Academic year 2011 - 2012 #2 | June

MOLLIER

Study Association
Building Physics and Systems

# INSIDE INFORMATION

MOLLIER | UNIT BPS | STUDENTS | ACTIVITIES | MEMBERS

## Research in Building Lighting

lighting design guidelines for elderly

## Leadership through sustainability

Renovation to meet the LEED standard

## Lords of the Board

Mumbai 2012

# Editor's note

Dear reader,

When the second INSide Information arrives, you know that the acadamic year is comming to an end. Once again we have had an eventful year and major changes are imminent with regard to the academic education. Should we run to the bank for a loan or is the outcome of the upcoming elections going to be in our favor? Only time will tell.

So for now, just sit back and enjoy this freshly printed copy you are holding in your hands. It is again filled with new articles and our field is ofcourse well represented by students, teachers and companies. For instance we have a great article about the Oval Tower by Deerns. Furthermore is the Unit BPS represented by Marielle Aarts, Myriam Aries and Jos van Schijndel with articles about building lighting and detecting moisture leakages.

Also a number of students will talk about their activities, both during and outside school hours. We'll conclude this edition with an article about the foreign study trip to Mumbai, India. An article with lots of different writing styles by the students who visited this amazing country. In short, an edition worthwhile reading

Finaly we wish you all every success in completing the final exams and projects of this year. For those of you who have completed their Master this year, good luck for the future and for the rest you, hope to see you next year!

*Enjoy the holiday!*


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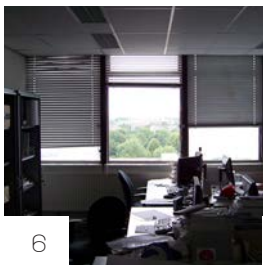
# This INSide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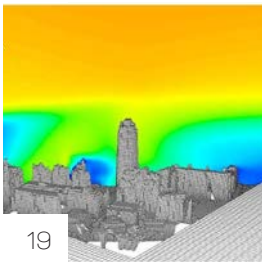
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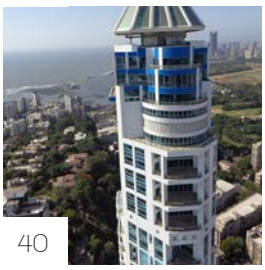
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# Research in Building Lighting

Written by: M.P.J. Aarts, M.B.C. Aries, R.A. Mangkuto, E.J. van Loenen

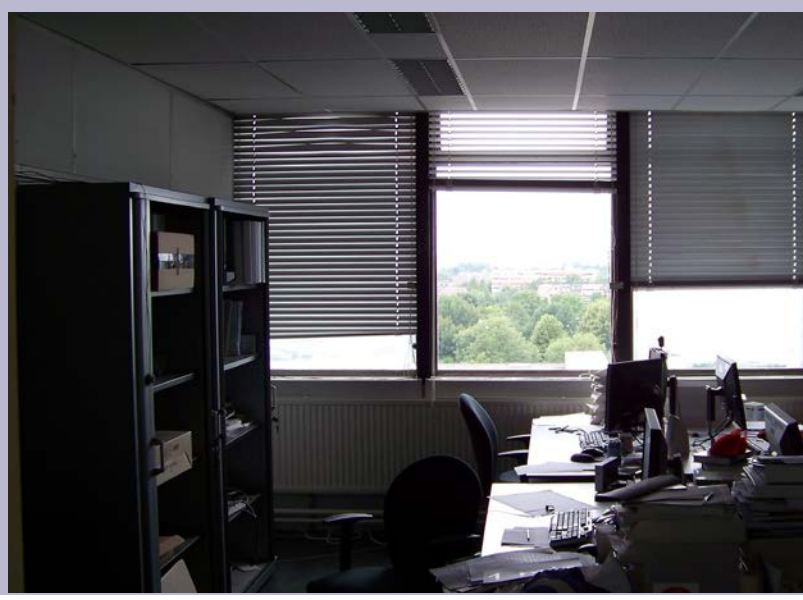

Figure 1. Working by daylight? (M. Aries/D. Steeghs)

Light is essential for human life and functioning. It influences the performance and well-being of people in a physiological, psychological and biological way. As such, light is a key element in the design of our buildings and our built environment. The BPS Building Lighting group of the TU/e combines research that addresses both daylight and electric lighting, that includes fundamental as well as applied research, and that evolves around people as well as technology. The focus research areas of the Building Lighting group are:

- "Healthy daylight in the built environment"
- "Lighting for the elderly"
- "Smart Lighting"

## Healthy daylight in the built environment

In the Western world, many people spent most of their time inside buildings during daytime. The consequences of the move from a dynamic outside to a static indoor environment are incalculable. Light is an important regulator of the human physiology and performance. Visual photoreception enables humans to see, while non-visual photoreception affects the circadian rhythm and directly stimulates parts of the brain. Lighting that meets both human visual and non-visual demands without causing visual discomfort is called 'healthy lighting'. Healthy lighting is not always available; either due to the construction of a building or due to people's interaction their environment (see Figure 1). Light dosage not only means a determination of intensity, but also of timing and positioning; light should be applied where and when it is demanded. Also, dynamics of lighting in terms of level, spectral composition and direction during the day play an important role.

The more we understand of the dynamics of our natural light, the better the built environment can profit from nature. Building facades, shading devices, smart energy glass, or electric lighting can respond to outdoor conditions and provide balance with human comfort demands and naturally occurring rhythms in human beings. This means that at specific periods over the course of a day, the amount of daylight entering should be controlled. Knowledge about daylight rhythms will enable greater daylight utilisation in buildings. In order to understand the dynamics of natural light with regards to human needs, measurements are on-going. In these experiments daylight conditions are studied in test rooms and real offices on days with diverse weather conditions. Results are linked to data collected by Actiwatches used to record spontaneous motor activity (SMA) and worn by healthy human beings. For all data Fast Fourier Transform (FFT) is used in order to transform time-dependent data into a sum of sinusoidal base functions. First results show that there are differences between daylight rhythms and naturally occurring human rhythms (see Figure 2) for different weather conditions.

## Lighting for the Elderly

Within this research line we try to develop lighting design guidelines for elderly in general and elderly with dementia. We take into account the visual aspects (e.g. what is the best lighting for performing everyday tasks, or to prevent falls), the non-visual (e.g. sleep/wake cycle, mood, behavior).

Within the next 30 years the estimation is that the number of people over 65 years old, will increase to 25% of the population of western society. Since dementia is a typical age related disease, the percentage of citizens suffering from dementia will likely increase as well. In an attempt to reduce the additional stress on care facilities and care takers, lighting is studied as one of the possible solutions. Behavioral (for example restlessness at night) symptoms lead to a situation where people are no longer able to live in their own dwellings and therefore become institutionalized. In several ways, lighting can have a positive influence on the behavior and well being of elderly people and specifically people with dementia. A strong correlation exists between activity/independence and quality of life while aging. It is therefore important to support elderly in their every-day activities. Light, adjusted to the visual needs of elderly is essential and is approximately a factor three higher than the need of young adults. Falling is a major cause of institutionalization. Poor visual acuity approximately doubles the risk of falling. Adequate lighting could reduce the number of incidents. Several studies showed that bright light therapy can actually lessen nocturnal unrest, enhance a more stable sleep wake cycle, increase nocturnal sleep time, possibly improve restless and agitated behavior and ameliorate progressive worsening of depressive symptoms and improve cognition. For this therapy, illuminances of over 1000 lx vertically at the eye are required. In one of our studies, providing at the eye, high

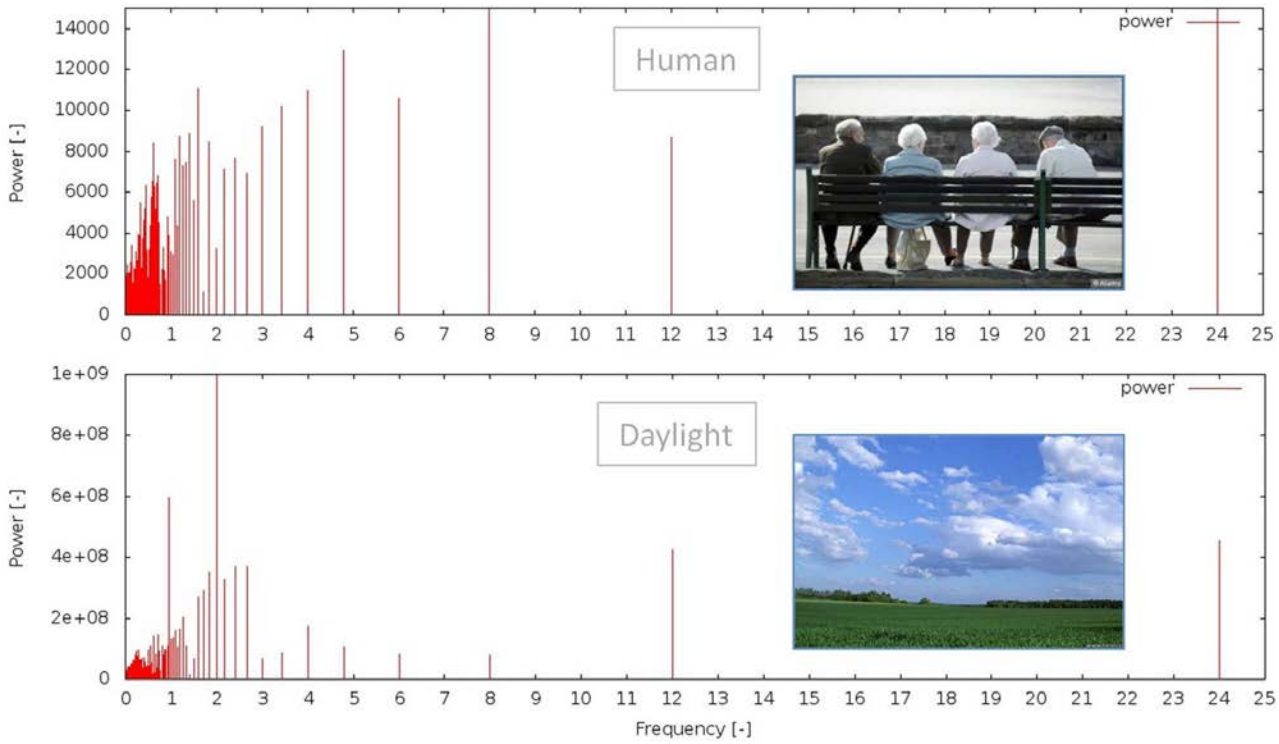


Figure 2. Periodiogram for a 24-hour period of daylight (13 consecutive days) and for a human being (6 consecutive days) with power as function of frequency (M. Aries)

illuminance levels (> 1000 lx) and a high CCT (> 6500 K) proved to be more effective than high illuminance and low CCT ~2700 K for increasing the range of tympanic temperature (this is an indicator that the disturbed circadian rhythm has improved) and improving restless behavior. Electrical lighting with a mediate illuminance level (~400 lx) and ultra high CCT (~10.000K) or low CCT (~2700 K) generated no effect. A disturbed sleep-wake pattern and therefore also disturbed sleep of the partner and informal caretaker, is an important cause for people with dementia to get institutionalized. In a study simulating dusk and dawn conditions in the bedroom, people slept longer and were less restless during the night. Also the sleep latency (time it takes to fall asleep) was shortened.

When making a lighting design, not only the illuminance is important but also the luminance of the direct surroundings. Therefore dark colors on walls and floor is not advisable. An example of a lighting design is demonstrated in Figure 3. The next step in this research line is to implement all the individual results in a living lab environment on a larger scale to valorize the total effect of light. Research set-ups are currently in a start phase.

## Smart Lighting

Sunlight impacts many biological and psychological processes, including those governing people's circadian rhythm and mental and physical health. But in modern societies people spend most of their time inside buildings. Designing building facades which provide optimal access to daylight without introducing glare and high heating and cooling loads is a key challenge. For interior spaces, future artificial daylight solutions that mimic the essential characteristics of real windows or skylights are being investigated (see Figure 4 left). But also there, balancing high light levels for health benefits with low energy consumption is a challenge. These conflicting requirements may be met by the application of Ambient Intelligence methods.

Context-aware systems allow automatic adaptation of environmental conditions to individual health, comfort or safety needs, while limiting energy use to relevant times and locations at the same time. This research area outlines key opportunities and challenges in this exciting field.

Figure 3. Example of a lighting design for an elderly care facility (M. Aarts/S. Chraibi)

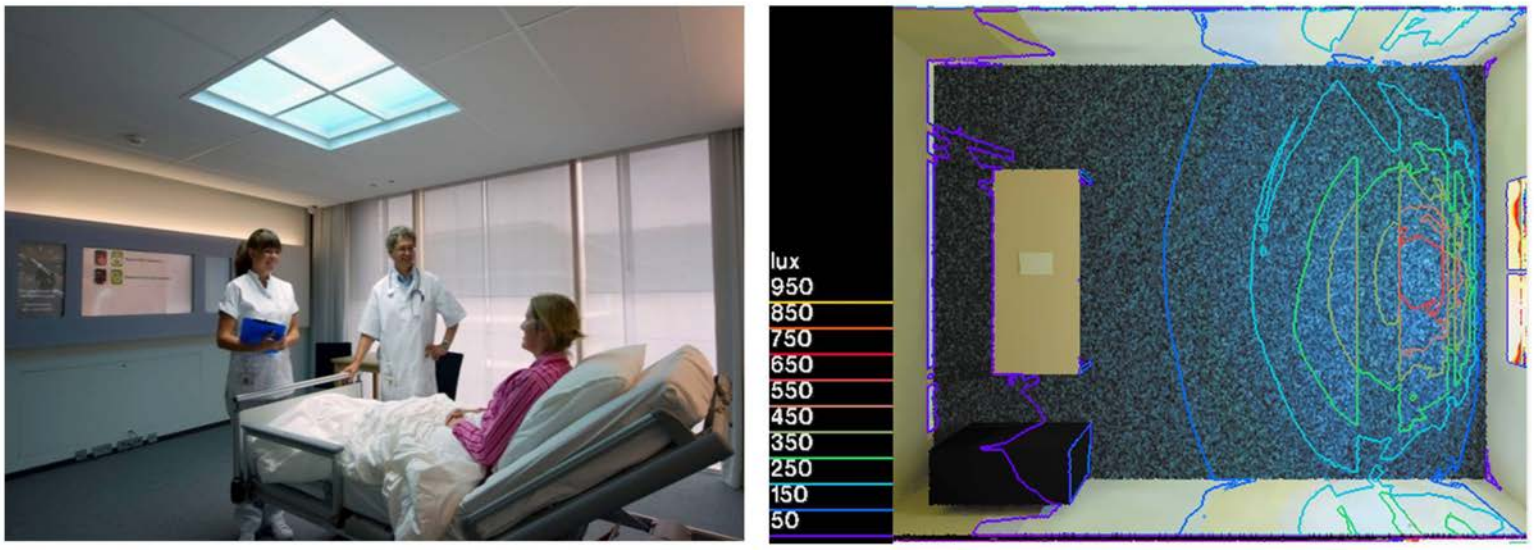


Figure 4. Left: Example of a smart lighting system in a patient room (source: Philips Research); Right: Example of light distribution simulation of a virtual window in Radiance (R. Mangkuto)

People have a strong preference for natural light inside buildings. However, natural light is highly variable and limited by time and space. Creating a shallow building plan might resolve the issue on one hand, but on the other hand we will require more space for construction (because, for instance, we need longer corridors). Night-shift working is another issue; workers are prone to having a lack of synchronization between the work schedule and their natural light-dark cycle, which may lead to several diseases. In summary, there is a need to have a virtual type of natural lighting opening, which can resemble all characteristics of the real natural light, to complement real windows or in situations where natural light is not present at all.

