Towards Healthy Air in Dwellings in Europe

THADE Project

Report

IMPORTANCE OF AIR QUALITY IN HOMES

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ABSTRACT

Europeans regularly spend 8-16 hours a day in dwellings, depending on local culture and climate. This makes indoor air quality in homes of paramount importance for vitality, productivity, independence, the number of healthy years in a life span, and other aspects of quality of life. THADE intends to arrive at concrete actions in 2006. We chose calculations of DALY (Disability Adjusted Life Years) and PAR (Population Attributable Risk) to show the possible improvements in the different European countries. Further research should strengthen the translation and communication of primary scientific knowledge into graphic representations for practice and policy making. In addition the existing EC Building Directive may be used to improve indoor air in European dwellings.

INTRODUCTION

Breathing is a prerequisite of life. We cannot stop breathing for more than a few minutes without loosing life. And during life, effective breathing with sufficient carbon dioxide removed from the body, and oxygen entering the bloodstream, determines a person's capacity for independence, for vitality and productivity, in short his or her capacity for high-quality living and a high number of vital years in the human life span.

Depending on regional culture and outdoor climate, Europeans spend most or almost all of their time in indoor environments. Something between 8-16 hours / day is regularly done in dwellings. To breath healthy indoor air is therefore considered a fundamental right1 by the World Health organisation. Apparently this fundamental right is regularly breached. Assessing the actual impact of poor air-quality at home is one of the central research questions in the THADE project.

3.1. POLLUTION, PEOPLE AND DWELLINGS

Everything we breath, except for acceptable concentrations of oxygen, nitrogen and carbon dioxide gasses, may be considered a pollutant. But not all of those accidentally inhaled gasses or dust particles are considered of health relevance. Disease or unhealthy conditions resulting from noxious exposures include different building (services) related diseases, allergic inflictions, the Sick Building syndrome, the Multiple Chemical Sensitivity Syndrome, and effects only seen by persons with an increased susceptibility to indoor air pollution (Reoprt 2).

