

# Designing integrated environments by combining accessibility and new technologies

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## Abstract

Nowadays the need to create a better quality of life for citizens involves a wide variety of built environments: a responsive design can enhance everyday life at home, at the office and everywhere else as well as improve the interface in terms of making the environment more comfortable and easier to use. Accessibility is therefore one of the first concepts we must take into account when designing an environment, not only because we agree with Universal Design principles or because norms and regulations require us to do so in some countries, but because it is more economic. To add a new element or to think of changing a design in a second phase, when the building is already built, is always more expensive. Moreover, our belief is that accessibility and usability inherent in good design can be further supplemented by customized and affordable user-friendly basic packages. Our major research concern is to blend the requirements for comfortable environments and for supporting daily life, as shown through the following goals:

- a responsive design;
- an accessible design;
- an affordable and effective design ;
- a technological and user-friendly environment.

We will show some outstanding examples which we believe to be blending good responses both on the design side and the technological equipment, so that any kind of citizen or user can really feel that the environment is familiar to his/her lifestyle's activities.

## 1 Introduction

Universal Design or Responsive Design or Design for All or Accessibility are worldwide becoming a common language sharing the same concepts, at least around research and educational tables [1,2,3]. Barrier free dwellings in Europe vary considerably from country to country. Plan types and spatial organisation show fundamental differences, construction methods vary, and there is a diversity of layouts of dwelling areas. Multi-storey concrete construction dominates in some countries. Low rise terraced or detached housing ranging from high to low density are preferred choices in others. In each country, however, a single plan type and construction method seems to prevail. This, however, is not due to legal or technical requirements for accessibility. The political objectives, the structure and content of the requirements are much the same everywhere; only details regarding dimensions differ. Instead, the choice of construction, type of development and plan form seems to rest on tradition. In every country new, barrier free/accessible housing conforms to traditional house and dwelling plans [4]. Thus, the typical British solution is a narrow frontage two storey terraced house with an accessible ground floor (similar to the houses built in Britain for several centuries). The Norwegian type is a single family, detached, one and a half storey timber frame structure and has a plan derived from traditional timber log houses. The dominating Italian and German types

are in multi-storey, blocks of flats and commonly have a plan type with a central corridor. There is reason to believe that the same differences and similarities apply also in a wider international context. Summarised:

1. The political policies and intentions as well as the main aims of barrier free planning and the theories behind it are almost identical in all five countries
2. The legal systems and the ways and means of implementing barrier free design have little in common.
3. The specifications for barrier free solutions are similarly structured and similar in content; only the details differ
4. Dwelling types and layouts differ greatly, but conform to traditional house and dwelling plans in each country.

The results show the effect of including and fully integrating accessibility as a basic design requirement, notably that accessibility will only cause only subtle changes to the long established and traditional models.

## **2 A Short View of the Conceptual Approach to Accessibility and Design for all in housing**

To give a wider understanding of the conceptual approach in the perspective of the national building codes as regards to accessibility in housing, we point out two basic systems that so far influenced the legislative framework: the prescriptive approach and the performance-based approach.

The first system, which is still fairly common, bases its requirements mostly on sizes, numbers and other quantitative and normative measures. The second system puts more effort in meeting users' needs by appropriate design of spaces and furniture, and thus relies on describing functional aspects which the solutions must satisfy. Although it seems an obsolete approach, most EU countries still rely on the first system. The trend, however, is towards the second. It has been adopted in the Nordic countries and to some extent also in Britain and the Netherlands as well as in the USA. All are now orienting their regulations towards performance requirements, as these are understood to be more responsive to larger user groups and more linked to design criteria on a sensitive case basis. Briefly put, this means design offering a wide range of different and good solutions to solve the same problem. Specifications and other normative issues are left to standards and guidelines.

A typical example of the two approaches can be found in a bathroom: the prescriptive system could result in an uneconomic use of space which nevertheless might not fully meet user satisfaction; instead, performance can match the inhabitant's requirements in a smaller room by better designed features, regardless of sizes or established measures. Italy and Sweden can be said to be among the first countries in the EU to alter their building codes to performance-based requirements for Design for All since 1996, while Norway (not in the EU but affiliated through agreements) since 1997 may seem to have carried the performance based system further than other countries [5].