A possible way to overcome those problems is to apply virtual windows and/or skylights, i.e., lighting display systems that resemble the natural light and/or view. However, none of the existing solutions have the ideal properties of real ones yet. Therefore, we are developing modeling approaches to evaluate the requirement of an acceptable Virtual Natural Lighting Solution (VNLS). A VNLS is a system that has the possibility to artificially provide natural lighting and realistic outside scene view, with all of its properties. In this research, the aim is to explore the potential of VNLS system for application in various building typologies. This means that first the relevant properties and performance indicators for a VNLS have to be determined. Next, the appropriate tools to model and simulate the VNLS have to be applied or created (see Figure 4 right). In the meantime, the potential economic value of applying VNLS systems in different buildings typologies is studied.

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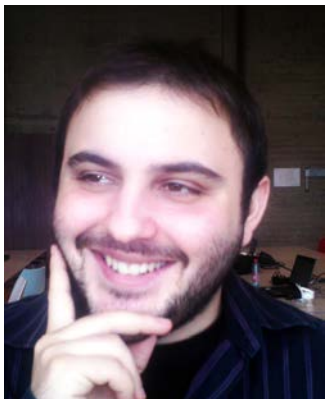
# Commitee Study trip abroad



**Who:** Arggyrios Papadopoulos
**Function:** President

**Tasks:** To put order into chaos, structure the commission tasks and appoint them to the commission members and actively be part of the organization process.

**My opinion:** Because ordering people what to do is always awesome!

**Memorable moments:** Realizing that Mumbai and Bombay, our travel destination, is actually the same city! It is! Really!

**Quotes:** ,,When you are in India respect the local cows,,

**Experience:** When you deal with the correct people, responsibilities are always more enjoyable and pleasing to undertake.

**Why this committee:** Just do it! Interacting to such activities provides you with working experience and teaches you how to behave in a working micro-environment.

**Who:** Jochem Straathof
**Function:** Co- President

**Memorable moments:** The killer ride on the mountainbike through the Belgian Ardennes during Mollier's end activity 2011.

**Experience:** Don't feel burdened to join or organise an activity!

**Who:** Joep Richter
**Function:** Secretary

**Tasks:** Correspond to all the external contacts relevant for the trip.

**My opinion:** Doing some commissions increases the motivation to come to the TU/e more frequently.

**Memorable moments:** Convincing the people at the embasy that we are going as tourists to India.

**Quotes:** ,,Money is relative,,

**Experience:** Teamwork and atmosphere of a commission always greatly improves after you all have a good night out together

**Why this committee:** You get to influence which destination will be visited, and additionally, plan all the things you want to do and experience there

**Who:** Mark de Waard
**Function:** treasurer

**Tasks:** Keeping an eye on the money, arrange approval of the university. What better function is there to let other people arrange the money, so you can control the cash flows and make the definite budget. Actually, the treasurer is the top dog in any board ;)

**My opinion:** It's nice, but maybe if I actually attended the study trip, the involvement would be much better.

**Memorable moments:** Making the budget fit. Try to make an estimation of the total cash flows without having any actual money. Challenging!

**Quotes:** "It's gonna be hard getting drunk in India..."

**Experience:** I already had some experience with finance of previous committee work, but it's still fun to do.

**Why this committee:** I attended the study trip last year and it was really good fun. So I wanted to take an active part in the organization of this year's study trip. Unfortunately I had some inconvenience with my own budget related to the duration of my study. TIP: Studying is becoming more and more expensive, finish a.s.a.p. but attend any study trip you can!

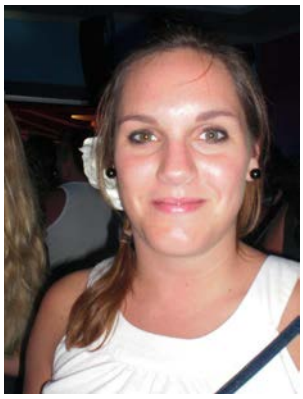
**Who:** *Richard Claessen*
**Function:** *Activity manager*

**Tasks:** *Aranging activities and company visits*

**My opinion:** *To me the BTL-commision is a great way to get in contact with other interesting cultures.*

**Quotes:** *'Perfect!'*

**Experience:** *You obtain organizational skills and have influence on the trip planning. Result: an even greater and more useful trip!*



**Who:** *Ilse Schoenmakers*

**Tasks study trip:** *Program booklet, Shirts, Gifts to companies, getting invited by companies*

**My opinion:** *It would be regrettable if you miss the benefits of being an active member of Mollier*

**Memorable moments:** *All the jokes during the meetings*

**Quotes:** *,,Many hands make light work fun, however many hands make fun light work''*

**Experience:** *Instructive, social intercourse*

**Who:** *Etienne Geurts*

**Tasks:** *Arranging travel documents and study related visits.*

**Your opinion:** *Great contact with foreign cultures*

**Quotes:** *'Life is a book you should write, not read'*

**Experience:** *Learn how to say one thing in ten different ways (due to a language barrier).*


# Gebouwinstallaties

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# Leadership through sustainability

Deerns is the largest engineering firm in the Netherlands in the field of MEP systems, energy supply and building physics. Deerns's investments in sustainability and its high quality allows Deerns to maintain a strong position in the current market. Engineer Lucien Engels, mechanical engineering project leader on behalf of Deerns for the renovation of Oval Tower (a Deka Immobilien project) in Amsterdam, comments: 'The investments yield good, sustainable, beautiful designs in all areas, both for new buildings and renovation projects.'

The Oval Tower, an office building of almost 24,000 m2 beside the Arena in Amsterdam, is being renovated by Deerns engineering firm to meet the American LEED standard. Leadership in Energy and Environmental Design (LEED) is the American standard used to determine the sustainability of buildings. Project leader Lucien Engels comments: 'Originally, the building owner, Deka Immobilien, and the manager/delegate client DTZ Zadelhoff wanted the building to be certified according to the British/Dutch standard BREEAM.' The new tenant, however, preferred that the building satisfy the more internationally well-known LEED standard. Engels continues: 'You don't achieve a high standard just like that. Deerns has been investing for some time in knowledge of and experience with sustainable construction, conversion and renovation. We have several LEED Accredited Professionals in service and we distinguish ourselves by very actively brainstorming with the client about making buildings sustainable.'

The LEED evaluation system is set up very broadly, though, according to Marten Valk, civil engineer and building physics project leader for the renovation of the Oval Tower. 'Even the accessibility of the building is taken into account,' Valk explains. 'This office building is close to a train and metro station, which also helps the building to score gold with LEED.' While gathering all of the necessary information, Deerns enjoyed good collaboration from LEED Accredited Professional and LEED Administrator for this project, BenR Adviseurs.

Illustration by DEKA Immobilien GmbHA

## RADIANT CEILING PANELS

The Oval Tower, now 10 years old, was drastically renovated and rebuilt in recent months in order to meet the LEED criteria. Marten Valk explains: 'The building was stripped on the inside. The outside, the shell, remained intact.' The biggest operation was tackling the climate system. Not only must this system be sustainable and reliable, it must also provide a high degree of comfort. Aquifer thermal energy storage (ATES), which stores heat in the summer for the winter and vice versa, in combination with radiant ceiling panels, was selected for the Oval Tower. Deerns convinced the clients that the radiant ceiling panels were a better, though more expensive, option compared with the previously planned convection units. The radiant ceiling panels are large panels with water at a moderate temperature flowing through them. Because the system is based on the radiation of heat and cold, less air is moved through the room, making the risk of draughts smaller. 'Draughts have a high air speed and are unpleasant,' comments Lucien Engels. 'For that reason, people find the type of heating selected here more comfortable. Many employees in these types of offices are well-educated professionals. You retain these people by providing them with smart, comfortable offices.'

These panels are more expensive to purchase, but much more energy efficient. Marten Valk explains: 'The radiant ceiling panels supply even, radiated heat, such that the same comfort level can be achieved even at air temperatures that are a few degrees lower.' This solution is also more energy efficient due to lower heat loss in the piping.

## OVAL INTERIOR SPACES

For the design of the radiant ceiling panels, Deerns worked closely with OPL Architecten and the manufacturer of the panels. Lucien Engels remarks: 'The name says it all: the building is a beautiful oval, even the interior. That meant, however, that we had to custom design the ceilings. The radiant ceiling panels all taper.' It has been done beautifully. When you walk around the office you would swear that the panels are straight rectangles. Only when you see the panels on the ground can you see that at a length of about 6 metres they taper by about half a metre. Engels approves: 'The designers have resolved this very tastefully.'

Along with comfort and energy efficiency, the radiant ceiling panels have another benefit. 'Acoustics are an issue in office buildings, especially in rooms where several people are working hard,' says Marten Valk. 'In order to optimise the utilisation value of the room, we designed the radiant ceiling panels in such a way that they contribute to the acoustics.' This also shows why Deerns is so successful. 'We know how to combine different aspects. We can do that because in-house we have so many disciplines and so much high-level experience, which enables us to create and execute integrated designs.'

## LOW-WIND ENTRANCE

In addition to the climate systems, the electricity supply and the data network have also been completely redone. Lucien Engels comments: 'The tenant set strict requirements for the reliability of the electricity supply. The current electrical wiring, despite being just 10 years old, only partly satisfied the reliability requirements. We replaced the wiring and also installed an emergency power supply. Should there be a power failure, the system can be switched over to a generator.'

Deerns also designed the data network for the future. 'All of the data cables incorporated in the building are of the modern Cat 7 type. The patch cables to the computers are currently still Cat 6 because the present hardware is not yet built for the speed of Cat 7.'

Even the workplace lighting is subject to study. 'We take daylight measurements and indicate the requirements artificial lighting must satisfy.' And one thing was changed on the exterior of the building: for the new tenant, the architect designed a new entrance at the top of the oval. Marten Valk comments: 'In order to prevent wind nuisance at the new entrance, a clever canopy was then designed together with the architect.' Attention to all of these aspects improves the lettability of the building. 'And for us, all of these constraints ensure that renovation plans are at least as interesting as new building projects.'

## SATISFACTION

Thanks to the wide-ranging experience with sustainability, such as the LEED rating, Deerns wins a lot of orders, even now, when the market is lagging. 'The offices market, which along with airports, data centres and hospitals is an important market for us, is currently a difficult one,' says Lucien Engels. 'Buildings that become vacant, or are in danger of doing so, have value if they distinguish themselves from other buildings, by sustainability, among other things. Deerns is known as an engineering firm that embraces sustainability as a principle, and because of that, we now have a reasonably well-filled order portfolio.' For Lucien Engels and Marten Valk, projects like the Oval Tower are also very attractive. Marten Valk explains: 'The fascinating thing about this work is seeing how the building turns into something better in just a short time. That gives me a lot of satisfaction. These projects are extremely varied and challenging and offer vast opportunities for development, which, incidentally, you get plenty of room for at Deerns regardless.'

The unique renovation of the Oval Tower is due in part to a close collaboration of several parties. In addition to the above-mentioned companies, this collaboration included BBN Adviseurs (building costs and building management), Zonneveld Ingenieurs (designer) and 3Deluxe (interior architect). DTZ Zadelhoff selected each party on behalf of Deka Immobilien.

*The unique renovation of the Oval Tower is due in part to a close collaboration of several parties. In addition to OPL Architecten, BBN Adviseurs (building costs and building management) and Deerns Raadgevende Ingenieurs (installations and building physics) have been closely involved with the project from the beginning. Other consultants include Zonneveld Ingenieurs (designer), 3Deluxe (interior architect) and BenR (LEED advisor). DTZ Zadelhoff selected these parties on behalf of Deka Immobilien.*

Illustration by DEKA Immobilien GmbHA


Illustration by DEKA Immobilien GmbHA

# Het optimum
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Bijdragen aan een optimaal duurzame en comfortabele leef- en werkomgeving is de kern van onze missie. Dat doen we door de ontwikkeling van innovatieve en energiezuinige gebouwconcepten. Deerns is het grootste onafhankelijke adviesbureau in Nederland. Met projecten over de hele wereld en veertien vestigingen in Europa, Dubai en de Verenigde Staten is Deerns bovendien een toonaangevend internationaal bureau.

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# Events 2011-2012

## Mollier activities throughout the year

21th of December
**KNOTSBAL | ESSF van lint studenten sport week**

On Wednesday 21th of December Mollier participated at the "ESSF Van Lint Studenten Sport Week (LSSW)". This is a yearly returning activity taking place in the week before the Christmas vacation. Due to the high popularity of this game within Mollier the registrations where overwhelming! Mollier was represented by two teams at the "knotsbal tournament" and of course our loyal fan base. Both teams where very competitive and won almost all of their games. Between and after the thrilling matches there was room for some refreshments to cool down.