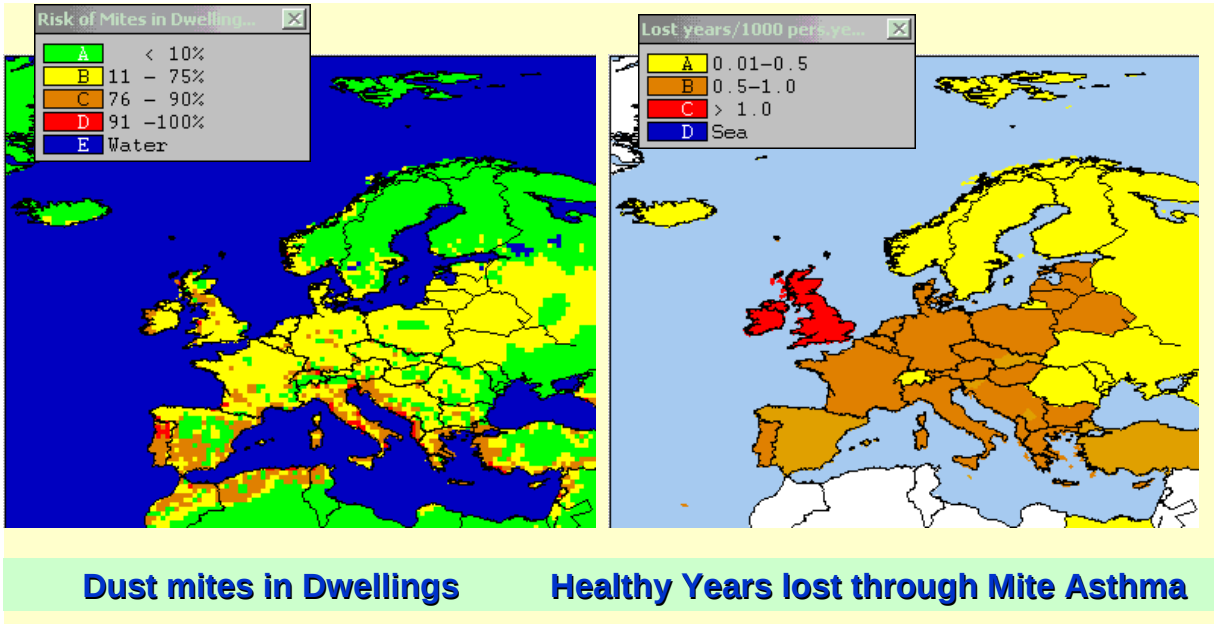


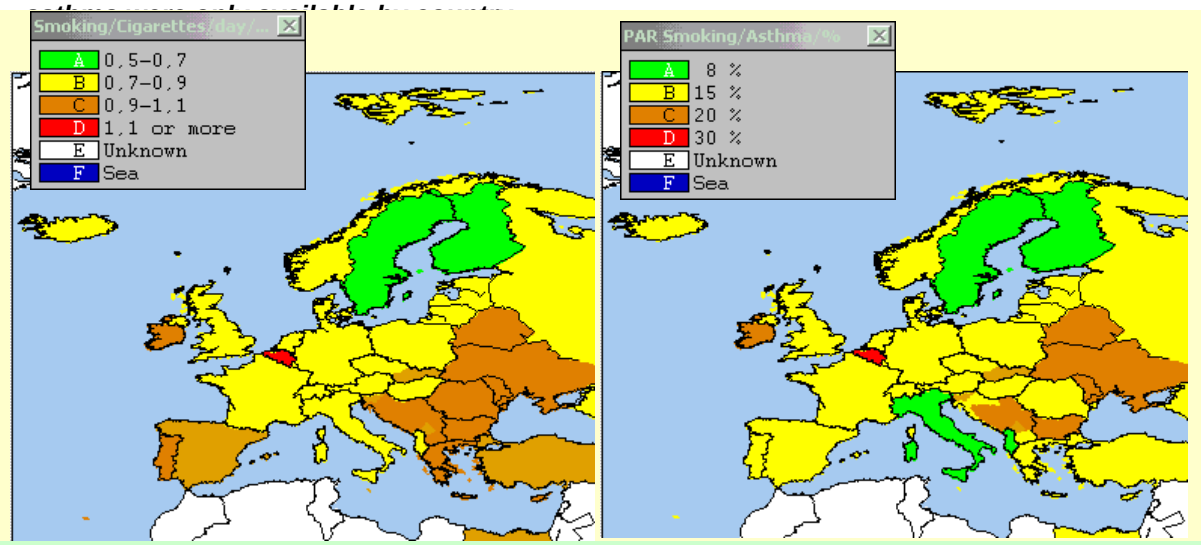
Figure 1: Infiltration of dwellings with dust mite populations and resulting loss of healthy years in a life span (DALY) as mapped in the AllerSan of THADE program (Report 5). United Kingdom and Ireland appear to be the worst countries for house-dust mite asthma in Europe. Because of the limited resolution of available disease prevalence figures, the health outcome to the right could only be mapped by country, not by 10'Latitude and Longitude as was possible with house dust mite exposure (map to the left).

In some cases the causal relation between pollutant and disease is immediately visible, due to a short incubation time of the disease. Think of building related infectious disease caused by the Legionella bacterium in potable and warm water systems (Veteran's Disease) or the SARS Coronavirus in ventilation and sewer systems of dwellings (SARS). In those cases awareness is generally high and measures to contain the disease are taken by policy makers, at least for the major part of the population.

Unfortunately more susceptible sections of society, the so-called YOPI: the Young, the Old, the Pregnant and the Immuno-suppressed, are catagorized as 'Persons with special needs', together with those that have a chronic condition, such as asthma or COPD, in stead of considering them as a part of the natural variation in society. This discrimination of susceptible persons is even stronger in case of chronic (partially) building-related inflictions, such as house-dust mite allergy.

