Subtask A: User perspective and requirements

A.3 Personas

Solar Heating and Cooling Technology Collaboration Programme (IEA SHC)

The Solar Heating and Cooling Technology Collaboration Programme was founded in 1977 as one of the first multilateral technology initiatives ("Implementing Agreements") of the International Energy Agency.

Our mission is *"Through multi-disciplinary international collaborative research and knowledge exchange, as well as market and policy recommendations, the IEA SHC will work to increase the deployment rate of solar heating and cooling systems by breaking down the technical and non-technical barriers."*

IEA SHC members carry out cooperative research, development, demonstrations, and exchanges of information through Tasks (projects) on solar heating and cooling components and systems and their application to advance the deployment and research and development activities in the field of solar heating and cooling.

Our focus areas, with the associated Tasks in parenthesis, include:
- Solar Space Heating and Water Heating (Tasks 14, 19, 26, 44, 54)
- Solar Cooling (Tasks 25, 38, 48, 53, 65)
- Solar Heat for Industrial and Agricultural Processes (Tasks 29, 33, 49, 62, 64)
- Solar District Heating (Tasks 7, 45, 55)
- Solar Buildings/Architecture/Urban Planning (Tasks 8, 11, 12, 13, 20, 22, 23, 28, 37, 40, 41, 47, 51, 52, 56, 59, 63, 66)
- Solar Thermal & PV (Tasks 16, 35, 60)
- Daylighting/Lighting (Tasks 21, 31, 50, 61)
- Materials/Components for Solar Heating and Cooling (Tasks 2, 3, 6, 10, 18, 27, 39)
- Standards, Certification, and Test Methods (Tasks 14, 24, 34, 43, 57)
- Resource Assessment (Tasks 1, 4, 5, 9, 17, 36, 46)
- Storage of Solar Heat (Tasks 7, 32, 42, 58, 67)

In addition to our Task work, other activities of the IEA SHC include our:
- SHC Solar Academy
- *Solar Heat Worldwide*, annual statics report
- SHC International Conference

Our Members

Australia	European Copper Institute	SICREEE
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For more information on the IEA SHC work, including many free publications, please visit www.iea-shc.org.

Subtask A: Personas

Personas

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KEYWORDS

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PREFACE

Lighting accounts for approximately 15 % of the global electric energy consumption and 5 % of greenhouse gas emissions. Growing economies, higher user demands for quality lighting and rebound effects as a result of low priced and more versatile electric lighting continuously still lead to an absolute increase of lighting energy consumption. More light is used, often less consciously.

Especially the electric lighting market but as well the façade, daylighting und building automation sectors have seen significant technological developments in the past decade. However these sectors still act mainly independent of each other, leaving out big potentials lying in a better technology and market integration. This integration is on the one hand beneficial to providing better user-centred lighting of indoor spaces. On the other hand it can contribute significantly to the reduction of worldwide electricity consumptions and C02-emissions, which is in line with several different governmental energy efficiency and sustainability targets.

IEA SHC Task 61 / EBC Annex 77 "Integrated Solutions for daylighting and electric lighting – From Component to system efficiency" therefore pursues the goal to support and foster the better integration of electric lighting and daylighting systems including lighting controls with a main focus on the non-residential sector. This includes the following activities:

‒   Review relation between user perspective (needs/acceptance) and energy in the emerging age of "smart and connected lighting" for a relevant repertory of buildings.
‒   Consolidate findings in use cases and "personas" reflecting the behaviour of typical users.
‒   Based on a review of specifications concerning lighting quality, non-visual effects as well as ease of design, installation and use, provision of recommendations for energy regulations and building performance certificates.
‒   Assess and increase robustness of integrated daylight and electric lighting approaches technically, ecologically and economically.
‒   Demonstrate and verify or reject concepts in lab studies and real use cases based on performance validation protocols.
‒   Develop integral photometric, user comfort and energy rating models (spectral, hourly) as pre-normative work linked to relevant bodies: CIE, CEN, ISO. Initialize standardization.
‒   Provide decision and design guidelines incorporating virtual reality sessions. Integrate approaches into wide spread lighting design software.
‒   Combine competencies: Bring companies from electric lighting and façade together in workshops and specific projects. Hereby support allocation of added value of integrated solutions in the market.

To achieve this goal, the work plan of IEA SHC Task 61 / EBC Annex 77 is organized according to the following four main subtasks, which are interconnected by a joint working group:

‒   Subtask A: User perspective and requirements
‒   Subtask B: Integration and optimization of daylight and electric lighting
‒   Subtask C: Design support for practitioners (Tools, Standards,
    Guidelines)
‒   Subtask D: Lab and field study performance tracking
‒   Joint Working Group: Evaluation tool & VR Decision Guide

Subtask A started with the wide literature review of user needs, which is presented in report A.1 User needs and requirements. Then, a registration of use of buildings and lighting systems have been done in different buildings in Europe. Parallelly, the literature review of use of buildings was done, see report A.2 Use of buildings. The present report is the final result of the Subtask A work, where the collected knowledge about user groups has been transformed into Personas.

EXECUTIVE SUMMARY

The consumption of energy for lighting in buildings depends very much on the way people interact with the build environment. In this study the following building types were studied, office, school, university, commercial and industry buildings. For each building type typical user groups were identified. Then, Personas have been created for each group. As opposed to describing users with numbers and statistics, a single Persona reflects a group and is presented with a narrative. The Persona has a name, a family and living conditions that are representative for the group, also her/his values and interests are not uncommon. The Personas "typical day" includes a time schedule typical for the group. Visual conditions are common for the group, but some specific challenges connected to the visual conditions that may occur in the group are also mentioned.

Personas were created using one of the three methods: interview at the working or learning place, workshop at the working place, and internet survey which was used in the time of pandemic lock-down. Those methods are described in the chapter 2 Methodology and evaluated based on the authors experience, chapter 9 Conclusions. Chapters 3-7 presents Personas for the offices, schools, university buildings, commercial buildings, and industry buildings. In the chapter 8 Home office personas, student and professional, are presented.

The report ends with the description of energy consumption calculation that applies Lumen method which is based on the use of a Coefficient of Utilization (CU). CU computes the fraction of lamp lumens that directly reach the workplane and the fraction from interreflections. The boundary conditions of use of the respective buildings, based on the results from literature review and interviews with users, are also presented, table 2.

IEA SHC Task 61 / EBC Annex 77: Integrated Solutions for Daylighting and Electric Lighting

Contents

IEA SHC Task 61 / EBC Annex 77: Integrated Solutions for Daylighting and Electric Lighting

1 Introduction

This report has been developed in the frame of the IEA SHC Task 61 Subtask A "User perspective and requirements". The main objective was to create Personas being a useful representations of various user groups in public buildings: offices, schools, university buildings, industry and commercial buildings, that is, building typologies studied in the Task 61 and described in the report A.2 Use cases.

Personas may help to create recommendations for lighting design based on user needs.

Three different methods were used to develop Personas: the interview method, the workshop method, and the internet survey method. The methods are described in the chapter 2 and Personas are presented in the following chapters 3-7 for the respective building types.

In the chapter 8 energy saving potential is discussed considering various building typologies and usage (as reported in Table 2). The calculation has been developed with a simplified approach based on Coefficient of Utilization (CU), calculated as an average value for each family of real luminaires proposed; 3 different luminaires have been considered (#1 commercial buildings/offices/schools/universities - #2 industrial part of production - #3 warehouse industrial part. About the efficiencies considered, they are typical of the family of luminaire considered.

Figure 1. Samples of Personas created during the IEA SHC Task 61 Subtask A

2 Methodology

To start with, the creation of personas was not straight forward. The group tried different methods for developing personas, the most used were the interview method, the workshop method and a digital survey. The last one was mainly the result of necessity caused by the pandemic lock-down, but it turns out that it has important advantage i.e., the number of responders is much higher, which allows usage of statistical methods .

The methods are described in the subchapters 2.1 – 2.3.

2.1 Interview method

The first method is based on a direct interview with subjects in relevant contexts, i.e. at their everyday working places. This method was the most used one in the scope of the IEA SHC Task 61, Subtask A. The interview questions were elaborated by Marzieh Nazari and Barbara Matusiak and the method was applied in many buildings (2.1.1) partly in Feb 2020, i.e. before the lock-down (e.g. in Norway 12.03.2020), and partly after the buildings were open again.

2.1.1 Locations

The interview method was applied for developing personas for offices, schools, university, industry, and commercial buildings. The buildings visited during developing of personas are the same as described in the report A.2 Use cases:

- RIAS Built Environmental Control Lab of the University of Campania "Luigi Vanvitelli" in Italy,
- Singsaker school in Trondheim, Norway
- Sopot University of Technology, Poland, and
- Elmarco lighting factory in Gdynia, Poland
- Gdansk University of Technology, Poland

2.1.2 Participants

The interviews were made with the employees representing the most typical user groups: office workers, administrative staff, students (low and high level), teachers (assistant, younger and experienced teachers, professors), industry workers, and the cleaning staff, minimum three people from each group.

2.1.3 Procedure

The interview was preceded by a phone call or an email contact during which the purpose of the interview was explained by the researcher and the time of the interview was appointed.

The researcher visited the room before the interview, made notes regarding practical information like room number classroom/rom location, has taken photos of the room with an eye for lighting related objects to recollect the design of windows and luminaires in the room (type, location, distribution, etc.)

The interview was carried out following the guiding questions presented in Table 1.

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Table 1. Guiding questions for the interview

Personal information and interest	▪ *For how long have you been working/studying here?* ▪ *Would you describe your typical day from the time that you wake up to come to the school/work?* ▪ *How is a typical day at work/in general, please describe it? Start-time, end time?*
Space description where the person and the group he represents, spends most of the time	▪ *How many students or colleagues?* ▪ *Where do you spend most of the time in your workspace?* ▪ *Do you have a personal space/table? How often do you use it?*
Activity description related to lighting condition in general	▪ *How is your workplace like? A space with a table lamp? Ceiling lamp? Which one you prefer, why?* ▪ *What are your typical tasks (type of visual task, fine details, colour discrimination)*
Visual condition	▪ *Have you experienced some uncomfortable situation related to lighting, daylighting at your workplace? (glare, specular reflexes)* ▪ *How do you feel about the controlling lighting? Manual switch on-off? Automatic?* ▪ *Other opinion or concerns about lighting!*
Eventually (not mandatory)	▪ *Could you tell me a little about yourself (What is your home like? / How many family members? / etc.)* ▪ *And what do you do in your free time like after school/work or weekends?* ▪ *May I also ask about what is your dream/passion?* ▪ *How do you think, most of your answer's are representative for the group?*

Depending on the situation, subject's willingness to talk and collaborate, allocated time, etc… the researcher considered to ask questions which could go more deeply into the details. He/she could point at the specific place or object and ask additional questions about details related to the visual environment. To make the evaluation of the visual environment in the room more specific, the subject was asked to give answer to questions about Lighting conditions:

Lighting condition at your workplace:

Satisfaction with daylight?
[*Not at all satisfied*   (0   1   2   3   4   <u>5</u>)   *Very satisfied*]

Satisfaction with electric lighting?
[*Not at all satisfied*   (0   1   2   3   4   <u>5</u>)   *Very satisfied*]

Satisfaction with lighting control system, if any?
[*Not at all satisfied*   (0   1   2   3   4   <u>5</u>)   *Very satisfied*]

Satisfaction with Light Level:
[*Not at all satisfied*   (0   1   2   3   4   <u>5</u>)   *Very satisfied*]

Level of Light
[*Dark*   (0   1   2   3   4   <u>5</u>)   *Bright*]

Spatial distribution of Light
[*Uniform*   (0   1   <u>2</u>   3   4   5)   *Varied*]

Glare

	[*Invisible*	(0	1	2	3	4	5)	*Disturbing*]
Shadows								
	[*Soft*	(0	1	2	3	4	5)	*Hard*]
Reflections								
	[*Diffuse*	(0	1	2	3	4	5)	*Strong*]
Color tones of Light								
	[*Warm*	(0	1	2	3	4	5)	*Cold*]
Color (surfaces)								
	[*Distorted*	(0	1	2	3	4	5)	*Natural*]

At the end of the interview, the researcher could ask additional questions of more personal character, last row in Table 1. The answers from this category helped to create personas with a touch of reality, representing living people with some information about theirs living conditions, family relations and even dreams for the future.

One persona was then created for each user group by the researcher based on gathered information from interview with minimum three and usually four persons from each category.

2.2 Workshop method

The "workshops" method designed by the group: Martyniuk-Peczek, J., Sokól N., Kurek J., Waczyńska M. 2021 was an extension of the "interview" method (see 2.1).   During the work, it was noticed that during the interview the participants had problems regarding assessing some lighting issues. Therefore, it was decided to select those places that required a special way to specify the lighting conditions, and there it was decided to use the workshop method. The workshop method involves all interested parties in the process of evaluation and assessment of the lighting conditions from the users' point of view. The method consists of five-steps: (i) the pre-interview; (ii) the observations and measurements; (iii) scenario-context workshop with elements of mentoring (teaching about lighting); (iv) the post-evaluation survey; (v) the creation of personas. The method was developed to analyses the users' perceptions and descriptions of lighting conditions in two scenarios: 1) without any specific and technical knowledge and 2) after getting some more information. This method was based on a literature review in the field of energy [1], [2], [3], [4], [5].

2.2.1 Location and building

Due to the nature of the building the University building was selected for the workshops. The method was applied in the main library and administration offices the of the Gdansk University of Technology in Poland in the historic building of the Faculty of Architecture, located on the campus.

The rooms selected for the study had a different character. Therefore, it was important to analyse lighting conditions as well as perception of lighting. The library consists of two main rooms at the first floor: the reading room and the library office rooms and storage. The reading room is a room 20m x 10 m with 6m height, with windows facing south-west. The office room and storage is located in the basement. It has irregular shape. The overall size is over 300 m2. It has only windows looking into the inner atrium. That specific features has led to conclusions that the lighting conditions can be difficult to assess by the users. That is why this method was involved.

2.2.2 Participants

The participants were the employees who are working and spending the whole day in the same area (which in University building is not so common. Tutors and students usually change places throughout the day). The participants were representing three groups: librarians, archivist and administration staff.

2.2.3 Procedure

Pre-interview

The aim of the pre-interview was to identify how the user perceive their work place and how do they assess the lighting conditions. To achieve this goal, the pre-interviews were designed and conducted among the users. The questionnaire was based on the one proposed in the interview method The questionnaire consisted of 18 open-ended questions. Due to the working hours, the interviews were done separately for each person. It was filled in native language of the participants (Polish) to ensure clarity and good understanding. The questionnaire covered three main topics: general data (gender, age, works position, work experience, workday schedule), description of the work environment (room, workplace, lighting conditions) and behavioural patterns (tasks, tools, challenges, positive/negative aspects of work, the use of light, overall expectations) (Appendix 1).

Observations and measurements on the site

The second step involved on-site observations of the users by the researchers while performing work activities and during brakes. The observations were noted and also some anonymized photos were taken. This step also included the on-site measurements of the light levels by luxmeters. Expert analysis allows to identify those places where lighting had unique features due to standards or requirements like there was insufficient illuminance, glare etc.

Workshop in the context with elements of mentoring

The third step was to introduce the user to the basics of lighting. A multimedia presentation was prepared (Appendix 2), which explained the basic definitions and recommendations in the lighting for example: illuminance, luminous flux, color temperature, Colour Rendering Index, luminous intensity, beam angle, glare. To show the users the differences of lighting conditions the mock-ups with the luminaries were presented. The main purpose was to show the different color temperature and colour rendering. Then the walk throughout the room was prepared. During the walk, the researchers were explaining different situations that were observed during the "Observations and measurements on the site". They showed the glare on the shelves. They also were explaining the light levels and their lower level than required in the standard. The whole workshops was about teaching about lighting – to gain knowledge by the user.

Post-evaluation survey

The aim of this part was to collect feedback from participants about the lighting conditions. The idea was that the participants gained knowledge and can more properly evaluate lighting conditions. The part of the questionnaire about the **lighting condition at workplace** was use (Appendix 2.1). The purpose of such an task, was to look for the differences in assessing and describing lighting conditions, before and after the workshops – gaining knowledge.

Creation of personas

Based on the information collected in previous steps a draft of Personas for two librarians and one student was made.

2.3 Internet survey method

2.3.1 Location

Rooms in homes and apartments used by participants as their working place (Home Office) during the COVID-19 pandemic.

2.3.2 Participants

Students and professionals from Brazil, Colombia, Denmark, Japan, Italy, and Poland.

2.3.3 Procedure

The survey was developed by the experts working on Subtask A of IEA Task 61 "Integrated Solutions for Daylighting and Electric Lighting" in September-November 2020 (Matusiak, B.; Amorim, C.N.D, 2020). It was distributed online from December 2020 to March 2021 in native languages of each country. Participants could use a computer, a smartphone or a tablet to answer the survey. Answering the survey took approximately 8 min. See Appendix 3 for the English version of the survey.

In the introductory section each participant was asked to provide informed consent before taking part. The survey was composed of 6 sections, containing 33 questions for students and 37 questions for professionals, including one open ended question at the end. The participant was also asked to take two photos with the cell phone, i) a photo of his/her home office desk with surrounding space and ii) a photo of the external view from the window (if present). It was clearly stated that people should not be included on the photos. The photos were helpful as sources of additional information about some characteristics of the space, as the number of layers seen, if the view is clear and if the sky is visible.