18 - 19th of January
**UNIT DAG**

The Unitday was organized on Wednesday 18th and Thursday 19th of January. During these days all BPS and BS student presents their current project. These projects can be a Master 1, 2 or 3 project or start colloquium. True to tradition there was a lunch organized by us.

8th of February
**CHINESE NEW YEAR CELEBRATION**

This year is the Chinese year of the dragon. On Wednesday 8th of February 2012 at the Common Room, the Mollier Chinese students organized a Chinese new year celebration event for Mollier members. It was an event for cultural exchange as well as a feast for tasting genuine Chinese food. During this event, Chinese dumplings made by Chinese students were served as main food. Chopsticks were used for eating instead of knife and fork. After that, rice balls, big white rabbit candy and some other sweets were served. During the event, some videos about Chinese culture were shown and  some questions about China were guessed and competed by Mollier members. All the members who attended the event got to know which animals of Chinese Zodiac they belong to. Moreover, Chinese students taught Mollier members to congratulate for new year in Chinese.

Find out your Sheng Xiao (12 animals)The Sh□ngxiào (Chinese: 生肖), better known in English as the Chinese Zodiac, is a scheme that relates each year to an animal and its reputed attributes, according to a 12-year mathematical cycle. The zodiac of twelve animal signs represents twelve different types of personality. The zodiac traditionally begins with the sign of the Rat. For people who still don't know their year of animal please find out for yourself, if you can't find your year of birth in the table, please make some smart calculations:

Chinese dumplings and rice balls

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Jan 31, 1976 | - Feb 17, 1977 | 龍 | Dragon | Feb 9, 1986 | - Jan 28, 1987 | 虎 | Tiger |
| Feb 18, 1977 | - Feb 6, 1978 | 蛇 | Snake | Jan 29, 1987 | - Feb 16, 1988 | 兔 | Rabbit |
| Feb 7, 1978 | - Jan 27, 1979 | 馬 | Horse | Feb 17, 1988 | - Feb 5, 1989 | 龍 | Dragon |
| Jan 28, 1979 | - Feb 15, 1980 | 羊 | Goat | Feb 6, 1989 | - Jan 26, 1990 | 蛇 | Snake |
| Feb 16, 1980 | - Feb 4, 1981 | 猴 | Monkey | Jan 27, 1990 | - Feb 14, 1991 | 馬 | Horse |
| Feb 5, 1981 | - Jan 24, 1982 | 鷄 | Rooster | Feb 15, 1991 | - Feb 3, 1992 | 羊 | Goat |
| Jan 25, 1982 | - Feb 12, 1983 | 狗 | Dog | Feb 4, 1992 | - Jan 22, 1993 | 猴 | Monkey |
| Feb 13, 1983 | - Feb 1, 1984 | 猪 | Pig | - | - | - | - |
| Feb 2, 1984 | - Feb 19, 1985 | 鼠 | Rat | Feb 3, 2011 | - Jan 22, 2012 | 兔 | Rabbit |
| Feb 20, 1985 | - Feb 8, 1986 | 牛 | Ox | Jan 23, 2012 | - Feb 9, 2013 | 龍 | Dragon |


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# Renovatie volgens Loes

“Met al die leegstaande kantoorpanden is het eigenlijk onbegrijpelijk dat er nog nieuwe worden gebouwd,” vindt Loes. “Dat is duurder dan een gebruikt gebouw duurzaam te renoveren.” Loes bewijst dat het anders kan. Met haar team boog zij zich over een van de eerste kantoortuinen van Nederland, het karakteristieke hoofdkantoor van DHV zelf. Door met een integraal team een uitgekiend pakket van verbetermaatregelen toe te passen is het gebouw weer toekomstgericht gemaakt: comfortabel en energiezuinig, met hergebruik van duurzame materialen. Bij de renovatie wordt het energielabel verhoogd van G naar A.

Niet de makkelijkste oplossing, maar die met het beste resultaat. DHV, altijd een oplossing verder.

Advies- en ingenieursbureau

DHV


15th of February
## 1# LUNCH LUCTURE WITH KUIJPERS & CAMFIL

On February 15th the first lunchreading of the academic year 2011/2012 was planned. The kick-off was done by Mike and Barry, representing Mollier’s alumni association, ‘Schoone leij’. They explained the goals of this association, and how alumni and also students can participate in it.

This short introduction was followed by a very interesting presentation of the installation company Kuijpers. They showed what fields and disciplines Kuijpers was active in, and how this privately owned company was still able to grow, despite the challenging economic times. They emphasised the great advantages of long term commitment, and true value of sustainable investments.

The lunchreading was completed by a very informative presentation of Camfil, a very internationally oriented company specialised in clean air solutions. Various different applications of clean air solutions were presented, and the very wide and overall presence of air filtering technology was illustrated. Yet again making clear the importance of air quality as an indispensible applications in our current society.

Overall, the first lunchreading of the year was very successful and satisfying. The next lunchreading will therefore be something to look forward to!


## 29th of February
## MEET & GREET SPONSORS

On Wednesday 29th of February s.v.b.p.s. Mollier organized the second Meet and Greet. After the great success of last year's Meet and Greet the board decided to continue this activity. The Meet and Greet is an activity, organized by the board of Mollier, giving her members the opportunity to meet the sponsors of Mollier and vice versa.

The Meet and Greet started at 16:00 hr with a Welkom drink and an introduction with the board of Mollier. During the event more and more members of Mollier joined, and had an informal talk with sponsors while having a drink and some nice snacks on the side.

After the event a lot of members indicated they really liked having contact with different companies. Some of them eventually send their CV to some companies.

## 20th of April
## EUROPEAN REHVA STUDENT COMPETITION

For a third time in a row (!) a student of Mollier won the European REHVA Student Competition! Rik Maaijen received his price at the REHVA annual meeting in Romania for his graduation project.

He proposed a new bottom-up approach to enhance a higher comfort level, while saving energy by making the human central in the control of building systems. As Mollier we are very proud of his achievement, which also indicates that our level of education certainly belongs to the top of Europe!


## 24th of April
## 2# LUNCH LECTURE WITH LBP|SIGHT AND DHV-ROYAL HASKONING

On Tuesday the 24th of April Mollier organized a lunch presentation. The sponsors LBP|SIGHT and DHV-Royal Haskoning presented their business and projects.

LBP|SIGHT presented one particular project the 'Scheepvaartmuseum', where a sound absorbing floor was the key feature. It is the first floor in the world that absorbs sound and prevents the reverb effect in a large space. This floor was specially designed, developed and tested for this project, by LBP|SIGHT. During the presentation a scale model used to explain this principle, which immediately caught the attention.

DHV-Royal Haskoning mainly presented the company structure and their innovative projects. Projects which distinguish them from other companies. Finally they ended the presentation with some interesting company facts and career opportunities.

Eventually, Derek Visser thanked the speakers and presented them a small gift.

## 25th of April
## HEIJMANS MANAGEMENT GAME

The Heijmans Management Game (Wednesday April 25th) gives students a fast and exciting introduction to a challenging problem wich could occur in the building sector. Empathize with the customer, choose from different perspectives, dealing with unexpected twists and diversions and finally convincing the customer where to focus in this case.

The Heijmans Management Game was a competition between six teams of students. The teams started with a large amount of information and there were also several consultants present. In addition, the teams had to deal with unexpected events, which they had to quickly solve during the game. The evaluation took place after the presentations, based on the realized outcome, but also on the creativity and group cooperation. The process that a team went through was also important. Heijmans offered the winning team a nice price.

## 26th of April
## KP&T SOLICITATIE TRAINING

On Tuesday the 26th of April Mollier organized in cooperation with KP&T a solicitation training. In advance, all participants sent their curriculum vitae to KP&T for correction. During the training, the changes in the curriculum were discussed.

KP&T explained various important aspects how to prepare yourself for a solicitation.

Also, in groups of 2, members practised their solicitation skills during a simulated solicitation. Finally, tips for negotiating secondary conditions of employment were discussed.

## 3th of May
## GIRLS-BEAUTY-DAY / BBQ / BEER TASTING COMPETITION

On the 3th of May Mollier organized a BBQ for its members. While the real men of Mollier tried to get the BBQ at the right temperature, the lady's enjoined a girls-beauty-day.

The girls had a make-up workshop given by an instructor of Ici Paris. During the workshop the girls used each other as test persons to practice their make-up skills.

The BBQ was held in the garden of a student residence, where 35 members joined some well-done sausages and burgers with a drink. In between there was even time for a beer tasting competition, where we had to guess for the brand of some well selected characteristic beers.

# Schoone Leij
## and the Spring event


*By Barry Tuip and Linda Pennings*

*Board member of alumni association 'Schone Leij' of s.v.b.p.s. Mollier*

Schoone Leij is the alumni association of s.v.b.p.s. Mollier. By organizing several activities per year we want to support contact and knowledge exchange between alumni and candidate members. The main event every year is a informal activity during the spring season. This year the activity is at 28th of april, for more information or to subscribe yourself you can use the following QR-code.

Beside the spring activity, symposia are organized by our members about a specific subject in the field of Building Services. Subjects of last year symposia where related to subjects like Renewable & Sustainable Energy Systems, Schools & Fire safety in Atria, Smart Grids & Smart Buildings.

We use Linked-In as social media to share information about the association, activities and theme days. Members can also discuss business related questions, or find other members with knowledge about specific subjects. You can become an official member after graduation in the master Building Services or Building Physics and Systems. Master students however can already become a candidate member and join all activities Schoone Leij organizes.

It's not only fun to meet your college students again, by joining the alumni association you join a network of people all working in the broad field of building services. So if you're interested, visit us on LinkedIn and become a member of our association.

The Board of Schoone Leij,

Niek van Erk, Linda Pennings, Barry Tuip, Mike van der Heijden

subscribe to spring activity

Schoone Leij linkedin Page

# Towards CFD analysis of the natural ventilation of urban areas:

## Development and application of urban CFD models based on GIS data for analysis of urban wind flow and heat transfer


ABSTRACT

Different methods exist for generating urban Computational Fluid Dynamics (CFD) grids based on Geographic Information System (GIS) data. In general however, it should be noted that a very limited amount of information is available on the advantages and disadvantages of adopting these grid development methods, which problems might occur, possible software limitations, or what computational resources are required. The aim of this study is to gain insight in the development and application of high-quality urban CFD grids for analysis of natural ventilation of urban areas.



Key Words:: Urban CFD model, GIS data, Urban wind flow and heat transfer. Grid generation technique, Natural ventilation of urban areas.


Natural phenomena come in all sort of forms, such as floods, heat waves, droughts, tornados, hurricanes, volcanic eruptions, earthquakes and landslides. When these occur in populated areas and cannot be prevented, they are referred to as natural disasters. It is possible to take precautions, e.g. building dikes, using earthquake and hurricane resistant foundations, and thorough investigation of geographic properties of areas before starting a building project. However, some natural phenomena, such as heat waves, cannot be prevented and are even amplified by human presence and activities. Climate change is already increasing the global temperature. In addition to this global change, the temperature in urban environments increases due to the Urban Heat Island (UHI) effect. The UHI effect refers to urban areas that are significantly warmer than the surrounding rural areas and is known to be most pronounced when wind speed and thus natural ventilation of the city are low. Bringing the complex problem of UHIs back to basics, the solution to mitigate the UHI effect would simply be counteracting of the sources. However, a city is an established and slowly changing environment. As a result, many countermeasures will take a long time to implement, not to mention that often measures will be impractical and financially not feasible.

A tool that could be used to analyze wind flow and heat transfer in cities is Computational Fluid Dynamics (CFD). To address large scale problems, such as the UHI effect and pollution dispersion in cities, urban CFD models are required; models with a domain size that allows for the analysis of, e.g. wind flow and heat transfer on a scale larger than a single building or group of buildings. There are multiple possible approaches for creating these large computational grids. The conducted literature study indicated a lack of available information on urban CFD models which are developed


using Geographic Information System (GIS) data. As a result, the emphasis in this study was not only placed on analyzing natural ventilation of cities, but foremost on the mapping of the applied methodology with respect to developing urban CFD models using GIS data. The heat transfer in the simulations was kept relatively simple by only including the convective heat transfer component. Heat transfer due to radiation and conduction are not included, nor are wall temperature differences due to, for example shadowing effect and thermal capacity of constructions. The most recent observations provide height data with a horizontal resolution of 0.5 m.

The aim of this study is to gain insight in the development and application of high-quality urban CFD models for analysis of natural ventilation of urban areas.

The Dutch harbor city of Rotterdam served as a case study city because of the presence of interesting high-rise and medium-rise buildings in the central business district (CBD) and the oceanic climate influence on the city. In addition, recently updated GIS data have become available for the city of Rotterdam.

In this study, it was intended to generate a target area of approximately 4.2 km2 and a computational domain of an estimated 32 million cells. The term 'target area' in this study refers to that part of the domain where buildings are explicitly modeled. A two-way nested-grid technique would be used to minimize cell count and allow for a higher resolution in the two target areas. Unfortunately, the adopted approach, combined with limitations of the CFD software, do not allow for the intended computational domain of 4.2 km2. To continue the study, the part of the city that is incorporated into the CFD model was reduced. Instead of one large computational domain three smaller domains were defined.

To provide answers to the devised research questions; a literature review was conducted, a method was developed to generate the computational domain using GIS data (Figure 1), and finally CFD simulations were performed. The emphasis in this project was placed on the used methodology for generating the computational domain using GIS data. After the validation study was performed and the computational domains were created (Figure 2 and Figure 3), the final simulations were conducted.

First, a set of isothermal simulations was performed, followed by two sets of non-isothermal simulations designed to analyze the natural ventilation of the case study city as a result of respectively wind-induced and buoyancy-driven ventilation flows.