The CIB W084 'Building a comfortable environment for all' [6] will make an effort to disseminate results of the performance-based approach to the research partners in order to evaluate the design responsibility to real needs of different user groups. In addition the CIB W084 provides researchers with the opportunity to exchange results and experiences as well as present on-going research on housing and the qualities of the built environment on a worldwide basis. The current leadership of the group will continue to summarise results and advances in the form of reports based on contributions and compilations from the various members. The group has members from Europe, North and South America and Japan. There are, however a number of problems when it comes to making comparative studies of diverse countries and cultures. Some priorities, such as housing the coming generation of elderly people, are common to most countries, but the scale of the problem varies. Other countries face other, more pressing problems, such as housing for poor people (Brazil), Aborigines (Australia). Similarly, housing may be at the top of the agenda in some countries, while improving other parts of the built environment takes precedence elsewhere.

A further problem concerns the nature of the legislation. The European Nations have largely had what may be called a "welfare state" approach, whereby the responsibility for comfortable environments is the concern of the state. Thus, control of the accessibility and usability of the built environment is subject to national codes, rather than, as in the USA being a civil rights issue. The Americans with disabilities act (ADA) is a

prime example. In recent years, however, civil rights issues are taking hold in Europe as well. Most states are now enforcing or preparing civil rights legislation, which, like the Disability Discrimination Act in the UK and Commonwealth states will complement the accessibility requirements in building codes and regulations. To further complicate matters, the actual content and legislative force of building codes and regulations vary, as do the ways in which they are laid out. Germany has no comprehensive, nation-wide codes or regulation. Legislative powers are instead left to the individual German states (Länder). Italy has a succession of laws (decrees) which cover accessibility and usability issues. As for requirements controlling the quality of housing, comparative studies of building legislation in Europe show that dramatic differences; Norway and the Netherlands have been quoted as having the weakest legislation in western Europe, with hardly any requirements for accessibility or usability in dwellings.

Research has also given interesting results regarding the two approaches outlined above. The main issue concerns interpretation. The “old” system, that prescribed minimum solutions by means of measurements, were largely simple (although problems did occur). Performance based requirements, which are more open to interpretation, pose a different problem. A main point is that the designer must be able to provide documentation that the chosen solutions satisfy the performance requirements. Some will do this by employing consultants, user representatives or by reference to other projects. Most, however, prefer a shortcut: They simply copy minimum solutions from guidebooks, standards or other reference material [2]. This obviously rather refutes the object of the performance based requirements, which was that the designer should have greater freedom of choice to create good solutions. In addition, solutions for minimum performance will not comply fully with the functional requirement in all buildings.

