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TEHNIKAÜLIKOOL

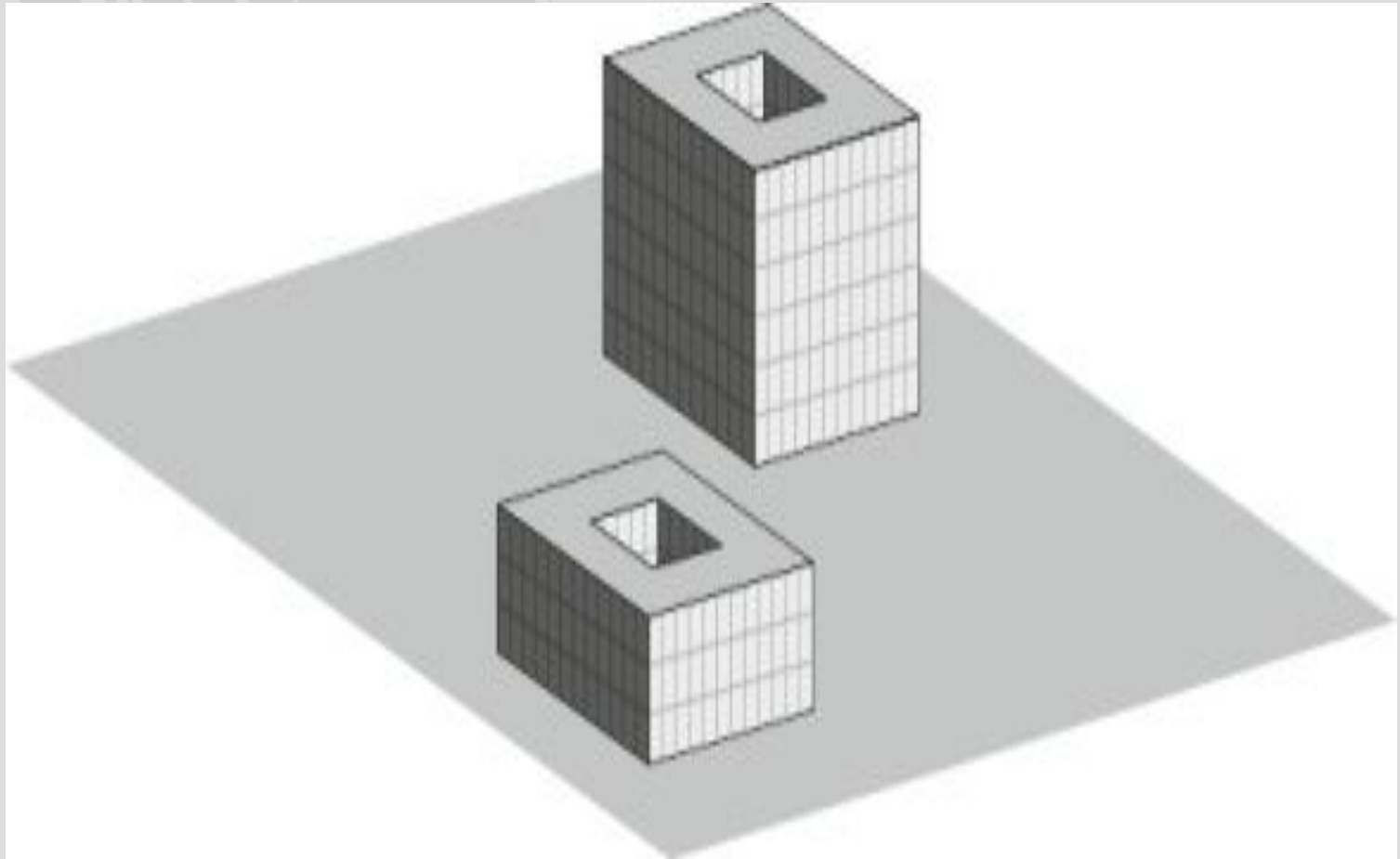
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Ergonomic design of workplaces in atrium-type buildings

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Atrium-type buildings A, B, C,

different work conditions in 3- and 6-storeyed buildings
(lighting worsened, -bad indoor air quality)



Ergonomic workplace design

- The ergonomis principles have to be taken into account already during the design of the building
- The interior architects have to be educated in OHS and ergonomics
- It is difficult to improve the workplace ergonomics afterwords
- It is like collective PE and personal PE