In case the incubation time of a disease or condition is increased or health effects are caused by prolonged exposure, such as for asthma and COPD, the long-term effects leading to these conditions tends to be ignored by policy makers and the general public.

Figure 2: Exposure to cigarette smoke in dwellings and the Population Attributable Risk(PAR) of this exposure for asthma. Belgium is the country were the most health can be gained by stopping indoor smoking. In this case prevalence figures of smoking and of



Cigarettes Smoked **PAR Indoor Smoking for Asthma**

These conditions tend to be classified as 'normal in our region', or 'intrinsically age-related', etc. The fact that the majority of European regions have a too high level of dust-mites present (Figure 1, left map) is considered just climatic variation, although in all green and yellow coloured regions building interventions may decrease mite populations below hygienic levels for sensitization and symptom development; thus greatly improving current poor indoor air.

3.2. CONCENTRATION, EXPOSURE, DISEASE

To understand the importance of poor indoor air in homes and its health consequences, we need to combine the effects of a large number of phenomena. This includes the time spent at home, the different sources of pollutants arising from persons, pets, household activities, indoor conditions suitable for mites, fungal and insect growth, and infiltrations from the outdoors through air or holes (rodent pests!), as well as the efficiency of the removal of pollutants with ventilation and infiltration of air (Reoprt 4).

These data are used to assess actual concentrations of air pollutants in dwellings as well as intensity and length of noxious exposures (Reoprt 5). Subsequently these short-term or long-term exposures may lead to disease.

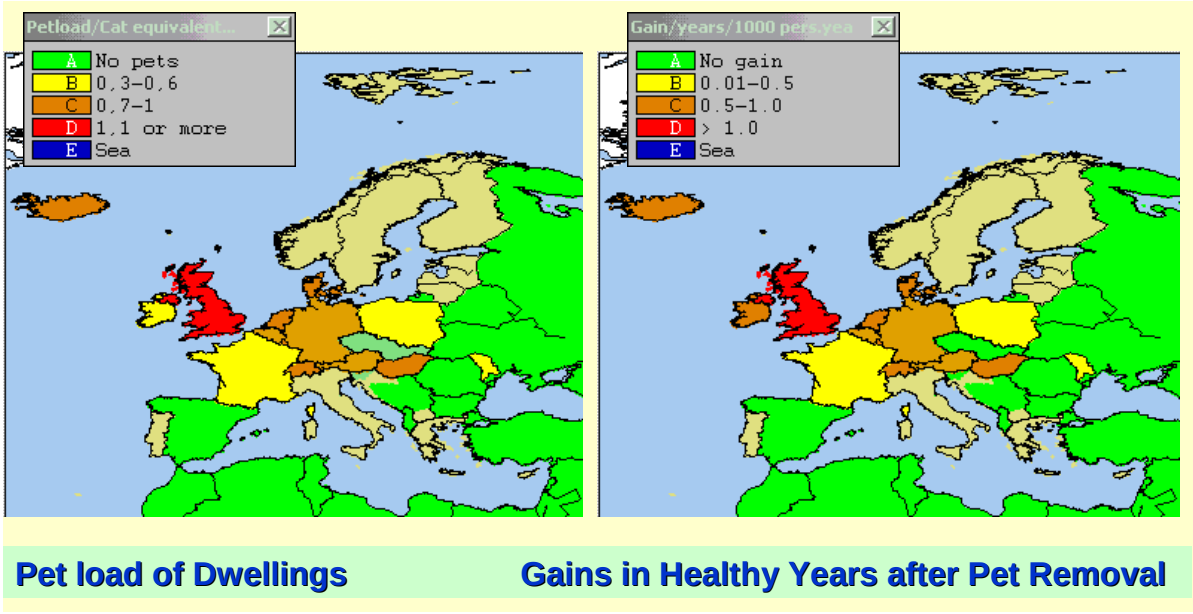


Figure 3: The result of pet-removal on gains in healthy years as related in asthma, can be dramatic, especially in the United Kingdom that shows the highest pet prevalence in Europe. Here the exposure map and the health outcome map show the same picture since removal of pets always decreases pet allergen concentration after some time. Considerable health gains are only possible, of course, in regions that have a high incidence of pets in dwellings..