### **3 Italian Case-studies**

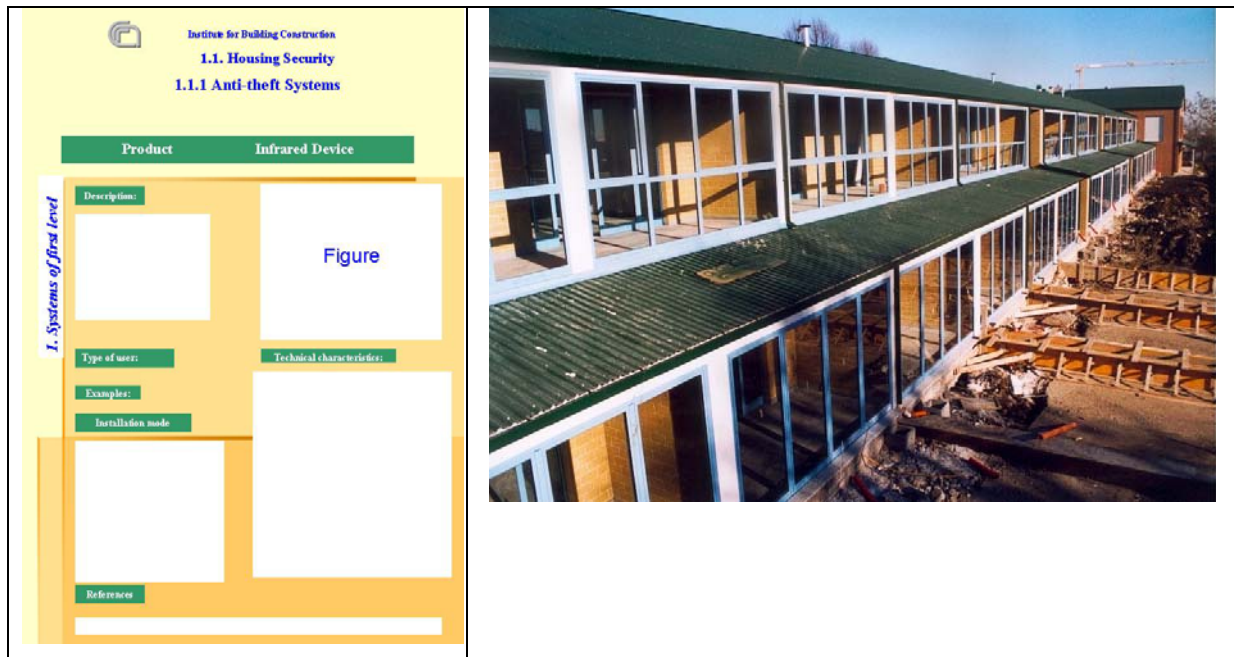
The description above may serve as a background to understand the Italian outline of the most recent case-studies. We present below a new housing district with mixed new/remodelled houses in Pinerolo, a small country in the Province of Torino (North West Italy) and a design model plan for a housing complex renovation in Verona, North East Italy.

#### ***Pinerolo***

The project started within the ‘Neighbourhood Agreement’ (NA) framework, funded by the Ministry of Infrastructures on behalf of municipalities. NA funds renovation of urban areas, districts and/or housing remodeling, together with support from suitable technologies and housing services, in order to strengthen the links between the dwelling, the residential complex and the inhabitants and, as regards older people, to sustain their independence in case of emergency or when carrying on daily home activities.

The urban renovation project of Pinerolo aimed at redeveloping a degraded built area that had long remained divorced from the town’s facilities and the social life. The situation prior to renovation showed obsolete houses, poor materials and equipment, no heating or insulation, disused factories and poor maintenance of common spaces. The inhabitants no longer had an identity as an integrated town district.

The new master plan gave the opportunity for a new urban image by retrofitting/adjusting older dwelling blocks and building a new housing complex which took adaptability to evolving household needs, house layouts, materials sustainability and energy saving into account (Figures 1 – 2).



Left: Figure 1: Sample of check-list record.

Right: Figure 2: Solar balconies (South view) of the new housing complex in Pinerolo.

CNR ITC conducted a survey and an assessment of the state-of-the-art of available technology products, systems and devices for the houses, according to the following process scheme:

- the state-of-the-art of the technology products, systems and devices available nationwide and also some not yet present in Italy but already on the market in elsewhere in Europe;
- an analysis of the appropriateness of technology products, systems and devices in the installation process;
- some considerations and results of the outcomes (installations effectiveness, users' perspective, assessments on lifestyles and daily routines).

The goal was to define and evaluate the most appropriate technology products, systems and devices for residents' home life. The evaluation of the state of art was carried out according to the following technological system categories [7]:

- the *basic or first level system*: we included products, tools and technologies which constitute the minimal technological equipment for houses, suitable for older people who still have self sufficient ability or, anyway, who don't require specific supports;
- the *second level system*: we include products, tools and technologies which characterize an additional equipment if compared to the basic system, in order to satisfy specific needs related to some failures of the inhabitant health status, as orientation aid, some dementia related problems, cognitive failures, etc.

Classification within the two groups is related to four types with the following goals: *Technologies*: systems which optimize the principal activities within the domestic environment, *Products*: supports for daily activities without constituting an integrated system; *Tools*: supports for health and medical needs; *Supports*: additional tools for specific needs and aids for the inhabitant.