Problems

- Airtight buildings
- Energy conserving
- Ventilation not regulated
- Low relative humidity
- New construction materials



Problems

- Eye irritation
- Upper respiratory tract irritation
- Skin dryness
- Headache
- Fatigue

Building A

Towards the atrium:

- built during period when the construction costs were very high (2003)
- the attention to the well-being at workers was not paid
- windows cannot be opened towards the atrium side
- the glass roof covers densely the atrium
- access to natural light is possible only from the 4th floor



Building A- atrium with closed glass roof



Building B

Office-rooms close to the atrium:

- The house built during period when construction cost were low (2009)
- windows close to the atrium could be opened
- the roof is covered with glass but there is a slope between the roof and the wall
- natural light accesses only upper floors (4 storeyed house)



Building B problems

Towards the atrium:

- wet climate of nordic countries
- windows of the first floor are too low
- moistered work rooms
- development of mycobacterium



Building B problems

Work-rooms closed to the outdoor:

- low temperature in cold season
- high temperature in warm season



Building B,

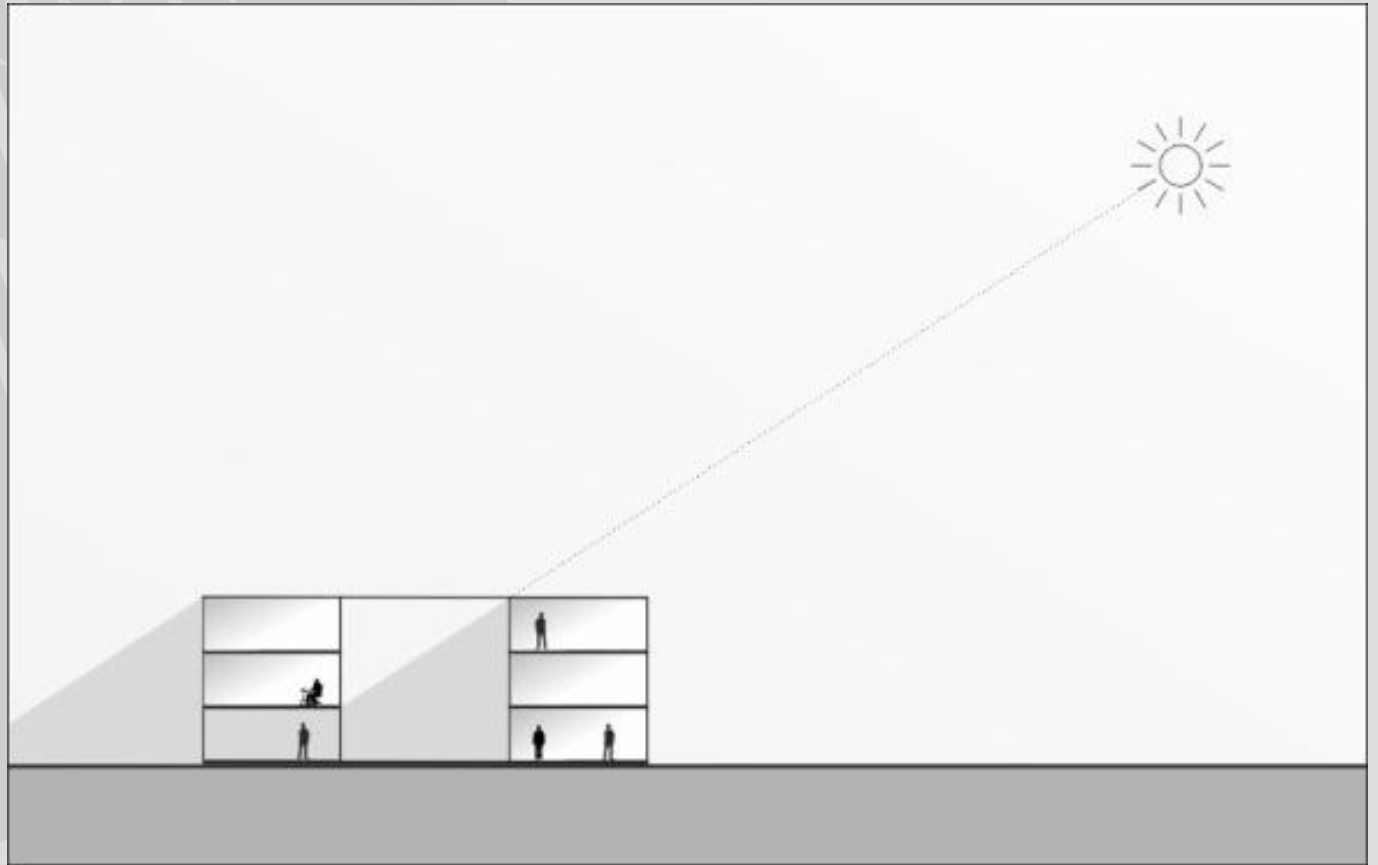
slope between the roof and walls; fresh air, cold rooms



