Chapter 3
The Backpack Project

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In April 2015, AiREAS was contacted by TNO, a powerful Dutch technological research organization, who had become a member of the AiREAS value-driven community one year earlier. During that year, we had been looking at ways to get TNO involved in our projects. This time, it was TNO itself that came up with the proposition. N.B. That is how AiREAS works; anyone can take the initiative following this directive:

> If you can do it yourself within the AiREAS context of healthy city development, you do it yourself; if it's too complex, then we try to make a project and do it together.

Together with another AiREAS partner, IRAS (Health risk assessment of the University of Utrecht), TNO was looking for a place where volunteers could be equipped with measurement equipment inside a backpack for a study of their direct exposure to UFP (ultrafine particles) pollution and their lifestyle. This project, of course, fit perfectly with the objectives of the POP described in the previous chapters: the POP1 medical insights that had been obtained through the medical studies, the GPS tracker info for the public space and lifestyle questionnaires using the limitations of the fixed ILM measurement and data infrastructure. These could now be enhanced with much more direct lifestyle and exposure information, both outdoors and indoors, using backpacks. It would be difficult to get to evaluate human dynamics in a city that were much closer than this.

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According a long-term Swedish study,[1] confirmed by our first POP steps, modern Western society spends 90 % or more of its time indoors. It is therefore very relevant for AiREAS to take indoor activities into account when defining steps towards healthy regional development. Scientific studies also indicate that, since the energy crisis in the 70s, the isolation of buildings has grown but the essence of proper ventilation has never been taken adequately into account. The indoor climate hence has suffered a great deal and, in some cases, is many times more polluted than that of the outdoors. People are not just affected by traffic, public events, construction activities and wood stoves, but also by their own cigarette smoke, perfume, indoor cleaning activities, cooking, etc. It would certainly be good to see if we could verify some of this through the 'backpack project'.

The technical aspects of this project can be read in the publication by TNO itself. Here, we concentrate on the civilian participation method, the outcome and the effects on the participants.

3.1 Getting Participation

One of the limitations of the execution of our POP project, as detailed in Chap. 2, was that we had only had access to people with a particular mindset and affiliation. This was not representative of the cross-section of an entire population. TNO had 4 backpacks available and proposed doing three sets of measurement with 4 participants, for 5 days each. The 5 days would go from Wednesday until Monday, allowing us to detect differences in behavior between weekdays and weekends. The measurements would only take place during the month of June 2015. This was a pity, because we would have liked to have gotten insight over a broader timescale, including seasonal variations and participation in all kinds of city events during the year. This was not possible, neither in practical terms nor budget-wise. We were already very happy with this window of opportunity, and AiREAS had entered the exercise without extra financial backing, so we needed to work with existing resources. The availability of space and the participants of the POP was already a great asset. Also, the experience built up during the POP, while interviewing people about lifestyle to back up the measured data, was of key importance in making the logistics, feedback collection and data analysis work, for AiREAS, but also for TNO.

The fixed setting of 4 backpacks and 5 days per session, over 3 different sessions in June 2015, spurred us into becoming creative and also introducing some diversity into the usage of the 4 backpacks. We determined three groups of people:

- 4× Participants of the original POP. This would allow us to cross-reference with the data from the POP.
- 4× Support members of City of Tomorrow or AiREAS without active involvement to date, with interesting potential contributions:

[1]Indoor air, the silent killer—ISBN 91-631-6161-3.

  - Reporter of the local media (newspaper)
  - Team member from the city administration (air quality specialist)
  - Residents of specific areas in town (e.g., near the airport).
- 4× TNO personnel. This would give us insight into commuting between home and work, different indoor situations (inside car, public transport, house or office …).

We were also hoping for some atmospheric or seasonal happenings in the air throughout town during the month. The groups established had the optimum mix of characteristics to obtain highly differentiated, individual lifestyle results. If an event were to occur, such as BBQ night, inversion peaks or an agricultural peak due to harvests, then we could look at the effects for the great variety of lifestyles.

An extra curiosity was the fact that TNO had recently published a very alarming report about ultrafine dust (UFP), later confirmed by the Dutch Ministry of Health (RIVM)[2] in relation to the movement of airplanes at the national airport Schiphol. This motivated us to direct some of our participants to the local Airport of Eindhoven.