3.3. HEALTH OUTCOMES OF EXPOSURE AND PREVENTION

Health effects of pollutant exposure may be assessed from 2 different angles: (i) a disease load on the population (DALY), and (ii) the amount of disease or condition abatable by eliminating a specific exposure (Population Attributable Risk or PAR (Figure 2). By mapping these health outcomes high priority regions are shown at a glance within the European sphere.

Our colleague Olli Seppänen (Denmark) supplied information on prevalence of asthma symptoms in 12 European countries. With the help of interpolation (taking into account mapped risk of exposure to dust mites, fungi and pollen) and additional data, DALY's (Disability Adjusted Life Years) and PAR's related to asthma could be mapped by country (Figures 1 and 2). A comparable procedure has been performed for COPD, taking into account mapped data on smoking and time spent indoors.

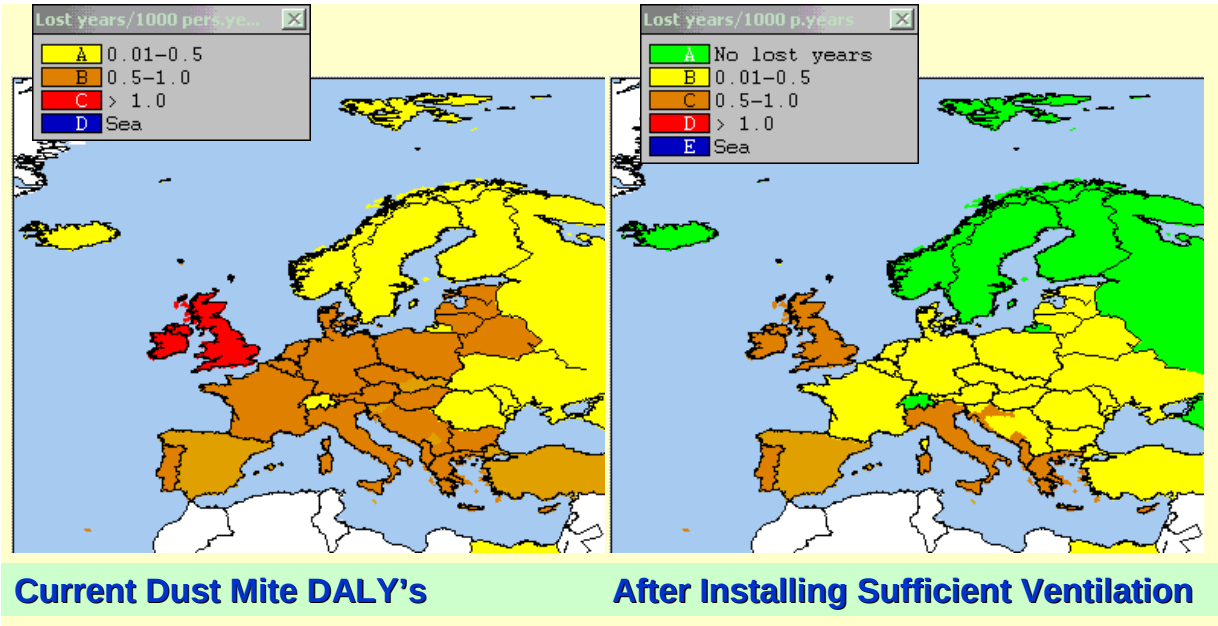


Figure 4: Prevention of house-dust mite asthma through optimizing ventilation of dwellings. This is most effective in regions with cold winters due to the low humidity associated with ventilation air in winter, and the increased ventilation efficiency when indoor-outdoor temperature difference increases. Fully air-conditioned dwellings are not taken into account.

