



Development and Testing of School Furniture Suitable for Disabled Pupils

H. Huwiler, A. Martens

***AEH Zentrum für Arbeitsmedizin, Ergonomie und Hygiene AG
Zurich, Switzerland
(AEH Health and Safety Consultants)***



School for Physically and Mentally Disabled Children, Zurich



Day school with several school and therapy offerings, , lunchtime programme and rooms for a rest period

- **Kindergarten:**
 - prepares children for school
- **Classes of 4 - 6 pupils (9 years):**
 - aim at the academic goals of a public school
- **Other school services:**
 - Instruction on an individual level
 - Support
 - Various therapeutic treatments and aids

2004: decision to replace all the furniture

New furniture has to meet:

- Ergonomic regulations
- The very individual needs of the disabled pupils

Pupils' desks and chairs:

- Shift from individually tailored solutions to products with a modular concept





Project

- **Steering committee was established**
- **Three Steps**
 - 1. Definition of the requirements for the future furniture**
 - Walk-through combined with interviews
 - Review of literature and anthropometric data
 - 2. Product search**
 - 3. Testing of products by pupils, teachers and therapists**
 - By means of Questionnaires (comfort, satisfaction)
 - Comparison with requirements defined
- **Discussion of results with steering committee**
- **Order of new furniture**



1st Step: Walk-through

- **Walk-through and semi-structured interviews in 9 different but representative rooms**
- **Rooms were chosen by the members of the steering committee**
- **Results:**
 - **Furniture was old**
 - **Furniture did not correspond to the expectations of teachers and therapists**
 - **Many chairs and some tables were adapted**
 - **Many individual tailored solutions**
 - **Pupils mentioned restricted leg space for wheelchair users and some degree of discomfort**



Some Impressions





1st Step: Requirements desks and tables

Defined important features for pupils' desks (incomplete list)

- **Leg space:**
 - Accessible with wheelchairs
- **Sit/stand desks**
- **Height:**
 - Adjustable, covering 5–95th percentile of users (43-116 cm)
- **Desktop:**
 - Can be tilted to 15°
 - Different shapes of desktops depending of the needs of the pupils
- **Desks are mobile, having possibility to clamp or lock**

Teachers' desks had to meet the usual ergonomic requirements



1st Step: Requirements chairs

Defined important features for for pupils' chairs (incomplete list)

- **Height:**
 - Adjustable, covering 5 – 95th percentile of users (29– 49 cm)
- **Footrest:**
 - Available
- **Sitting surface:**
 - Adjustable in depth, tiltable between 0°-5°
 - Rotatable, having the possibility to clamp or lock
- **Backrest:**
 - Adjustable in height and depth
 - Lumbar support to maintain lumbar spine in lordosis
 - Easily exchangeable in case of special needs (custom-built backrest)

Teachers' chairs and stools had to meet the usual ergonomic requirements

2nd Step: Product search

- **Product search, based on the defined requirements**
- **Products were standard products, chosen either out of school- or office-furniture sector**
- **Number of selected furniture to be evaluated:**

Age / Application	Chairs	Pupils desks	VDU desks	Group work tables, dining tables	Stools for teachers / therapists
Kindergarten	1				
7 - 12	3	2	1		
13 – 20	4	3			
Therapy	1*	1			
Not specific				4	2

* Chair which should be adaptable to very individual needs due to a handicap

3rd Step: Product Tests

- **1 week: All products tested by all interested users**
- **3 weeks: Pupils' desks and chairs tested in certain classes**
 - **Latin Square Design was used for the avoidance of coincidence effects.**

Age between 7 -12	Subjects Class A	Subjects Class B	Subjects Class C
1. Week	Chair 50, 51	Chair 52	Chair 53
2. Week	Chair 53	Chair 50, 51	Chair 52
3. Week	Chair 52	Chair 53	Chair 50, 51

3rd Step: Subjects

- **Overall data from 225 questionnaires :**
 - 38 pupils out of 72
 - 14 teachers
 - 12 therapists
- **60 questionnaires concerned pupils' desks, 122 their chairs**
- **Individual data were available from 22 pupils:**

N = 22	Mean	Min.	Max.
Age (years)	11.4	5	18
Weight (kg)	46.3 kg	30 kg	63 kg
Height (cm)	152.2	140	163

Health problems	N max. = 22
Walking	18
Wheelchair use	10
Instability in trunk	18
Affected coordination of movements of body/arms/legs	14
Vision affected	8



3rd Step: Evaluation by Questionnaire

Pupils' desks

Comfort (5-point scale *unpleasantly to very pleasantly*)

- Neck/shoulders
- Elbow/forearms
- Back

Satisfaction (5-point scale *applies not at all to applies completely*)