One of the mixed backpack teams

Nicolette Meeder was once again in charge of the agenda, the logistics of the participants and the collection of feedback. Jean-Paul Close was in charge of the explanation of context, while TNO took care of the technicalities.

[2]htttp://www.rivm.nl/Documenten_en_publicaties/Algemeen_Actueel/Nieuwsberichten/2015/Ultrafijnstof_door_luchtvaart_rond_Schiphol.

This time, it was easy to establish the teams. The information evening also went very smoothly. TNO came well-prepared technologically and AiREAS well-prepared in human interaction. It proved yet again a very pleasant exercise for everyone involved. IRAS, at the same time, got a car with measurement equipment to travel through town in order to get additional environmental data, but at the time of this publication, we had not received the input and hence could not take it into account in our analysis.

It took TNO over three months to analyze and interpret the data. The analysts acknowledged back that they were surprised that such a relatively small group of participants had generated such a gigantic mountain of data. Cross-referencing between questionnaires, activity logs, GPS and air quality data, all related to time, geographic position and characteristics of such location, made the interpretation very laborious and impossible to automate.

Every backpack participant received their own private report about the TNO findings. Additionally, TNO and AiREAS gave a workshop together in October 2015 with all of the participants. We wanted to share the general insights and see if people would be willing to use innovations to improve their awareness and interaction with public spaces when making personal decisions.

3.2 The Outcome

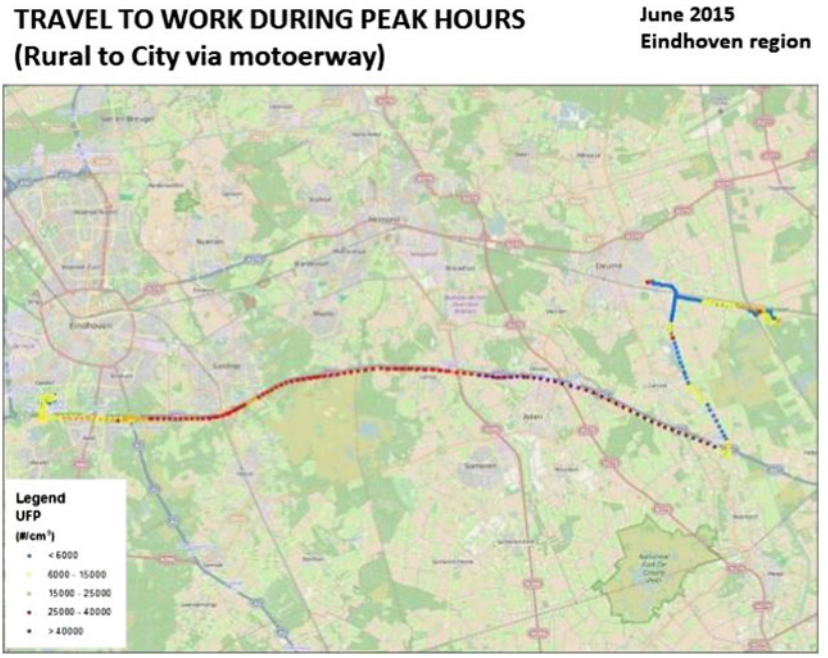
The measurements were very surprising indeed, even though we needed to make some remarks in regard to the interpretation. For instance, when people were cooking in their homes, we would detect a peak in our data, but could not determine precisely what it was. It could have been simple water vapor, since this equipment does not distinguish materials nor does it first dry the air before counting. There is always room, therefore, for some speculation, which makes the logging of personal activities and observations very important. When someone is doing jobs in the house, it makes a lot of difference as to when the person is demolishing a wall, dusting or washing the dishes. Simply observing data does not provide the proper insight; it always needs to be cross-referenced with additional reliable information for interpretation within the proper context.

The backpack project was extensively covered by the local TV and newspaper media. One reporter had registered himself as volunteer and took part in the exercise, allowing him to report first-hand about his experiences. You can watch the TV coverage of the project here (in Dutch): https://www.youtube.com/watch?v=M7619Gzbwzw.

In general, we can reconfirm that both the contribution to air pollution and exposure is very individual and lifestyle-dependent. Lifestyle is not just the voluntary exercise of filling the day with activities; it also has to do with the involuntary activities imposed by labor commitments and other behavioral aspects that are defined more by the reigning socio-economic culture and paradigm than self-aware, voluntary choice. This could be easily seen in the individual readings.