Any chosen component is accompanied by a form containing the above described category, the technical characteristics, the type of problem which can contribute to solve (safety, security, functional aspects, etc.) the proposed solution, the user type addressing (from the non specific users group to the older person with different levels of autonomy) and the place of the house in which is located. Forms are completed by the most relevant figures and references, including web sites. Within the classified forms there are both very simple products, still not much used even if useful, innovative examples facing now the market and new experimental products still at the test phase which can give an idea of the future trends.

### ***The technology package in Pinerolo***

The *first level system* includes four principal types of home automation, the first two related to the safety and security, the third and fourth to support specific domestic activities:

- home security (theft, water, gas and smoke alarms);
- people safety (active alarm due to emergencies such as falls or diseases);
- easy management of the house (monitoring of internal temperature, automatic watering);
- easy management of some functions (lights control, windows, doors and shutters control, automation of working areas and cabinets in the kitchen, etc.).

A fifth type regards the integrated system, in which we can find components of the four previous types, but not necessarily all. Many companies offer integrated systems, but the first choice has been on smaller packages of items in order to carry on economic selections among products rather than systems. Moreover, all systems are now flexible and can be supplemented with new components at any time, according to specific needs of the tenants. Among general older users, i.e. people with no special needs, the first two types – house security and people's safety – are certainly the favorites, as well as those tools or supports offering good performances for low-mobility functions are selected as regards to home routines management.

In addition to the features of the first level systems, the *second technological level* offers technologies and supports for specific needs, largely using information or communications tools (screens, messengers, network connections). They can be divide into four main categories:

- Supporting tools (for memory loss or reminders to perform some activities) to ease the basic daily life activities of users with cognitive problems perform (e.g. personal care or eating);
- Health data monitoring (pressure, glycaemia, ECG, etc.);
- Wandering monitoring in order to assess the wandering event so to prevent from environmental dangers (e.g., if a person goes out and does not know how to come back);
- Lifestyle monitoring (to prevent, instead of reacting; passive systems) [8].

### ***Verona***

CNR ITC has been recently worked with a team of professionals, architectural firms and policy-makers of the City Council of Verona for developing a design plan with the aim of adapting and refurbishing an existing housing complex. The principal design criteria were: suitable and user-friendly design for older tenants, installation of effective and affordable home technologies, construction of new systems and plants and general re-arrangement of indoor and outdoor layouts.

The current building is a municipal property and accommodates old tenants in small and inadequate flats. The general equipment, like the elevator, is quite old and no longer matches the requirements for contemporary lifestyles. The ground floor accommodates some common halls and health services, but the layout of the rooms pose difficulties for both for walking about and for orientation as there are many steps and an unclear distribution path to service areas. The latter causes mixed use and creates a conflict between public and private rooms.

The elevator is very small, old and inconveniently located. The access from the outside is complicated and has some crucial obstacles. These problems became apparent during the preliminary investigation of the building in order to survey innovative measures for improving spaces' usability at four different levels, as follows: *Spaces needing remodelling* (both services and houses areas); *New equipment and systems*; *Home technologies*; *Energy saving*.

The framework of improving measures forms a 'Pilot Project' intended as a milestone for prospective municipal interventions for public housing. The goals were:

- Usability of spaces;
- Equipping spaces and security;
- Environmental quality and comfort.

The ground floor service areas is provided with a new clearer layout of walking paths, a new entrance hall with a larger lift and a better connection to the outdoor thanks to a gently sloping ramp. An outdoor balcony is remodelled to a winter garden, as an extension of the common living room. Surrounding outdoor areas become gardens with trees with some leisure activities, like barbecues and flower beds. Housing takes up the four floors above ground floor. There are 36 overall flats, mainly occupied by persons aged 65+ in good health conditions. The major focus is re-designing the quality of life, security and usability of rooms, equipping new bathrooms and kitchens and installing security tools and alarms to help tenants' home life (Figure 3). New overall design is carried out in 32 flats, 8 in each floor, two of which are for one person (29-38 m<sup>2</sup>), and 6 are for two persons (40-45 m<sup>2</sup>).