From the survey, the following information was extracted and analysed:

GENERAL DATA: personal characteristics (age, sex, nationality), workday schedule, tasks

PHYSICAL SPACE CHARACTERISTICS: window orientation, solar protection elements (external and internal), distance to the window, electrical light fixtures

PREFERENCES: what influences the overall satisfaction with lighting

BEHAVIOUR: what are the standard actions specially regarding electrical lighting

ACTIONS: what they would like to do to improve visual environment

From the answers, descriptive statistics, simple correlations, pictures analysis and qualitative analysis with the software Nvivo have been performed, to create Personas for Home Office, both for Professionals and Students categories.

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3 Office buildings

All the "personas" for office building has been created using the interview method, minimum 4 people were interviewed for each persona. The data reported for this "personas" reflect those related to all the people interviewed. The name of the "personas" is invented and represents one of the three names most used in Italy.

The gender of the "personas" is representative of the gender of most of the people interviewed.

The age of the "personas" is obtained as an average of the age people interviewed.

3.1 Office worker 1: Sofia

Hard Facts

Sofia is living in an apartment of about 150 m^2, together with her family (husband and 2 sons).
She is 39 years old and is graduated. She works in the production department as a technical designer for 2 years.

Interests and Values

She likes to relax working with outdoors gardening; she spends her free time with her family.

She loves to cook and read paper books.

A Typical Day

From Monday to Friday, Sofia gets up no later than 06:30 am. She makes breakfast for all the family and then she eats breakfast. After breakfast, she takes a shower, dresses, and goes to work. Usually, at 8:30 am she arrives at work.

In the morning (08:30 - 13:00) she works at the PC, she reads emails, and works on AutoCAD, a program of computer-aided design. During the afternoon (14:00 - 17:30) she reviews/continuous the works on AutoCAD, reads the email and prepares a file to send to the workers. From 13:00 to 14:00 she has the lunch break.

On Saturday and Sunday, Sofia gets up no later than 08:30 am and dedicates her time to the family and housework's.

During free time, she cultivates her interests.

Visual conditions in the office

There are 3 colleagues in the office. The office is located on the first floor of the building, and it has 1 window facing south-west. Sofia has a desk by the rear wall (opposite the door) with the window on the left side. The artificial lighting system consists of 6 ceiling luminaires (she has no desk lamps available). The artificial lighting system is manually controlled and usually, when Sofia arrives in the office, the artificial lighting is already turned on. She turns off the luminaires during the lunch break. At 17:30, Sofia leaves the office without turning off the artificial lighting system.

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Sofia has a perfect vision. She does not find any discomforts related to daylighting and/or artificial lighting.

The email box used by Sofia has a white background; when she works on AutoCAD (about 5 hours/day), the software has a black background.

Future Goals

She dreams about a new house.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight?

[Not at all Satisfied	(0	1	2	**3**	4	5)	Very satisfied]

- Satisfaction with electrical lighting?

[Not at all Satisfied	(0	1	2	3	4	**5**)	Very satisfied]

- Satisfaction with lighting control system?

[Not at all Satisfied	(0	1	2	**3**	4	5)	Very satisfied]

- Light Level:

[Not at all Satisfied	(0	1	2	3	4	**5**)	Very satisfied]

- Level of Light

[Dark	(0	1	2	3	**4**	5)	Bright]

- Spatial distribution of Light

[Uniform	**(0**	1	2	3	4	5)	Varied]

- Glare

[Invisible	**(0**	1	2	3	4	5)	Disturbing]

- Shadows

[Soft	**(0**	1	2	3	4	5)	Hard]

- Reflections

[Diffuse	(0	**1**	2	3	4	5)	Strong]

- Color tones of Light

[Warm	(0	1	2	3	**4**	5)	Cold]

- Color (surfaces)

[Distorted	(0	1	2	3	4	**5**)	Natural]

3.2 Office worker 2: Francesco

Hard Facts

Francesco is living in a row house of about 150 m^2, together with his family (wife and 2 sons).
He is 39 years old and is graduated. He has worked in the sales department for 15 years.

Interests and Values

He spends his free time with his family. He likes to read and cook.

In addition, he relaxes doing outdoors gardening.

A Typical Day

From Monday to Friday, Francesco gets up no later than 06:00 am. He has breakfast at home. Then, he takes a shower, dresses and goes to work. Usually, at 7:30 am he arrives at work.

In the morning (07:30 - 13:00) he works at the PC, he reads/writes emails, calls clients and uses a sales management software. During the afternoon (14:00 - 18:30) he works at the PC, he

reads/writes, calls clients and uses a sales management software. From 13:00 to 14:00 he has the lunch break.

Saturday and Sunday, Francesco gets up after than 08:00 am and, during their free time, he cultivates his interests; in particular, he spends his free time with his family and dedicates his time to the garden.

Visual conditions in the office

There are 1 colleague in the office. The office is located on the ground floor of the building and has 1 window facing south-est. Francesco has a desk in front of the door with the window on the right side. The artificial lighting system consists of 4 ceiling luminaires (he has not a desk lamp). The artificial lighting system is manually controlled and usually, when Francesco arrives in the office, he turns on the luminaires. He turns off the luminaires during the lunch break and when he leaves the office at 18:30.

Francesco does not find any discomforts related to daylighting and/or artificial lighting.
The email box used by Francesco has a white background (about 4 hours/day), when he works on the sales management software (about 4 hours/day), the background is grey.

Future Goals

He dreams to win the lottery.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight?

  [Not at all Satisfied   (0   1   2   3   4   **5**)   Very satisfied]
- Satisfaction with electrical lighting?

  [Not at all Satisfied   (0   1   2   3   4   **5**)   Very satisfied]
- Satisfaction with lighting control system?

  [Not at all Satisfied   (0   1   2   3   4   **5**)   Very satisfied]
- Light Level:

  [Not at all Satisfied   (0   1   2   3   4   **5**)   Very satisfied]
- Level of Light

  [Dark   (0   1   2   3   **4**   5)   Bright]
- Spatial distribution of Light

  [Uniform   (**0**   1   2   3   4   5)   Varied]
- Glare

  [Invisible   (**0**   1   2   3   4   5)   Disturbing]
- Shadows

  [Soft   (**0**   1   2   3   4   5)   Hard]
- Reflections

  [Diffuse   (**0**   1   2   3   4   5)   Strong]
- Color tones of Light

  [Warm   (0   1   2   3   **4**   5)   Cold]
- Color (surfaces)

  [Distorted   (0   1   2   3   **4**   5)   Natural]

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3.3 Administration staff including leaders: Giulia

Hard Facts

Giulia is living in a row house of about 150 m^2, together with her family (husband and 2 sons).
She is 38 years old and is graduated.

Interests and Values

She likes to spend her free time with her family or friends.

She loves to do shopping.

A Typical Day

From Monday to Friday, Giulia gets up no later than 06:00 am. She makes breakfast for all the family and then she eats breakfast. After breakfast, she takes a shower, dresses, takes the kids to school and goes to work. Usually, at 8:00 am she arrives at work.

During a typical workday (08:00 - 13:00 and 14:00 - 17:30), she works at the PC, she reads/replays emails and carries out other administrative procedures. From 13:00 to 14:00 she has the lunch break.

Saturday and Sunday, Giulia gets up no later than 8:30 am and dedicates her time to the family and housework's.

Visual conditions in the office

There are no colleagues in the office and the office has 1 window facing south-east located at the first floor of the building. Giulia has a desk by the rear wall (opposite the door) with the window on the right side. The artificial lighting system consists of 2 ceiling luminaires (she has no desk lamps available). The artificial lighting system is manually controlled and usually, when Giulia arrives in the office, the artificial lighting system is already turned on. She turns off the luminaires during the lunch break. At 17:30, Giulia leaves the office and turns off the artificial lighting system.

Giulia does not find any discomforts related to daylighting and/or artificial lighting.

The email box used by Giulia has a withe background, when she works with others administrative programs, the software has a grey background (about 6 hours/day).

Future Goals

She dreams to have more time to cultivate her interests.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight?
  [Not at all Satisfied   (0   1   2   3   4   **5**)   Very satisfied]
- Satisfaction with electrical lighting?
  [Not at all Satisfied   (0   1   2   3   4   **5**)   Very satisfied]
- Satisfaction with lighting control system?
  [Not at all Satisfied   (0   1   2   3   4   **5**)   Very satisfied]
- Light Level:
  [Not at all Satisfied   (0   1   2   3   4   **5**)   Very satisfied]
- Level of Light
  [Dark   (0   1   2   3   4   **5**)   Bright]
- Spatial distribution of Light

- [Uniform ... Varied]

	(0	1	2	3	4	5)	
[Uniform	**(0**	1	2	3	4	5)	Varied]

- Glare

[Invisible	**(0**	1	2	3	4	5)	Disturbing]

- Shadows

[Soft	**(0**	1	2	3	4	5)	Hard]

- Reflections

[Diffuse	(0	**1**	2	3	4	5)	Strong]

- Color tones of Light

[Warm	(0	1	2	3	**4**	5)	Cold]

- Color (surfaces)

[Distorted	(0	1	2	3	4	**5)**	Natural]

3.4 Cleaning staff: Anna

Hard Facts

Anna is living in an apartment of about 100 m^2, together with her family (husband and 1 son).
She is 57 years old and is not graduated. She is a member of the cleaning staff of the office building.

Interests and Values

She loves to cook.

A Typical Day

From Monday to Friday, Anna gets up no later than 05:20 am. She takes a shower and dresses, then she makes breakfast at home, and she goes to work. Usually, at 7:00 am she arrives at work.

She cleans all the offices. From 12:30 to 13:30 she has the lunch break.

Visual conditions in the office

There are 3 colleagues that work with Anna in the cleaning staff. Anna has not a private office/desk.

During her work and she does not find any discomforts related to daylighting and/or artificial lighting.

She doesn't use software.

Future Goals

She dreams of traveling around the world.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight?

[Not at all Satisfied	(0	1	2	3	4	**5)**	Very satisfied]

- Satisfaction with electrical lighting?

[Not at all Satisfied	(0	1	2	3	4	**5)**	Very satisfied]

- Satisfaction with lighting control system?

[Not at all Satisfied	(0	1	2	3	4	**5)**	Very satisfied]

- Light Level:

[Not at all Satisfied	(0	1	2	3	4	**5)**	Very satisfied]

- Level of Light

[Dark	(0	1	2	3	**4**	5)	Bright]

- Spatial distribution of Light

[Uniform	**(0**	1	2	3	4	5)	Varied]

- Glare

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	[Invisible	(**0**	1	2	3	4	5)	Disturbing]
▪ Shadows								
	[Soft	(**0**	1	2	3	4	5)	Hard]
▪ Reflections								
	[Diffuse	(**0**	1	2	3	4	5)	Strong]
▪ Color tones of Light								
	[Warm	(0	1	2	3	**4**	5)	Cold]
▪ Color (surfaces)								
	[Distorted	(0	1	2	3	**4**	5)	Natural]

4 School buildings

4.1 Students: Alexander (second class)
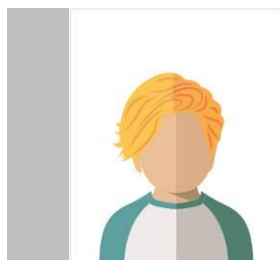
Hard Facts

Alexander is living in a row house in Trondheim, together with mom, dad, an older sister and a younger brother.

He is 8 years old and goes to an elementary school in the neighborhood.

Interests and Values

He likes to play outdoors; he spends about one hour every day on the family trampoline; he tries to impress his friends and sister with new jumps.

He loves to play football, and he is proud to be a member of the local football team for 7-10 years boys.

The best summer vacation for him is in the mountains, together with mom, dad and siblings.

He can read and write, slowly but correctly. He remembers the names of the mountains and can write them down with nearly correct spelling.

He claims he is the best one in mathematics in his class, and he does not want to lose this position.

He likes to joke and laugh with other boys, to tease girls, occasionally he is involved in fights.

Alexander also loves to play computer games. He has his own tablet with games carefully chosen by his father.

A new computer game will be the best gift for his next birthday.

A Typical Day

Alexander gets up no later than 7am. He eats breakfast at home and goes to school about 8 am every morning.

At school (08:30 - 13:00) he spends most time in a classroom. He has gym twice a week (45 min.) in the gym hall or at the school playground.

At about 13 he goes to the school's dayroom located in the same building on the ground floor, where he eats a warm dish with other children and plays with them indoors or outdoors, depending on the weather.

Dad takes him home at about 16.

Monday is the most important weekday since he goes to soccer training at the neighboring sports field (18:00-19:30).

On Wednesday he has swimming lessons in a swimming hall located approx. 15 km from his home. Mom or Dad drives him there with a car.

Visual conditions in the school

There are 25 children in the class, a tutor teacher and one part-time assistant.

The classroom has four large windows oriented to the west and a large whiteboard on the shorter wall where the tutor teacher usually explains the new stuff writing on the board with coloured markers. Alexander has a sitting place by the rear wall (opposite to the window wall), near the whiteboard and the door. The light on his table is adequate (even and larger than 300lx, for most of the time due to the pendulum luminaires). The specular reflections appears at the bord both when the electric light is on and when the sun is shining. Even though he has a perfectly good vision, the specular reflections bother him and interfere with concentration. The teacher is aware about the condition and distributes students in the classroom differently each year, Alexander thinks one year is a very long time.

Alexander enjoys video and slide projections, which happens usually for about ½ hour a day.

Future Goals

Alexander dreams to become a famous football player.

4.2 Students: Isabella (fifth class)

Hard Facts
Isabella is living in a row house in Trondheim, together with mamma, papa, and a younger brother.
She is 12 years old and goes to an elementary school in the neighbourhood.

Interests and Values

She likes everything connected with water. She likes to swim and is a member of the swimming club in Trondheim where she has just advanced to the level B, which is a great achievement.

She likes to read books, everywhere, she reads books in the bus or/and in the car and even when going up-down on the stairs.

Drawing is her another passion; she likes to make funny drawings illustrating animals and exaggerating their characteristic features. She is one of the best in the class in drawing.

Sometimes she watches TV and plays computer games, it seems that computer graphics is more exciting to her then winning a game.

She likes to listen to the music and dance to it.

She has three best friends and spent much of her free time with them. She likes to talk and laugh with them, boys are childish, she thinks.

The best summer vacation for her is on a sailboat, together with mom, dad, grandfather and siblings.

A new book will be the best gift for her next birthday or even better a smart phone….

A Typical Day

Isabella gets up no later than 7am. She eats breakfast at home and goes to the school about 8 am every morning.

At school (08:30 - 14:30) she spends most of the time in a classroom on the third floor.

Twice a week she has gym (45 min.) in the gym hall or, if the weather is good, on the school sports court.

After school she goes home, together with the classmates who live in the neighbourhood.

She is training in the swimming pool three times a week, usually in the evening (1800-1930). Mom or Dad drives her. She hopes to be able to cycle there alone next school year.

Visual conditions in the school

There are 25 children in the class and one tutor teacher.

The classroom has four large windows to the east and a large whiteboard on the shorter wall where the tutor-teacher usually explains the new stuff. Isabella has a sitting place by the window, half-way from the whiteboard. This place has been assigned for her to improve her visual conditions. She has to wear glasses due to advanced myopia (-4) and she claims that she likes and needs bright light. Her desktop is illuminated mostly by daylight, the mean illuminance is seldom lower than 500 lux.

Future Goals

Isabella dreams to become a book illustrator.

4.3 Teacher assistant, SIMRAN

Hard Facts
Mr. Simran Singh started his carrier as a teacher in India. In 1991 he decided to move to Norway and continue his career here. After he received a bilingual teaching certificate from NTNU in 2000, he stared to work as a teacher in the school. He has three children, two sons and a daughter. He lives with his wife, the younger son and the daughter in a wooden house with three bedrooms.

Interests and Values

Mr. Singh has a very positive attitude to people. He loves his job and believes that being a teacher gives him an opportunity to prepare young children for their future. He talks about his workspace with great engagement, like it was his second home. During weekends or on his free time he prefers to spend time with his family.

A Typical Day

Simran usually wakes up early in the morning, takes shower and spends some time to pray. Then he has a breakfast and drives about fifteen minutes by car to reach his job. He starts at 8:30. His workday usually begins by joining students that are playing on the courtyard. During the day he works with other teachers in a team to arrange students' schedule or activities. Most of his time at school he is supervising students during their physical activities, for example in gym, or at the main courtyard. He also attends some theoretical classes when the main teacher needs some extra help to create a better learning conditions. His day at work usually ends with being on the playground and companying students.

Visual conditions in the school

Because of his role as a teacher assistant, he doesn't work in a one specific classroom. He has an office space that is shared with four other colleague that are working as a team. He has a desk there to use for taking notes and planning his schedule, no desk lamp. He spends most of his time in gymnasium, different classrooms, or on the outdoor playground.

Light is controlled automatically in the school. The good thing that he has noticed, is the benefits of automatic shading devices. He is very satisfied with shading and lighting control system in the school in different weather condition specially during winter. He describes the glass roof in the main hall is very well designed and because of daylight there the students like the space very much and prefer to play there. He thinks that the lighting control system in the school functions perfectly well. He

observed that during cloudy days the system automatically controls lighting in the environment and teachers don't feel the need to adjust the light very often. So, they can focus more on children and their teaching tasks.

He finds the lighting control is also informative. At the end of working hours when there is no one in a classroom a small red light turns on which shows the classroom is empty and everyone has left.

Future Goals

Seeing students learning and growing is his passion.