Office-rooms close to the atrium:

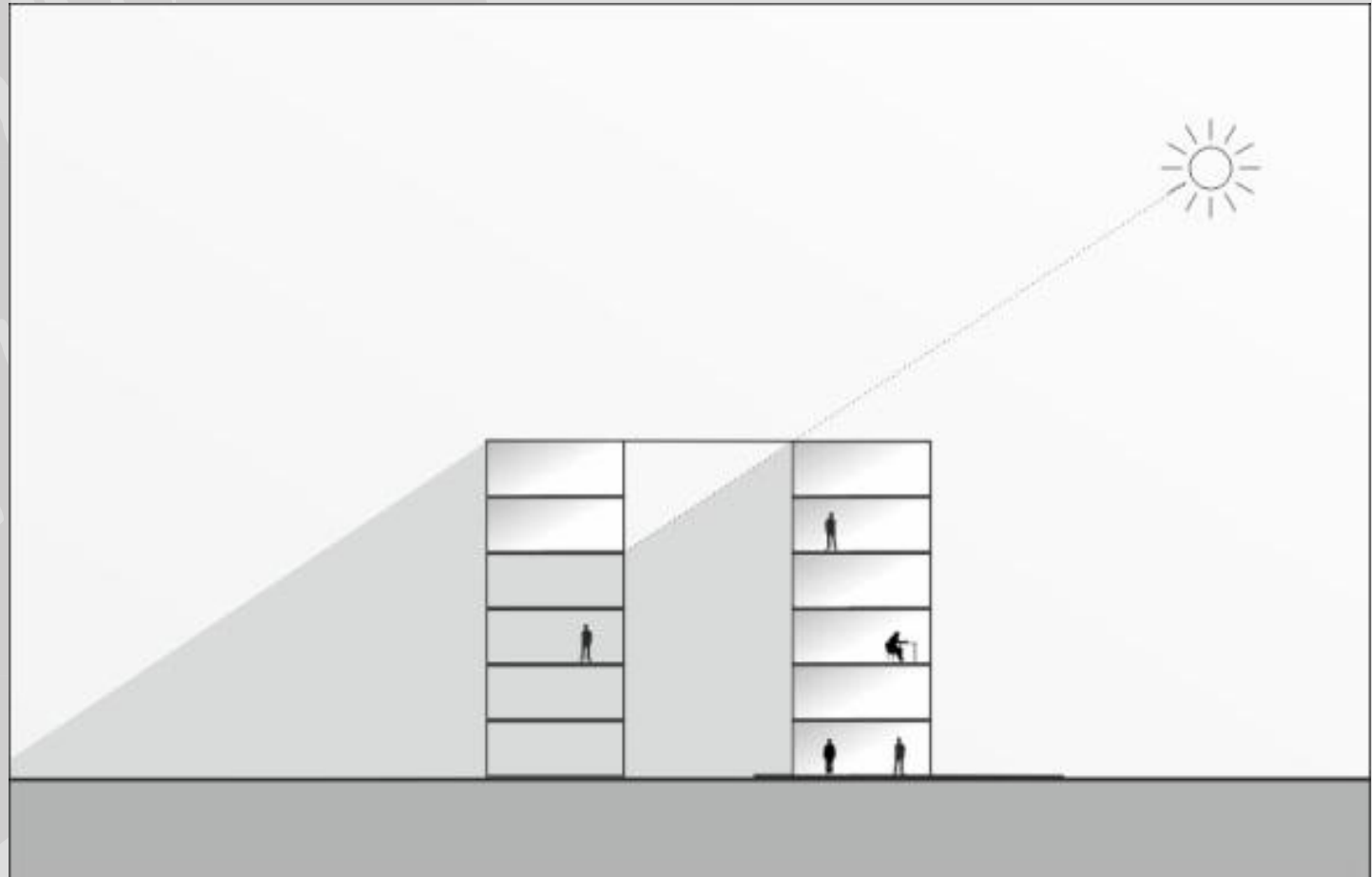
- wet climate of nordic countries
- windows of the ground floor are too low
- natural lighting in the rooms with computer workplaces is not sufficient
- the workers and workplaces from the other side of the atrium are disturbing factor for the workers working in the room showed in the photo