### ***The technology package in Verona***

Besides the implementation of the standard systems (power, heating, air conditioning and lighting), designed with sustainability and energy saving concepts in mind, a user-oriented perspective is highly considered in planning home technology packages in order to guarantee safety, security and comfort for the residents and their daily home activities as well as to enhance the overall building functioning and prevent accidents. Systems can be self-standing products or integrated systems.

CNR ITC adopted the system categories grid as tested for the case-study in Pinerolo. That categorization refers to a basic package level, intended as essential to cope with today's home needs. In particular, we proposed the following solutions:

### Security

- Smoke detectors (in case of emergency, alarm is forwarded to the safety porter's room and/or to other remote receiver centres);
- Gas detector with a sound alarm, which is linked to immediate stopping of gas supply and usefully located next to the cooking board, where fires are automatically switched off;

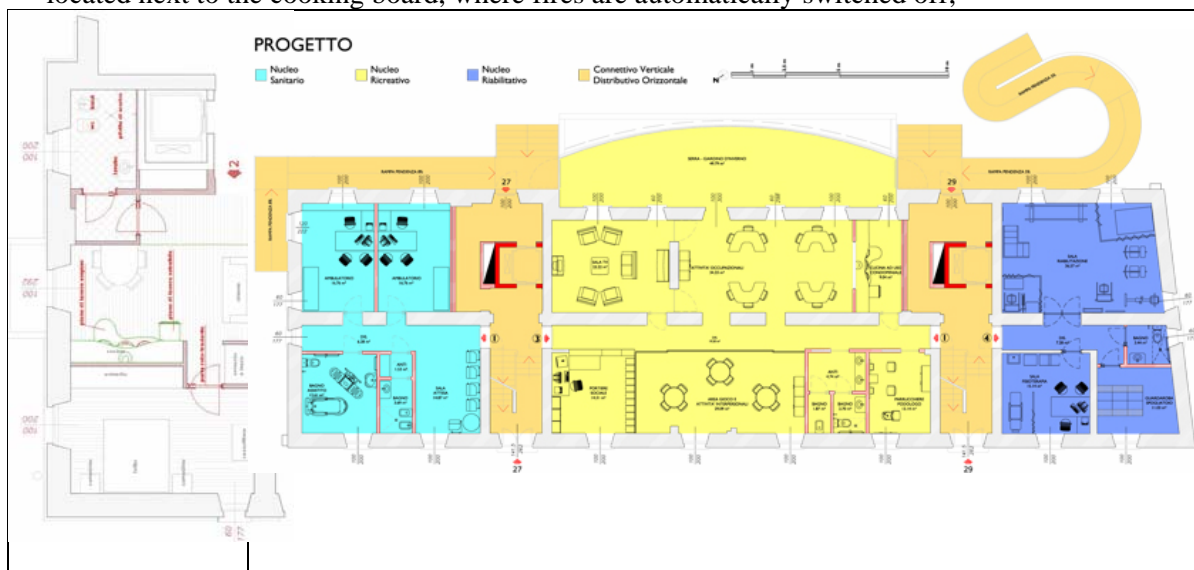


Figure 3: Plan of remodelled home and layout of remodelled common services at the ground floor

- Videocom, which is connected to the outside entrance and to the safety porter's room;
- Intrusion proof system, that can be composed by infrared sensors, doors/windows detectors, shutters' electronic sensors, and glass-breaking detectors.

### Safety

Lighting motion sensors to minimize energy consumption to the real usage and passage time of the users; these can be installed both in the multipurpose hall as an indirect energy-saving system and in crucial home spots, for example, the bathroom passage for nighttime use, when sensors are activated by the person walking nearby.

The motion sensors can also be applied to detect anomalies in home activities; no lighting motion for a long time might mean that somebody has fallen, is ill or is unable to get out of bed for other reasons. For the latter purpose, a motion sensor can be also installed next to the bed or replaced with an emergency pocket light. Generally, it is useful in case of emergencies such as in escape routes and passages.

### *Home functions*

Doors/windows/shutters – a control system unit which operates automatically locking/unlocking; shutters controls can be also operated manually in case of electric power black-out. The control system unit can be a remote control, a PC or voice-commanded device. PC can also provide time scheduling of locking/unlocking.