4.4 Young teacher: Astri

Hard Facts
Astri has been teacher in four years and this is the second year that she works in Singsaker school. She teaches fourth grade. She has 27 students in her class, she works partly alone and partly with another teacher as a team.

Interest and values

Astri enjoy sports, her favorites are running, skiing and weightlifting. In her free time, she also like knitting. Her interest most of time is working out and sport and when she wants to relax, she stays at home and knit.

A typical day

Astri wakes up at 7:00. It takes 10 minutes by bike to arrive to the school at 8:00. The class starts at 8:30. When she enters the classroom the first thing she does is to switch the light on. She switches light off when she leaves the room for breaks. She works with students until 14:30, then she goes to the teacher office and stays there until 4:00 pm. She leaves the school and bike home. At home, she makes dinner and do some work out.

Visual Conditions in the school

Astri works in a classroom at the corner of the building in second floor with two windows toward the south and west but windows are small compared to the size of the class. She believes that her classroom is dark so she has to keep the lights on all the time. The biggest problem is when she is using the video projector. The light from the projection is rather week, so she has to switch the ceiling light off for visibility of the video images, but then the light level in the room is low, and the students cannot see their books and it's hard for them to make notes. She thinks that if they have had a possibility to keep a part of the luminaires switched on that would be a good option but for now all the lamps are controlled by one switch.

Because the window of the classroom is toward the south when the sun is shining, she must cover the window by curtains to avoid glare or reflection on the white, shiny board. Part of her teaching time goes to think about adjusting the light or curtains.

She has an office space in the teacher's room at the ground floor that is shared with five other teachers. She doesn't have a table lamp there, but she feels that the lighting is good enough. She also doesn't have any table lamp in the classroom but she also doesn't need a one; she prefers to work in the teachers room anyway.

About lighting control system, she prefers to have the possibility of controlling some part of class separately. Astri has the experience of teaching in a classroom with automatic control system for

shading and electric lighting. She refers to a problem of 15 minutes delay of the system to adjust the shading of the windows. She thinks this is a long time to wait and is annoying. She would prefer to also be able to adjust it manually herself.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight?

[Not at all Satisfied	(0	1	2	**3**	4	5)	Very satisfied]

- Satisfaction with electrical lighting?

[Not at all Satisfied	(0	**1**	2	3	4	5)	Very satisfied]

- Satisfaction with lighting control system?

[Not at all Satisfied	(0	**1**	2	3	4	5)	Very satisfied]

- Light Level:

[Not at all Satisfied	(0	1	2	**3**	4	5)	Very satisfied]

- Level of Light

[Dark	(0	1	2	**3**	4	5)	Bright]

- Spatial distribution of Light

[Uniform	(0	**1**	2	3	4	5)	Varied]

- Glare

[Invisible	(0	**1**	2	3	4	5)	Disturbing]

- Shadows

[Soft	(0	**1**	2	3	4	5)	Hard]

- Reflections

[Diffuse	(0	1	2	3	4	**5**)	Strong]

- Color tones of Light

[Warm	(0	1	**2**	3	4	5)	Cold]

- Color (surfaces)

[Distorted	(0	1	2	3	**4**	5)	Natural]

4.5 Experienced teacher: Vilde

Hard facts
Vilde is 48 years old and lives with her husband and their dog in a house in south east of Trondheim. She has been teacher for 17 years. She has two sons who study and live in Oslo now. She has worked as a teacher in the same primarily school for the last 8 years.

Interest and values

Vilde is interested in literature and vocabulary. In her free time, she usually fills the crosswords. During the weekend she likes reading books and going to hiking with her husband.

A typical day

Vilde gets up at 6:30 and after breakfast she goes to the school. She drives to work every day and it takes around 15 minutes for her to arrive to the school. Her class starts at 8:30, and she has 16 students this year. She teaches fourth-grade and the course that she enjoys the most is the Norwegian language. After school and before going back home she usually drops by her sister's house to check how she feels because she was recently sick. When she comes back home around 16:30 she cooks dinner with her husband. In the evening they usually go for a short walk with their dog around their neighborhood.

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Visual condition in the school

Vilde believes her classroom is very bright and good. It has three big windows and several pendent luminaires. Most of the time, when she arrives at the classroom, she needs to switch the electrical light on because in the morning, especially in winter, the classroom is dark. Most of days in autumn and winter here in Trondheim are cloudy so, she thinks it is necessary to use electrical light otherwise there is not enough light, which makes students feel sleepy especially in the mornings.

Future goals

Vilde is thinking maybe she should start writing. Her interest in literature made her read hundreds of books during the years and she think maybe now is time to start writing short texts or poems in her free time. She thinks maybe one day she could publish them.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight?
  [Not at all Satisfied   (0   1   2   3   **4**   5)   Very satisfied]
- Satisfaction with electrical lighting?
  [Not at all Satisfied   (0   1   2   3   **4**   5)   Very satisfied]
- Satisfaction with lighting control system?
  [Not at all Satisfied   (0   1   2   **3**   4   5)   Very satisfied]
- Light Level:
  [Not at all Satisfied   (0   1   2   3   **4**   5)   Very satisfied]
- Level of Light
  [Dark   (0   1   2   3   **4**   5)   Bright]
- Spatial distribution of Light
  [Uniform   (**0**   1   2   3   4   5)   Varied]
- Glare
  [Invisible   (**0**   1   2   3   4   5)   Disturbing]
- Shadows
  [Soft   (0   **1**   2   3   4   5)   Hard]
- Reflections
  [Diffuse   (0   **1**   2   3   4   5)   Strong]
- Color tones of Light
  [Warm   (0   1   2   3   **4**   5)   Cold]
- Color (surfaces)
  [Distorted   (0   1   2   3   **4**   5)   Natural]

4.6 Principal: Sten

Hard Facts
Sten has been the principal of Singsaker school for ten years. He has a master's degree in music and before his current job he was working in a culture school. He has two daughters 30 and 24 years old. One is moved out to her own house and the younger studies in Bergen and live there.

Interest and values

His passion is music. He is guitar player, singer and composer and he recently published his own violin record with his dialect from north of Norway. He spends nearly all of his free time on composing, recording and producing albums. Also, he performs with a band in city center some weekends.

A typical day

In the morning the first thing that he does is switching on the lights. At the end of working hours when he wants to leave the office, he organizes his desk and arranges everything in ordered then he switches off the light.

Visual Conditions in the school

His office is in ground floor with very big window to the south west. His office has two main area separated with furniture, on the window side there is a desk for paper work and on the other side there is a table for meetings. In the meeting area there is a monitor screen on the wall to use for presentation in meetings.

The school is an old building and Sten's office has very high ceiling, around four meters from the floor. This makes that his office looks very bright and specious. His computer is at the corner of his office next to the window. Although at noon sometimes he has to adjust the screen of his computer to avoid disturbing light and glare, he is very satisfied with daylight. In general, he feels satisfied with lighting in the school even though there are some moments of solar glare in some classrooms oriented to the south especially in May and June. He mentioned that during these months they also experience some problems with too much heat from the sunlight.

Sten's office has three fluorescent pendent luminaires and he thinks they function very well. He doesn't have a table lamp but never felt any need for that. The windows in his office have curtains with very low level of transparency. Sometimes when the sunlight is disturbing, he uses curtains to cover the windows but this doesn't happen very often. The school and his office have manual switch on/off lighting control system and Sten never felt that it is a problem. He thinks that this is enough for what he needs from a lighting system.

He is currently changing the school, the new school that he is going to work at has two parts, one from 1970s, and the other from 2015. After visiting the other school, he thinks that the new building has much better standard regarding lighting system. But also, that school buildings from 1800s, like the school that he is working in now (Singsaker), because of high ceiling and large windows have spaces that have better daylighting compared to the schools that were built in 1900s because they don't have high ceiling.

Future goal

His dream is connected to his passion, music. He likes to prepare another album and would like to perform for more audiences when this pandemic is over. He also has passion for traveling and there are lots of places in his bucket list to visit.

4.7 Cleaning staff: Ida
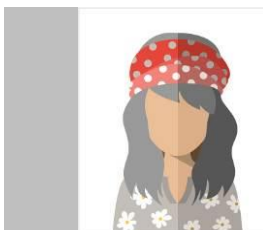
Hard Facts
Ida is 52 yours old. After her husband moved away, she lives alone in a rather small apartment (70 m2) on the other side of the city. She has two children and one two years old ground child.

Interest and values

She is preoccupied with the health and well-being of the family; she enjoys each meeting with her children and the ground child who is, as she describes it "sweetheart-cute". She visits her old mother few times a week and brings her healthy food, e.g. vegetables, fruits, nuts, in addition to home-made mixtures. She follows activities of other family members as well, partly on facebook.

A typical day

She is one of the first people coming to the school in the morning. It is usually few minutes before 07:00. She shifts into her cleaning coat, takes one of the trolleys from the cloak room and starts the cleaning. The order and the scope of the work is planned together with the principal, some tasks have to be made daily, others once in a week or month or depending on the situation like e.g. cleaning after sporadic activities in the evenings. She usually starts the day by cleaning toilets on all floors where she uses special type of disinfection, then the corridors and areas for administrative personal and teacher's rooms. She cleans the classrooms at the end of the day, after the children have left the classrooms. She usually follows the schedule, but additional cleaning tasks appear sometimes in connection with the activities during lectures and breaks. She is also eager to help teachers and children with small occasional problems, like a need for a plaster, or helps a forgetful teacher to open a classroom or a storage room. She works 7,5 hours a day, that is from 07:00 to 1530, with a 1/2-hour break in the middle of the day 11:30 – 12:00. Then she shifts and takes a bus home.

Visual Conditions in the school Visual Conditions in the school

The visual conditions are very important for the quality of her work, she would like to clean each room as good as possible, she needs to see all the smallest details both on the tables and shelfs, and on the floor beneath them. During the cleaning she swich on all the lamps in the room. She thinks that the illumination in toilets could be brighter and that the light in corridors could be more even, there are some dark corners there.

Future goal

She passed the difficult time of separation and divorce some years ago and has now a positive outlook for the future. She would like to be helpful to other peoples, she considers participating in the church aid in the future.

5 University buildings

When creating the "personas" at the University building two different methods were used. The first method was used to build a persona of a student, professor and cleaning staff. There where 18 people interviewed with the person – to person relations. The second method was used to define the librarian and the administrative staff. There were 12 people taking part in the workshops. The data like the gender, age and names reflect those related to all the people interviewed.

5.1 Students - Julia

Hard Facts

Julia lives in a dormitory by the University. She comes from a small town. She is 20 years and she is studying architecture. She works part time in the restaurant.

Interests and Values

She likes sports. Julia often runs in the woods and rides a bike. In her spare time, she also likes to travel. She like taking pictures. Julia is also running Instagram profile about modern design.

A Typical Day

Julia has a varied schedule. Sometimes it starts in the morning and sometimes in the afternoon. She usually gets up around 8.00 am. She eats breakfast and have coffee at the cafe. Before classes, if she has time, Julia goes to work. Then she goes by bike to university. The classes are taking usually 5 hours per day. Depending on time and the workload, sometimes after school she goes to the pub with her friends. Usually, she goes home to do her assignments.

Visual conditions in the office

The Architecture is situated in an old building. There are large rooms with high ceiling. Julia has classes in different classrooms. She likes drawing classes which are conducted in the attic. There are skylights that look north. Classes are often conducted in large rooms, where Julia sits at the table with her friends. During classes, she makes notes and sometimes she draws. She also uses her laptop to make notes or to do some design.

The artificial lighting system is manually controlled and usually is turned on.

Future Goals

She dreams about a trip to USA.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight?
  [Not at all Satisfied   (0   1   2   **3**   4   **5**)   Very satisfied]
- Satisfaction with electrical lighting?
  [Not at all Satisfied   (0   1   2   **3**   4   *5*)   Very satisfied]
- Satisfaction with lighting control system?
  [Not at all Satisfied   (0   1   2   **3**   4   5)   Very satisfied]
- Light Level:
  [Not at all Satisfied   (0   1   2   **3**   4   5)   Very satisfied]
- Level of Light

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	[Dark	(0	1	2	3	**4**	5)	Bright]
▪ Spatial distribution of Light								
	[Uniform	(0	**1**	2	3	4	5)	Varied]
▪ Glare								
	[Invisible	(0	1	**2**	3	4	5)	Disturbing]
▪ Shadows								
	[Soft	(0	1	2	3	**4**	5)	Hard]
▪ Reflections								
	[Diffuse	(0	1	**2**	3	4	5)	Strong]
▪ Color tones of Light								
	[Warm	(0	1	2	**3**	4	5)	Cold]
▪ Color (surfaces)								
	[Distorted	(0	1	2	**3**	4	5)	Natural]

5.2 Professors - Joanna
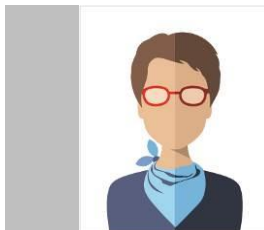
Hard Facts

Joanna lives in a semi-detached house in the suburbs with her husband and two teenage kids. She works at the University at the Faculty of Architecture since she graduated. It is now over 22 years.

Interests and Values

Joanna loves reading. Her main interest is culture. During holidays she likes to travel to distant countries.

A Typical Day

Joanna always starts her day with a cup of coffee. She gets up quite early, at 6.00. She drinks her cup of coffee in the garden. Then, she prepares breakfast for the family. She usually gets ready to go to work at 9.00. She commutes by car. Joanna does not have classes with students every day. She teaches 3 times per week. Sometimes she works in her room, sometimes she has various meetings. Around 4 p.m. Joanna comes back home. She prepares the dinner for her family. Twice a week she goes out for yoga evening classes. Joanna spends evenings at the computer working on articles or grant proposals.

Visual conditions in the office

Joanna has an office in an old building. She shares office with 4 other colleagues. The room has large windows facing north. Joanna has her desk at one of the windows. Sometimes she works at her desk, but mostly she runs classes or attend other meetings. Joanna also conducts classes with students in various classrooms. Her favourite room is close to her office, because there are large windows there. In the old building of the University, the classrooms are usually large rooms, 5m x 10m and 4 meters height. There are three rows of fluorescent lamp hanged on the ceiling. The color temperature is neutral white. Joanna doesn't like electric light. But whenever she enters the room she then turns on the light. When leaving the room, she always turns off the light. She doesn't turn on lights only if she has a lecture. She has been wearing glasses for 5 years. She has myopia.

Future Goals

Her dream is to travel around the world.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight?
  [Not at all Satisfied   (0 1 2 3 4 **5**)   Very satisfied]
- Satisfaction with electrical lighting?
  [Not at all Satisfied   (0 1 **2** 3 4 5)   Very satisfied]
- Satisfaction with lighting control system?
  [Not at all Satisfied   (**0** 1 2 3 4 5)   Very satisfied]
- Light Level:
  [Not at all Satisfied   (0 1 2 **3** 4 5)   Very satisfied]
- Level of Light
  [Dark   (0 1 **2** 3 4 5)   Bright]
- Spatial distribution of Light
  [Uniform   (0 1 2 **3** 4 5)   Varied]
- Glare
  [Invisible   (**0** 1 2 3 4 5)   Disturbing]
- Shadows
  [Soft   (0 1 2 **3** 4 5)   Hard]
- Reflections
  [Diffuse   (0 1 2 **3** 4 5)   Strong]
- Color tones of Light
  [Warm   (0 1 2 3 4 **5**)   Cold]
- Color (surfaces)
  [Distorted   (0 1 2 **3** 4 5)   Natural]

5.3 Administrative staff including leaders- Piotr

Hard Facts

Piotr lives with his family in a modern apartment in the city centre. He as two daughters who study at the University. Piotr is 50 years old. He is a leader of the Research department. Parallel he also is teaching at Doctoral School.

Interests and Values

Piotr likes nature. His hobby is photography. Lately he bought a drone to take photos over the landscape and city. His dream is to hike in Nepal.

A Typical Day

Piotr gets up at 6.30 every day. He eats breakfast with his wife. He commutes by tram to the University every day. He takes a tram at 7.30 and gets to the University around 8.00. He usually stars his day with a meeting with his co-workers by the coffee, they talk about the day schedule and the tasks. Then he often has some meetings in his office, or he has to visit outer Departments. At lunchtime, he usually goes out and have a break in the near cafe. Very often after a lunch he has to do some paperwork. Then, he sits by the desk and works on computer. Sometimes he has more meetings in the afternoon. Piotr usually finish a day at the University around 4. pm but he often takes some paperwork home.

Visual conditions in the office

Piotr's office is a room in the modern building at the second floor. It has a rectangular shape, about 6m x 4m and 3 m high. He has a wooden furniture's that are painted white. The windows are facing south so in summertime it is very hot. He has blinds and he uses it very often. There are 6 typical office luminaries with fluorescent lamps in his room. Piotr turns on the light when it is needed. When he goes

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into the office and there is still dark outside, he turns it on. The light colour temperature is neutral. There is over 500 lux on Piotr desk. Piotr's desk is situated perpendicular to the window. He likes the electric light when it is dark but during summertime when the sun shines, he turns it off and cover the blinds. He feels like there it too much light in the room. When he leaves a room, he always switches light off. He has been wearing glasses since he was a kid. He is far-sighted.

Future Goals

His dream is to buy a tiny house in the mountains and move there for the retirement.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight?

  [Not at all Satisfied (0 1 2 3 4 **5**) Very satisfied]
- Satisfaction with electrical lighting?

  [Not at all Satisfied (0 1 2 3 4 **5**) Very satisfied]
- Satisfaction with lighting control system?