- Adjustability height
- Height while standing
- Desktop tilt
- Falling down of articles
- Desktop dimensions
- Desktop material
- Storage space
- Leg space
- Tilt resistance
- Manoeuvrability
- Usability adaptation mechanism
- Global evaluation

Pupils' chairs

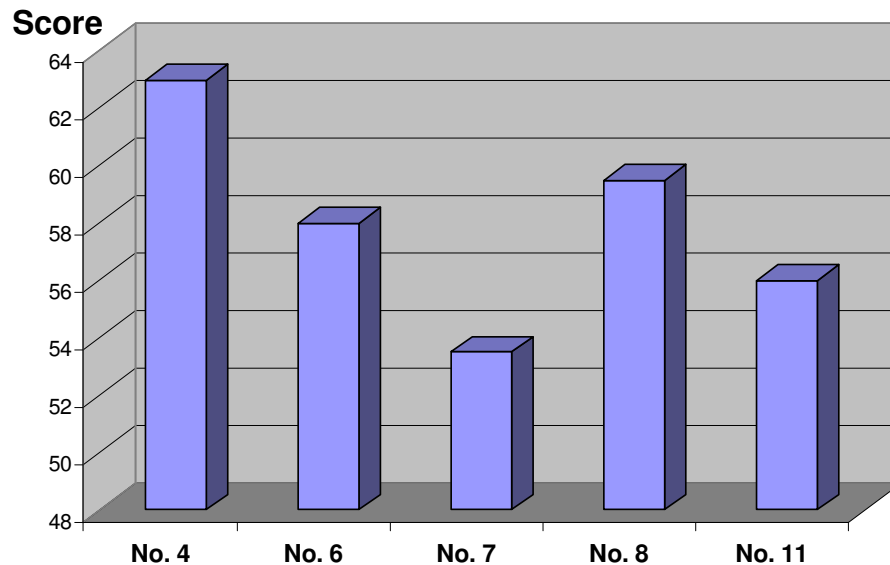
Comfort (5-point scale *unpleasantly to very pleasantly*)

- Knee/thighs
- Bottom/lumbar spine
- Back

Satisfaction (5-point scale *applies not at all to applies completely*)

- Adjustability height
- Seat depth
- Tilt of seat
- Slipping
- Comfort seat
- Mould of backrest
- Adaptability of backrest
- Usability adaptation mechanism
- Adaptability to needs
- Tilt resistance
- Manoeuvrability
- Global evaluation

3rd Step: Pupils' Desks



- 5 desks from 4 manufacturers were tested
- Desks number 4, 6 and 8 showed highest score
- All did not meet all of the requirements defined
- Discussions in steering group: desk 4 had high acceptance, manufacturer showed interest for improvements



- Desk number 4 was finally selected with conditions

3rd Step: Selected Pupils' Desk




Improvements:

- Adjustability of height
- Addition of a desktop side edging
- Development of storage space
- Displacement of the height adjustment lever (safety reasons)

Some features (final version):

- Leg space 60 x 75 cm
- Height adjustability
 - 43 – 90 cm (primary students)
 - 53 – 120 cm (high school students)
- Desktop 80 x 80 cm, tiltable 0° - 75°, desktop side edging
- Pneumatic spring, easily operated with one hand

- 9 chairs were tested
 - 6 chairs showed high satisfaction
 - None of them met the requirements sufficiently
 - New needs arose during the tests
 - Optimisation was not possible without large effort
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- New product search out of the school-furniture sector
 - Chair with a modular concept used in industry was found
 - Prototype was designed and tested for 1 week
 - Optimisation in 3 steps, e.g.:
 - Levers
 - Dimensions and form of seat and backrest
 - Range of height adjustability
 - Range of seat tilt
 - Final version was brought into production

Some features:

- **Height adjustability:**
 - 31 – 38 cm (primary students)
 - 36 - 48 cm (high school students)
 - Pneumatic spring
- **Sitting surface:**
 - adjustable in depth
 - tiltable between 0°-5°
 - rotatable or fixable
- **Backrest:**
 - adjustable in height and depth
 - lumbar support
- **Armrest and footrest available**





Conclusions

- All furniture has now been replaced
- New furniture meets ergonomic regulations
- Pupils' desks/chairs: from individually tailored solutions to modular concept
 - Pupils' desks: no individual solutions were necessary
 - Pupils' chairs: First-time individual adaptation in shorter period of time
- First feedback indicates high rate of satisfaction
- Reduction of diversity of furniture in school stock: costs could be lowered

Keys for success:

- Requirements for future furniture defined within participative process
- Products were tested by teachers, therapists *and* pupils
- Test results: discussed in steering committee, considered when selected final products
- Manufacturers interested in optimisation of their products
- Modular concept of pupils' desks and chairs: products adjustable to the very individual needs of the disabled pupils



Thank you for your attention!



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