Building C in 2010, Lighting conditions in 3-storeyed building good



Building C in 2012 (6 storeyed)

Lighting conditions worsened

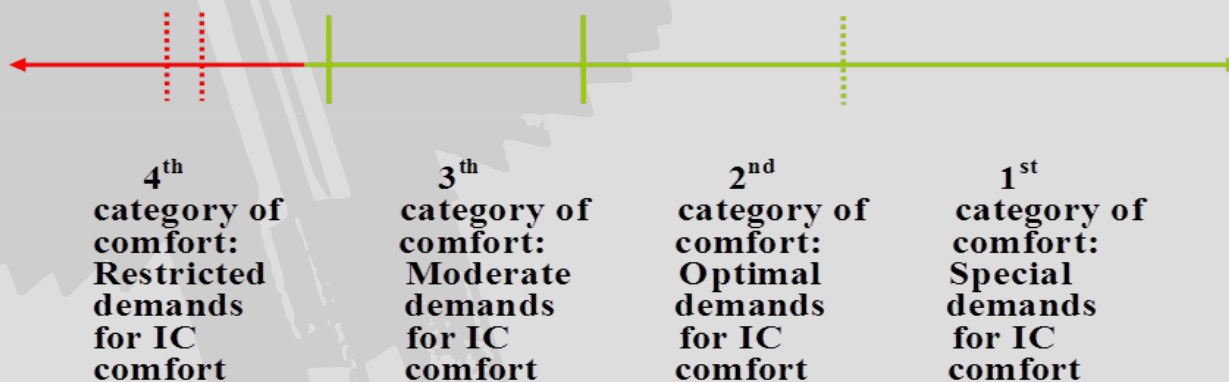


Measurements

Room type	Indoor air temperature, °C, U = 0.6 °C		Indoor air humidity, %, U = 2.0%		Air velocity, workplace, m/s, U = 0.01 m/s	Lighting, lx, U = 10.4%	Concentration of carbon dioxide
	Cold season	Warm season	Cold season	Warm season			CO ₂ , ppm U = 2ppm
Building A, towards the atrium	21.2...23.5	22.7..25.6	24.3..25.7	48.2..53.0	0.02...0.17	300..847	598..1152
Building A, towards the outdoors	10.8...21.4	22.5..32.6	14.0..33.1	44.2..62.4	0.02...0.33	690..1209	462..744
Building B, towards the atrium	21.0...23.8	21.3..26.5	24.0..32.5	35.1..47.6	0.02...0.19	433..915	575..935
Building B, towards the outdoor	20.4...21.1	21.0...31.0	22.7..24.6	41.4...48.7	0.01...0.25	525..1180	478...852
Atrium A	20.9..22.7	23.0..27.0	22.9..29.1	45.1..48.9	0.01..0.05	350...360	572...978

EVS-EN 15251:2007

< 300	300	500	1000 - 1500 ¹	Lighting, lx
< 4	< 4	> 7	> 10	Ventilation, l/s per person
< 20	> 20	> 25	> 30	Humidity, %
> 800	< 800	< 500	< 350	CO ₂ ppm
more	19 - 27	20 - 26	21 - 23.5	Operative temperature, °C
> 15	< 15	< 10	< 6	PPD ²
< - 0.7; > + 0.7	-0.7 < PMV < +0.7	-0.5 < PMV < +0.5	-0.2 < PMV < +0.2	PMV ³