From the obtained results it can be concluded that a fair number of papers are already available on the subject of natural ventilation of cities. Foremost, these papers describe isothermal simulations. There are multiple modeling approaches possible towards creating these large computational grids: 1) manually create the surface representation, 2) semi-automated using GIS data directly in the preprocessor, and 3) semi-automated with the use of a CAD environment. This study focused on developing an urban CFD model using the second approach. In general, it can be said that a very limited amount of information is available on the advantages and disadvantages of these grid development methods, which problems might occur,

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*Ir. W.D. Janssen*

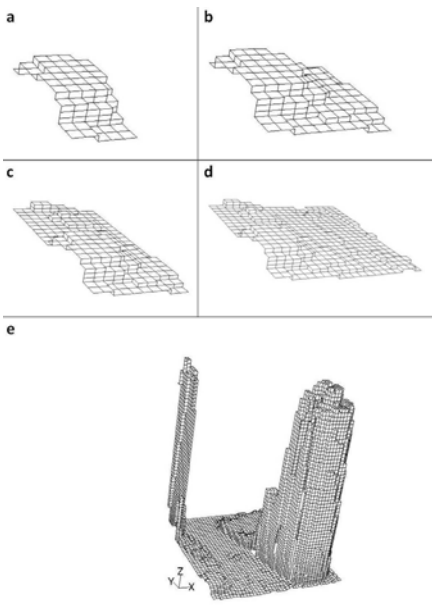


Figure 1: Appending mesh files to generate the computational domain; displayed are respectively a) 1; b); 2; c) 4; d) 8; e) 32 mesh files.

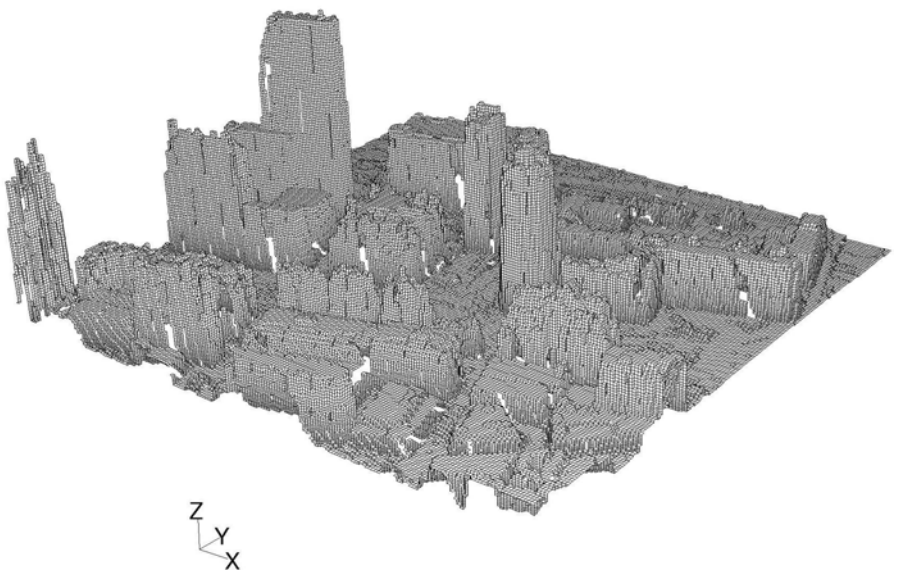


Figure 2: Computational grid of the domain Station'

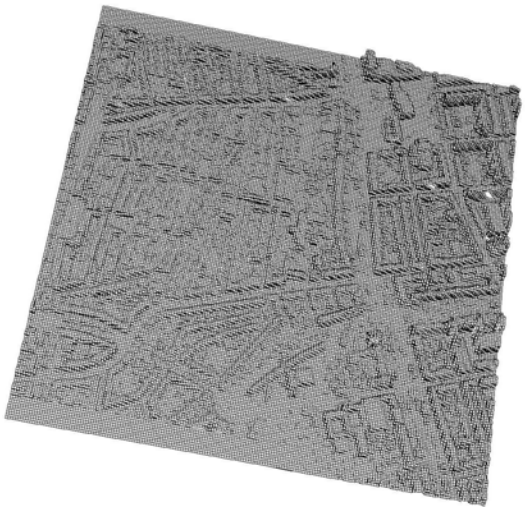

Figure 3: Geometrical representation of the domain 'Residential area'

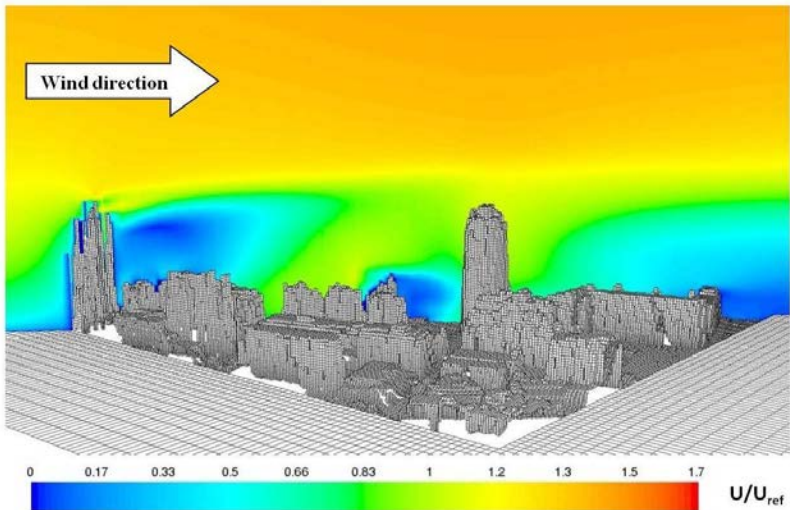


Figure 4: Contours of normalized mean velocity magnitude U/Uref for domain Station, Uref = 8 m/s

possible software limitations, or what computational resources are required. As a result, the emphasis in this study was not placed on analyzing natural ventilation in city, but on the implementation and evaluation of the applied methodology with respect to developing urban CFD models using GIS data.

In this research project an urban CFD model was successfully created and used to analyze natural ventilation of a city by wind and buoyancy. For this purpose, both isothermal and non-isothermal simulations were conducted. The simulations showed interesting results, such as complex wind-induced flows (Figure 4) and high-velocity buoyancy-driven upward flows.

Lastly, it can be concluded that GIS data can form the basis for generating an urban CFD model with a body-conformal structured grid. However, it has to be taken into account that the applied method in this study was not optimal; this was noted in a relatively late stage of the grid-generation process, when errors and software limitations became clear. It should be stated that, in the end, the biggest problem with the adopted methodology is the number of volumes, faces, and boundaries that were created for the grid. By mapping and analyzing the knowledge obtained in this study, a step was made in the right direction towards developing a method to efficiently generate a body-conformal structured grid for an urban CFD model.



Wij gaan voor 'n tien!

Doelgericht in detacheren en selecteren

**Aandacht voor onze kandidaten, weten wat er speelt en waar behoefte aan is en doelgericht oplossingen bieden. Dat zijn factoren die bij KP&T zorgen voor de perfecte match. Wij gaan voor een 10, bij alles wat we doen! En het resultaat? Jij als kandidaat kunt je focussen op waar je goed in bent... en wij ook.**

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DETACHERING &SELECTIE VANTECHNICI

# PHD

By Wendy Janssen

Am I a PhD student? Not exactly, officially I'm a research and education employee at Building Physics and Services at Professor Bert Blocken's group. This means that I don't have a 4-year research contract but that I conduct researches with a smaller time span, which in the future can possibly be combined into a PhD research proposal.

My starting projects were two wind comfort studies, the first here on the campus terrain concerning the new W-hal (MetaForum) and the second in the Eindhoven city center near a large tower where we were asked to solve the pedestrian wind discomfort issue. Although we validated the CFD (Computational Fluid Dynamics) simulation studies with on site wind measurements I'm still curious how well our predictions are and what the effects of our suggested improvements are! Luckily both projects are in Eindhoven so the results can easily be experienced in the near future.

Performing wind speed measurements in the city center was a challenge for the lab, because how do you make your equipment hooligan proof? Well, first you make sure the equipment blends in with the environment by in this case disguising it as plant container and secondly you make this plant container heavy enough for drunk people to get bored trying to move it. It actually worked, measurements were performed during several months and in these months PSV has played quite some matches

Figure 1: Hooligan proog measurement setup

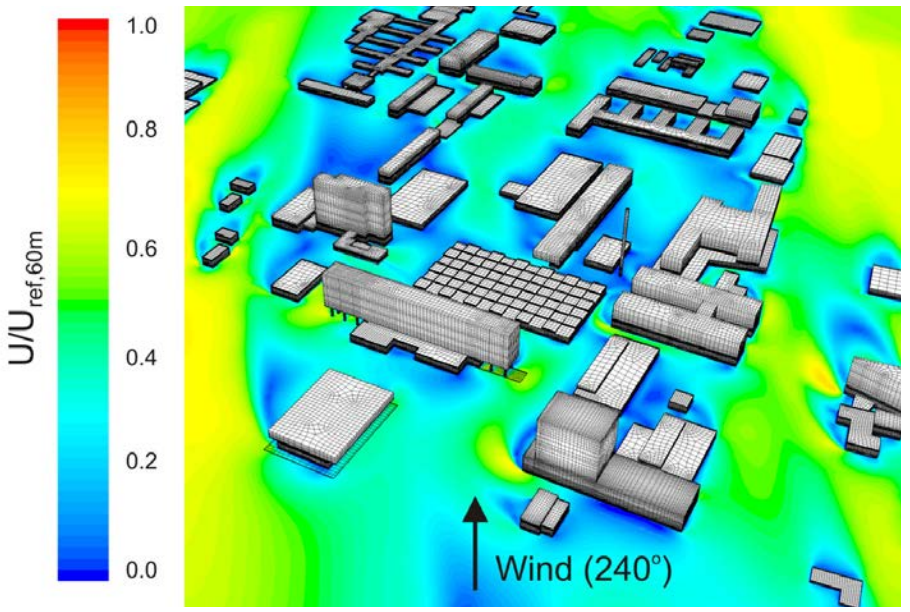


Figure 2: Wind speed ratio at pedestrian level for southwest wind at the campus (blue low wind velocity, yellow higher wind velocity

On my graduation W-hal wind comfort study I'm currently writing a scientific article and another, having Bert Blocken as First author and me and Twan van Hooff as co-authors, is already published. It was really cool to see that the article became the most downloaded article during three months time, of the journal we published in. So a lot of people actually see the figures I spend so much time on and I must say that my CorelDraw skills are improving! Still a lot to learn though!

The current project I'm working on is translating the macro wind climate at the weather station "hoek van Holland" to the micro wind climate in the harbour docks of the Port of Rotterdam. This information can help navigating ships more safely into the harbour. Ships are so heavy that they can have quite a slow reaction turning and slowing down. People at the harbour actually told me that one of the biggest ships entering the harbour, needed to start slowing down at 2 km before the coast and could only enter the harbour at high water level. Then the cargo needs to be released quickly, new containers loaded again and the ship should leave again before the water level is too low making the ship strand.

The measurement campaign of this study is completed now, but there were some complications when setting up the measurement equipment in the harbour. We wanted to raise some measurement towers and anchor them to the ground but the ground was frozen (and so were we). So that took some perseverance from our side. Also making sure the anemometers (equipment to measure wind speed and wind direction) were correctly directed to the north was not as straightforward as you might think. If you're standing too close to a steel ship a compass leads its own life. But eventually we managed using maps that showed for instance how many degrees a straight road was turned from the north direction.


Figure 3: Outdoor carting with phD students from Vertigo floor 6

The area of interest at the port of Rotterdam is about 100 km2, making it definitely too big for wind tunnel research. The CFD model consists of about 80 million cells and has a calculation time of several days on the best server we have. At this moment these simulations are running.

Figure 4: Aerial photo of the port of Rotterdam

On March 7 2012 the scientific tv programma Labyrint (VPRO "tegen de wind" ) also showed the harbour project together with other wind oriented topics, and on the accompanying website you can find some background articles (in Dutch).

I started this text by saying i'm a research and education employee and as you can see my main focus is on research, but there's some nice educational variation also. I'm a daily supervisor of four nice master students performing their graduation project. And this semester I started supervising a 2nd year Bachelor project together with a much more experienced supervisor. For me, it's a good learning experience to see how students and co-supervisors tackle certain issues.

I'm also looking forward to getting some education myself: coming May I will attend Urban Physics spring school in Cyprus. Where, for instance, attention will be given to CFD modelling and the Urban Heat Island effect. I'm currently also involved in the Climate Proof Cities project, where this is a very relevant and interesting topic. When we're on Cyprus we will of course also spend a day on discovering the island and hopefully enjoying the weather!

Although I'm not officially a PhD student my PhD colleagues still let me join their activities, like for instance carting and Christmas dinner . And in one of the pictures you see me and my colleagues in a sack race at the Sports Day last year. We didn't end last so that was good enough for us!

Figure 5: Practicing the sack race at the Sports Day for TU/e employees last year

# INSide Committee

**Who:** Jordi van Laarhoven

**Why this committee:** I wanted to be more involved with Mollier but to start as a board member, that was a little too much for me. So when this came on my path I thought "why not?" and haven't regretted it since!

**Tasks:** We meet an hour every other week to discuss where we are, what needs to be done and try to resolve problems we encounter. Because we work in a group you can divide the workload and it doesn't take up too much time.

**Experience:** It's fun to play a little with Adobe and try to make a dull black and white article come to life!

**Memorable moments:** The first time you get your hands on the printed version of the Inside, which you helped to create!

I like that we all have a common goal and that everyone's creativity helps to improve the magazine!

**Who:** Rik Maaijen

**Tasks:** Put all the parts of the Mollier magazine together

**My opinion:** Great to have the experience how to put a magazine together.

**Memorable moments:** The moment that you see the first magazine, that just arrived from the printing office! Nice!

**Who:** Ellen Boesten

**Why this committee:** You can put your creativity in composing the magazine

**My opinion:** Getting other members acquainted with companies.

**Memorable moments:** The great dinners during the board meeting and the constitution...

**Who:** Yasin Toparlar

**Favorite moment:** When we were dancing "sirtaki" while riding a bike with Argyrios.

**My opinion:** I believe in TU/e, however there is more than enough time for study, so stop worrying and enjoy the association.

**Who:** Joep Richter

**Tasks:** Write and/or edit articles for the magazine of Mollier.

**Why this committee:** because people will might actually read what your write, and there is physical evidence that you have really produced something.

**Who:** Ilse Schoenmakers

**Tasks:** Creating a good-looking/ high quality magazine with articles of companies, PHD students, professors and students.

# Durf jij in een dynamische situatie een sprong te wagen?

BAM Techniek is op zoek naar talentvolle, ambitieuze collega's die willen samenwerken aan innovatieve en duurzame oplossingen. Collega's die 'techniek in hun genen' hebben en verder willen kijken dan wat voor de hand ligt. Wij moedigen je aan om anders te denken en te handelen.