  [Not at all Satisfied (0 1 2 **3** 4 5) Very satisfied]
- Light Level:

  [Not at all Satisfied (0 1 2 3 **4** 5) Very satisfied]
- Level of Light

  [Dark (0 1 2 3 4 **5**) Bright]
- Spatial distribution of Light

  [Uniform (0 **1** 2 3 4 5) Varied]
- Glare

  [Invisible (0 1 2 3 4 **5**) Disturbing]
- Shadows

  [Soft (0 1 2 3 4 **5**) Hard]
- Reflections

  [Diffuse (0 1 2 **3** 4 5) Strong]
- Color tones of Light

  [Warm (0 1 2 **3** 4 5) Cold]
- Color (surfaces)

  [Distorted (0 1 2 3 4 **5**) Natural]

5.4 Library staff - Magda
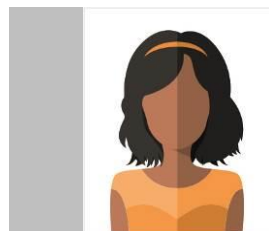
Hard Facts

Maggie lives with her family in a residential area in a multi-family block of flats. He has a daughter and a son, and a dog and a cat. Her husband works in a production plant.

Interests and Values

Magda likes animals. She often goes with her dog for a long walk into the woods. Magda also likes cooking so she is kin on making parties for her friends.

A Typical Day

Before going to work, Magda goes out with her dog every day. Sometimes she eats breakfast with her husband and prepares sandwiches for him to work. Then she commutes by the tram to work. She has different plans for the day depending on the season. During the summer, Magda works between 8:00 am and 4:00 pm. There are two shifts during the school year, from 8.00-16.00 or 11.00-7.00 pm. Such a system of work influenced the irregular lifestyle. At library, she usually spends time at her desk. She has a half-hour break once a day.

Visual conditions in the office

Magda works in the library's reading room. The room is 200 m2. There are 2 large double windows in the room facing south. This often makes the room hot. Magda turns on electric light when she thinks it's needed. She prefers working with lower light intensity. She doesn't like fluorescent luminaries which are maintained in the library. There is 360 lux on her desk. The colour temperature of light is neutral. Magda has a co-worker. Together they share a desk space. But Magda sits more often at the computer than her co-working friend. There are wooden shelves and desks painted with reflective paint in the room. She never has felt like there is a glare, but she feels sometimes tired with the light conditions.

Future Goals

Her dream is to live in the countryside with a large garden.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight?

[Not at all Satisfied	(0	1	2	3	**4**	5)	Very satisfied]

- Satisfaction with electrical lighting?

[Not at all Satisfied	(0	1	**2**	3	4	*5*)	Very satisfied]

- Satisfaction with lighting control system?

[Not at all Satisfied	(0	1	2	3	4	**5**)	Very satisfied]

- Light Level:

[Not at all Satisfied	(0	1	2	3	**4**	5)	Very satisfied]

- Level of Light

[Dark	(0	1	2	3	**4**	5)	Bright]

- Spatial distribution of Light

[Uniform	(0	**1**	2	3	4	5)	Varied]

- Glare

[Invisible	(0	1	2	**3**	4	5)	Disturbing]

- Shadows

[Soft	(0	1	**2**	3	4	5)	Hard]

- Reflections

[Diffuse	(0	1	2	**3**	4	5)	Strong]

- Color tones of Light

[Warm	(0	1	**2**	3	4	5)	Cold]

- Color (surfaces)

[Distorted	(0	1	2	**3**	4	5)	Natural]

5.5 Cleaning staff - Ela

Hard Facts

Ela is 42 years old. She lives with her mother and a dog in an two-room-apartment in a block of flats in a large housing estate. Her mother is an elderly person, that needs to be looked after.

Interests and Values

Ela likes to bake cakes. She often makes various cakes and then sells them. Ela also likes to go for walks with her dog.

A Typical Day

Ela works on shifts. Week by week she comes either early in the morning or starts work late in the afternoon. When she starts her work in the morning, she has to get up at 4.30 am. She takes her dog for a walk. Then she takes a bus to work. She starts at 6.00. She has to clean corridors of two floors in the main building of the University. That usually takes two hours. Then she eats a breakfast. When the students have classess she has to look after if the corridors get dirty. If Ela starts evening shift, she usually commutes at 5 pm to work. She starts cleaning the office rooms at 4 pm. The evening job is more tiring and it takes 3 hours to clean all the rooms at those two floors. When she gets back home, she is walking her dog and she is cooking meals. Then she watches TV with her mum.

Visual conditions in the office

Ela 's job is to take care of first and second floor of a main building. The building is an historic building. At the corridors there are stone and wooden floors. There are different conditions in the office rooms. There are PVC floors or wooden floors which makes the cleaning it not so easy because differed detergents must be used. There are also different lightning conditions in the corridors and offices. The corridors are darker with diffused light. The office rooms are much brighter and have an overall good lighting conditions, but there are desks which creates shadows and sometimes it is not easy to clean the floor. Electric lighting is always on at the corridors but in the offices, Ela has to turn it on and off when she uses the room.

Future Goals

She would like to get married and have a family.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight?

  [Not at all Satisfied (0 **1** 2 3 4 5) Very satisfied]
- Satisfaction with electrical lighting?

  [Not at all Satisfied (0 **1** 2 3 4 5) Very satisfied]
- Satisfaction with lighting control system?

  [Not at all Satisfied (0 1 2 3 **4** 5) Very satisfied]
- Light Level:

  [Not at all Satisfied (0 1 2 **3** 4 5) Very satisfied]
- Level of Light

  [Dark (0 1 2 **3** 4 5) Bright]
- Spatial distribution of Light

  [Uniform (0 1 2 3 4 **5**) Varied]
- Glare

  [Invisible (0 **1** 2 3 4 5) Disturbing]
- Shadows

  [Soft (0 **1** 2 3 4 5) Hard]
- Reflections

  [Diffuse (0 1 **2** 3 4 5) Strong]
- Color tones of Light

  [Warm (0 1 **2** 3 4 5) Cold]
- Color (surfaces)

  [Distorted (0 1 2 3 4 **5**) Natural]

6 Commercial buildings

Personas for commercial buildings have been developed after a series of visit and interviews in Extra convenient store, a middles large store located in Trondheim, Norway

6.1 Cashier, Anne

Hard Facts
Anne is 32 years old, and she is spending her third and half year as an employee at Extra convenient store in Trondheim. She lives in a rented apartment. She has two siblings who also live in Trondheim. The trip by bike or bus from home to work takes approximately 20 minutes.

Interest and values

Anne is from Trondheim. She enjoys hiking on the mountain and skiing. She is also a good dancer. She has started working in the store 7 years ago.

A typical day

Anne describes her day when she has an evening shift at work. The shift starts in the afternoon at 3 pm. She wakes up around 8:30 am and does some exercises and dance practice in the morning. Then she prepares her lunch and also pack her dinner for work. She likes that she can use the morning time for doing different things but she really doesn't like evening shifts when friends invite her for some gatherings and she cannot participate. She usually arranges to meet them the days when she has morning shifts.

After Anne starts her works at 3 pm, there is a peak time for the store from 3:30 to 6 pm; people come to the store after their work. When the store is not very crowded or most people do they shopping by automatic checkout machines, she goes to the storage of the store to pick up some products and fill shelves that are empty. Usually there are two or three employees in the same shift.

Visual Conditions in the store

The store has florescent lamps and some spotlights. Also, all the refrigerators and some shelves also have light. The store has three windows, but they all are covered by reclama posters, so daylight comes only from the entrance glass door. The cashier desk has a screen and Anne experience sometimes reflections that make reading the text difficult on the screen, but she has a solution, that is, she moves her head a bit to the right. Since it happens only for a short time in the evenings when the sun is low, she thinks she has nothing to complain.

Anne thinks the light is sufficient in the store and she has never experience any complains from costumer about it. The only thing that she thinks would be better is to be able to control lighting by dimming down or up above her head in the cashier desk. She thinks the lighting condition in general is good and it never was her concern although there are always ways to improve it. She doesn't wear any glasses or contact lenses.

Future goal

Anne would like to have a happy and relaxing life. She thinks working in the store gives her the free time that she needs in some morning to go for her dance practice and this is something that she likes most about her job.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight? (the store didn't have access to daylight.)

[Not at all Satisfied	(**0**	1	2	3	4	5)	Very satisfied]

- Satisfaction with electrical lighting?

[Not at all Satisfied	(0	1	2	**3**	4	5)	Very satisfied]

- Satisfaction with lighting control system?

[Not at all Satisfied	(0	1	2	**3**	4	5)	Very satisfied]

- Light Level:

[Not at all Satisfied	(0	1	2	3	4	**5**)	Very satisfied]

- Level of Light

[Dark	(0	1	2	3	**4**	5)	Bright]

- Spatial distribution of Light

[Uniform	(0	1	2	3	**4**	5)	Varied]

- Glare

[Invisible	(0	1	**2**	3	4	5)	Disturbing]

- Shadows

[Soft	(0	**1**	2	3	4	5)	Hard]

- Reflections

[Diffuse	(0	1	2	**3**	4	5)	Strong]

- Color tones of Light

[Warm	(0	1	**2**	3	4	5)	Cold]

- Color (surfaces)

[Distorted	(0	1	2	3	4	**5**)	Natural]

6.2 Employee with the management tasks, Mohamed

Hard Facts
Mohamed is 42 years old. He comes from Turkey and works in a convenient store own by his family. He lives in Trondheim with his wife and his two sons in an apartment in south part of Trondheim. He came to Norway to help his family to run this store. The store sells Mediterranean products of high quality that are appreciated by customers.

Interest and values

Mohamed was working in their family store in Turkey. He has more than 15 years' experience in his job, and he likes it well. In his free time, he plays music. Also, he likes to play with his children and help them in their homework.

A typical day

Store opens from 8 am so Mohamed wakes up around 6 am and go to work at 7:30 am. He has his breakfast with family and assists his wife with preparing children for school and kindergarten. He is mainly responsible for ordering new products and collecting deliveries and arranging them in the store. He rarely works as cashier but sometimes when some of employees are on holiday or they are sick, he also works there. He leaves store around 5 pm, but sometimes when a new package arrives at night, he has to go back there and pick it up.

Visual Conditions in the store

The lighting in the store is made of fluorescent lamps evenly distributed over the floor, there is no daylight. The store has manual on-off lighting switch. Mohamed considers that it is enough for what he needs at his work. Mohamed thinks that the storage, which is his main workspace and also includes a

small desk that is his office workplace, is gloomier than the main store space but still enough for reading labels and doing his tasks.

The light is switched on during the whole opening time, both in the store space and in the storage.

He doesn't wear optical glasses and he doesn't remember any difficulty related to lighting in the store.

Future goal

Mohamed's family recently added a baking section that includes different Turkish pastries and bread and he thinks Norwegians like those. Mohammed would like to expand his family business as a Turkish bakery.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight? (the store didn't have access to daylight.)

[Not at all Satisfied	(**0**	1	2	3	4	5)	Very satisfied]

- Satisfaction with electrical lighting?

  | [Not at all Satisfied | (0 | 1 | 2 | 3 | **4** | 5) | Very satisfied] |

- Satisfaction with lighting control system?

  | [Not at all Satisfied | (0 | 1 | 2 | 3 | **4** | 5) | Very satisfied] |

- Light Level:

  | [Not at all Satisfied | (0 | 1 | 2 | 3 | **4** | 5) | Very satisfied] |

- Level of Light

  | [Dark | (0 | 1 | **2** | 3 | 4 | 5) | Bright] |

- Spatial distribution of Light

  | [Uniform | (0 | 1 | 2 | 3 | **4** | 5) | Varied] |

- Glare

  | [Invisible | (**0** | 1 | 2 | 3 | 4 | 5) | Disturbing] |

- Shadows

  | [Soft | (**0** | 1 | 2 | 3 | 4 | 5) | Hard] |

- Reflections

  | [Diffuse | (**0** | 1 | 2 | 3 | 4 | 5) | Strong] |

- Color tones of Light

  | [Warm | (0 | 1 | 2 | **3** | 4 | 5) | Cold] |

- Color (surfaces)

  | [Distorted | (0 | 1 | 2 | 3 | **4** | 5) | Natural] |

6.3 Customer (male): Sigurd

Hard Facts

Sigurd is 30 years old and works in an office in city center. He is from Kristiansund where his parents live, and he also has one older brother who lives in Oslo. Sigurd came to Trondheim to study at NTNU and after finishing study he got a job in Trondheim. He recently has bought his apartment at Øya so he often comes to Extra Øya to shop.

Interest and values

Sigurd is very interested in history and in his free time he usually listens to podcasts about historical events or read historical books. He also likes jogging and going for hiking and spending time with his girlfriend.

A typical day

Sigurd wakes up around 6:30 am. While he drinks his coffee, he reads the newspaper. He needs to be updated about all the news in Norway because of his job. Then he does a short morning exercise and

after breakfast he leaves home at 8:30 to start his work at 9 am. He usually walks to work but sometimes he uses his bike. He really enjoys his neighborhood because it is next to a beautiful river and his path to work is very nice. He leaves work at 4:30 pm and goes to the gym. After that he goes home for dinner.

Visual Conditions in the store

We asked Sigurd to describe his experience while he is shopping in the store that the interview has happened. He doesn't wear optical glasses and feels the lighting in the store is good and strong enough. He never experienced any difficulty related to the lighting except sometimes some reflections on the checkout screen but nothing that bother him seriously.

Future goal

Sigurd would like to get a promotion at his work soon.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight? (the store didn't have access to daylight.)

[Not at all Satisfied	(**0**	1	2	3	4	5)	Very satisfied]

- Satisfaction with electrical lighting?

[Not at all Satisfied	(0	1	2	3	**4**	5)	Very satisfied]

- Satisfaction with lighting control system?

[Not at all Satisfied	(0	1	**2**	3	4	5)	Very satisfied]

- Light Level:

[Not at all Satisfied	(0	1	2	3	**4**	5)	Very satisfied]

- Level of Light

[Dark	(0	1	2	3	**4**	5)	Bright]

- Spatial distribution of Light

[Uniform	(0	**1**	2	3	4	5)	Varied]

- Glare

[Invisible	(0	**1**	2	3	4	5)	Disturbing]

- Shadows

[Soft	(0	**1**	2	3	4	5)	Hard]

- Reflections

[Diffuse	(0	1	**2**	3	4	5)	Strong]

- Color tones of Light

[Warm	(0	1	2	**3**	4	5)	Cold]

- Color (surfaces)

[Distorted	(0	1	2	3	4	**5**)	Natural]

6.4 Customer (female): Sofie
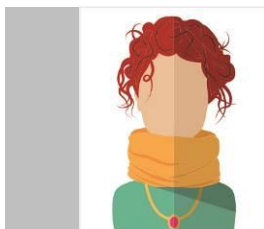
Hard Facts
Sofie is 27 years old and is a student at NTNU. Sofie lives in a collective with two other girls in a wooden house in Tempe. At the end of this year she will finish her master degree and goes back to Oslo to start her new job in a company focusing at green energy

Interest and values

Sofie comes from Oslo and her parents lives there. She is the only child. She is doing her master degree thesis these days so she is very focused on its topic, which is related to renewable energy. She thinks this is very important theme especially in Norway that has a big industry in oil sector, she means it is necessary to think green.

A typical day

Sofie wakes up very early at about 5 am in morning. After her breakfast she starts working on her thesis and around 9 am when the sun rises high enough and it is bright outside, she goes for running. In summer she could easily go for running as soon as she gets up but in winter, she waits till 9am (sun rise) because she doesn't like running outdoor in darkness, it is difficult for others, especially bike riders, to see people. She feels it is safe to do it when it is bright enough outside.

Visual Conditions in the store

The store that we held the interview has LED linear lamps with spotlights. Sofie is happy with the light level in the store, but at the same time, she feels maybe it is too bright. She wears contact lenses and doesn't feel any problem about it. When she thinks about the time that she uses her glasses also she couldn't remember any specific difficulty related to lighting with her glasses.

Future goal

Sofie is very excited and also nervous about her master thesis. She thinks about it all the time and hope to submit it soon and defend it very well. She is also very excited to go back to her hometown and start her new job. Sofie already spent her internship with them and therefore she knows the company and feels very happy for this opportunity.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight?

  [Not at all Satisfied   (0   **1**   2   3   4   5)   Very satisfied]
- Satisfaction with electrical lighting?

  [Not at all Satisfied   (0   1   2   3   **4**   5)   Very satisfied]
- Satisfaction with lighting control system?

  [Not at all Satisfied   (0   **1**   2   3   4   5)   Very satisfied]
- Light Level:

  [Not at all Satisfied   (0   1   2   3   **4**   5)   Very satisfied]
- Level of Light

  [Dark   (0   1   2   3   4   **5**)   Bright]
- Spatial distribution of Light

  [Uniform   (0   **1**   2   3   4   5)   Varied]
- Glare

  [Invisible   (**0**   1   2   3   4   5)   Disturbing]
- Shadows

  [Soft   (**0**   1   2   3   4   5)   Hard]
- Reflections

  [Diffuse   (**0**   1   2   3   4   5)   Strong]
- Color tones of Light

  [Warm   (0   1   2   3   **4**   5)   Cold]
- Color (surfaces)

  [Distorted   (0   1   2   3   4   **5**)   Natural]

7 Industry buildings

A small factory was selected to prepare the Persona for industry – Elmarco company, Poland. The company is located on the outskirts of the city of Gdynia. The production profile is outdoor and indoor lighting. The company uses metal, aluminum and wood for processing. The company employs 37 people, 24 of which work in production, 4 in logistics and 9 in the office. The persona profile has been created on the basis of several phases such as: space recognition, getting to know the production system - understanding the workflow, -making friends with people / building a trust and conducting interviews with individual employees.