Population Attributable Risk (= Attributable risk x prevalence of exposure to a certain risk factor in the population), has been calculated from exposure and prevalence figures European wide. Due to missing data and level of integrity of available data this calculation is only reliable for the combinations 'cigarette smoke & COPD', and 'house-dust mites & asthma' (Figure 2).

What can prevention do? Let's take the case of asthma (Figures 3 and 4). A 'simple' measure such as pet removal, shows a straight forward result (Figure 3), since the act of pet removal always diminishes pet allergen concentration after some time. The effect of improved ventilation on asthma disease load is more complex (Figure 4). In all regions increased ventilation will lead to a higher degree of removal of mite allergen from indoor air. Since, however, most of the mite allergen in dwellings is stored in soiled textiles used in furniture and furnishing, the 'loss' of airborne allergen is quickly replenished. Depending on the conditions of outdoor air and ventilation efficiency, ventilation can have a second effect on dust mite concentrations: hampering or stimulating mite growth and indoor allergen production. Especially the moisture content of indoor air is important. Therefore, optimizing ventilation will have (almost) no effect on disease load in sub-tropic European countries and a net reduction in other regions.

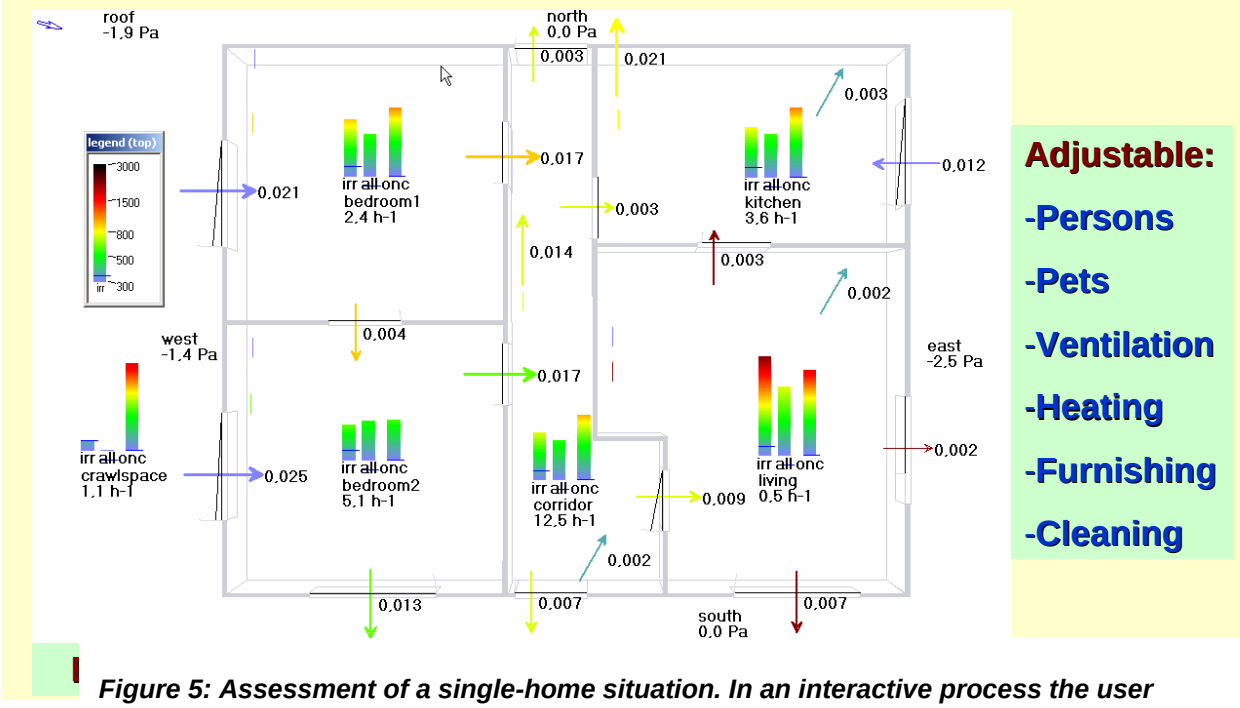


Figure 5: Assessment of a single-home situation. In an interactive process the user adapts the standard dwelling, virtually executes preventive measures and observes the short-term and long-term effects on exposure. Shown is an apartment with kitchen, living room, 2 bedrooms and a corridor. Colours indicate pollutant load, also of air streams (denoted with arrows). Outdoor arrow in the upper left corner signifies wind direction and wind pressure.

By mapping exposures and health outcomes on a geo-spatial European scale, the epidemiological priorities and effects are shown. What about more localized or even personal prevention? To assess those conditions the mapping procedure uses a simulated dwelling (Figure 5). Depending on local cultural, personal and climatic conditions, most effective measures to ease disease load vary from removal of pets (especially in pet-loving regions), optimizing ventilation and furnishing (regions with extensive heating in winter), and improved cleaning routines (sub-tropical regions mainly).

It is interesting to note that no single preventive measure is significantly effective in each European region. This makes it difficult to formulate a European agenda on specific long-term (aimed at children) and short-term (aimed at both children and adults) preventive measures, given the diversity of the member states and their inhabitants. A broader perspective, aiming at understanding the mechanisms leading to poor indoor air, should be taken into account. This should also lead to a united call for