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Mail naar ikkomer@bamtechniek.nl of zie onze website voor meer informatie.

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# Lords of the board

Budget cuts, no more Master scholarships, rising student debt and governmental fines are changing the face of studying at an academic level. Less time and less money make studying a lot more stressful than when I started studying in 2003. It leaves less time for extracurricular activities in your already so full social calendar. So why would anyone in their right mind still want to run a study association as a member of the board? Well, I'll tell you why.

## EXPERIENCE

My first experience with the study association board was in September 2003, when I got an invitation as a member of Mollier to attend the board change assembly. I showed up in a suit (which was more or less a custom), not really having an idea of what Mollier actually did and how it worked. During that meeting it was made very clear and immediately volunteered for the activities committee. After a few years of committee work and getting my study credits up to an acceptable level I was preparing to run the board of Mollier for a full year. Having gained a little insight in the work of the board over the years, I had a good idea what was coming. Or at least that's what I thought.

## HOW TO...

Getting started turned out to be the hardest part of the job: How to do finances? Which meetings are when? Where are the right documents? Why are there magazines in the freezer? Luckily we figured out how most things worked and are done pretty quickly (even why there were magazines in the freezer). We learned a lot from former board members who were always helpful (albeit grudgingly at times).

The attentive reader may have noticed I switched from 'me' to 'we'. This is because the running a study association is a team effort. Even though each member of the board has his/her own tasks, you always depend on each other to make it work. This is not only true for the administrative & stuff en in lesser extent for the multitude of meetings that may not always seem useful, but mostly during the twenty something constitution drinks throughout the year where board members sometimes literally need each other's support.

Figure 1: Board Koen Smelt, Peter van Mierlo and Rick van Pruissen

## BENEFITS

The (free) drinks, BBQ's, parties and dinners are definitely the most enjoyable parts of being a board member, but it is understood that in exchange for these privileges you run the study association like a boss, not only pulling it through the year but assuring the association's future with a sound financial and social agenda. This future lies not only with financial support from our loyal sponsors but also in the involvement of the members. Organizing study trips, parties, tournaments and other events are the best way to assure this (and maybe find your successor).

You might be thinking, this sounds like a lot of work, and I'm already so busy with studying/being a student. Yes, you may spending more time with you fellow board members than your friends, but you're meeting lots of new people. And if you already have enough friends, invite them to the constitution drinks and parties you almost weekly get invitations too.

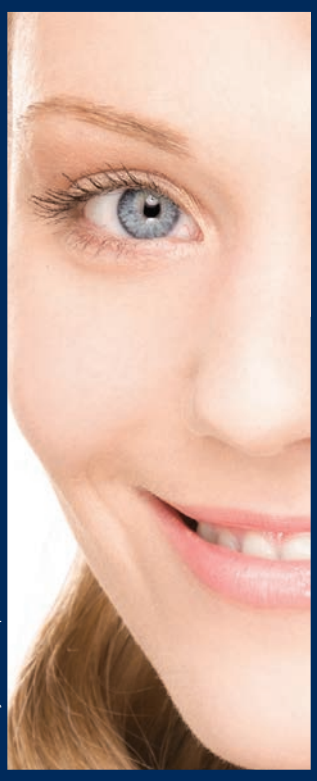
Indeed, running a study association may take up a little bit more of your time, but it's surely possible to still acquire the study credits you need. Work smart, manage your time, create some committees to take some of the workload off (and grooming some members for the next board), and last but not least remember that the university is rewarding you for your efforts in the form a nice deposit on your bank account.

All in all, taking part in running a study association provides you with valuable skills and experience, not only during your studies, but through your whole career as an addition to your technical knowledge. In the short period since January that I now call my professional life, I've already encountered several occasions in which the skills and experience I've gained during my year in the board

Not only do companies value students who are involved in extracurricular activities above others, but the skills have been useful in everyday activities as well. During projects the experiences you gain during your board year help with working in teams and coping with deadlines. Experience with accounting comes in handy during estimation of project costs and working on a budget. And the badgering you've experienced general member meetings increases your attention to detail and dealing with annoying or demanding audiences. And finally, the (internal en external) meetings add assertiveness and the power to present your ideas clearly.

In hindsight I still have no regrets about my decision to join the study association's board. Even though it delayed my graduation somewhat, the memories I've made during that year have become unforgettable, the accomplishments make nice success stories, but most of all the amount of experience and knowledge gained during that one year is something that will serve you the rest of your professional life.

Figure 2: Board Koen Smelt, Peter van Mierlo and Rick van Pruissen

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# Evaluation of inverse modeling techniques as a tool for pinpointing moisture entering locations from inside surface moisture patterns


## ABSTRACT

The location and nature of the moisture leakages are sometimes difficult to detect. Moreover, the relation between observed inside surface moisture patterns and where the moisture enters the construction is often not clear. The objective of this paper is to investigate inverse modeling techniques as a tool for the de-tection of moisture leakage locations in building constructions from inside surface moisture patterns. It is con-cluded that although the presented methodology is promising, more research is needed to confirm its usability.


## INTRODUCTION

Hunting Lodge St. Hubertus is one of the most prominent buildings from the beginning of the twen-tieth century and is noted in the top 100 list of Dutch monuments. The conservation of the building and its interior are of great importance. The Dutch Government Building Department, which takes care of the maintenance of the building, has expressed their concern about the observed damage due to high moisture levels by the rain that finds its way to the interior at places of inadequate detailing and there-fore causes damage mainly near openings in the façade and on the inside of the façade below balconies. The main problem is that the location and nature of the moisture leakages are not easily detectable. We often don't know the relation between the observed inside surface moisture patterns and where the moisture enters the construction. The objective is to investigate inverse modeling techniques as a tool for the detection of moisture leakage locations in building constructions, i.e. we want to investigate the (in)possibilities of pinpointing moisture leakages from inside surface moisture patterns using inverse modeling techniques.

The research approach was as follows: First, a study and evaluation of previous work. Second, the implementation of three dimensional moisture mod-els of building constructions in COMSOL. Third, the simulation of scenarios with different moisture source load characteristics including surface load sources at different locations. Fourth, the inverse determination of moisture source characteristics from 'fingerprints' of typical leakages. Fifth, the applica-tion of the approach to a real building with moisture leakage problems, i.e. the Hunting Lodge St. Huber-tus. Sixth, the testing of the method with laboratory experiments. Seventh, the evaluation of the approach as instrument for pinpointing the location of leak-ages. This paper presents the preliminary results of the first five steps. Currently we also are working on the last two steps. The results will be available in due time.

## SUMMARY OF THE OBSERVED MOISTURE PROBLEMS AT THE HUNTING LODGE ST. HUBERTUS

Hunting Lodge St. Hubertus is located on the north-ern side of the Dutch National Park 'De Hoge Ve-luwe'. The Hunting Lodge is built as a guesthouse between 1916 and 1922, by Holland's most well-known architect from that time, H.P. Berlage. The building consists of a low-rise rectangular volume with wings that stretch out diagonally and with a characteristic high tower of over 30 meters height in the middle of the building (see figure 1). A large pond is situated south-west of the building and the building is surrounded by forest in all other directions.

Figure 1. Hunting Lodge St. Hubertus


*A.W.M. (Jos) van Schijndel,*

Eindhoven University of Technology, Department of Architecture and Planning, Unit Building Physics and Systems,
Eindhoven, Netherlands

Figure 2. Observed moisture damage in the tower of the building: moist spots and efflorescence.

The damage that occurs in the tower were systematically inspected to enable a thorough assessment of the possible causes of the moisture problems by Briggen et al. (2009). The damage on the inside of the tower, and where possible also on the outside, is systematically inspected. The location and type of each moisture problem are documented in a table, il-lustrated with a picture of the damage. The moisture problems that manifest themselves in the tower of the Hunting Lodge can be divided in the following categories: efflorescence, cracking, soiling, moist spots, mechanical damage and biological growth. A few pictures of the moisture damage that occurs in the tower are shown in figure 2 (Briggen et al. (2009)).

Regarding the location of the damage it can be concluded from the inspection that most damage oc-curs on the interior surface of the south-west facade of the tower. Since the prevailing wind direction in the Netherlands is south-west, which means that the south-west facade of the tower is subjected to wind-driven rain the most, there appears to be a connec-tion between the rain load of the facade and the damage on the inside. There are no clear differences between the damage on lower or higher floors or be-tween the damage on the middle and on the sides of the facade. Most damage occurs near openings in the facade and on the interior surface of the facade below balconies.

## MEASUREMENTS

The data set is part of the measurement program at the Hunting Lodge St. Hubertus site, performed during 2006-2007 by Briggen (2007). Details of this project can be found in Briggen et al (2009). One of problems seemed to be high moisture contents at the inside surface of the façade of the tower. The con-struction of this façade is shown in figure 3.

The outside climate conditions were measured by a weather station within 50m from the building. The inside air temperature and relative humidity were measured using standard equipment (see figure 3). A representation of inside surface conditions were ob-tained by placing a small box (5cm x 5cm x 1cm) against the wall and measure the air temperature and relative humidity inside. The estimation of the measurement error of this method is left over for future research.

The data consists of the measured time series of the indoor and outdoor climate as presented in figures 5 and 6.

Figure 3. The building façade

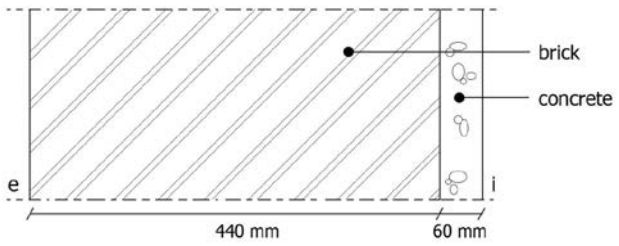




Figure 4. Measurement of the surface temperature and relative humidity using a box

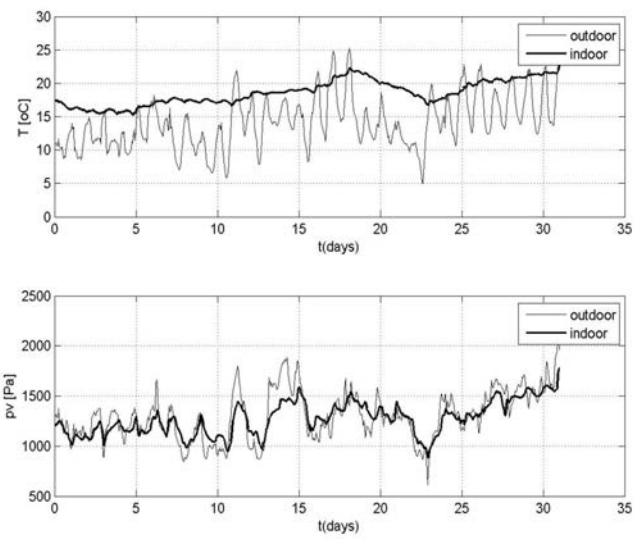



Figure 5. The measured air temperatures (top) and calculated vapour pressures (bottom, from measured T/RH)

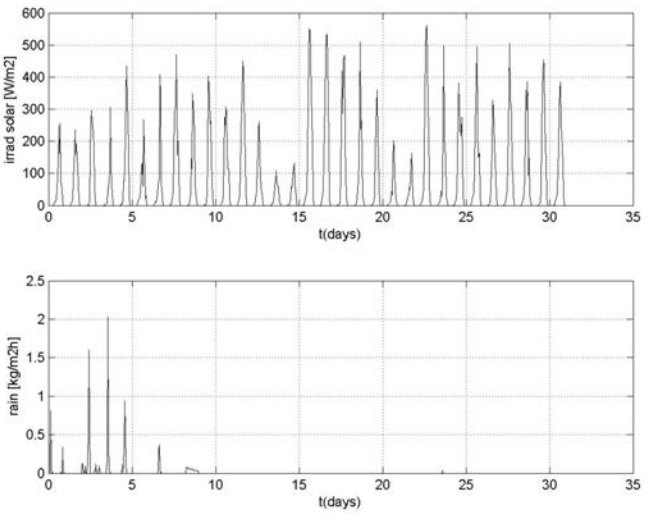



Figure 6. The measured solar irradiance (top) and rain intensity (bottom)

## MODELING

The multiphysics modeling approach of van Schijndel (2007) is used. The heat and moisture transport can be described by the following PDEs:

$$C_T \frac{\partial T}{\partial t} = \nabla \cdot (K_1 \nabla T + K_2 \nabla LPc)$$

$$C_{LPc} \frac{\partial LPc}{\partial t} = \nabla \cdot (K_2 \nabla T + K_2 \nabla LPc)$$

With:

$$LPc = \log(P)$$

$$C_T = \rho \cdot c$$

$$K_1 = \lambda$$

$$K_2 = -l_v \cdot \delta_p \cdot \phi \cdot \frac{\partial P}{\partial LPc} \cdot Psat \cdot \frac{M_w}{\rho_a R},$$

$$C_{LPc} = \frac{\partial w}{\partial P} \cdot \frac{\partial P}{\partial LPc}$$

$$K_2 = -K \cdot \frac{\partial P}{\partial LPc} - \delta_p \cdot \phi \cdot \frac{\partial P}{\partial LPc} \cdot Psat \cdot \frac{M_w}{\rho_a R},$$

$$K_2 = \delta_p \cdot \phi \cdot \frac{\partial Psat}{\partial T},$$

Where t is time [s]; T is temperature [oC]; Pc is capillary pres-sure [Pa]; ρ is material density [kg/m3]; c is specific heat capac-ity [J/kgK]; λ is thermal conductivity [W/mK]; llv is specific la-tent heat of evaporation [J/kg]; $\delta_p$ vapour permeability [s]; φ is relative humidity [-]; Psat is saturation pressure [Pa]; Mw = 0.018 [kg/mol]; R = 8.314 [J/molK]; $\rho_a$ is air density [kg/m3]; w is moisture content [kg/m3];K is liquid water permeability [s].

MatLab is used for the implementation of material and boundary properties. These functions are used to convert measurable material properties such as K, φ, $\delta_p$ and λ which are dependent on the moisture con-tent into PDE coefficients which are dependent on the LPc and T.

This is schematically shown in figure 7.

