The future of the underground space

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It is only during the last decade that there has been a growing consciousness and alertness regarding environmental problems. At the same time, infrastructure is becoming more complex, demanding extra space and directly affecting the quality of life in the urban environment. Building underground would initiate new developments and also improve the quality of life. Today, cities cannot withstand traditional planning and building practice, and in the following years they will have to go through a transformation process. This paper will deal with the planning and design aspects of a few realised underground projects. These projects are good examples of improving the urban environment just by better “layering” and concentration of functions. Through specific design proposals they also managed to improve the quality of the underground environment, showing that the prejudices regarding underground spaces, so deeply anchored, have little justification. Discussing the “Quality of Life” it is not possible to omit Information and Communication Technology (ICT), the role it can play in daily activities and influence it may have on urban forms in the future. © 1999 Elsevier Science Ltd. All rights reserved

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Introduction

It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us, we were all going direct to Heaven, we were all going direct the other way... (Dickens, 1994, p 1).

These words, dating from the 19th century, can best describe the age we are now living in. Each action and innovation seems to be controversial and awareness of such dualism brings us closer to a more pragmatic judgement. This does not exclude the decisions made by planners and architects, and the ways to deal with urban environments.

Buildings and roads emerge rapidly, invading the landscape and making the “horizontal expansion” a remarkable characteristic of the last decade’s developments. Very often this growth seems to get out of control, which in most cases results in a deterioration of environment quality. The “solution space” for improvements to the urban environment is tremendous and this paper deals with building underground, which is seen as an important area in future planning. A few other aspects from the solution space are briefly mentioned, indicating together the complexity of the problem solving area.

Trends, processes and a need for change

Understanding the importance of underground space utilisation requires an awareness of urban development trends and the course that contemporary planning is taking. In such a way, its position within planning concepts for the future can be conceived. This is also necessary to be able to justify the utilisation of this unclaimed territory.

Due to traffic congestion, increased noise and air pollution, scarce green and recreation areas, cities are
becoming “user-unfriendly” environments. Stretching the city borders and therefore invading the countryside does not solve the problems but only postpones them, making them all the more acute. For cities, an expansion of infrastructure and increased mobility are only some of the concerns at the dawn of the 21st century. The question still remains: how to solve these problems and yet manage to improve the overall quality and ensure a healthy urban environment?

Environmental concern and a need for change

Environmental concern brought in new concepts and approaches to problem solving and thinking more consciously of further urban form developments. The environment has never before been subject to such concern as it has become in the last decade, but today it has gained a global dimension since each country, in one way or another, contributes to pollution. Air and water pollution, global warming and the greenhouse effect, exhaustion of raw materials and natural resources, the loss of green/recreation areas, affected bio-diversity, are to name only some environmental concerns. This demands cleaner production technologies, but it requires bold changes in the built environment as well, since:

- 50% of material resources taken from nature are building-related;
- over 50% of national waste production comes from the building sector;
- 40% of energy consumption in Europe is building-related (Anink et al., 1996).

Apart from these facts, there is also a concern regarding population growth. It is estimated that at the beginning of the 21st century more than 50% of the world’s population will be living in big cities and metropolitan areas, and this percentage will increase further. Cities should be able to withstand such large migrations, but even with today’s infrastructure and contemporary population numbers, many cities are on the edge of satisfying their residents’ requirements.

Sustainable development and compact city

It was actually the technology boom of this century which initiated enormous changes in lifestyle and environment. All three aspects play an important role in steering the course of future planning. Throughout the centuries there has been an obvious relationship between technology and lifestyle. Only during the last decade have these two started seriously affecting, in first instance, the closest surroundings and thereafter, global, environment as well. Two very important concepts have emerged: sustainable development and compact city.

Sustainable development is development which meets the needs of the current generation without compromising the ability of future generations to meet their own needs. (Colegio Oficial de Arquitectos Vasco Navarro, 1996, p 112).

This definition of sustainable development is explained in more detail in the following quotation, where the relationship between human needs and the capacity of the ecosystem is more evident:

Meeting the needs of the present...: economic needs; social, cultural and health needs; political needs.
Without compromising the ability of future generations to meet their own needs: minimising use or waste of non renewable resources; sustainable use of renewable resources; wastes from cities keeping within absorptive capacity of local and global skins. (Mitlin and Satterthwaite, 1996, pp 31 – 32).

Since cities are seen as the main “collaborators” of unsustainable development it is no wonder that their future course of development is now being scrutinised. A compact city strategy is one of the possible paths that may lead to a sustainable urban form.

In existing cities, the concept of compaction arises through processes that intensify development and bring in more people to revitalise them. The ideas behind the compact city are an important strand in the attempt to find sustainable urban form... The vision of the compact city has been dominated by the model of the densely developed core of many historic European cities. They are seen, often by those from outside, as ideal places to live and experience the vitality and variety of urban life... (Jenks et al., 1996, p 5).

The sentence from the quotation above: “they are seen, often by those from outside...”, indicates that a visitor and a resident perceive the city differently. A visitor is attracted by city’s image and atmosphere, while a local resident there are much higher requirements regarding transport and traffic mobility within the city, quality of air, noise levels, quality of public spaces, as well as the quality of the resident’s own neighbourhood. In that sense it is much more difficult to satisfy the resident’s needs.

Having in mind all of the above mentioned aspects it becomes obvious that changes are needed in a building and planning sector.

Changes in the building sector. There is a need for new building methods, which would reuse and recycle building materials and components and therefore reduce building waste as well. These are important aspects of sustainable development, since by increasing the exploitation time of components, there is a considerable reduction of raw material use, energy used and waste produced. In this article these aspects are mentioned only briefly; more details can be found in Durmisevic (1998).

