
- ☐ Children who use the Internet > 3 times/week spend only 66% time reading compared with non-users.
- ☐ Internet savvy kids score more 'As' in school, but do worse in spelling, punctuation and grammar.
- ☐ At present rates, during their lives children will spend >2 years on e-mail.
- ☐ At present rates, during their lives children will spend at least 23 years on the Internet.

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**Technology Integration In Schools**


- ☐ School Technology integration plans typically do not address ergonomic workstation design issues
  - ☐ Typical Technology Plan (e.g. ICSD, 1995)
    - ☐ Teacher training
    - ☐ Updating building infrastructure (power, network)
    - ☐ Hardware and software acquisition
  - ☐ United States Congressional Study (1995)
    - ☐ "America's Schools not designed or equipped for the 21st Century"

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**Computer Use Issues**

- How much do children use computers in schools in 2001?



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**Ergonomic Design Questions**

- How should computer workstation design be addressed in school technology integration plans?
  - What is the impact of computer workstation design on a student's physical well-being?
  - What is the impact of workstation design on the effectiveness of computer use?

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**Risk Factors and Exposure:**  
How are children working at computers?



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**Neutral Work Posture**

- ☐ Upper body posture
  - ⊗ Back supported by chair
  - ⊗ Feet firmly on surface
  - ⊗ Head balanced on neck
  - ⊗ Popliteal angle >90°
  - ⊗ Upper arms relaxed close to body
  - ⊗ Elbow angle >90°
  - ⊗ Wrist neutral (<15°)

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**Children's Posture at Computers**

(Oates et al., Computers in Schools, 14, 55-63, 1998)

- ☐ 95 elementary school children (46 boys, 49 girls)
- ☐ Grades 3 through 5 studied
- ☐ Ages 8.5 – 11.5 years
- ☐ Approx. equal numbers at the 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> %iles for stature
- ☐ Urban, suburban and rural schools studied

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**Research Procedure**

(Oates et al., Computers in Schools, 14, 55-63, 1998)

- ☐ Children evaluated in their typical computer work area
- ☐ Children evaluated while working on a novel text-writing task
- ☐ Workspace dimensions and layout recorded
- ☐ Posture evaluated using the Rapid Upper Limb Assessment (RULA) method
- ☐ RULA measures taken after 5 minutes of work

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**Workstation Dimensions**  
(Oates et al., Computers in Schools, 14, 55-63, 1998)

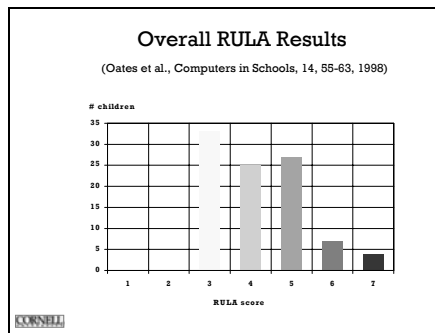
Dimension	Recommended	Observed
Keyboard height	21.5 - 24"	25.6 - 39.4"
Monitor height	31.5 - 38"	37.4 - 51.2"
Backrest height	26 - 30"	23.6 - 31.5"
Seat pan width	13 - 15"	11.8 - 17.7"
Back rest angle	90° - 120°	90° - 108°