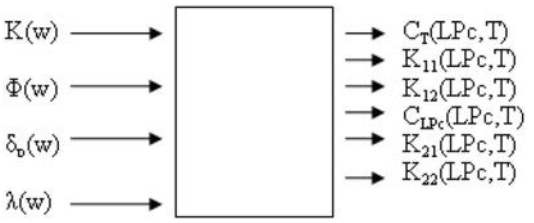



Figure 7. The conversion from measurable material properties into PDE coefficients

The material database of DELPHIN (2010) is used to provide material properties for the first guess. For brick, the Brick material properties of DELPHIN are used with constant ρ = 1700; c = 840; λ = 0.85 and variable moisture properties using the tables. For concrete, the Lime plaster properties of DELPHIN (ρ = 1800; c = 840; λ = 1.05) are used in the same way. From these data, the PDE coefficients were de-termined together with the boundary conditions im-plemented using the COMSOL model of Section 3. Figure 8 and 9 show the results.

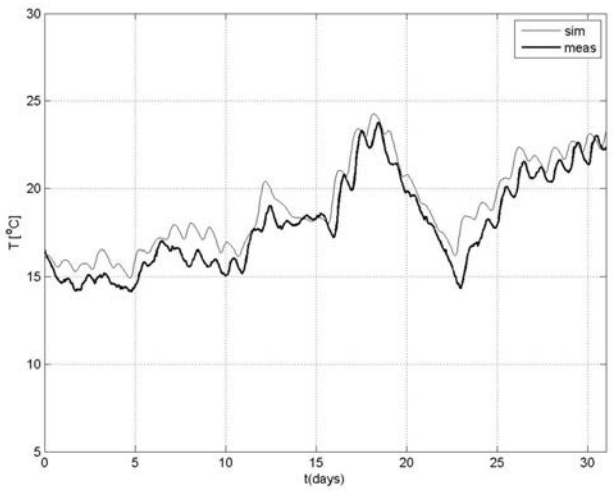



Figure 8. The measured and simulated inside surface temperature.

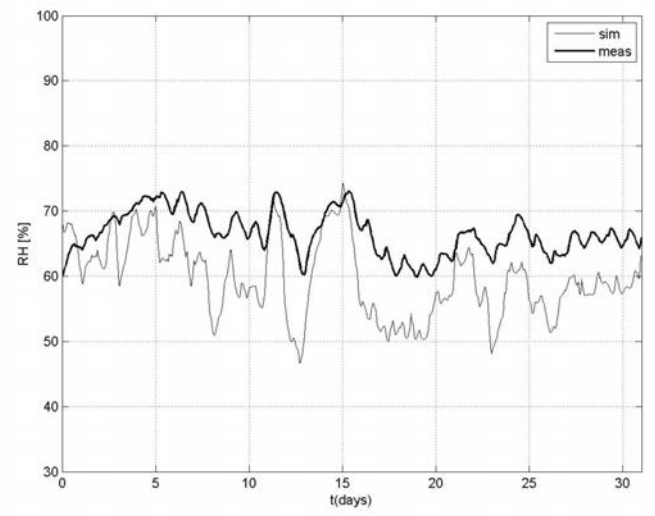



Figure 9. The measured and simulated relative humidity at the surface

Figure 8 shows that the simulated inside surface temperature is already quite close to the measured one.

The simulated relative humidity at the inside surface of figure 9 seems to be less close to the measured one compared to the previous figure. This gives also rise to the just mentioned questions

For each material and at each point the vapour pres-sure can be calculated using a similar corresponding function.

## DETERMINATION OF MOISTURE SOURCE CHARAC-TERISTICS

In this Section we try to reproduce the following ob-served moisture spots (see figure 10). The modeling approach of the previous section was used. The mesh of (simplified) geometry is presented in figure 11. The first step of the inverse modeling procedure is to switch one or more boundary conditions from dry in-to wet and then investigate it's effect on the inside surface moisture print. For example, Figure 13 shows the simulated profile at the inner surface by switching the location provided in Figure 12 from dry into wet.

There is no match between the simulated profile at the inner surface of figure 13 with the observed pro-file of figure 10. Therefore it is concluded that the location of figure 12 is not a possible candidate that causes the observed moisture spots.

From the simulation of 9 different situations it has been shown that from these results, the best candidate for the moisture leakage location seems to be at the bottom of the window.

Figure 10. Observed moisture spots at the inner surface near the windows

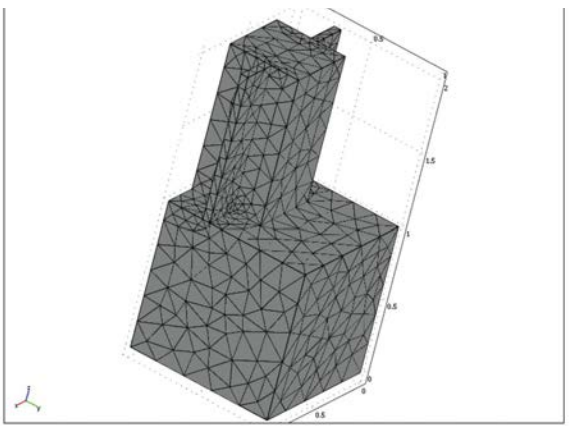
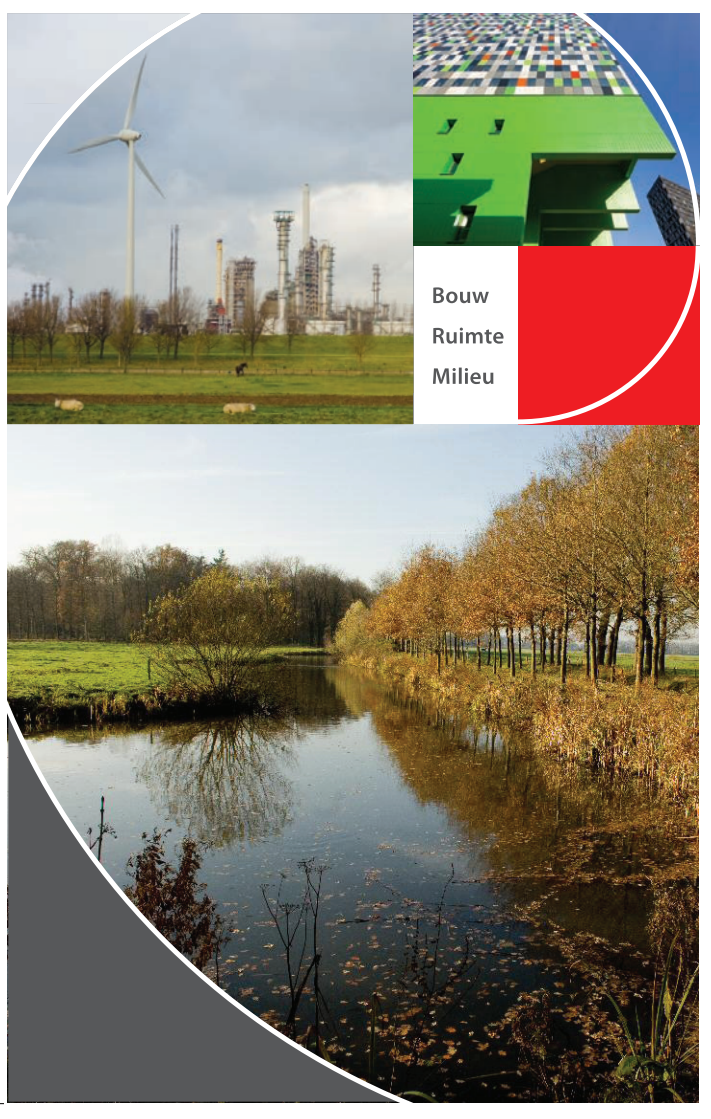


Figure 11. The mesh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## DISCUSSION AND CONCLUSIONS

This paper investigates the (in)possibilities of pin-pointing moisture leakages from inside surface mois-ture patterns using inverse modeling techniques.

It is concluded that although the presented method-ology is promising, more research is needed to con-firm its usability.

The current inverse modeling technique is still rather basic by manipulating the boundary conditions by hand. A more sophisticated method, where the boundary conditions are manipulated by a computer algorithm is under investigation. Other future re-search include the testing of the method with labora--tory experiments and a thoroughly evaluation of the approach as instrument for pinpointing the location of leakages.

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DELPHIN http://de.wikipedia.org/wiki/Delphin_(Software)
HAMLab http://archbps1.campus.tue.nl/bpswiki/index.php/Hamlab
COMSOL http://en.wikipedia.org/wiki/COMSOL


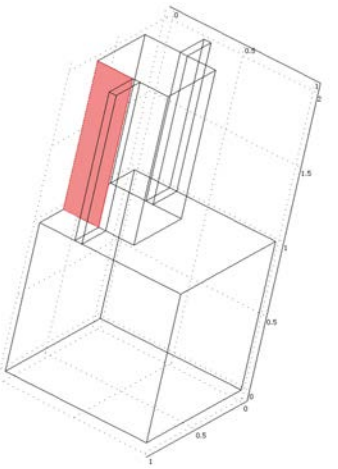

Figure 12. The location of the wet surface condition.

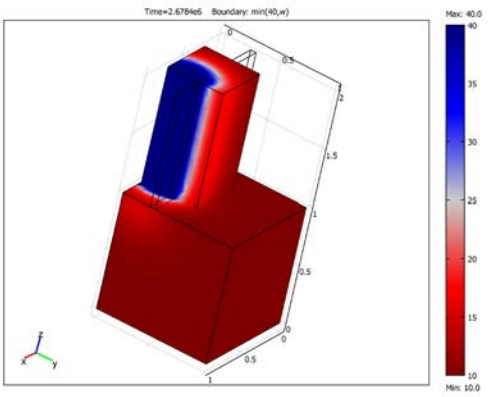

Figure 13. The steady state moisture spot at the inner surface.



Je bent een kei in je vak. Daar ben je trots op. Want je bent zo goed omdat je altijd een stap verder bent dan die ander. Zo is het bij Unica ook. Wij maken bijvoorbeeld bio-energiecentrales voor een milieu-vriendelijke energieopwekking. De mensen van Unica zijn voortdurend met innovaties bezig. Daar-mee bieden we onze klanten daadwerkelijk instal-latieoplossingen met toegevoegde waarde. Op het gebied van duurzaamheid, veiligheid, communicatie, zorg en comfort denkt Unica verder. Jij ook? Kijk dan op onze carrieresite: www.installatietoppers.nl

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# Members

## & their involvement in Mollier & unit BPS

Lunch presentations, website, financial administration, student-assistant Unit BPS, education committee & additional activities

**Who:** *Derek Vissers*
**Commission:** *Lunch presentations*

**Memorable moments:** *A memorable moment was when a mistake had been found of 0.01 euro and the response of Yasin: "I sew you."*

**Quotes:** *'Toen ik hem zag, zag hij er niet zo groot uit, toen ik hem kreeg wel'*

**My optinion:** *Enjoy yourself. It's later than you think. So do not hesitate and choose for Mollier!*

**Who:** *Rick van Pruissen*
**Commission:** *Website & Financial adminiastration*

**Tasks:** *Being a former board member, helping out with some stuff like website management and checking the financial administration.*

**My opinion:** *Although we have a very good board this year, Mollier is not living up to its potential. A lot is possible, but involvement of members is needed to arrange events like excursions, tournaments, party's etc. It's a lot of fun to help and you'll learn a lot!*

**Memorable moments:** *Arriving in Dubai, lying on the beach at 10 in the morning after months of preparation for this first overseas studytrip.*

**Quotes:** *,,Dude, I'm not gonna repeat my own quote!''*

**Who:** *Patrick Creemers*
**Commission:** *Financial administration*

**Tasks:** *My task is to check if the treasurer has done her job properly.*

**Memorable moments:** *A memorable moment was when a mistake had been found of 0.01 euro and the response of Yasin: "I sew you."*

**Quotes:**
*+ "Where did you write down this payment?"*
*- "There."*
*+ "Why there?"*
*- "Where else?"*

**Experience:** *Just a little, but more than enough to perform the task.*

**Why this committee:** *It comes down to just checking if the treasurer did not burry a hidden treasure and make sure the whole board has the right financial policy. It is for the benefit of the entire association and has to be done; apart from the benefits of the financial control, which you will only find out if you do it.*

**Who:** *Adelya Khayrullina*
**Commission:** *Education committee*
**Function:** *Communication*

**Tasks:** *Communication with international students in order to help them during their study at TU/e. A nice chance to be involved in a development of your study program.*

**My opinion:** *Nice to be a member of committee- you can plan the trip yourself, create your own routes and events with other members!*

**Memorable moments:** *My first experience of having meetings held in Dutch language (still I cannot speak much though)*

**Experience:** *It learns you how to take into account not only your own interests but also those of the students of your study program; you meet in person with academic personnel, not just to check your report/ discuss your project but to share your view – really interesting experience!*

**Who:** *Laura de Coo*
**Commission:** *Student-Assistant Unit BPS*

**Tasks:** *As student-assistant, you are the contact point for students. Tasks are organising the BPS Student Day, updating the student data and meetings with mentors about education issues. Making project descriptions for bachelor and masterstudents is also part of the tasks.*

**My opinion:** *Because ordering people what to do is always awesome!*

**Memorable moments:** *Realizing that Mumbai and Bombay, our travel destination, is actually the same city! It is! Really!*

**Quotes:** *,,Live your life,,*

**Experience:** *A lot! This job appealed to me, because of the social and organisational skills. And it is nice to have good contacts with mentors and students.*