7.1 Welder - Jacek

Hard Facts
Jacek is 36 years old. He is a welder. Jacek has worked for 12 years in the Lighting Factory. He lives with his family, wife, and two teenage boys, in a small house in the suburbs.

Interest and values

During weekends he loves to work in the garden. His dream is to go on Safari.

A typical day

Every day he wakes up at 5:00 am. His wife is preparing for him a breakfast and he eats it with her at 5:20. He needs to leave home at 5:50 to get to his work at 6:10. The day at work depends on the agreed schedule. At 6:15 am Jacek drinks coffee. The first breakfast break is at 10:00, the next coffee break is at 12:00. Works end at 2:45 p.m.

Visual Conditions in the factory

Jacek doesn't wear glasses and wears protective helmets at work. Jacek works in the largest room in the company. It is a hall of an area of 200 m2. There are 4 small windows located on the walls facing the North. The daylight is provided by 3 big skylights. The room has to be bright and even electric lighting which is always on. There are 4 colleagues working with Jacek. Jacek has a place for his own work, but he often changes it. It depends on the production schedule.

Jacek usually works at the welding table. He uses a compressor and a welding machine. He puts on a helmet so as not to spoil his eyes. After finishing a task, he must see clearly to check if there are any mistakes. For this purpose he removes the protective glasses.

Jacek welds both small and large elements, so the quality of seeing details is very important. Secondly, he must also pay attention to glare.

Jacek is very careful about the welding lighting because he knows that it is dangerous to his eyesight. Each of his friends has his own box, which ensures safety against welding glare.

Electric lighting is on all the time. It is switch on by the one who first enters the room, and it is turned off by the last one to leave the room. Jacek thinks it is a good solution.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight? (the store didn't have access to daylight.)
  [Not at all Satisfied   (0   1   2   3   4   5)   Very satisfied]
- Satisfaction with electrical lighting?

	[Min	(0	1	2	3	4	5)		Max]
	[Not at all Satisfied	(0	1	2	3	**4**	5)		Very satisfied]
▪ Satisfaction with lighting control system?									
	[Not at all Satisfied	(0	1	2	3	4	**5)**		Very satisfied]
▪ Light Level:									
	[Not at all Satisfied	(0	1	2	3	4	**5)**		Very satisfied]
▪ Level of Light									
	[Dark	(0	1	2	3	4	**5)**		Bright]
▪ Spatial distribution of Light									
	[Uniform	(0	1	2	3	4	**5)**		Varied]
▪ Glare									
	[Invisible	(0	**1**	2	3	4	5)		Disturbing]
▪ Shadows									
	[Soft	(0	**1**	2	3	4	5)		Hard]
▪ Reflections									
	[Diffuse	(0	1	**2**	3	4	5)		Strong]
▪ Color tones of Light									
	[Warm	(0	1	2	**3**	4	5)		Cold]
▪ Color (surfaces)									
	[Distorted	(0	1	2	3	**4**	5)		Natural]

7.2 Painter - Tomek

Hard Facts

Tomek is 32 years old. He has been working at Elmarco for 8 years. He is a car mechanic by profession, but he works in the profession of a painter. Tomek lives with his family in a village near Gdańsk. He is proud because he built the house for his family himself. He lives with his wife and two little daughters.

Interest and values

In his spare time, Tomek likes to work around his home. Builds a treehouse for girls or plays with them at weekends. His dream is to travel with his family.

A typical day

Every day Tomek gets up at the earliest from his family to go to work. He wakes up at 5:15 every day and prepares breakfast and sandwiches for work. He commutes to work with a friend in one car. They travel to the company in light traffic, so Tomek needs to leave his house at 5:45. They usually arrive at the factory at 6:15 am. Then around 6:30 a.m. Tomek drinks coffee and eat a snack. The first breakfast break is at 10:00, the next one at 12:00. The work ends at 15.00.

Visual Conditions in the factory

Tom doesn't wear glasses. He wears goggles and special clothing for work. Tomek works in a narrow room measuring 20m x 5m. The painting booth is located in a box-room with dimensions of 7m x 3m. Most part of the work is done there. The room is located along the eastern walls of the building. There is a row of 12 windows on the eastern wall. Some of the windows are covered by blinds. They are usually half closed. The room is bright, but electric lighting is always on. Additional uniform lighting is provided in the paint booth. It is always on too.

One colleague cooperates with Tomek. They change jobs, sometimes one paints in the booth, and the other works outside the booth. However, it is Tom who is responsible for the powder coating. He uses a special protective suit. He covers the elements to be painted with powder and then puts them in an oven until the paint is burned off. Sometimes it is necessary to paint wet the wood and then a different

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table to paint is used. The painter's work requires a high level of illumination and therefore the electric light is always on. However, daylight, which is irregular, is sometimes disturbing and therefore blinds are installed.

Electric lighting is on all the time. It is switched on by the one who enters the room, and it is turned off by the one who leaves. Tom believes that this is a good solution.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight? (the store didn't have access to daylight.)

  [Not at all Satisfied   (0   1   2   **3**   4   5)   Very satisfied]
- Satisfaction with electrical lighting?

  [Not at all Satisfied   (0   1   2   3   4   **5**)   Very satisfied]
- Satisfaction with lighting control system?

  [Not at all Satisfied   (0   1   2   3   4   **5**)   Very satisfied]
- Light Level:

  [Not at all Satisfied   (0   1   2   3   **4**   5)   Very satisfied]
- Level of Light

  [Dark   (0   1   2   3   **4**   5)   Bright]
- Spatial distribution of Light

  [Uniform   (0   1   **2**   3   4   5)   Varied]
- Glare

  [Invisible   (0   **1**   2   3   4   5)   Disturbing]
- Shadows

  [Soft   (0   **1**   2   3   4   5)   Hard]
- Reflections

  [Diffuse   (0   1   2   **3**   4   5)   Strong]
- Color tones of Light

  [Warm   (0   1   2   3   **4**   5)   Cold]
- Color (surfaces)

  [Distorted   (0   1   2   3   **4**   5)   Natural]

7.3 Logistic - Mirek

Hard Facts
Mirek is 44 years old and has been working in Elmarco for 18 years. During this time he was promoted and became the head of the logistics department. Mirek lives alone in an apartment in the city, he has a dog.

Interest and values

In his spare time, Mirek likes to do sports. He goes to marathons and rides his bike on weekends. Mirek loves sports and is a fan of many teams. His dream is to go to the Olympics.

A typical day

Mirek gets up at 5:30. He goes for a walk with his dog. He starts making breakfast around 6.00. He always takes lunch to work so he has to prepare it in the morning. He commutes to work with a bus. He lives close to the company, so it takes him 15 minutes to get there. He arrives at the company around 7.00 a.m. He starts his day by saying hello to all his friends. At 7.30 drinks coffee and checks the tasks. For him, breaks for breakfast are irregular because it depends on the workload. However, during the day, he tries to have lunch at around noon. Usually, he finishes his work around 4 p.m., but sometimes he has to stay longer if necessary.

Visual Conditions in the factory

Mirek wears glasses, but only when he is working at the computer or writing letters. Mirek works in two rooms. The first room is a 10 m^2 office and the second room is a warehouse. Depending on the type of work, he uses one or the other room. Quite often he goes outside because there is also a warehouse there.

In a small office room, Mirek has a window facing the west side. Mirek has roller blinds, but he uses only those that block the view from the outside so that people passing by do not look into the computer. He sees the view outside. The warehouse has 4,0 x 4,0 m high windows and two large skylights. The warehouse has two levels and therefore there is uniform electric lighting in the room, which is always on.

There are 3 people working with Mirek. They have different functions: warehouse worker and driver. Mirek works at the computer for a part of the day, but also packs goods and takes goods out. His work is in constant motion.

Electric lighting is always on in the warehouse. It is lit by the one who enters the room, and it is turned off by the one who leaves. However, he turns it on when he enters and tries to turn it off when he knows that he will be away for a long time. Mirek believes that this is a good habits.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight? (the store didn't have access to daylight.)

[Not at all Satisfied	(0	1	2	3	4	**5**)	Very satisfied]

- Satisfaction with electrical lighting?

[Not at all Satisfied	(0	1	2	3	4	**5**)	Very satisfied]

- Satisfaction with lighting control system?

[Not at all Satisfied	(0	1	2	**3**	4	5)	Very satisfied]

- Light Level:

[Not at all Satisfied	(0	1	2	3	**4**	5)	Very satisfied]

- Level of Light

[Dark	(0	1	2	3	**4**	5)	Bright]

- Spatial distribution of Light

[Uniform	(0	1	2	3	**4**	5)	Varied]

- Glare

[Invisible	(0	1	**2**	3	4	5)	Disturbing]

- Shadows

[Soft	(0	1	**2**	3	4	5)	Hard]

- Reflections

[Diffuse	(0	1	**2**	3	4	5)	Strong]

- Color tones of Light

[Warm	(0	1	2	**3**	4	5)	Cold]

- Color (surfaces)

[Distorted	(0	1	2	**3**	4	5)	Natural]

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7.4 Administrative staff and leaders - Maciek

Hard Facts
Maciek is 53 years old. He lives in suburbs with his wife and son in a modern house. He has been working in the company for 12 years.

Interest and values

Maciek likes sports. In his spare time, he and his son go play football. They also cycle. Their favorite activity is downhill cycling. Maciek dream is to become a chair of the factory where he works.

A typical day

Maciek gets up at 6.30 am and starts his day with morning exercises. At 7.00 a.m. he eats breakfast with his wife and son. Then he drives his son to school. She is in work at 8.00 am. Every morning Maciek checks the tasks to be performed. He arranges a coffee-drinking meeting with his co-workers, and they analyze the results and check the resources. Then he goes to the production department he has a meeting with the head of production. When he comes back, he works at the desk. He tries to have lunch at around noon. Usually, he finishes his work around 4 p.m., but very often he has to stay longer.

Visual Conditions in the factory

Maciek works in an office building. His room is on the first floor. His room is 4x4 m. It is not a big room, but if he is organizing a meeting, he can use the conference room. His room has windows facing south. There are blinds on the windows. There are 4 LED luminaries hanging from the ceiling which gives uniform electric lighting in the room. His furniture is wooden. The desk is located by the window. Maciek works at the computer most of the day. He has meetings and then he often uses the conference room. Maciek turns on electric lighting when he enters a room. He often forget to turn off if when he is leaving a room for a meeting. But he always turns it off when he goes back home.

Results of lighting survey: (selected answer is in red and underline text)

- Satisfaction with daylight? (the store didn't have access to daylight.)

  [Not at all Satisfied   (0   1   2   3   **4**   5)   Very satisfied]
- Satisfaction with electrical lighting?

  [Not at all Satisfied   (0   1   2   3   **4**   5)   Very satisfied]
- Satisfaction with lighting control system?

  [Not at all Satisfied   (0   1   **2**   3   4   5)   Very satisfied]
- Light Level:

  [Not at all Satisfied   (0   1   2   3   **4**   5)   Very satisfied]
- Level of Light

  [Dark   (0   1   2   **3**   4   5)   Bright]
- Spatial distribution of Light

  [Uniform   (**0**   1   2   3   4   5)   Varied]
- Glare

  [Invisible   (**0**   1   2   3   4   5)   Disturbing]
- Shadows

  [Soft   (**0**   1   2   3   4   5)   Hard]
- Reflections

  [Diffuse   (**0**   1   2   3   4   5)   Strong]
- Color tones of Light

  [Warm   (0   1   2   **3**   4   5)   Cold]
- Color (surfaces)

[Distorted   (0   1   2   3   4   **5**)   Natural

8 Home Office Personas

During the period of Coronavirus pandemic, a measure to mitigate the spread of Covid-19 was to stay home, when and as better as possible. Teachers, academic employees, office workers and students transferred their activities for home, in many different situations. The behaviour, conditions and needs of these categories regarding their visual environments are represented here by "personas" – one for students and one for professionals.

All the "personas" for home offices have been created using the online survey method. In total, 253 answers from students and 458 from professionals were used to create each persona (one student and one professional). The data reported for this "personas" reflect those related to all the people interviewed.

The name of the "personas" is invented.

The gender of the "personas" is representative of the gender of most of the people´s answers.

The age of the "personas" is obtained as an average of the people´s age answers.

The characteristics of the workplace, tasks, appreciation and preferences as the behaviour of the personas are based on averages of descriptive statistics, simple correlations, pictures from cell phones and qualitative analyses from open ended questions. Picture from cell phones gives information about the number of layers seen, if the view is clear and if the sky is visible.
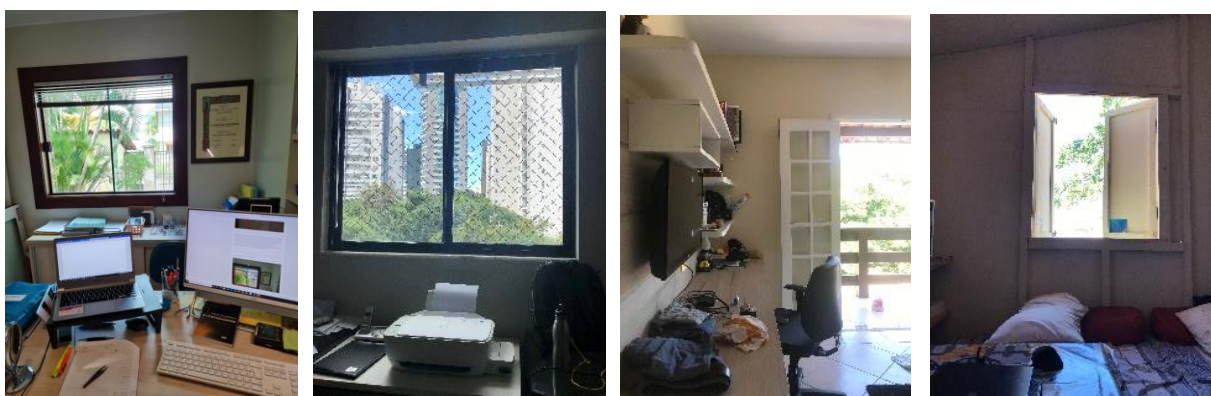
Figure 2. Examples of home offices, professionals -two photos on the left-hand side, students -on the right-hand side.

8.1 Student

Hard Facts
Camilla is 21 years old. She is studying Psychology in a public university in the last three years. She studies in her own table in the living room, used as home office and sometimes divided with other people. The room has a window facing South and her table is one meter distant from the window, what is very much appreciated. The window has only thin curtains to control daylight.

Interest and values

She is satisfied with daylight, but the external view from the window is not so good, as she can see only two layers of view, the ground and a part of landscape or the sky and a landscape. The general light level is good enough for her. Despite this, she would like to have more daylight, but in a controlled way to avoid overheating and glare, maybe only changing the table position. She doesn´t

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need to use any electrical light in the presence of daylight, but at night she normally uses a ceiling lamp and sometimes a desk lamp. She wants to continue in home office after the Covid-19 pandemic.

A typical day

She is studying more than before the pandemic period, sometimes 6 or 7 days in a week and also some hours late in the evening. The main activities are Reading and writing on a digital screen and a computer, and she has also a lot of digital classes.

Visual Conditions

The visual environment is good, and daylight is the most appreciated quality. The light level is median, tending to bright, lighting distribution tends to be uniform, glare is invisible, there are soft shadows and diffuse reflections. The colour of the light is neutral and surface colours appear tending to natural (but this could be improved).

8.2 Professional
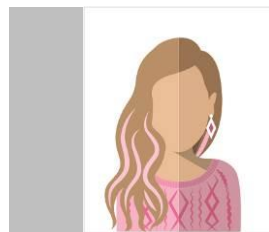
Hard Facts
Marta is 30 years old. She has been working at one private institution for 3 years. She is a lawyer by profession. She works in one room, used as home office only for her. The room has a window facing North and her table is one meter distant from the window, what is very much appreciated. The window has only thick curtains to control daylight.

Interest and values

She is very satisfied with daylight and the also with the external view from the window, as she can see sky and landscape and ground. The general light level is good enough for her. She would like to have more control over daylight, maybe improving solar protection. She doesn´t need to use any electrical light in the presence of daylight, but at night she normally uses a ceiling lamp and sometimes a desk lamp. She really wants to continue in home office after the Covid-19 pandemic, if possible.

A typical day

She is working more than before the pandemic period, in the typical working hours as before, sometimes late in the evening. The main activities are Reading and writing on a digital screen and a computer.

Visual Conditions

The visual environment is very good, and daylight and view are the most appreciated qualities. The light level is bright, lighting distribution tends to be varied, glare is almost invisible, there are soft shadows and diffuse reflections. The color of the light is neutral and surface colors appear natural.

9 Conclusions

The consumption of energy for lighting in buildings depends not only on requirements for lighting combined with the operation time but also on the way people interact with the build environment, that is, on user behaviour. In this study the following building types were studied, office, school, university, commercial and industry buildings. For each building type typical user groups were identified. Then, for each user group Personas have been created. The description of Personas is structured in four parts:

1. Hard facts
2. Interest and values
3. A typical day
4. Visual conditions

As opposed to describing users with numbers and statistics, a single Persona represents a group and is presented with a narrative which is very probable, since it has been developed through direct contact with users. The Persona has a name, a family and living conditions that are representative for the group (1.), also her/his values and interests (2.) are not uncommon. The Personas "typical day" (3.) includes a time schedule typical for the group. Visual conditions (4.) are common for the group, but some specific challenges connected to the visual conditions are also mentioned. Personas were created using one of the three methods evaluated in the following subchapter (9.1).