Building C,

built in 2010

The house was built as 3-storey in 2010

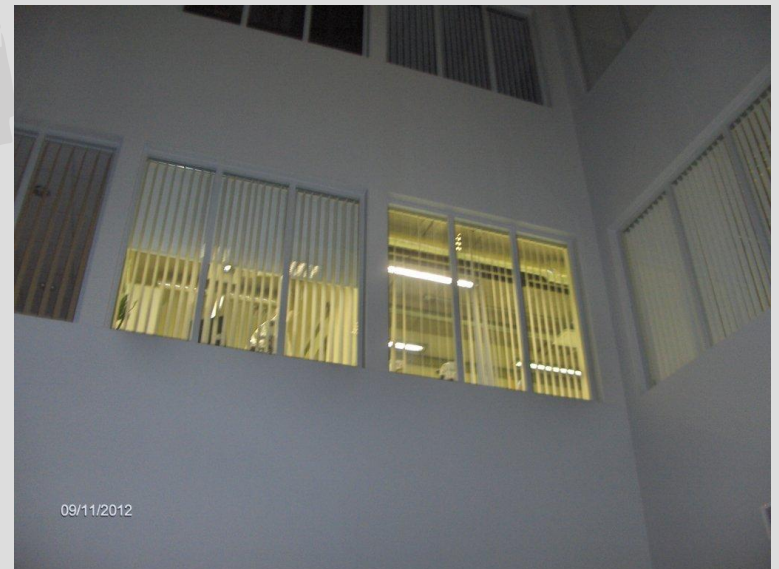
Closed atrium
Good working conditions in
the 1 and 2nd floor