3.3 The Commuters

As mentioned before, we had established three groups of volunteers. The group representing the labor-related commuters of a technology firm showed peaks corresponding to their travel time between home and work. One of those commuters lives in the rural countryside outside of town. Every morning, this person drives to work and encounters a traffic jam on the motorway. The time spent in this traffic jam shows great exposure to ultrafine dust.



Commuting during a traffic jam has important health consequences

Other people, those who commute by bicycle in town, find themselves exposed to occasional peaks when passing special hotspots of pollution, such as crossroads, having to stand still at a traffic light with a scooter nearby or cycling along a busy road. We see the GPS-related trail showing a diversity of ups and downs in measured values that cannot always be seen as static regions of pollution, but are merely related to the local circumstances at a specific moment in time.

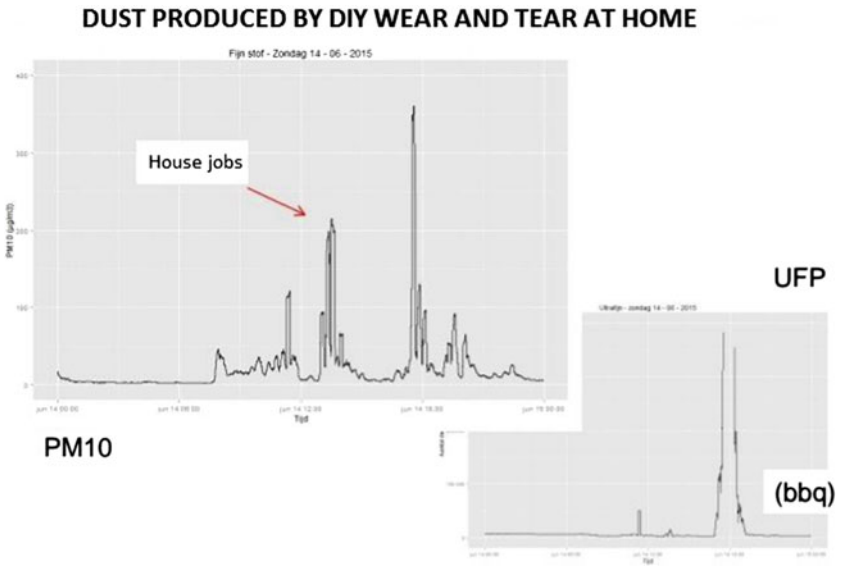
Reducing the need for people to commute during peak traffic times would not only reduce personal exposure to pollution, it would also reduce the personal contribution to pollution and traffic intensity. AiREAS has suggested deploying high level internet and workspace environments in the rural villages. In our age of knowledge-based labor, people do not need to work from 9 to 5 anymore, nor be present at a specific location. Redesigning our presence at locations in time and

space, using modern technological facilities close to home, can improve our wellness and well-being, creating increased productivity potential. The same can be done in the city quarters, where people can meet and contact each other in open spaces through communication facilities that network with the rest of the world.

Since all stakeholders are involved, they all start talking the same language, which, in turn, influences the local community. When the local government talks about the "health deal" as a strategic roadmap, this motivates the entire societal dialogue all the way up to and throughout the entire general population. Signs of a new socio-economic reality can be seen when looking at value-driven options relating infrastructure, individual societal contributions, lifestyle and rewards.