The study shows that people have great potential for adaptation to the luminous conditions. Most respondents do not complain, they accept and make the best of the conditions, like turning the head or moving it closer, and of course wearing glasses. In general, people do not demand improvements even though the researcher shows how it could be done.

9.1 Conclusions about the used methods for creation of personas

Advantages of the three different methods for developing personas can be summarised as follows:

The Interview method:

- enables very good communication with the subject,
- presence in the real context where the subject is working, which enables researcher to obtain light-technical data and to relate the answers to the room design, lighting, shading, control of lighting and shading
- a certain degree of intimacy that enables to ask more private questions, and discuss also negative aspects, e.g., regarding the routines in the institution, own habits and habits of co-workers, control of lighting,

The workshop method:

- answers from few people simultaneously, which means shorter time for researcher
- users have an opportunity to share opinions
- gives researcher an opportunity to gather precise information about lighting conditions, to show few alternative lighting scenarios and/or solutions
- gives the researcher a possibility to guide and mentor subjects by commenting the alternatives and argue which one is better and why
- for user it gives an opportunity to gain knowledge of lighting, which raises awareness of the lighting conditions

The survey method:

- large number of participants, which gives enough data for statistical analysis
- a few tools are required, mainly softwares and computers

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- gives the possibility to obtain data about the building without necessarily be physically present, from the point of view of users (technical data are more difficult to collect)
- users have an opportunity to share opinions and intentions

9.2 Estimation of energy consumption

Based on the use of buildings in the studied categories and the lighting requirements for the respective user groups represented in the form of personas, an estimation of energy consumption is proposed.

The Lumen Method is used in calculating the average illuminance, $\bar{E}$, on a workplane in an indoor space using the following equation:

$$\bar{E} = \frac{\phi_{tot} \cdot CU \cdot MF}{A}$$

(Eq. 1)

The Lumen Method is based upon the use of a Coefficient of Utilization (CU), which computes the fraction of lamp lumens that directly reach the workplane and the fraction from interreflections, as well as other assumptions.

As stated, CU is expressed as a ratio of the total light emitted by the fixture to the light that falls on an area of a defined size, as reported in the following equation:

(Eq. 2)

$$CU = \frac{\phi_u}{\phi_{tot}}$$

The manufacturer usually provides CU value, and it is influenced by the geometry of the room, the reflectance of the ceiling, the walls and the working plane.

The assumptions considered for the computation are:

- the illuminance computed by the lumen method is an average value for the whole room; for this reason, the common criteria for a good lighting design still stand, as a final optimum result will be reached only if the luminaires are uniformly spaced across the whole room;

- the calculation of the Coefficients of Utilization is based on a simplified room, without furniture and which surfaces (walls, floor and ceiling) exhibit perfectly diffuse reflectance characteristics

- since the design objective is usually maintained illuminance, a Maintenance Factor (MF) must be applied to allow for the estimated depreciation, losses from dirt collection on the luminaire surfaces (including lamps) and other factors.

Table 2 provides the guidelines values for the usage and operating time of schools, university buildings, offices, commercial and industry buildings, the related average illuminance values to be guaranteed in the different rooms, the installed lighting power density as well as the electric energy consumption associated to the lighting systems. This table was developed on the basis of DIN standard [1] and on the information gathered during Persona-interviews for the time schedules. In particular, this table reports the daily usage and operating time of the above-mentioned building typologies during the whole year upon varying the room. In addition, Table 2 shows the lighting design guidelines related to the values of:

(i) the horizontal illuminance,

(ii) the vertical illuminance in the visual field,

(iii) the light level during breaks;

(iv) the light level when projectors are used, as a function of the room.

The estimation of the installed lighting power density (W_{el}), expressed in W/m^2, room by room, is provided using the equation reported below:

$$W_{el} = \frac{\phi}{A \cdot \eta_{luminaire}} = \frac{\overline{E}}{CU_{avg} \cdot MF \cdot \eta_{luminaire}}$$

(Eq. 3)

where:

Φ is the luminous flux of the luminaire (depends on the luminaire, see Appendix 4);

A is the surface area of the plane where the illuminance value is guaranteed;

$\eta_{luminaire}$ is the efficiency of the luminaire (assumed equal to 130 lm/W);

E is the value of the maintained horizontal illuminance (the values are reported in Table 2);

CU_{avg} is the Coefficient of Utilization, (in this report, for each building typology, the CU value is an average of the CU values provided by the manufacturer for different reflectance values (for ceiling, walls and working plane) and for different room indexes. The commercially available luminaires, considered as references for the computation of CU_{avg} value in this report, are reported in Appendix 4);

MF is the Maintenance Factor (considered equal 0.7).

The values of the installed lighting power density obtained using this simplified are very similar to those reported in the ASHRAE 90.1-2019 Lighting Standards [2] and in [3].

Finally, the yearly electric energy consumption (EC_{el}) associated to the lighting system is calculated considering the installed lighting power density (W_{el}) and considering the operating time during the day (t_{day}) and the night (t_{night}) as well as reduction factors for visual task area (r_{task}), for the relative absence (r_{abs}) and for the lighting related to the building operating time ($r_{building}$) using the following formula:

$$EC_{el} = W_{el} \cdot \left(t_{day} + t_{night} \right) \cdot r_{task} \cdot \left(1 - r_{abs} \right) \cdot r_{building}$$

(Eq. 4)

The reduction factors are defined according on the basis of DIN standard [1]. In particular:

- the reduction factor for visual task (rtask) is determined based on a surface ratio of the area of the visual task to the surrounding area assumed for use and the ratio of the maintenance value of the illuminance required for the area of the visual task and for the surrounding area ascertained. Example are predominantly space-related lighting (offices), which allow flexible use of space or represent the case that the exact use of space is not yet known;

- the reduction factor field for relative absence (rabs) indicates the proportion of the period of use to which no person is present in a calculation area (= 0: permanent stay, = 1: no stay). The relative absence considers a partial temporal operation of a day of use (for example, meetings, breaks, etc.);

- the reduction factor for the lighting related to the building operating time (rbuilding) indicates how much the usage time specified for the respective usage profile may be reduced when calculating the energy requirement for lighting considering partial operation due to holidays, sickness, etc…

References

[1] DIN V 18599-10, Energetische Bewertung von Gebäuden – Berechnung des Nutz-, End- und Primärenergiebedarfs für Heizung, Kühlung, Lüftung, Trinkwarmwasser und Beleuchtung – Teil 10:

Nutzungsrandbedingungen, Klimadaten. Energy efficiency of buildings – Calculation of the net, final and primary energy demand for heating, cooling, ventilation, domestic hot water and lighting – Part 10: Boundary conditions of use, climatic data.

[2] ASHARE, "ASHRAE 90.1-2019 Lighting Standards," 2019

[3] F. Goia, Search for the optimal window-to-wall ratio in office buildings in different European climates and the implications on total energy saving potential," Solar Energy, vol. 132, pp. 467–492, Jul. 2016, doi: 10.1016/j.solener.2016.03.031.

Table 2. Guidelines values for the boundary conditions of use of schools, university buildings, offices, commercial and industry buildings.

Building Typology	Beginning of usage (time)	Lunch break, empty room (h)	Other breaks, together (h)	Use of projectors (h)	End of usage (time)	Daily usage time without projector (h/d)	annual usage time 5,6,7 days->250,300,365 (d/y)	daytime usage hours per annum (h/y)	night-time usage hours per annum (h/y)	Maintained horizontal illuminance (lx)	Maintained vertical illuminance in the visual field (lx)	light level during breaks (lx)	light level when projectors are used (lx)	Height of the work plane (m)	reduction factor for visual task area	relative absence	Space/room index	Reduction factor for lighting related to the building operating time	Coefficient of Utilization (CU)	Maintenance Factor (MF)	Efficiency (lm/W)	Installed electric power (W/m²)	Electric energy consumption (Wh/m²y)
Offices																							
Personal office (single occupant)	08:00	1	0.2	0	16:00	6.8	250	2543	207	500	200	200	100	0.8	0.84	0.3		0.7	0.864	0.7	130	6.4	7198.2
Workgroup office (two to six workplaces)	08:00	1	0.1	0	18:00	8.9	250	2543	207	500	200	200	100	0.8	0.84	0.3		0.7	0.864	0.7	130	6.4	7198.2
Landscaped office (seven or more workplaces)	08:00	0.5	0	0	18:00	9.5	250	2543	207	500	200	200	100	0.8	0.93	0		1	0.864	0.7	130	6.4	16264.1
Meeting, conference and seminar room	08:00	0	4.5	2.5	16:00	1	250	2543	207	500	200	200	100	0.8	0.93	0.5		1	0.864	0.7	130	6.4	8132.1
Toilets and sanitary facilities	08:00	0	6.5	0	18:00	3.5	250	2543	207	200	50	100	0	0.8	1	0.9		1	0.864	0.7	130	2.5	699.5
Traffic/circulation areas	08:00	0	5.5	0	18:00	4.5	250	2543	207	100	50	100	0	0	1	0.8		1	0.864	0.7	130	1.3	699.5
Schools																							
Classroom (primary school)	08:30	1	0.8	1	14:30	4.2	200	1398	2	300	100	200	100	0.65	0.97	0.25		0.9	0.864	0.7	130	3.8	3497.6
Teachers room /meeting room	08:00	0	1	0.2	15:00	5.8	200			500	200	200	100	0.8					0.864	0.7	130	6.4	0.0
Personal office (single occupant)	08:00	1	3	0	15:00	3	250	2543	207	500	200	200	0	0.8	0.84	0.3		0.7	0.864	0.7	130	6.4	7198.2
Administration (as workgroup office)	08:00	0.5	0.2	0	15:00	6.3	250	2543	207	500	200	200	0	0.8	0.93	0.5			0.864	0.7	130	6.4	0.0
Toilets and sanitary facilities	07:00	0	5.5	0	16:00	4.5	250	2543	207	200	50	100	0	0.8	1	0.9		1	0.864	0.7	130	2.5	699.5
Corridors/circulation areas	07:00	0	5.5	0	16:00	4.5	250	2543	207	200	50	100	0	0	1	0.8		1	0.864	0.7	130	2.5	1399.1
University buildings																							
Lecture room, auditorium	08:00	0	1.5	6.5	17:00	1	150	1409	91	300	100	100	100	0.8	0.92	0.25		0.7	0.864	0.7	130	3.8	2764.4
Offices for teachers/research personel	08:00	1	4.5	0	17:00	5.5				500	200	0	0	0.8					0.864	0.7	130	6.4	0.0
Offices for adm. personel	08:00	1	1.5	0	16:00	5.5				500	200	0	0	0.8					0.864	0.7	130	6.4	0.0
Meeting, conference and seminar room	08:00	0	2.5	2.5	16:00	3	250	2543	207	500	200	200	100	0.8	0.93	0.5		1	0.864	0.7	130	6.4	8132.1
Labs	08:00	1	5.5	0	17:00	3.5				500	200	0	0	0.8	0.88	0			0.864	0.7	130	6.4	0.0
Library - reading rooms	08:00	0	0	0	20:00	12	300	2999	601	500	200	0	0	0.8	0.88	0		1	0.864	0.7	130	6.4	20146.5
Library - open stacks area	08:00	0	0	0	20:00	12	300	2999	601	200	100	0	0	0.8	1	0		1	0.864	0.7	130	2.5	9157.5
Retail/commercial																							
Retail shop/department store	08:00	0	0	0	20:00	12	300	2999	601	300	100	0	0	0.8	0.93	0		1	0.864	0.7	130	3.8	12774.7
Retail shop/small area shop	10:00	0	0	0	18:00	8	300	2999	601	300	100	0	0	0.8	0.93	0		1	0.864	0.7	130	3.8	12774.7
Auxiliary spaces	08:00	0	0	0	20:00	12	250	2543	207	100	20	0	0	0.8	1	0.9		1	0.864	0.7	130	1.3	349.8
Storeroom, technical equipment room, archiv	08:00	0	0	0	20:00	12	250	2543	207	100	20	0	0	0.8	1	0.98		1	0.864	0.7	130	1.3	70.0
Industry buildings																							
workshop, assembly, manufacturing	07:00	0.5	0	0	16:00	9	250	2192	58	500	200	0	0	0.8	0.88	0		1	0.944	0.7	148	5.1	10120.2
magazine and stores	07:00	0	7	0	16:00	2	300	2999	601	100	50	0	0	0.8	1	0.9		1	0.814	0.7	140	1.3	451.4

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Appendix 1. Pre-interview based on the first methodology. This interview was user in the workshop method as first stage of the workshop.

– The interview sheet is in polish – as it was conducted.

Imię:

………
………………………………………………………………………………

Wiek / płeć:

………
………………………………………………………………………………

Miejsce wypełnienia ankiety (uczelnia, biuro, zakład produkcyjny, biblioteka):

………
………………………………………………………………………………

Stanowisko/zadania:

………
………………………………………………………………………………

Data:

………
………………………………………………………………………………

- **Dane podstawowe**
  - *Jak przebiega Twój dzień pracy / ogólnie, proszę pisz go*
- ……
  ……
  ……
  ……
  …………………………………………………………………………………………………

  - *Czy nosisz okulary?*
  - ……
    ……
    ……
    ……
    ……
    ……………………

- **Opis przestrzeni:**
  - *Budynek I pomieszczenie w którym pracujesz*
- ……
  ……
  ……
  ……
  …………………………………………………………………………………………………

  - •
  - *Jak wiele jest w nim okien, jakiego rodzaju/ ile opraw oświetleniowych*
- ……
  ……

....
....
....

   ▪ *Ile osób pracuje z Tobą w tym pomieszczeniu?*
● ....
....
....
....
....

   ▪ *Gdzie spędzasz najwięcej czasu w trakcie pracy w tym pomieszczeniu?*
● ....
....
....
....
....

   ▪ *Czy masz swoje własne stanowisko pracy? Jak często je używasz? Czy zmieniasz pozycję pracy i jak często jest to na dzień?*
● ....
....
....
....
....

● **Aktwyności zwiazane z jakościa oświetlenia i ogólnie:**
   ▪ Jak opiszesz swoje miejsce pracy? Miejsce z lampka biurkową?
● ....
....
....
....
....

   ▪ *Jakie sa typowe twoje zadania? (czy praca na komputerze, praca na Sali ze studentami, wykłady)*
● ....
....
....
....
....

● **Warunki wizualne:**
   ▪ *Czy doświadczyłeś jakiejś niewygodnej sytuacji związanej z oświetleniem w miejscu pracy?* *(glare)*

- ....
....
....
....
....

  - *Jak oceniasz system sterowania oświetleniem?*
- ....
....
....
....
....

  - Jak jest zarządzane oświetlenie - kto włącza i wyłącza oświetlenie?
- ....
....
....
....
....

- **Warunki oświetleniowe w miejscu pracy, w tym momencie:**

  .

  - Zadowolenie ze światła dziennego?
    [wcale nie zadowolony   (0   1   2   3   4   5) bardzo zadowolony]

  - Zadowolenie z oświetlenia elektrycznego?
    [wcale nie zadowolony   (0   1   2   3   4   5) bardzo zadowolony]

  - Zadowolenie z systemu sterowania oświetleniem?
    [wcale nie zadowolony   (0   1   2   3   4   5) bardzo zadowolony]

  - Zadowolenie z poziomu światła:
    [wcale nie zadowolony   (0   1   2   3   4   5) bardzo zadowolony]

  - Poziom oświetlenia
    [ciemno   (0   1   2   3   4   5) jasno]
  - Rzokład światła
    [jednolity   (0   1   2   3   4   5) różny]
  - Olśnienie
    [niewidoczne   (0   1   2   3   4   5) przeszkadzjace]
  - Cienie
    [miekkie   (0   1   2   3   4   5) mocne]
  - Refleksy

[rozproszone   (0   1   2   3   4   5) mocne]

- Barwa światła

  [ciepła   (0   1   2   3   4   5) zimna]

- Kolor (powierzchnie)

  [zniekształcone   (0   1   2   3   4   5) naturalne]

IEA SHC Task 61 / EBC Annex 77: Integrated Solutions for Daylighting and Electric Lighting

Podstawowe określenia w oświetleniu

- Mentoring w ramach IEA SHC Task 61 Subtask A "User perspective and requirements".

dr hab. inż. arch. Justyna Martyniuk-Pęczek, prof. PG

IEA SHC Task 61 / EBC Annex 77: Integrated Solutions for Daylighting and Electric Lighting

Promieniowanie / Źródło światła	Promieniowanie temperaturowe	Wyładowanie elektryczne	Luminescencja
Naturalne źródło	słońce	błyskawica	owady - świetliki
Sztuczne źródło	żarówka	lampa Hg, MH, Na	Dioda LM
	żarówka halogenowa	świetlówka	
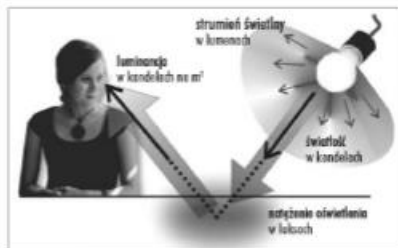
Strumień świetlny Φ (symbol międzynarodowy)
w lumenach [Lm]

Ilość światła, jaką dane źródło promieniuje na wszystkie strony

Strumień świetlny

Żarówka 100 W = 1200 lm
=
Świetlówka kompaktowa 18 W Φ = 1200 lm

Lampy matelohalogenkowe 150 W Φ = 12 000 lm

Natężenie oświetlenia Lx (lux) lm/m²
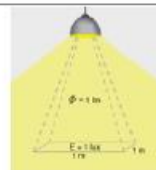
Ilość światła padającego
Ilość lumenów na m²
E = światłość Φ / S pole powierzchni

Natężenie oświetlenia Lx (lux) lm/m^2

1. Afryka e= 150 000 lx
Czyste niebo i słońce po kątem 90 stopni

Natężenie oświetlenia Lx (lux) lm/m^2

Polska E = 100 000 lx jak chmury to 10 000 Lx

Natężenie oświetlenia Lx (lux) lm/m^2

Polska „Natężenie listopadowe" = 2000 lx

Natężenie oświetlenia Lx (lux) lm/m^2

Pełnia księżyca E = 2-5 lx

Natężenie oświetlenia Lx (lux) lm/m^2

Szkoła E = 500 Lx

LUMINANCJA L= (cd/m^2)

✓ Odczucie jaskrawości (pierwsze skojarzenie!!!)
✓ Związana ze stanem zaadoptowania wzroku
✓ Jaskrawość jest pojęciem fizjologicznym.
✓ Luminancja pojęcie techniczne.