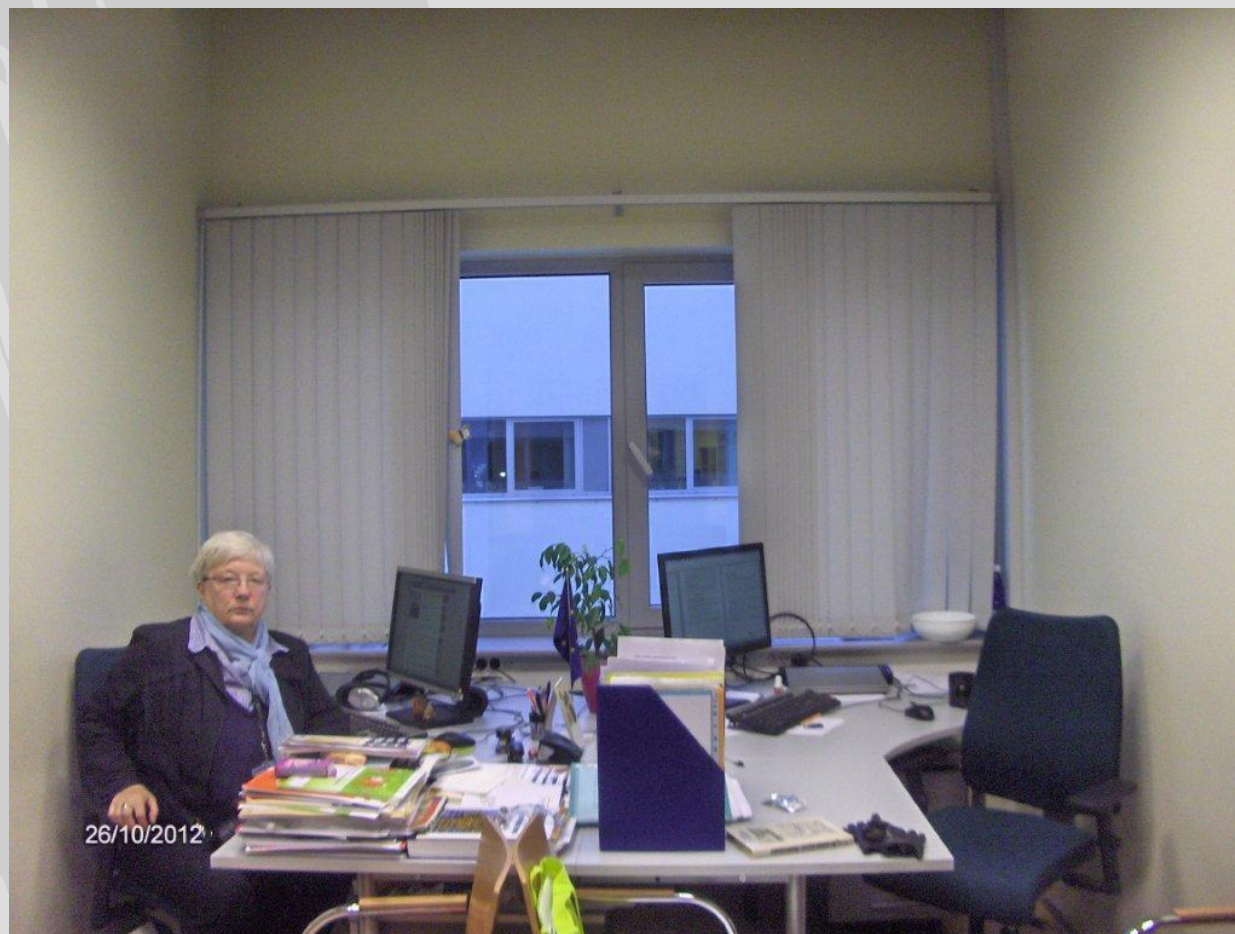
Building C, 6 storey

3 storeys were added to
the 3-storeyed house in
2012

The working conditions
worsened in the 1-2
floors.



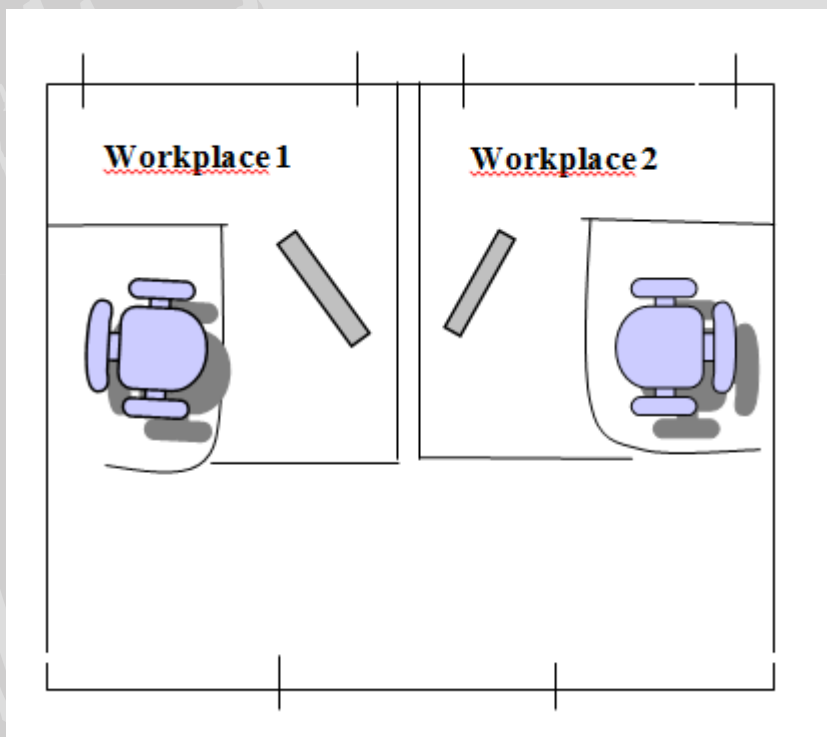
Investigated room, building B, $2800 \times 4300 = 12 \text{ m}^2$; the window 3 m^2



Standards and health

- ISO 7250:1996, Basic human body measurements for technological design
- Daylighting is meeting the need for contact with outside living environment.
- The body uses light as a nutrient for metabolic processes similar to water or food.