further research and the creation of network structures to regularly update the content of the mapping tool.

3.4. GAPS IN KNOWLEDGE AND RECOMMENDATIONS

The gap in knowledge on the importance of air quality in homes is primarily a gap of translation and communication. Data have been collected on almost all noxious exposures and resulting health problems. Part of them are managed in databases of primary research results, such as in the EC funded project EUROHEIS, and were analysed for certain regions and specific noxious agents.

In the THADE project, a long list of problems has been encountered, when we tried to tap data from existing primary databases to translate the result into European wide, comparative concentrations, exposures and health outcomes to guide consumers and policy makers (Report 5).

The much needed translation and communication of required knowledge to practice and policy making would be greatly enhanced when financial barriers to data availability would be demolished.

In addition, the distinction between primary research databases and knowledge databases for practice and policy making, should be made more clear in both the scientific and policy world. Primary research databases need more detail as to sources and methodology of individual data in order to re-analyse the body of data under future new hypotheses. Database tools for European wide practice and policy making, such as AllerSan of THADE (Reoprt 5), ask for a higher level of aggregation and more extensive interpolation of figures to show European variation, trends and relationships. Of course this is something of a cultural ‘revolution’ among building researchers and epidemiology scientists, who have to accept a lower level of reliability of individual data used by consumers and policy makers. By constructing soft-ware links between the primary research databases and AllerSan of THADE this practice and policy mapping tool could regularly be updated with the newest scientific findings, taking away part of the resistance that may be found in the scientific world.

Within the European Research Area a Network of Excellence has recently be formed under the name of GA²LEN (Global Allergy and Asthma European Network)2. It consists of 25 leading European institutions and 2 organisations, the European Academy of Allergology and Clinical Immunology (EAACI), and EFA as the only patients' organisation. The objective of GA2LEN, among others, is to enhance the quality and

relevance of research, to address all aspects of the disease, and to eventually decrease the burden of allergy and asthma throughout Europe. We think that the GA²LEN network is well suited to take up the continuous task of collecting and assessing primary scientific knowledge to be included in the AllerSan of THADE mapping program for use by consumers and policy makers.