## **4 Two Norwegian Examples**

Two Norwegian cases, both accessible but without the support of technologies. The first is a housing complex for older people in the South of the country. The second is a detached house not specifically devoted to elderly people. The results from extensive field-testing of accessibility features in new, multi storey as well as low-rise housing project provided basic design requirements in both cases. The first example was also one of several cases used to study the use and satisfaction with communal spaces in housing for elderly people. The case study background and evaluation was unconnected to the Italian studies.

### *Dwellings for Elderly People*

As a result of a government-financing scheme designed to meet the expected rise in the number of elderly people, Norway has in recent years erected a large number of new dwellings for the elderly. Most projects are small scale, one or two storey timber frame structures. The number of units in each project varies from as little as four up to twenty or thirty; projects with more than about twenty five units are, however, rare. Architectural expressions vary considerably, although the layouts are rather similar: Most developments are in the form of terraced housing, with two room flats placed side by side. Normally, the bedroom and the living room will face one way, and the kitchen and entry the other as shown in the sketch below. Importantly, all units and all projects have a high degree of accessibility, particularly for persons with reduced mobility, and all the projects are executed within strict cost limits set by the government.

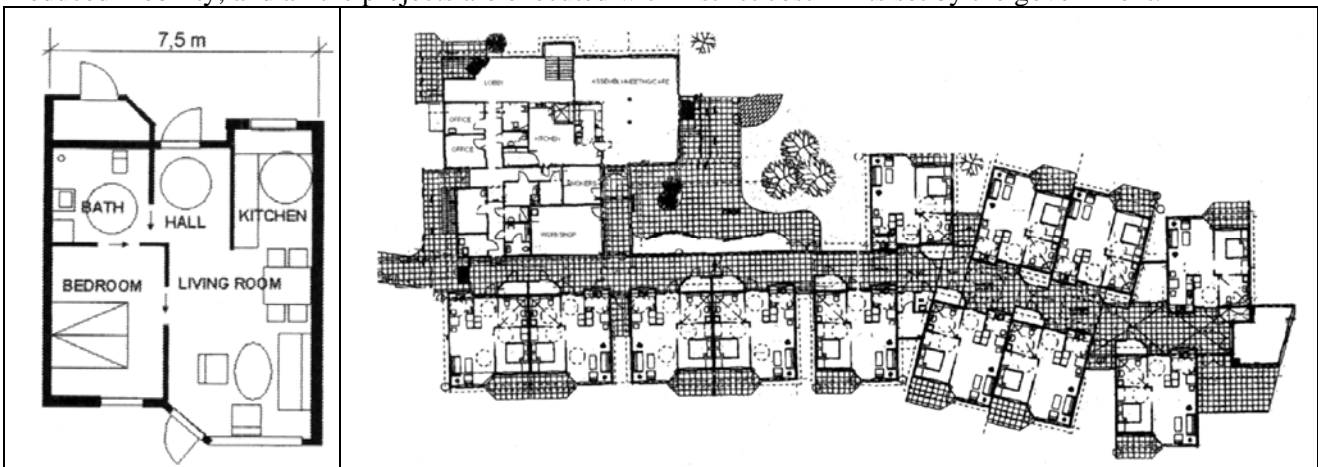


Figure 4: Example of a housing project for elderly people in the south of Norway. The project consists of two room flats arranged side by side along a common walkway and linked to the housing building for communal use (upper left hand corner of the plan)

### *A single-family house*

When buying a new house, Norwegians will commonly select a model from a catalogue of standardised house types. There are a large number of suppliers and several operate on a nation wide basis. This example shows such a model, from Norway's largest supplier of standardised house types and one of the larger building firms in the country. During the last decade, this type of house dominated the market for single family, detached houses. Interestingly, the solution not only conforms to the Norwegian life span standard, i.e. is accessible - the circles marked on the plan below indicate turning circles for mobility aids - but it is also one of the cheapest models on the market; clear proof that accessibility can be achieved without extra cost. As is obvious from the plan, the formerly popular narrow bedroom corridor that also gave access to a minimal bathroom has been replaced by a wide (and in this case two) roughly hallway(s). Thus, circulation space is controlled and an effective solution both functionally and in terms of cost is created.