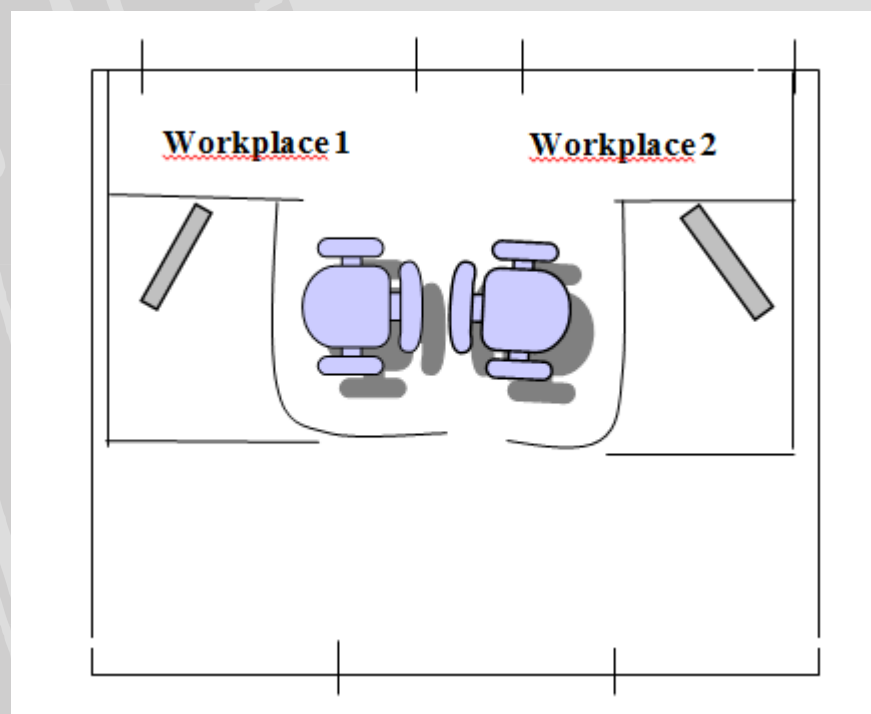
Current placement of workplaces



The ergonomic problems

- Shortages:
- The workers are looking at each other (psychological stress factor)
- The place for chair is very tight
- The workers cannot open the window

Possible other solutions

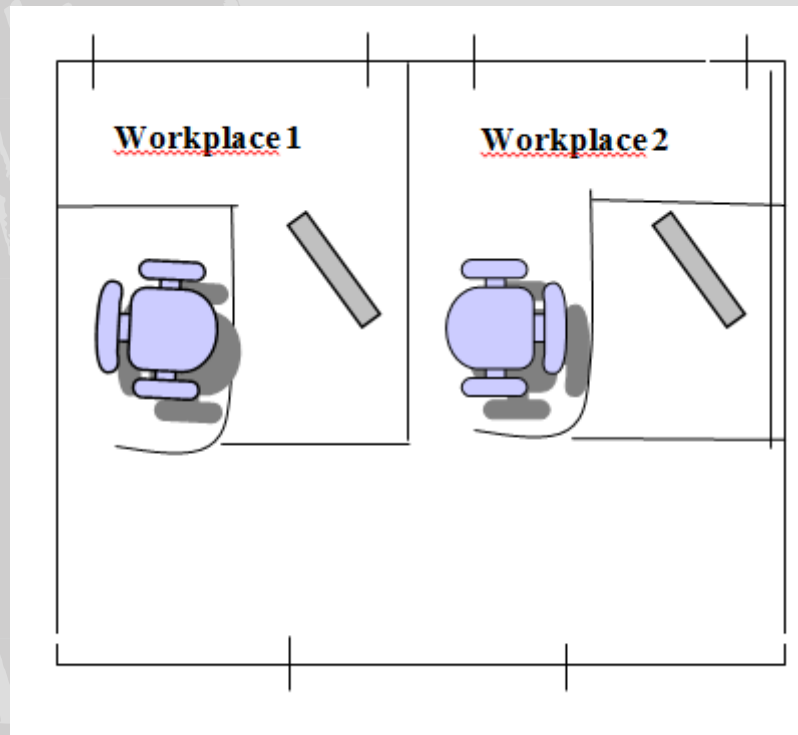




Improvements?

- Shortages:
- The chairs could hit each other
- Advancements:
- If only 1 worker is in the workplace, then the conditions are better (for the worker 2 particularly)

Possible other solutions



Improvements?

- Shortages:
- the worker in workplace 1 can follow the monitor of worker number 2
- Advancements:
- The natural light is coming from the left side to the worker
- There is a possibility to open the window

Conclusions: the indoor air problems in atrium-type buildings (close to the atrium)

- 1. Shortage of fresh air
- 2. High concentration of CO₂
- 3. Shortage of natural lighting
- 4. **The ergonomics of workplaces is not considered during design of workplaces**
- 5. Particularly there are problems in the office-rooms close to the atrium with closed roof



Thank you