And last but not least the category of 'People with Special Needs' should be dissolved and the Young, the Old, the Pregnant, the Immuno-suppressed (YOPI) as well as those Europeans that carry chronic inflictions, such as asthma or COPD, should be included in the natural variation of human populations. Legislature pertaining to built environments can subsequently also take into account the needs and capabilities of all sections of society. By advocating Universal Design3 the European Union expressed this view already, but this Universal Design approach should be implemented more fully in the different disciplines of policy making in Europe.

3.5. BUILDING DIRECTIVE

The European Union possesses a splendid tool for improving indoor air conditions that has not be used yet to its fullest power. The allowable health risk of a building is treated in EU Council Directive 89/106/EEC4 it says that "The construction work must be designed and built in such a way that it will not be a threat to the hygiene and health of the occupants and neighbours ..". It also states that this condition should be satisfied for both existing and new dwellings. Since a sizable part of the European population is currently experiencing dwelling-related health-diminishing effects, Member States should be requested to show to which level of "hygiene and health" national building legislation guarantees. Subsequently a discussion may start as of the required level in the Union, and national legislature can be adapted to prevent mite and fungal growth, and to more efficiently eliminate other pollutants in indoor air. This way long-term effects of poor indoor air can be reduced and the societal burden of disease diminished.

BEST PRACTICE: EDUCATING YOUNG SCIENTISTS

European diversity in culture, technology, legislature and climate in relation to built environments is treated as an asset in the Joint European USO-Built Graduate Research School (www.uso.tue.nl), where doctoral and postdoctoral students are educated in design, engineering, management and maintenance of user-oriented built environments for the 21st century. Extending healthy years in the human life span and increasing consumer satisfaction pertaining to individual dwellings and whole residential areas, are researched subjects. The school includes further development of Universal Design or Design-For-All, as was advocated by the European Union[1]. USO-Built's approach to research and design does not consider 'Persons with special needs' as being special or extraordinary (stigmatization!), but as elements of a large and fluctuating array of natural variations to be taken into account. Teaching this approach to young scientists in 33 academic institutions from 19 countries, and incorporating it in their (future) research is an excellent example of striving towards a society for all with a European identity.

In the Joint Doctorates Project of the European Universities Association (http://www.eua.be/eua/) led by the Università di Roma 'La Sapienza', six networks, including USO-Built have joined forces to develop joint education of young professionals in the different academic disciplines to handle European diversity for the benefit of all, at the same time constructing an element of the European Higher Education Area.

[I] Council of Europe. Resolution ResAP (2001)1 on the introduction of the principles of universal design into the curriculum of all occupations working on the built environment. Adopted by the Committee of Ministers on 15 February 2001, at the 745th meeting of the Ministers Deputies.

BEST PRACTICE: AMBIENT INTELLIGENCE

Including ‘persons with special needs’ in the large and fluctuating array of natural variation, poses problems known as mass-individualisation. How can we make products and services, in fact whole dwellings both adaptable and automatically adaptive to changing needs and changing environmental conditions in order to prevent poor indoor air at all times?

The information and communication technology (ICT) revolution has given us the technical means to unobtrusively monitor pollution, store the results, extract the patterns belonging to a specific household and react accordingly in each dwelling space, unless ordered otherwise by an inhabitants. However, having the technological means does not necessarily bring success, since user interfaces should also be adaptive and learning, and these are not incorporated in current building practices of dwellings in Europe.

Under the label *Ambient Intelligence*[1] the concept of both technological adaptivity and user-interface adaptivity has been proven successful for home appliances focusing on leisure activities. A number of successful products are penetrating the market. Expanding this concept to building services controlling indoor air quality seems a small step, waiting only for the building (services) industry to adopt the approach.

[1]Aarts E, Marzano S, editors. The new everyday. Views on Ambient Intelligence. Rotterdam: 010 Publishers; 2003; ISBN 90-6450-502-0

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