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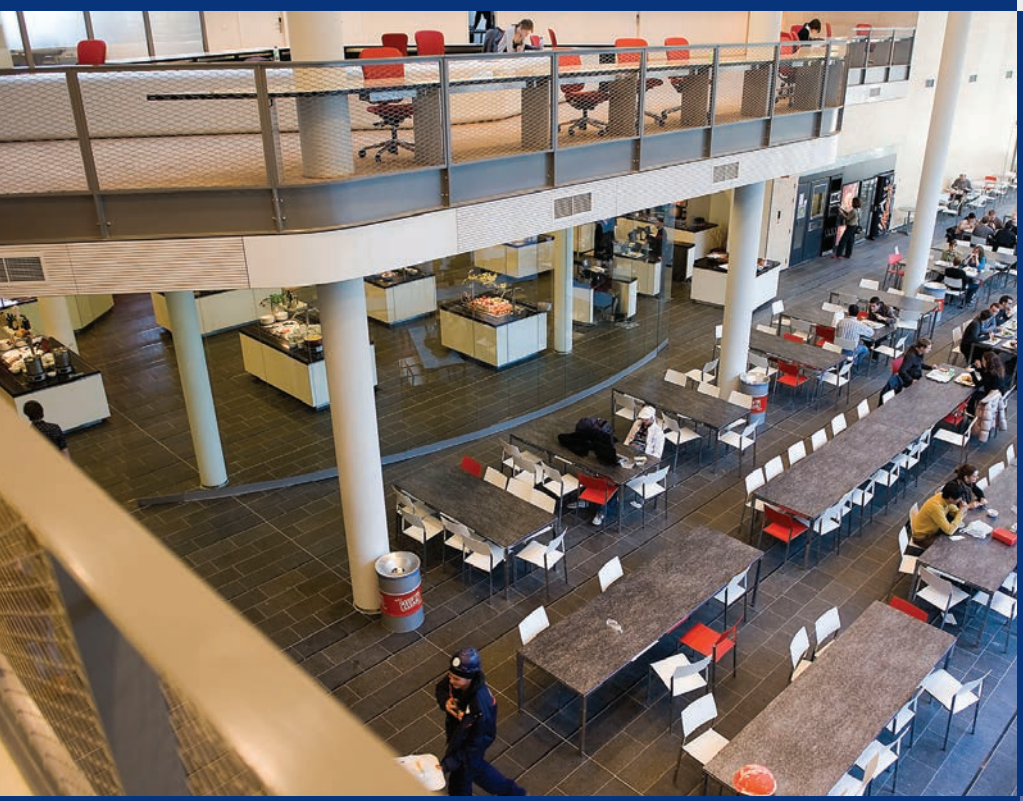

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**Who:** Tom Thomassen
**Commission:** *Education*
**Function:** *Chairman*

**Short discription:** *The Education Commission is a commission in which students have influences on the problems, changes, courses and other discussions concerning the education.*

**Importants:** *As a member you are the link between the commission and the students.*

**Experience:** *As a Chairman of the education committee and as chairmain of Mollier I really learned how to manage different commissions and represent the association in all sorts of meetings.*

**Who:** *Rik Maaijen*
**Commission:** *Mollier board*
**Function:** *Secretary & vice-president of Mollier*

**Tasks:** *Be the communicating spill between the companies and students*

**My opinion:** *Having a great time with the other board members and in the mean time getting a lot of experience.*

**Memorable moments:** *The great dinners during the board meeting and the constitution...*

**Why become a board member:** *Why not?!*

**Who:** *Zuokui Ning*
**Commission:** *Chinees new year Activity*

**Tasks:** *Shopping for typical Chinese food and preparing*

**Quotes:** *,,No quote is a good quote,,*

**Experience:** *I'm glad to be a member of Mollier. During the first year, I got a lot of help from the old Mollier members, therefore I could adjust to the new environment quickly. They showed me how friendly Dutch people are, hereby, I'm proposing to all the international students to join Mollier and be active on floor five of Vertigo building.*

# ICE-BREAKER

## Niki Ke Li

Hello there! My name is Ke, or a nick name Niki. I hope you still remember that Chinese New Year night, when we served fantastic dumplings and rice balls. I am among one of the four Chinese Mollier participants who had tons of fun with you!

My home town is Beijing, a famous populated mega city of China, which is known for being the capitals of various Chinese emperors for more than 1000 years; meanwhile, unavoidably, has also a notorious reputation on air pollutions, as well as being the target of western media's attack onto several human rights issues such as blocked information and so on  like every city else has its pro and con. Not so like people coming from a sophisticated city, I would consider myself having a light and positive personality. I like to smile, making friends, or just simply having fun. Also I have bunch of habits that give me great motivations to wake up happily every morning: sports, travelling, cooking, listening to music, making friends with different background and knowing their cultures.

I came to TU/e not only because it's regarded among the best technical university in Europe, but also the Netherlands is well considered as an innovative country  many times even strangely creative. I still remember the top three features of the Dutch culture ranked on "stuffdutchpeoplelike.com" blog are: kissing three times, meshing their food (the stamppot) and celebrating the gezellig Sinterklass with his friends Zwarte Piets. I totally agree!

Currently I am involved the master program of Building Services, which I joined in autumn in 2011.  Besides gaining knowledge from many interesting courses, I had also countless sweet memories getting in touch with Mollier, such as studying together on 5th floor of Vertigo, borrel, Mexican food night, and the Chinese New Year is also one of my favorite events.

Many people like to ask international students what do they like to do after graduation. Becoming an engineer in the field of indoor environment is a premier interest for me. I have also a nice dream that this job could bring positive benefits to people who live below poverty line. For the past three years, I had done several volunteer works for low-income groups in countries such as India, Sri Lanka and Ghana, which triggers me this idea. When I enter an extended room that is made of metal board and plastic sheet roof without basic sanitation facilities, or seeing women cooking in cave-like kitchen with charcoal and their kids playing around in heavy smokes generated, I always felt I could do something to improve their living quality, from a technic perspective. When I keep this dream activated, I believe I can get to somewhere in the future.

As a closing statement, it is great pleasure to ice-break me to Mollier members. I sit on the 5th floor for studying quite often, you are always welcome to have beer and snack together. Serious discussions on news, sciences and religions are also very much encouraged!

# Puzzle time

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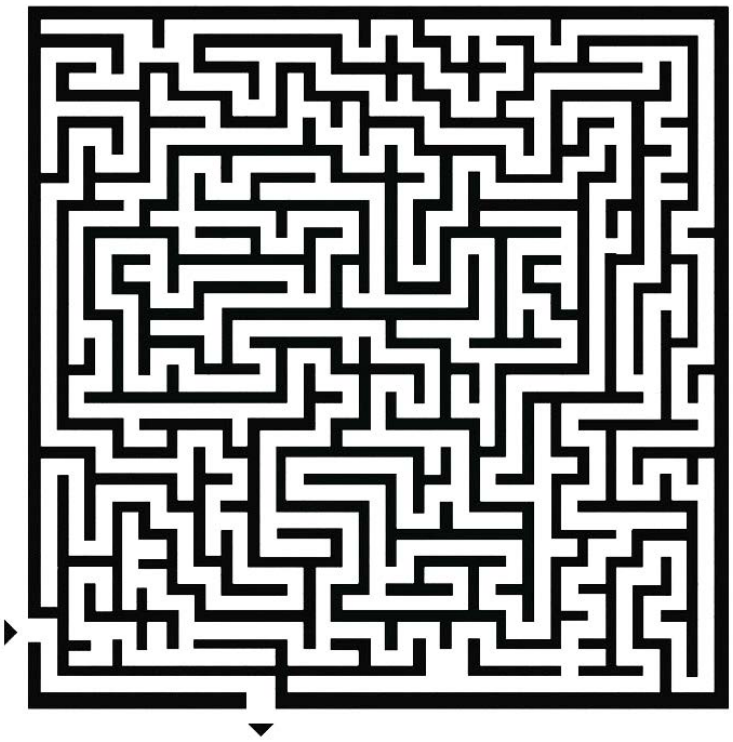


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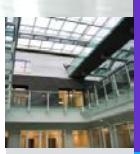
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**Voor***elkaar*

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# MsC and Then ...

Engineer and then? That's a question on which the answer seems trivial during your study. After graduating: you party, work at a company, leave your student house, burn your study books, your master thesis changes into a dust collector and most of all you're glad that you don't have to see our professors, teachers and supervisors anymore. Right?

*Written by: Sander ter Mors*

After graduation I was not in a hurry to start my working-man life. I enjoyed my free time, doing very little during my Christmas holiday which lasted well into March. Of course I had to celebrate getting my diploma, but I could not completely forget about my research. In the first months after graduation I did still have contact with my graduation supervisors to revise the article of my graduation research, which eventually got accepted and published in Building and Environment. Even after this my thesis could not collect dust; last Februari I also wrote an article for the TVVL magazine, which is yet to be published.

When I did start looking for work, I did not have many difficulties finding it. I started working at Gebr. Van Hout in Veldhoven, working in 'general' engineering, but also energy savings, renewable and efficient technologies and even some financial and legal aspects of our field. Sustainability is still a developing subject within the company, so I can also help in setting up the research and report methods for these types of projects. These various tasks make the job quite challenging and I've learned a lot in the year I've worked so far. I think that during your MSc education you don't only learn (some of the) practical knowledge, but also develop skills in problem analysis which are very helpful in many situations. Luckily, the company also knows that you can't be serious all the time and that a vacation should be started with a party.

So, what has changed for me. With my work close to Eindhoven, I chose to keep living here and I even still live in the same appartment. This means I still have to get on my bike in the morning, I just have to cycle in the opposite direction. The other difference is that as a student, you can decide on a sociable evening to take the next day off. As a genuine 'working man' this is a bit trickier, more often leading to a short night's sleep. Even if this means going to stratum isn't part of my normal week, I am still in contact with students and alumni of Mollier. It's always fun meeting other alumni from time to time to recollect all the great activities we've had during our years at Mollier. Since me and some of the other alumni have also studied the BSc program we've been on a lot of activities, so there is plenty of reason to get together for drinks to discuss our student years.

There have been some changes in the MSc program and study association in recent years, but meeting the current board and students I can see that new legendary activities are still being organised. Sometimes these are planned activities, but I suspect there will also be last-moment sunny-afternoon drinks in front of the Vertigo building this summer. Of course I hope to be invited should this happen.


You should all enjoy your time as students, make sure you take full advantage of this time to make friends and everlasting memories. Of course, don't forget to get your MSc degree so you can also write for the INSide Information.

# Study trip 2012 Mumbai India

**After all the hard work that has been done by the commission, Friday 11-05-2012 the trip to Mumbai has officialy begun. The plane takes off from Schiphol Airport and we are on our way. This article describes the days that will follow, the companies we visited and the memories that will stay with us forever. It gives you an overview of what we experienced, written from the point of view of the participants.**

**Saturday 12-05-2012**

Saturday morning about 8'o'clock the pilot landed the plane after a very pleasant flight and there we were at Mumbai International airport. After a few checks, getting/finding our suitcases and a time consuming immigration officers check, we got a stamp in our passports which gave us permission to enter India. At the airport entrance a bus was waiting for us. Our first mission begun, getting all the suitcases and luggage on and in the bus while trying to fit in ourselves. Ac-

Nirlon IT park

complishing the first mission, we started immediately the second one, staying alive in the Mumbai traffic. On a two-lane road four cars were driving next to each other, at the same time Rickshaws and motorcycles tried to fit in as well, while almost constantly using the horn. The influence of the Brits was very obvious, they all drive on the left hand side, which gave the whole experience an unfamiliar feeling. Luckily our bus driver didn't have any problem with all this. Safe arrival at the hotel was a relief to most of us, the quest for a sleeping place begun and we all had a short nap. At half past two we all went to the first project, the Nirlon IT park, where we were welcomed with a cold drink and some presentations about the project. After a tour through the buildings which are LEED gold labeled, we came to the conclusion that there is still much to do to make the buildings really sustainable. The biggest potential energy reduction and at the same time production factor, the sun, was not used to their advantage at all. A visit to a building site was a real shock for us compared to a typical building site in the Netherlands. There were ten people to do a two man's job, not to mention the safety regulations. At the end of the day we went for dinner, we first tasted typical Indian food and the most of us liked it.

**Sunday 13-05-2012**
After the exciting first day everybody was really looking forward to day 2. We visited, together with a guide, Dharavi, where the poor people of Mumbai live. Dharavi is also known as the 'largest slum in Asia'. And large it is: 1 million people on just 1.7 km2! This results in tiny huts (with several floors), narrow streets (better described as 'open sewage') and terrible living and working conditions. I think everybody of us was really impressed.

Our guide however also showed us a different side of Dharavi: Dharavi as heart of the small scale industry in India. We saw people recycling plastics, cardboard and oil cans and people creating all types of pots.

The guide told us these small businesses have an annual turnover of about US$ 665 million, really amazing! People seem to be proud of what they do and where they live. Most of the time people live in harmony together and connected.

Our guide also told us about the love-hate relationship the people of Dharavi have with their government: on the one hand people use facilities, such as healthcare and education, provided by the government. On the other hand people are very suspicious towards the government as it continuously tries to demolish and redevelop the slums (i.e. their homes).

The day was ended in the south of Mumbai, near the harbor. We saw the Gateway of India, which must be the best known building in Mumbai, and the (also) famous Taj Mahal Palace & Tower. We had a couple of drinks and something to eat before we returned, satisfied, back to the hotel.

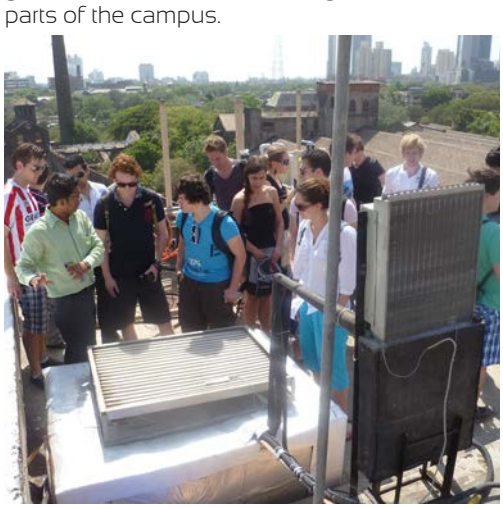
Panasia Engineers -

- Boat trip to Elephanta Island

**Monday 14-05-2012**
On the Monday, after a very early rise and shine we travveled in the morning to the Indian Institute of Technology Bombay (IIT Bombay), the University of Technology in India. We arrived at 11:00 AM. We were expected in an old building, called the main building. At that place we've got a guided tour through the building of the department Civil Engineering. It was quiet and desolated, the students have holiday in may and June.

At this department, we have seen a lot of laboratories with measurement setups, used for studies of material composition and water supply. All the equipment were dated, we use them for a few years in the Netherlands. Two enthusiastic students explain us the operation of the equipment.

The department of mechanical engineering is doing research on earthquakes. In Mumbai these frequently suffer from earthquakes. Another department was doing research on solar energy bij gaining energy from solar cells. In a clean room two students were prepairing a solar cell, it was very distinguished to see that after seeing the other parts of the campus.