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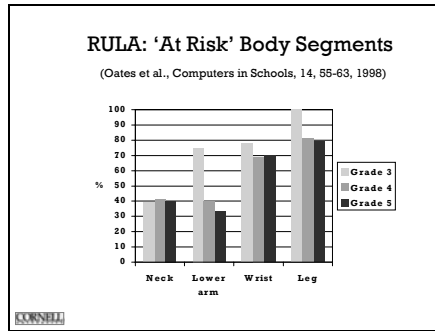
- Interpretation of RULA Scores**
- ☐ (1-2) Posture is acceptable if it is not repeated for long periods of time.
  - ☐ (3-4) Further investigation is needed and changes are required.
  - ☐ (5-6) Further investigation and changes are required very soon.
  - ☐ (7) Further investigation and changes are required immediately.
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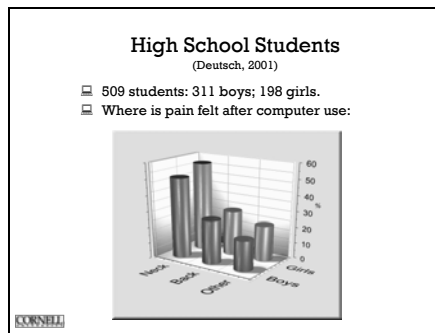
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- ### Research Conclusions
- (Oates et al., Computers in Schools, 14, 55-63, 1998)
- ☐ Children working in 'at risk' postures:
    - ⊗ Keyboards too high
    - ⊗ Incorrect keyboard angle
    - ⊗ Monitors too high
    - ⊗ Legs dangling
  - ☐ Short duration of computer work
  - ☐ Marked lack of attention and commitment to consideration of ergonomic issues in schools
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**Ergonomic Design Research**


- How 'ergonomic' are different hardware and furniture designs?



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**Risk Reduction:**  
Ergonomic Interventions for Better Posture?



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**Improving Workstation Ergonomics**  
(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)

- Tested effects of computer workstation design on:
  - Posture
  - Task performance
  - Engaged behavior
  - Preferences
- Studied keyboard and mouse use
- Compared conventional and tiltdown keyboard arrangements


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**Research Design**

(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)

- 58 middle school children tested:
  - ⊗ 30 6th grade students
  - ⊗ 28 8th grade students



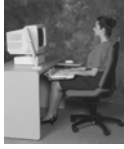
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**Research Design**

(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)

- Keyboarding and mousing tasks performed under two conditions:
  - ⊗ desktop arrangement
  - ⊗ tilt-down keyboard system



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**Experimental Measures**

(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)


- Posture
  - ⊗ RULA method
- Performance
  - ⊗ computer program for each task
- Engaged Behavior
  - ⊗ video tapes
- Preferences
  - ⊗ interview

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**6th Grade: keyboard use**  
(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)

- 6th grader using the keyboard on the table top set at the height of the school computer surfaces.




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**6th Grade: keyboard use**  
(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)

- 6th grader using the keyboard on a tiltdown tray system.




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**6th Grade: mouse use**  
(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)

- 6th grader using the mouse on the table top set at the height of the school computer surfaces.




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**6th Grade: keyboard and mouse use**  
(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)

- 6th grader using the keyboard on a lowered platform.




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**8th Grade: keyboard and mouse use**  
(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)

- 8th grader using the keyboard on the table top set at the height of the school computer surfaces.




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**8th Grade: keyboard and mouse use**  
(Laeser, Maxwell & Hedge, J. Res. Comp. Ed., 31, 173-188, 1998)

- 8th grader using the keyboard on a tiltdown tray system.




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**8th Grade: keyboard and mouse use**  
(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)

- 8th grader using the mouse on the table top set at the height of the school computer surfaces.




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**8th Grade: keyboard and mouse use**  
(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)

- 8th grader using the mouse on a lowered platform.




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**8th Grade: keyboard and mouse use**  
(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)

- Tall 8th grader using the keyboard on the table top set at the height of the school computer surfaces.




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**8th Grade: keyboard and mouse use**  
(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)

- ☐ Tall 8th grader using the keyboard on a tilt-down tray system.




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**8th Grade: keyboard and mouse use**  
(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)

- ☐ Tall 8th grader using the mouse on a lowered platform.