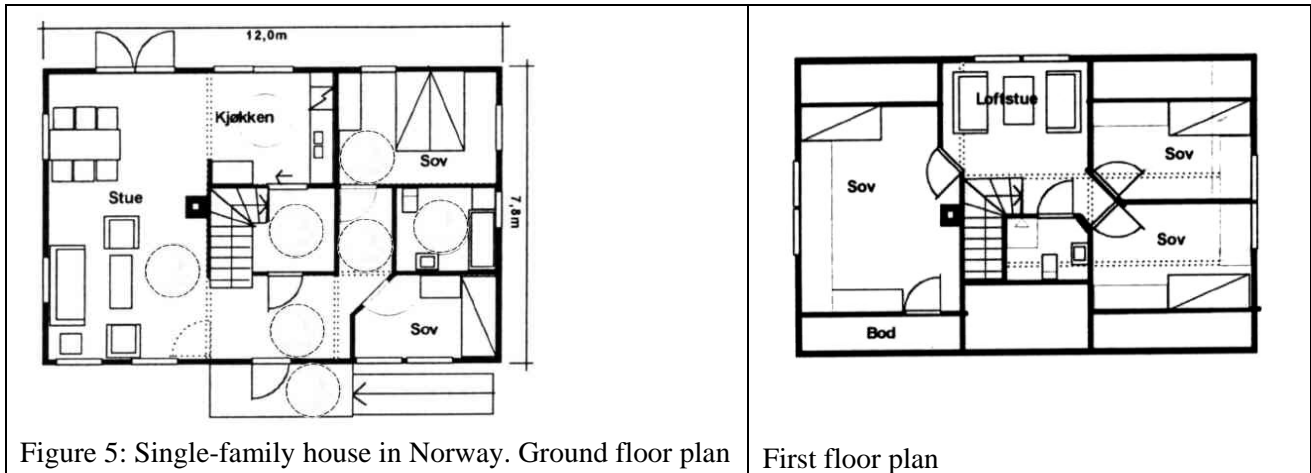


Figure 5: Single-family house in Norway. Ground floor plan

First floor plan



Figure 6: Single family house

The circles on the ground floor plan indicate turning space for wheelchairs; the plan conforms to the requirements in the Norwegian “life span standard”. The first floor plan is one of several alternative solutions offered by the supplier.

## 5 Conclusions

New residential environments must be built with a careful attention to:

- a responsive design, matching users'needs without any additional efforts in a second phase and of course including all the accessibility or Universal Design criteria;
- the support of new technologies, which can ensure a safer and more comfortable environment for any type of inhabitant, in order to carry on easier his/her daily home activities.
- the design of the supporting technology must be flexible enough to allow for different user needs and at the same time balance the need for privacy with the requirement for surveillance and monitoring necessary for safety and assistance in cases of accidents, sickness and other emergencies.

In each country designers and architects have a different concept of housing types, because of traditions and habits that in addition in the housing environment are stronger and remain longer if compared to other building types as offices or commercial centres, services, etc. Nevertheless, homes have the common focus on accessibility and the idea that everyone should be able to use their environment as much as possible as well as independently, comfortably and safely.

Common legislation is nowhere near a reality, even in EU countries, because of different cultural approaches and fears that some countries can get an advantage over another. Probably, the idea of a technical agreement on few requirements to be achieved could overcome the problem.

The idea of requirements and performance criteria rather than stiff rules is becoming accepted and adopted as an advantage for achieving a goal, even if perplexity remains among some technicians because the concept of definite schemes, rules and dimensions is easier to be followed. Further, accessibility is only recently adopted as an important tool in the building field, both at European and worldwide level. At EU level, the 6 items related to construction are recently studied and accessibility must be included in each of them, while worldwide, there is the feeling of many discussion tables that are going in this direction: one for all, ISO TG59 “Building construction”, which is finally including “accessibility and usability in buildings and urban areas” in its planning (see ISO/TC 59, Business Plan, March 2005)



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