- Slums of Mumbai

After a long day, at 06:00 PM we were going to eat near to the hotel. Although they are far behind in technology, they do a very good job by thinking of sustainability. Such a large country like Mumbai, has a huge impact on the environment.

**Tuesday 15-05-2012**
After a tiring but interesting day at the IIT university of Mumbai and again too little night's rest we visited a small company called "Panasia Engineers". This was the first time during our trip we could see that there are also people in India committed to the importance of reducing the energy use in the current Indian building stock.

After a warm welcome, their showpiece was presented to us. A concrete core activation look-a-like zero energy solution, which reduces the indoor temperature with a maximum of 5 OC in comparison to an indoor environment without this system. Very contradictory to the energy slurping airconditioning which was blowing in our fragile European necks.

The presentation was followed by a (more American than Indian, however delicious) lunch. After this treat we where guided through the office where they applied their showpiece. They showed us that the system indeed decreases the temperature of the walls with 5 OC. However, a wall with a temperature of 30 OC is in my opinion still unconfortable. Nevertheless, a very good and interesting initiative which should receive as much attention as possible.

After attending the presentation and tour at "Panasia Engineers" we visited the historical museum of Mumbai. A small deception. Although the interiour showed very luxurious the size of the museum was a bit disapointing for a city with over 20 million inhabitants. The day came to an end after filling our stomachs with the chicken burgers, vegetable burgers and club sandwiches of Gaylord's restaurant. A decent and popular restaurant despite its unusual name.

**Wednesday 16-05-2012**
On Wednesday we had an early wake up at 07:00 in order to avoid the hottest part of the day to visit the Elephanta Island. We took the bus and arrived at Gateway of India in south Mumbai, to get the ferry to reach at Elephanta Island harbor. The Elephanta Caves are a complex of ancient cave temples on Elephanta Island, an hour-long ferry ride from Mumbai. Designated a UNESCO World Heritage Site in 1987, Elephanta Island is not only a worthy destination in itself, it also provides a great view of Mumbai's skyline and an escape from the chaos of the city. After a few hours of a guided tour in the caves, counteraction with the local monkeys, and bargain at the souvenir stores we got back to Mumbai for lunch at a luxurious restaurant near Mahalaxmi temple. Later on in the evening we took the bus to get at Wankhede Cricket Stadium, were we attended a cricket match of Mumbai Indians against Kolkata Knight Riders. At about 23:30 that the game finished, everyone was quite tired, so we took the bus back to the hotel.

**Thursday 17-05-2012**
A day with Architect Hafeez Contractor.

The office of Hafeez Contractor is situated in a normal not to flashy building, and outside you would not suspect it to be a very big company, but it is! Hafeez Contractor bought extra floor space every time he wanted to expand, and now there are 530 people working in the office. Hafeez does not slow down because of some crisis, there are still 500 projects in progress.

After the office, we went to visit one of the icons of the Mumbai skyline, the Imperial SD Tower (designed by Hafeez). These towers are part of a slum rehabilitation project, these projects are being used to get rid of all the slums in Mumbai. How it works: The project owner wants to build expensive high-rise apartments in the center of Mumbai, so he takes the ground of a slum. Because he uses the ground of the slum, he needs to build free houses for the people from the slum. So he builds small apartments for the people from the slum, and when they have got there place, he can build

- IIT university of Mumbai

- Ellen's 25th birthday

his tower. In the end, everybody in the slum has a new house, and the project owner has a high-rise apartment building in the center of the city.

After the Imperial Towers we were taken to the Hiranandani Gardens, these are circles of high-rise buildings for the middle-upper class. They have been built to create a nice kid friendly and calm area with less cars and noise. It is a big area with a few different of those circles, and together they form their own little city. It is sort of comparable to Beverly Hills, a city in a city.

**Friday 18-05-2012**
After being a week in Mumbai under a hot shining sun, we finally had the opportunity to cool off in Water Kingdom. Everyone was waiting for this day. Water Kingdom is Asia's largest theme water park. With the famous rides and slides like The Lagoon, Missphisly Hill, Adventure Amazonia, Wetlantic and Brat zone. But before we were there we had to travel for 2 hour from our hotel.

Around 10 o clock we arrived at Water Kingdom. Before entering the park the girls had to buy shorts and shirts because it was advised not to wear bikini.

Once inside we went to Wetlantic, it is the largest wave pool in the world. After Wetlantic we divided some of us went to slides (Missphisly Hill), where Tom was trying to reach they end of the slide and he did after trying couple of times.

On the way back we all went for diner to Subway, almost everyone had enough off spicy Indian food. After diner we went shopping and one thing is for sure u need to bargain! The first price what you hear is like 3 times higher than the normal price and most of the time even more!

**Saturday 19-05-2012**
Saturday it was time to visit the Rachana Sansad Institute (RSI) for the first time. And although there was no Building Services or Building Physics faculty at this university, the Institute of Environmental Architecture also had a strong link with our students interest. This graduate program is done by 20 students who work during the week and study at the institute during the weekend days, the expression by one of the students 'it can be very busy and stressful sometimes' seemed very appropriate here.

We were shown some of the projects the students had been working on, where it become more clear what the content their study actually was. Water-, material-, and energy conservation in the built environment are major


ver vooruit in duurzame technologie

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concerns. From our group a presentation was given about the TU/e, the unit BPS, and the study association. To give a clear example of our work Mike gave a presentation about both his graduation and PhD projects. In addition to these introductions, we received a tour through the university building. They showed us the all the other faculties present at the university, and the rooms where they received lectures and worked on their projects. It was interesting to see how this small scale institute, compared to the TU/e, functioned. And how the students experience student life.

**Sunday 20-05-2012**

Today, we had scheduled for another appointment with the Rachana Sansad Institute in the afternoon. On a last minute call, Argyrios arranged a visit to the Comedy Store in the evening, because there was nothing planned yet.

Today the visit consisted out of a few presentations presented by the Indian groups, after which a discussion followed. The projects were interesting and very broad, with the fact that those people studied architecture and took more aspects in consideration then the Dutch architect. They had to design a whole ecofriendly resort about 100kms from Mumbai.

At around 6 o' clock we said our goodbyes, and received a certificate with some names spelled incorrectly. I do remember receiving a text in which the head of the Institute asks if "water melon head" is a real name, because she doubted it. It's all about the idea though, and it was really nice of them to offer! We also received a picture of Lord Ganesh, which will own a prominent spot in the Mollier corner.

In the evening we went to the Phoenix Mill, a shopping center just at a short distance from the Institute. We had a "nice" meal at the comedy store, consisting of (tiny, very tiny) pizzas, with of course, coriander.

Some Indian comedians performed on this evening, in which they told jokes in English and Hindu, which "most of us" (except ELLEN) did not understand. At one certain moment, one comedian made a reference towards the Lord of the Ring movies, of course, everybody started to laugh in our corner since I'm related (in appearance) to Frodo. Besides, Ellen was able to laugh on almost all the jokes (and until this day we still do not understand why).



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**Monday 21-05-2012**
Monday was the only day we had a program outside Mumbai. We went to Pune to visit the Atos Origin Company. We woke up very early to start the long trip of four hours to Pune. In Pune we entered a kind of campus with different companies. The Atos building was recently completed but some floors need to be finished. The building was equipped with all kind of facilities and was very western. The ventilation could be regulated by floor and sometimes even by office. There was also emergency power in case there was some power failure. The employees of the company could use a large cafeteria, a gym, a pool table and some other facilities. Short: it was a well-organized building.

After the Atos Company we had a small lunch in Pune and after that we went to another project: Orange County. This project consisted of 3 buildings with apartments. The first building was already completed and inhabited. The second and third buildings were built according to the same concept as the first building, but with improvements. There first building had solar panels on the roof and two windmills for electricity. It also had water tanks in which water could be recycled.

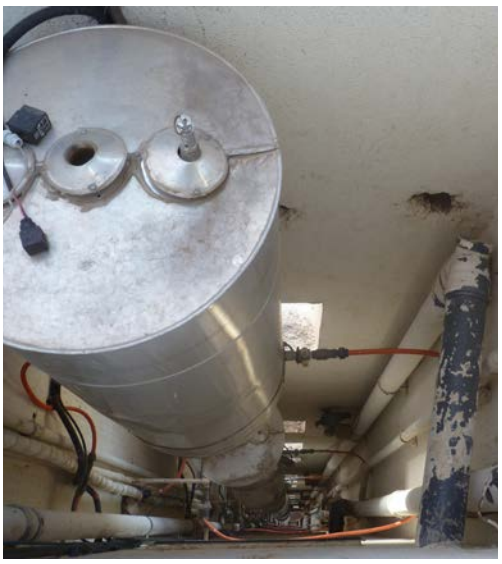
**Tuesday 22-05-2012**
The last day of our study trip has arrived. Everyone was getting tired, but Richard arranged two more projects for us. First we visited the Royal Palace and after that the Marathon future building.

The Royal Palace is a fully residential tower with services. In the tower there was a atrium, this atrium was about 150 meter high. They also made openings in the façade to get sunlight in the bottom of the atrium. These apartments are aboutb 900 m tom1800 m and the cheapest apartment cost about 10 million euro.

The next building we visited was the Marathon future building. This building has a gold certificate from the Indian green building council and also is an gold category LEEDS certified building. There has been a lot of research about "green" buildings around the world and they tried to put the best things in this building.
One of the points they looked at was the orientation, they placed the building on a way it needs the least cooling. Also there are placed double glass with a coating to keep out the heat. Another unique point are the 15 skygardens. The rainwater on these gardens will be harvest, so it can be used elsewhere in the building.

After been welcomed in the Marathon Futurex building, we had a presentation about the building. Before we had a tour through the building, they arranged a lunch with dominos pizzas. After the tour there was another surprise waiting for us. We already had been filmed while we were there, but at the end they had arranged some kind of press conference, where we were asked about our opinion of the building.

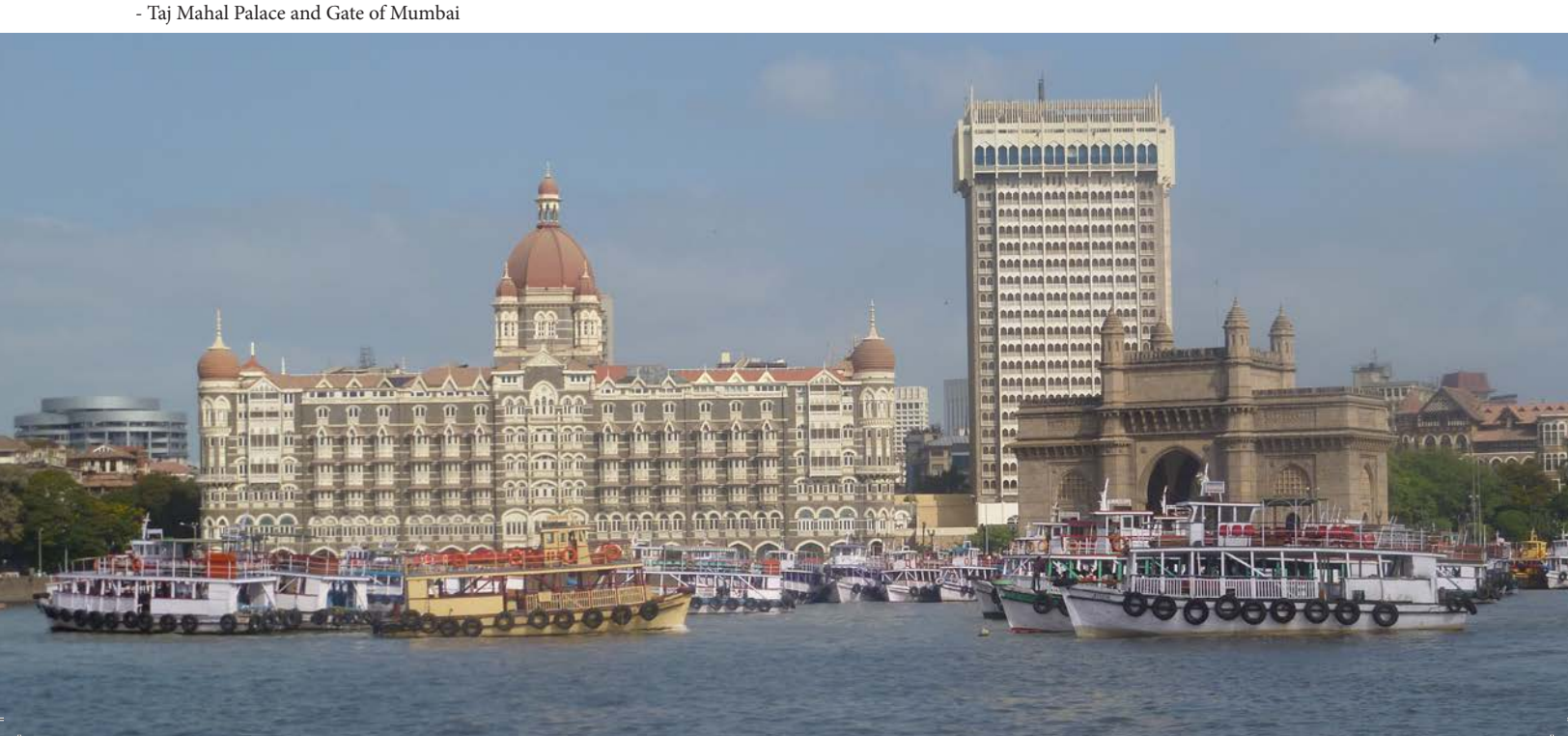
In the afternoon we had some free time before we had to pack our bags for our flight back. So naturaly, we went shopping (okey, some of us). We couldn't get back from India without ~~rubbish~~ souveniers! Just one last ride with the riksja and for the second time we went to the vegetarian restaurant down the street.


- Orange County: hot water storage tanks

Around 00.00 am the bus showed up. Not our old and familiar yellow Tata bus, but a huge touringcar accompanied by our unintelligible friend for the last week, the driver. After a little struggle at the parking we all got on to the plane safely and our journey back had begun.

After we had arrived on Schiphol airport again, we sat down at a small bar and made a toast to a successful trip...!

- Taj Mahal Palace and Gate of Mumbai



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