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LUMINANCJA   L= (cd/m^2)

Czym większa światłość w danym kierunku i czym
mniejsza jest ta powierzchnia tym, wiąsze wrażenie
jaskrawości.

Patrz Dioda i żarówka kompaktowa.

LUMINANCJA   L= (cd/m^2)

Luminancja słońca L = 2 250 000 000 cd/m^2

Tarcza księżyca   L= 5000 cd/m^2

Autostrada L= 2 cd/m^2

Tablica reklamowa w mieście L= 100 cd/m^2

Monitor telewizora LCD L=500 cd/m^2

LUMINANCJA   L= (cd/m^2)

Dobrze oświetlona kartka papieru L= 200 cd/m^2

Żarówka 100 W   L=1 000 000 cd/m^2

Żarówka matowa Matowa L = 10 000 cd/m^2

LUMINANCJA   POWIERZCHNI

Luminanacja powierzchni zależy od jej właściwości
refleksyjnych

LUMINANCJA   POWIERZCHNI
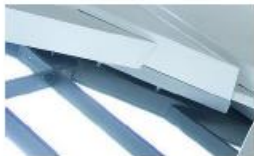
Luminancja powierzchni zależy od kierunku patrzenia – badania

Olśnienie

- - warunki widzenia, które odczuwa się
jako nieprzyjemne, lub w których
występuje obniżenie zdolności
rozpoznawania szczegółów lub
przedmiotów, albo oba wrażenia razem,
na skutek nieodpowiedniego rozkładu
lub zakresu luminancji lub na skutek
występowania nadmiernych kontrastów

Od czego zależy?

- Od luminancji oprawy
- Od wielkości powierzchni świecącej
- Od jej położenia
- Od luminancji otoczenia
- Od stanu adaptacji

Rodzaje olśnienia

- PRZESZKADZAJĄCE – pogarsza postrzeganie przedmiotów, ale niekoniecznie powoduje przykrość (np. nasłoneczniony śnieg)
- PRZYKRE – powoduje przykrość, ale niekoniecznie pogarszające postrzeganie przedmiotów (np. olśnienie kontrastem)

Światło - promieniowanie optyczne, promieniowanie elektromagnetyczne o **fali długości 380-760 nanometrów.**
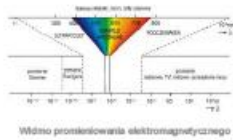
Widmo promieniowania elektromagnetycznego
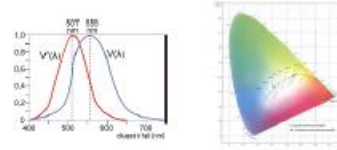
Największa czułość oka 555 nm

= barwa „żółtozielona"

= największe wrażenie jasności

Efekt światła białego uzyskujemy jeśli występuje duża różnorodność długości fali
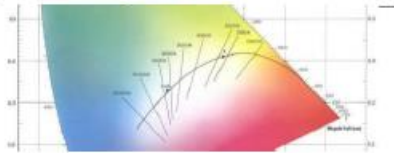
TEMPERATURA BARWOWA Tc

Mieszkaniec Norwegii / mieszkaniec Afryki – inne odczucia bieli

TEMPERATURA BARWOWA Tc

– stopień „biel" światła

TEMPERATURA BARWOWA Tc
Czym niższa temperatura barwowa, tym światło wydaje się cieplejsze
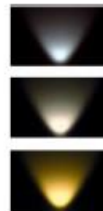
-Zimna barwa
5300-7000K (5000K)
CRI 70
zastosowanie na zewnątrz (parki, ogrody, tereny zielone)

-Neutralna barwa
3800-5300K (4100K)
CRI 75
kombinacje różnych źródeł np. sklepy

-Ciepła barwa
2800-3000K (3200K)
CRI 80
wnętrza, gdy ważne jest oddawanie kolorów

Wskaźnik oddawania barw
- oznaczany jako Ra lub CRI niesie informacje o tym, w jakim stopniu dane źródło światła umożliwia obserwację kolorów

Oddawanie barw
Colour Rendering Index (CRI)

Człowiek ma większe wymagania dotyczące widzenia barw przy dużych luminancjach (zastosowania wewnętrzne), a mniejsze przy mniejszych (zastosowania zewnętrzne np. przy iluminacji obiektów).

Appendix 2.1 Post-evaluation survey about the lighting condition at workplace

Photos form the workshops – mentoring on how to "see the light" an assess conditions like illuminance, glare, shadows.

Warunki oświetleniowe w miejscu pracy, w tym momencie:

.

- ▪ Zadowolenie ze światła dziennego?
  [wcale nie zadowolony   (0   1   2   3   4   5) bardzo zadowolony]

- ▪ Zadowolenie z oświetlenia elektrycznego?
  [wcale nie zadowolony   (0   1   2   3   4   5) bardzo zadowolony]

- ▪ Zadowolenie z systemu sterowania oświetleniem?
  [wcale nie zadowolony   (0   1   2   3   4   5) bardzo zadowolony]

- ▪ Zadowolenie z poziomu światła:
  [wcale nie zadowolony   (0   1   2   3   4   5) bardzo zadowolony]

- ▪ Poziom oświetlenia
  [ciemno   (0   1   2   3   4   5) jasno]
- ▪ Rozkład światła
  [jednolity   (0   1   2   3   4   5) różny]
- ▪ Olśnienie
  [niewidoczne   (0   1   2   3   4   5) przeszkadzjace]
- ▪ Cienie
  [miekkie   (0   1   2   3   4   5) mocne]
- ▪ Refleksy
  [rozproszone   (0   1   2   3   4   5) mocne]
- ▪ Barwa światła
  [ciepła   (0   1   2   3   4   5) zimna]
- ▪ Kolor (powierzchnie)
  [zniekształcone   (0   1   2   3   4   5) naturalne]

Appendix 3. Questionnaire from the internet survey

The visual environment in home offices

Dear reader, we would like to invite you to participate in this online survey. Please read the short description below before you decide to participate. Thank you.

This survey is a part of the research in a frame of International Energy Agency (IEA) Solar Heating and Cooling (SHC) Task 61 Integrated Solutions for Daylighting & Electric Lighting https://task61.iea-shc.org/

In the Subtask A User perspective and requirements, we are working with registration of the visual environment conditions at workplaces in public buildings trying to better understand people's needs. The results will be used to propose new requirements to the visual environment in international reports (IEA) and standards.

In the time of pandemic, a large part of employees and students worldwide has been advised to work at home. We must be prepared that the home office may became a long-lasting form (full or part-time) for many of us.

- What is included in this survey?

1. Basic information about participants (anonymized, non-sensitive data for statistical analysis)

2. Questions about visual conditions in your home office including access to the window, electric lighting and some general questions about the character of your work and employment.

3. You will be asked to take two photos of your home office and upload them during the work on the survey. Please, do not show people on the photos. The photos will be used for better understanding of the visual conditions, like light distribution on the desk, potential sources of glare, daylight access and view content.

- Why have I been chosen?

All people (independent of any form of background) who work at home are welcome to participate.

- Do I have to take part?

No, the participation is voluntary. If you do decide to take part in the survey, you can easily exit at any time with no penalties for either the researcher or yourself.

- What will happen to me if I take part?

If you decide to take part, it will take up to 7 minutes to fill out the survey.

- What are the possible disadvantages/risks and benefit of taking part?
There are no disadvantages/risks of taking part and there are no immediate benefits of taking part.

- What if something goes wrong?

This online survey is designed to have no risks involved. If you do have any concerns, please contact: Julia Kanno, University of Brasilia - juliarkanno@gmail.com

- What will happen to the results of the research project?
The results will be statistically analyzed for the research purpose in the frame of IEA SHC Task 61.

- Confidentiality

The survey is completely anonymous, and no data can be traced back to the participant, meaning full confidentiality.

Thank you for reading this.

The home office is here defined as a workplace in your apartment, a place that you use repetitively for the work-related tasks, for example a table with a laptop.

The questionnaire should be filled up during the working time typical for you.

Subtask A participants and Barbara Szybinska Matusiak, the Subtask A leader, IEA/SHC Task 6

Please tick the box to continue if you agree to proceed and use your images for analysis. Thank you so much for your willingness to participate.

- Yes, I have read the text above, agree to participate, and agree to use my photos for analysis

Your home office

Please choose one of the alternatives:

- I am a professional
- I am a student

(For professional)

General Information

1. Name and Nationality (optional):

2. Age*:
   - 10-20
   - 20-30
   - 30-40
   - 40-50
   - 50-60
   - Above 60

3. Gender*:
   - Female
   - Male
   - I prefer not to inform
   - Other

4. City/Country of residence*

5. Nature of your company or organization*:
   - Public sector
   - Private sector
   - Self-employee

6. Your work is mainly related to*:
   - Office tasks
   - Education
   - Health
   - Sales
   - Industry
   - Arts
   - Other, please explain below

7. Inform your profession, activity or role in the company:

8. Date*:

9. Time NOW*:

10. Where do you have the space for the home office?*
- I use one of the rooms in my apartment/house for the home office purpose only
- My home office is mainly a table in one of rooms (a living room, a bedroom, etc.)
- The table that I use for home office purpose is also used by others for other purposes

Lighting condition in the whole home office room NOW:

Please, evaluate the lighting condition at your home office NOW:
11. Satisfaction with daylight? (if no window, do not answer this question)
[Not at all satisfied   (1   2   3   4   5   6 7)   Very satisfied]

12. Satisfaction with external view from window? (if no window, do not answer this question)
[Not at all satisfied   (1   2   3   4   5   6 7)   Very satisfied]

13. Satisfaction with electrical lighting? (if no electric light, you mark no relevant
[Not at all satisfied   (1   2   3   4   5   6 7)   Very satisfied]
14. Satisfaction with the general light level in the room?
[Not at all satisfied   (1   2   3   4   5   6 7)   Very satisfied]

Lighting condition in the home office area NOW:

The following questions are about the home office, which may be only a part of the room. Evaluate the lighting condition NOW.

15. Level of Light
[Dark   (1   2   3   4   5   6 7)   Bright]

16. Spatial distribution of Light
[Uniform   (1   2   3   4   5   6 7)   Varied]

17. Glare

[Invisible   (1   2   3   4   5   6 7)   Disturbing]

18. Shadows
[Soft   (1   2   3   4   5   6 7)   Hard]

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Reflections

[Diffuse   (1 2 3 4 5 6 7)
Strong]

DIFFUSE   STRONG

19. Color tones of Light
[Warm   (1 2 3 4 5 6 7)
 Cold]

WARM   COLD

20. Color of the surfaces
[Distorted (1 2 3 4 5 6 7)   Natural]

Pictures of your home office

Before you fill up the next page, please, take two pictures with your smart phone. If there is no window in the room, please skip this section. Please, do not show people on the photos.

- Picture 1: A photo from your typical working position toward the window. Check that the **HDR**-function is switched **off** at your photo-camera/smartphone. If you have to choose between good visibility of outdoors and indoors, make sure that the **outdoors** is well visible. If there is a computer, please let it on with a **white** screen background.
- Picture 2: You stand up and take one big step back (you are about one meter from the worktable), then take a photo of your home office. The **HDR** is also switched **off**. The picture must contain your home office area and the window. If you have to choose between good visibility of outdoors and indoors, make sure the **indoors** is well visible. If there is a computer, please let it on with a **white** screen background

Employment information

21. For how long have you been working at your present company?
- 0 to 1 year
- 1 to 5 years
- 5 to 10 years
- 10 to 15 years
- 15 to 20 years
- more than 20 years

22. Is your position permanent?
- Yes
- No

Describing your home office

23. How many days per week are you working from home?

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- 1 day/week
- 2 days/week
- 3 days/week
- 4 days/week
- 5 days/ week
- 6 days/week
- 7 days/week

24. Have you had a full working day in your home office during COVID-19 pandemic?
- I have had full working day as before COVID
- I have had shorter working day than before
- I have worked more than before
- I have had part-time day, as before COVID

25. How is a typical working time in the home office for you?
- I have worked in the typical working hours
- I have worked some hours late in the evening
- I start working early in the morning
- Other, please explain below

26. Select the option(s) that better describe your activities during the home office:
- Reading and writing on a digital screen and a computer
- Reading and writing, partly digital, partly on paper
- Participation in digital meeting
- Telephone talks
- Video recording
- Other, please explain below

27. Select the option(s) that better describe your preference(s) regarding the light in your home office:
- I appreciate natural light as the illumination in the room
- It does not matter how the room is illuminated
- I prefer daylight for reading/writing
- I prefer electric light for reading/writing
- I prefer both, daylight and electric light for reading/writing

28. The window orientation is facing:
- To the north or north-east or north-west
- To the east
- To the south or south-east or south-west
- To the west

29. Sun shading (it is possible to select more than one option)
- The window has no sun shading
- Thin curtains (it is possible to see the outdoors through the curtains)
- Thick curtains (not possible to see the outdoors)
- Thick curtains on the sides and thin at the middle
- Internal blinds
- External sun shading devices (overhang, louvres, sidefins)
- Other, explain below

30. Distance to the window (from your eyes when you are working to the middle of the window):

- <1,0m
- 1,0 - 2,0m
- 2,0 - 3,0m
- > 3,0m
- There is no window

31. Select the option(s) that better describe the artificial light in your home office:
- There is a ceiling lamp in the room with home office
- There are lamp(s) mounted on walls
- There is a floor lamp
- There is a table/desk lamp on my table
- There is specific lighting for video recording
- There is no window

32. To have good lighting at your home office workplace in the PRESENCE of daylight, you need (you can select more than one option):
- The ceiling lamp has to be switched-on
- Wall lamps have to be switched-on
- The floor lamp has to be switched-on
- The table/desk lamp has to be switched-on
- The specific lighting for video recording has to be switched-on
- There is not need for any lamp
- Others, please explain below

33. To have good lighting at your home office workplace in the ABSENCE of daylight, you need (you can select more than one option):
- The ceiling lamp has to be switched-on
- Wall lamps have to be switched-on
- The floor lamp has to be switched-on
- The table/desk lamp has to be switched-on
- The specific lighting for video recording has to be switched-on
- Others, please explain below

34. Overall, are you satisfied with the visual environment at your home office?
- Yes
- Rather yes
- I am uncertain
- Rather no
- No

35. Will you continue your home office in any way after the COVID pandemic?
- Yes
- Rather yes
- I am uncertain
- Rather no
- No

36. What would you like to improve in the visual environment in the case you must use the home office?

Thank you very much for your participation. We wish you a successful work in good lighting conditions.

(For student)

General Information

1. Name and Nationality (optional):

1. Age*:
   - 10-20
   - 20-30
   - 30-40
   - 40-50
   - 50-60
   - Above 60

2. Gender*:
   - Female
   - Male
   - I prefer not to inform
   - Other

3. City/Country of residence*

4. You are studying in*:
   - a public institution
   - a private institution

5. Date*:

6. Time NOW*:

7. Where do you have the space for the home office?*
   - I use one of the rooms in my apartment/house for the home office purpose only
   - My home office is mainly a table in one of rooms (a living room, a bedroom, etc.)
   - The table that I use for home office purpose is also used by others for other purposes

Lighting condition in the whole home office room NOW:

Please, evaluate the lighting condition at your home office NOW:

8. Satisfaction with daylight? (if no window, do not answer this question)
[Not at all satisfied   (1   2   3   4   5   6   7)   Very satisfied]

9. Satisfaction with external view from window? (if no window, do not answer this question)
[Not at all satisfied   (1   2   3   4   5   6   7)   Very satisfied]

10. Satisfaction with electrical lighting? (if no electric light, you mark no relevant
[Not at all satisfied   (1   2   3   4   5   6   7)   Very satisfied]
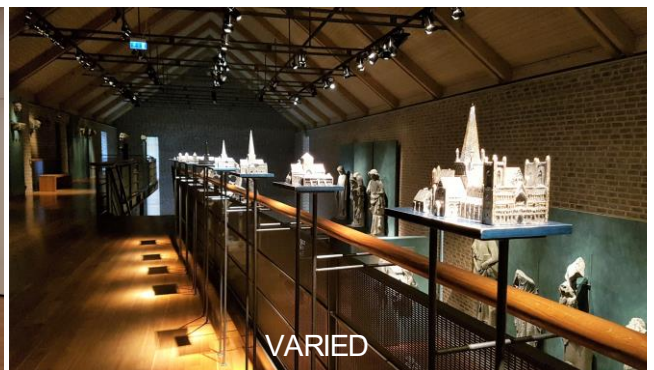
11. Satisfaction with the general light level in the room?
[Not at all satisfied   (1   2   3   4   5   6 7)   Very satisfied]

Lighting condition in the home office area NOW:

The following questions are about the home office, which may be only a part of the room. .
Evaluate the lighting condition NOW.