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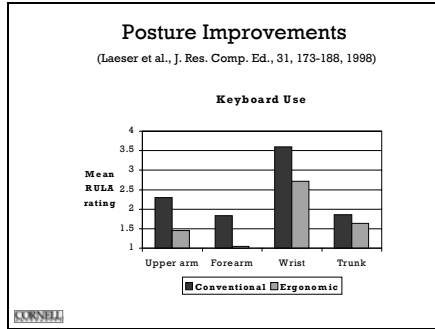
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**Posture**  
(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)

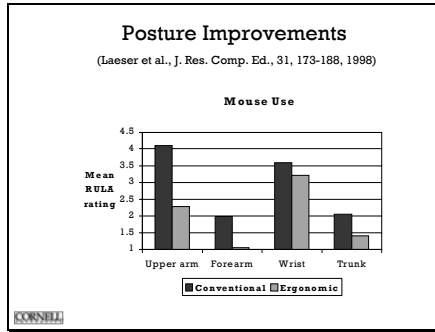
- ☐ Results confirmed that seated posture improved when the workstation had the adjustable tilt-down system:
  - ☒ keyboarding ( $p < .001$ )
  - ☒ mousing ( $p < .001$ )

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### Performance

(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)

- ▣ **Typing performance**
  - ☞ small but significant decrease with Ergonomic arrangement (<1%: p<.001)
  - ☞ Likely can be overcome with practice
- ▣ **Mousing performance**
  - ☞ small but significant improvement with Ergonomic arrangement (3%: p=.018)
  - ☞ may be due to change in posture or possibly improved mouse pad surface


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**Limitations of the Study**  
(Laeser et al., J. Res. Comp. Ed., 31, 173-188, 1998)



- ☐ Implications limited to immediate effects of the workstation
- ☐ Students all from the same school
- ☐ Unequal number of males and females
- ☐ Self-selection – volunteer sample
- ☐ Normal ability children
- ☐ Desktop computer



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**Ergonomics Information Research**

☐ How effective is currently available ergonomics information?




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**Ergonomics Programs Research**

☐ "Get Techfit" program –Blackwell Elementary School, WA and Cornell University.

- ☐ Classroom instruction on computer ergonomics
- ☐ Class exercises on computer ergonomics
- ☐ Parents booklet on computer ergonomics
- ☐ Web-based program information
- ☐ Teacher commitment (Diane Tien)



E R G O N O M I C S




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**Good or bad?**

☐ What is right or wrong with these pictures?


Extract from an Ergonomics slideshow prepared by children for children at Blackwell Elementary School, WA.



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**Laptop Computers in Schools**



<http://www.ammsa.com/sage/APRIL99.html>

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**Future Research and Actions**

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**Ergonomic Issues**

- ☐ Children's Posture
- ☐ Children's age
- ☐ Computer design
- ☐ Furniture design:
  - ☉ Desktops
  - ☉ Laptops
- ☐ Laptop Weight
- ☐ Backpack design
- ☐ School and home use
- ☐ Effective Ergonomics Information
- ☐ Effective Ergonomics Education



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**Ergonomic Design Issues**

- ☐ Environmental conditions for computers:
  - ☉ Lighting
  - ☉ Ventilation (heat, IAQ)
  - ☉ Cable management/electrical fields
- ☐ Furniture for computer work
  - ☉ Worksurface
  - ☉ Monitor height
  - ☉ Keyboard tray
  - ☉ Mouse platform
  - ☉ Document holder
  - ☉ Chair
- ☐ Layout for computer work
  - ☉ Workstation layout
  - ☉ Classroom layout

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**Future Agenda**


- ☐ Intensify efforts to promote public awareness of the importance of Ergonomics in school and home computer use.
- ☐ Promote professional awareness of classroom ergonomics issues.
- ☐ Provide effective Ergonomics education information for schools and parents.
- ☐ Define effective Ergonomic designs for hardware, software and furniture.
- ☐ Continue encouraging professional initiatives for IEA/HFES to promote Ergonomics in Schools.

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**Our Responsibility?**

☐ It is our responsibility to protect future generations against known injury risks, and to ensure that our children acquire good lifelong skills based on sound ergonomics practice.




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**Cornell Ergonomics Web**  
<http://ergo.human.cornell.edu>

**CU Ergo**



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