3.4 Lifestyle-Related Exposure

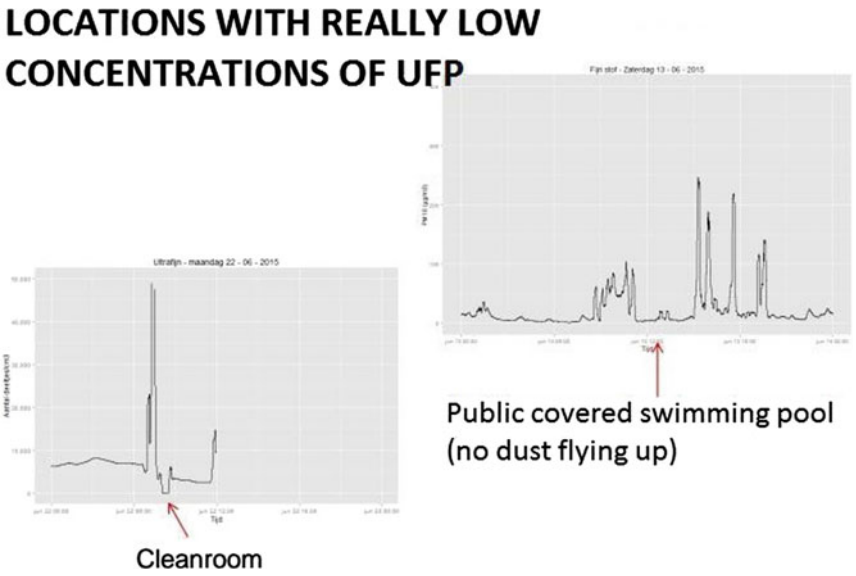
Other interesting observations in AiREAS were made while looking at the indoor activities of our participants. At home, people engage in all kinds of activities, such as cleaning, cooking, recreation, partying, smoking, etc. Lifestyle issues such as candles, stoves, individual food culture, hobbies, decoration, cigarettes, household work, furniture, etc., all contribute to pollution. This could clearly be observed in the measurement results. Again, we needed to relate the data to the logbooks of personal notes of the participants in order to find the relationships. It is clear that different seasons produce a diversity of polluting factors. In winter, wood stoves are more common than in summer, while summer features particular activities at home, such as barbecuing.



Very high peaks are related to specific activities in or around the house

In general, we observe the tendency for peaks to last longer indoors than outdoors. Outdoor dispersion of fine dust and gases is influenced very much by weather conditions, while indoor dispersion depends on ventilation.

We did not only look at high concentrations, but also observed the very low ones. Working in a clean room in a high tech environment features nearly zero exposure to fine dust. Also, the public swimming pool has a very low concentration of fine dust. Expecting a higher density of humidity in the pool, we see that we do not seem to measure water. This can be useful when interpreting household measurements.



3.5 Product Innovations

TNO presented various potential products that people could use. Examples were an App for the mobile phone, an indoor measurement system and a personal portable sensor. The participants reflected openly about the use of such devices. Many concluded that they might be useful for specific target groups, like people who already suffer from respiratory or heart problems, or those who benefit from healthy air indicators, like outdoor sport people.

People also reasoned that such services could be integrated into other standard devices that people tend to use in a home, such as a fire alarm or smoke detector. Special, personal sensor equipment was particularly seen as something one might

use on those occasions when people sense the need to gain more insight. Ownership of such devices seems unnecessary and a lending mechanism could be more appropriate. Participants observe that insight does not always change behavior. One does not necessarily stay at home even when it's raining. Often, one has no choice. Apps are of interest if some interaction and personalization can be achieved.

In the end, the participants indicated that they did not want to pay much for such devices and that maybe insurance companies should get involved to co-finance investments.

3.6 Conclusions

Human beings produce and are exposed to a lot of pollution through a whole load of lifestyle-related products, habits and obligations, both indoors and outdoors. We are often not aware of it, because the pollution is invisible or not experienced as damaging. Many medical studies[3,4,5] reveal that such exposure has serious and lasting consequences for our health, as well as causing behavioral or productivity disorders, even if we still retain a sense of well-being. Much of the pollution can be reduced or avoided through social innovation, but the rest may require cultural and technological innovation, often related to an important repositioning of the way society is organized and facilitated through infrastructure, regulation and reward.

For the participants in the backpack project, the information was an eye opener, but not necessarily a major stimulus to change lifestyles, especially when the lifestyle being experienced is of high quality. One would sooner expect that innovation and regulation would resolve the main issues. Some exposure to pollution seems unavoidable, such as during one's commute between work and home. One cannot change that by oneself without challenging one's financial stability and dependence.

Contrary to the POP participants in Chap. 2, most of the people in this group were only followed up on after their personal reports had been sent out to them. Feedback was particularly necessary in regard to usage of devices or information apps. They were also only confronted with data of exposure, not their personal health. We detected a slightly less proactive attitude for change here than in the previous POP group. Since the groups are small, this is just a minor indicator and possibly subjective observation that can only be enhanced when more are involved.

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[3]Pope III, C. Arden, et al. "Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution." *Jama* 287.9 (2002): 1132–1141.

[4]Hoek, Gerard, et al. "Association between mortality and indicators of traffic-related air pollution in the Netherlands: a cohort study." *The lancet* 360.9341 (2002): 1203–1209.

[5]Loomis, Dana, et al. "Air pollution and infant mortality in Mexico City." *Epidemiology* 10.2 (1999): 118–123.