12. Level of Light
[Dark   (1   2   3   4   5   6 7)   Bright]
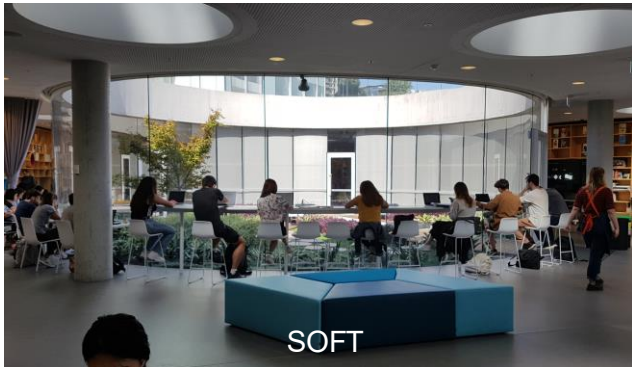
13. Spatial distribution of Light
[Uniform   (1   2   3   4   5   6 7)   Varied]
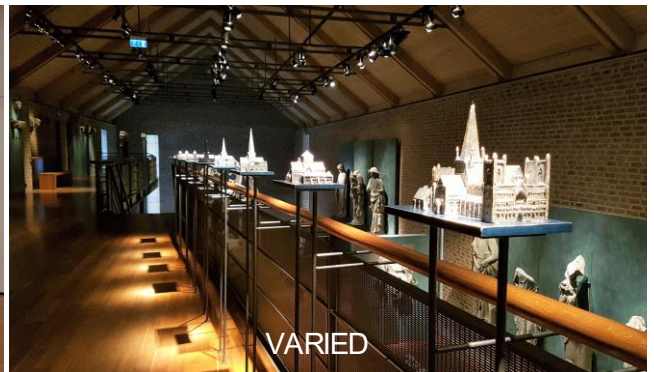
14. Glare
[Invisible   (1   2   3   4   5   6 7)   Disturbing]

15. Shadows
[Soft   (1   2   3   4   5   6 7)   Hard]

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SOFT

HARD

16. Reflections
[Diffuse   (1   2   3   4   5   6 7)   Strong]

DIFFUSE

STRONG

17. Color tones of Light
[Warm   (1   2   3   4   5   6 7)
    Cold]

WARM

COLD

18. Color of the surfaces
[Distorted   (1   2   3   4   5   6 7)   Natural]

DISTORTED

NATURAL

Pictures of your home office

Before you fill up the next page, please, take two pictures with your smart phone. If there is no window in the room, please skip this section. Please, do not show people on the photos.

- Picture 1: A photo from your typical working position toward the window. Check that the **HDR**-function is switched **off** at your photo-camera/smartphone. If you have to choose between good visibility of outdoors and indoors, make sure that the **outdoors** is well visible. If there is a computer, please let it on with a **white** screen background.
- Picture 2: You stand up and take one big step back (you are about one meter from the worktable), then take a photo of your home office. The **HDR** is also switched **off**. The picture must contain your home office area and the window. If you have to choose between good visibility of outdoors and indoors, make sure the **indoors** is well visible. If there is a computer, please let it on with a **white** screen background

Describing your home office

19. How long have you been studying at your present university?
- 0 to 1 year
- 1 to 2 years
- 2 to 3 years
- 3 to 4 years
- 4 to 5 years
- more than 5 years

20. How many days per week are you working from home?
- 1 day/week
- 2 days/week
- 3 days/week
- 4 days/week
- 5 days/ week

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- 6 days/week
- 7 days/week

21. Have you had a full working day in your home office during COVID-19 pandemic?
- I have had full working day as before COVID
- I have had shorter working day than before
- I have worked more than before
- I have had part-time day, as before COVID

22. How is a typical working time in the home office for you?
- I have worked in the typical working hours
- I have worked some hours late in the evening
- I start working early in the morning
- Other, please explain below

23. Select the option(s) that better describe your activities during the home office:
- Reading and writing on a digital screen and a computer
- Reading and writing, partly digital, partly on paper
- Participation in digital meeting
- Telephone talks
- Video recording
- Other, please explain below

24. Select the option(s) that better describe your preference(s) regarding the light in your home office:
- I appreciate natural light as the illumination in the room
- It does not matter how the room is illuminated
- I prefer daylight for reading/writing
- I prefer electric light for reading/writing
- I prefer both, daylight and electric light for reading/writing

25. The window orientation is facing:
- To the north or north-east or north-west
- To the east
- To the south or south-east or south-west
- To the west

26. Sun shading (it is possible to select more than one option)
- The window has no sun shading
- Thin curtains (it is possible to see the outdoors through the curtains)
- Thick curtains (not possible to see the outdoors)
- Thick curtains on the sides and thin at the middle
- Internal blinds
- External sun shading devices (overhang, louvres, sidefins)
- Other, explain below

27. Distance to the window (from your eyes when you are working to the middle of the window):
- <1,0m
- 1,0 - 2,0m
- 2,0 - 3,0m
- > 3,0m
- There is no window

28. Select the option(s) that better describe the artificial light in your home office:
- There is a ceiling lamp in the room with home office
- There are lamp(s) mounted on walls
- There is a floor lamp
- There is a table/desk lamp on my table
- There is specific lighting for video recording
- There is no window

29. To have good lighting at your home office workplace in the PRESENCE of daylight, you need (you can select more than one option):
- The ceiling lamp has to be switched-on
- Wall lamps have to be switched-on
- The floor lamp has to be switched-on
- The table/desk lamp has to be switched-on
- The specific lighting for video recording has to be switched-on
- There is not need for any lamp
- Others, please explain below

30. To have good lighting at your home office workplace in the ABSENCE of daylight, you need (you can select more than one option):
- The ceiling lamp has to be switched-on
- Wall lamps have to be switched-on
- The floor lamp has to be switched-on
- The table/desk lamp has to be switched-on
- The specific lighting for video recording has to be switched-on
- Others, please explain below

31. Overall, are you satisfied with the visual environment at your home office?
- Yes
- Rather yes
- I am uncertain
- Rather no
- No

32. Will you continue your home office in any way after the COVID pandemic?
- Yes
- Rather yes
- I am uncertain
- Rather no
- No

33. What would you like to improve in the visual environment in the case you must use the home office?

Thank you very much for your participation. We wish you a successful work in good lighting conditions.

Appendix 4. Luminaires considered for energy calculations

1.   A luminaire for commercial buildings, offices, schools and universities

RC461B PSD W60L60 1 xLED40S/940

1 x 4000 lm

Polar intensity diagram
120°   180°   120°
90°   90°
60°   -150-   60°
            -300-
            -450-
            -600-
       g →
30°   -750-   30°
(cd/1000 lm)   0°   L.O.R.= 1.00
——— 0-180°   ——— 90-270°

Light output ratio   1.00
   Service upward   0.00
   Service downward   1.00

CIE flux code   67 95 99 100 100

S/H ratio crosswise   max. 1.5
          lengthwise   max. 1.5

UGRcen (4Hx8H, 0.25H)   16
EN12464-1   65 deg, 1500 cd/m2

UTE71-121:   1.00C + 0.00T

LVT0000700

Quantity estimation diagram
nr. of luminaires

hroom: 2.8 m
Reflectances: 0.70, 0.50, 0.20
Maintenance factor: 1.0
Ceiling mounted

750 lx
500 lx
300 lx

10   30   50   70   90   (m²)

UGR diagram
16.0

hroom: 2.8 m
Refl: 0.70 0.50 0.20
Ceiling mounted

12.0   m
Y |||16
         ⊥16

|| : viewed endwise
⊥ : viewed crosswise
Y : Parallel to viewing dir.

8.0

4.0   8.0 → x   12.0   m   16.0

Utilisation factor table

Room Index k	Reflectances for ceiling, walls and working plane (CIE)										
	0.80 0.80	0.70 0.70	0.70 0.70	0.50 0.50	0.30 0.30	0.00					
	0.50 0.50	0.50 0.50	0.50 0.30	0.30 0.10	0.30 0.10	0.00					
	0.30 0.10	0.30 0.20	0.10 0.10	0.10 0.10	0.10 0.10	0.00					
0.60	0.60 0.57	0.60 0.58	0.57 0.51	0.50 0.46	0.50 0.46	0.45					
0.80	0.71 0.67	0.70 0.68	0.66 0.60	0.60 0.56	0.59 0.56	0.54					
1.00	0.80 0.74	0.79 0.76	0.74 0.68	0.67 0.63	0.67 0.63	0.61					
1.25	0.88 0.81	0.86 0.83	0.80 0.75	0.74 0.71	0.73 0.70	0.68					
1.50	0.94 0.85	0.92 0.88	0.84 0.80	0.79 0.76	0.78 0.75	0.73					
2.00	1.03 0.92	1.00 0.95	0.91 0.87	0.86 0.83	0.85 0.82	0.80					
2.50	1.08 0.95	1.05 0.99	0.94 0.91	0.90 0.88	0.89 0.87	0.84					
3.00	1.12 0.98	1.09 1.02	0.97 0.94	0.93 0.91	0.91 0.90	0.87					
4.00	1.16 1.00	1.13 1.06	0.99 0.97	0.96 0.94	0.94 0.93	0.90					
5.00	1.19 1.02	1.15 1.07	1.01 0.99	0.97 0.96	0.96 0.94	0.92					

Ceiling mounted

Luminance Table

Plane Cone	0.0	45.0	90.0
45.0	5184	6342	5217
50.0	3783	5502	3796
55.0	2429	3976	2429
60.0	1568	2319	1583
65.0	995	1327	1005
70.0	899	924	902
75.0	821	821	825
80.0	751	737	758
85.0	681	642	692
90.0	-	-	-

(cd/m2)

2019-09-17

RC461B PSD W60L60 1 xLED40S/940

L.O.R.= 1.00   1 x 4000 lm

Polar intensity diagram
120°   150°   180°   150°   120°
90°   90°
-750-
-600-
-450-
60°   60°
(cd/1000 lm)   30°   0°   30°   L.O.R.= 1.00
——— 0 - 180°   ——— 90 - 270°   ——— 20 - 200°

0°

Imax = 514 cd/1000 lm
C = 20 γ = 1°

LVT0000700   2019-09-17

2. Luminaire for the industrial part of production

BY481P PSD 1 xLED250S/840 MB

1 x 25000 lm

Polar intensity diagram
120° 180° 120°

(cd/1000 lm) 0° L.O.R.= 1.00
— 0-180°
— 90-270°

Light output ratio 1.00
    Service upward 0.00
    Service downward 1.00

CIE flux code 88 97 99 100 100

UGRcen (4Hx8H, 0.25H) 20

Quantity estimation diagram
nr. of luminaires

h room: 2.8 m
Reflectances: 0.70, 0.50, 0.20
Maintenance factor: 1.0
Ceiling mounted

750 lx
500 lx

10 30 50 70 90 (m²)

UGR diagram

16.0
m
12.0
Y
8.0
4.0

4.0 8.0 x 12.0 m 16.0

h room: 2.8 m
Refl: 0.70 0.50 0.20
Ceiling mounted

‖ 22
⊥ 22

‖ : viewed endwise
⊥ : viewed crosswise
Y : Parallel to viewing dir.

Utilisation factor table

Room Index k	Reflectances for ceiling, walls and working plane (CIE)										
	0.80 0.80 0.30	0.80 0.50 0.10	0.70 0.70 0.30	0.70 0.50 0.20	0.70 0.50 0.10	0.70 0.30 0.10	0.50 0.50 0.10	0.50 0.30 0.10	0.30 0.30 0.10	0.30 0.10 0.10	0.00 0.00 0.00
0.60	0.77	0.73	0.76	0.74	0.73	0.68	0.68	0.65	0.68	0.65	0.64
0.80	0.84	0.79	0.83	0.81	0.79	0.74	0.74	0.71	0.73	0.71	0.69
1.00	0.91	0.85	0.90	0.87	0.84	0.80	0.79	0.77	0.79	0.76	0.75
1.25	0.97	0.89	0.95	0.92	0.88	0.85	0.84	0.81	0.83	0.81	0.79
1.50	1.02	0.92	1.00	0.95	0.91	0.88	0.87	0.85	0.86	0.84	0.83
2.00	1.08	0.97	1.06	1.01	0.96	0.93	0.92	0.90	0.91	0.90	0.88
2.50	1.13	1.00	1.10	1.04	0.99	0.97	0.96	0.94	0.94	0.93	0.91
3.00	1.16	1.02	1.13	1.07	1.01	0.99	0.98	0.97	0.97	0.96	0.94
4.00	1.20	1.04	1.17	1.09	1.03	1.02	1.00	0.99	0.99	0.98	0.96
5.00	1.22	1.05	1.19	1.11	1.04	1.03	1.01	1.01	1.00	0.99	0.97

Ceiling mounted

Luminance Table

Plane Cone	0.0	45.0	90.0
45.0	10102	18001	11380
50.0	7588	7870	8970
55.0	7313	7247	9051
60.0	7043	6953	9322
65.0	6705	6533	9267
70.0	6181	6004	8842
75.0	5212	5138	6923
80.0	3631	3734	4326
85.0	1510	1652	2060
90.0	-	-	-

(cd/m2)

LVP0202600
2020-08-03

BY481P PSD 1 xLED250S/840 MB

L.O.R.= 1.00
1 x 25000 lm

Polar intensity diagram
120° 150° 180° 150° 120°

90° 1000 800 600 90°

60° 60°

(cd/1000 lm) 30° 0° 30° L.O.R.= 1.00
— 0 - 180°
— 90 - 270°

0° ⊿
Imax = 762 cd/1000 lm
C = 0 ℽ = 15°

LVP0202600
2020-08-03

3. Luminaire for the warehouse industrial part

WT470C L1300 1xLED23S/840 WB

1 x 2300 lm

Polar intensity diagram

(cd/1000 lm) 0° L.O.R.= 1.00
— 0-180°
— 90-270°

Light output ratio 1.00
Service upward 0.03
Service downward 0.97

CIE flux code 57 92 98 97 100

S/H ratio crosswise max. 1.7
lengthwise max. 1.8

UGRcen (4Hx8H, 0.25H) 18
EN12464-1 65 deg, 3000 cd/m2

UTE71-121: 0.97C + 0.03T

Quantity estimation diagram
nr. of luminaires

h_room: 2.8 m
Reflectances: 0.70, 0.50, 0.20
Maintenance factor: 1.0
Ceiling mounted

750 lx
500 lx
300 lx

UGR diagram

h_room: 2.8 m
Refl: 0.70 0.50 0.20
Ceiling mounted

II : viewed endwise
⊥ : viewed crosswise

Y : Parallel to viewing dr.

II 19
⊥ 19

Utilisation factor table

Room Index k	Reflectances for ceiling, walls and working plane (CIE)										
	0.80 0.80 0.30	0.80 0.50 0.10	0.70 0.50 0.30	0.70 0.50 0.20	0.70 0.50 0.10	0.70 0.30 0.10	0.50 0.50 0.10	0.50 0.30 0.10	0.30 0.30 0.10	0.30 0.10 0.10	0.00 0.00 0.00
0.60	0.52	0.50	0.51	0.50	0.49	0.42	0.42	0.37	0.41	0.37	0.35
0.80	0.64	0.60	0.63	0.61	0.60	0.53	0.52	0.48	0.51	0.47	0.45
1.00	0.74	0.68	0.72	0.70	0.68	0.61	0.60	0.56	0.59	0.55	0.53
1.25	0.83	0.76	0.81	0.78	0.75	0.69	0.68	0.64	0.66	0.63	0.60
1.50	0.89	0.81	0.87	0.83	0.80	0.74	0.73	0.69	0.72	0.68	0.66
2.00	0.98	0.88	0.96	0.91	0.87	0.82	0.80	0.77	0.79	0.76	0.73
2.50	1.04	0.92	1.01	0.95	0.91	0.87	0.85	0.82	0.83	0.81	0.78
3.00	1.08	0.95	1.05	0.99	0.93	0.90	0.88	0.86	0.86	0.84	0.81
4.00	1.13	0.98	1.09	1.02	0.96	0.94	0.91	0.89	0.89	0.88	0.84
5.00	1.16	0.99	1.12	1.04	0.98	0.96	0.93	0.92	0.91	0.90	0.86

Ceiling mounted

Luminance Table

Plane Cone	0.0	45.0	90.0
45.0	5675	6263	8413
50.0	4558	5077	7150
55.0	3367	3454	5179
60.0	1691	2089	3243
65.0	984	1297	1988
70.0	676	759	1152
75.0	475	551	767
80.0	386	420	491
85.0	328	349	233
90.0	293	314	95

(cd/m2)

LVP0146900 2016-12-23

WT470C L1300 1xLED23S/840 WB

1 x 2300 lm

Polar intensity diagram

(cd/1000 lm) 0° L.O.R.= 1.00
— 0-180°
— 90-270°
— 15-195°Imax

LVP0146900 2016-12-23