Changes in the planning sector. Three main proposals for urban form development can be distinguished (Breheny, 1996):

(1) decentralisation, which promotes very low densities;
(2) centralisation, promoting high densities;
(3) a combination of the above, proposing medium levels of density.

These concepts are present today as well, perhaps dressed in another style, but with the main idea still recognisable. Yet today the issues do not seem so straightforward, since there are other processes more actively involved that determine future urban activities. At the moment there are two main groups of processes taking place.

(1) One group focuses on finding “new expansion territories” (this can include all three processes mentioned earlier, but to greater extremes due to technology improvements).

(2) A second group that focuses on city renewal, in other words, renewal of already existing urban structures and especially improving the quality of existing city centres, which is explained in the following.

City renewal and quality of life

In order to preserve the city as a cultural, social and economic centre there is a need for more “compact” solutions. Growing cities will require more efficient use of space in the future (or in other words, multi-layered land use) particularly in city centres where demand is highest. Locating some functions (such as traffic, shopping, catering facilities, cinemas, museums and theatres) underground, will create more space aboveground for recreation and social activities in the vicinity of residential areas, and will also create possibilities for the development of new residential areas (Sariyildiz and Durmisevic, 1997). In such a way, the city’s vertical line can be utilised more efficiently by integrating subsurface spaces with the aboveground city’s network. In short, the advantages of compact cities that would make use of subsurface space would be: more efficient use of space; better traffic mobility; more green areas; reduced traffic congestion; better air quality and reduced noise level. This means that by building underground, the quality of the urban environment can be significantly improved. Building underground can be placed in both of the earlier mentioned groups, since it is at the same time an expansion territory, but it is very important for city renewal as well. Its advantage is that by building underground, valuable space is provided without necessarily extending the city’s borders, which is always the case in horizontal expansion.

City centres are mostly dense urban areas that are socially and culturally exclusive. Due to extensive migrations towards the city and its rapid growth, we could say that two important things happened which influenced the quality of life.

(1) Stagnation in the development of city centres. During the greatest migrations toward cities, the main city centres could not follow growth by offering new functions and qualities for the increased demands. City centres stagnated, while there was more interest in rapid suburban developments. The lack of activities weakened the city’s core, so that they slowly became less attractive to the resident.

(2) The main infrastructure became an obstacle for continuous city development. Constant horizontal extension of the urban fabric had another consequence. In some cases, the main traffic infrastructure (railways and highways) that was originally on the periphery of the city, was swallowed by the city and became a barrier for continuous city development, with the side effects that they brought into the city: air pollution and noise, becoming a visual, physical and psychological barrier and a nuisance for the residents.

There are examples around the world which indicate the possibility of solving this problem, through utilisation of underground space, as for example in the city of Boston (USA), where a six-lane elevated road will be replaced by an eight-to-ten lane underground expressway, a so-called Central Artery/Tunnel Project. This underground expressway “will speed the traffic into and through the city, create links to mass transit, result in a cleaner air, and in downtown Boston, create around 110 ha of new open space”. The project should be finished in the year 2004.1

Apart from such examples, there is nowadays a tendency to “heal” the landscape “wounds” caused by large masses of highway networks, so that the highways are partially covered to reduce the noise level and to provide more green areas in general. In such ways, the negative effects of built structure, such as heat emission and temperature rise, can be reduced.

From the above, it becomes clear that renewal comes as a wish to maintain or improve the quality of life in cities and to sustain an identity in the future as well. City centres should be, on the one hand, strengthened by extending functional capacity. This means that the number of cultural activities, shopping facilities and entertainment possibilities should be increased, rehabilitating the old city core. On the other hand, there is a need to deal with the traffic, especially rapid transit, that passes through the city.

Since city centres are densely built areas, building underground can accommodate many functions, relieving pressure on the surface, and it can be an attractive solution for solving traffic problems and increasing mobility. This means that the answers to urban paralysis, already a big problem in larger cities and densely inhabited areas, should be sought in better land use, particularly in city centres. That is to say, more efficient use of the vertical line by integrating the subsurface space into the everyday life of a

city. Now that it has been shown that building underground can contribute to the improvement of the quality of life in cities, it remains to be seen how to deal with underground spaces. In the following, realised underground projects in Canada and the Netherlands will be discussed, and both planning and design aspects considered.

**Montreal as an example**

When talking about more efficient use of the subsurface, it would be impossible to exclude Montreal’s underground. Many lessons can be learned from this example. The development of these underground spaces started some 35 years ago. Today, the city is well known for its underground pedestrian network, one of the most beautiful indoor cities in the world, covering altogether around 30 km of corridors, tunnels and public spaces. Its underground is well integrated with the aboveground buildings, both functionally and structurally.

In Montreal’s case, the traffic remained above ground and the whole “indoor city” for pedestrians was created underground. Here it becomes evident that better separation of pedestrians and vehicles can be experienced so that the activities of neither group would be disrupted, since direct interactions were minimised. At first sight it may seem odd that the traffic remained above ground: why not the other way round? Different factors led to the development of the underground system. It is difficult to say which of them was the most important, because they all influenced the creation of Montreal’s underground as we know it today (Besner, 1997). Three main factors are:

1. severe climate;
2. sufficient density of population and a wish to create a “compact city”;
3. development of underground transportation system and the wish to combine transport with other functions.

Severe climate was perhaps the strongest reason to design an underground pedestrian network and provide a protected environment. Due to the harsh winters (–32 degrees celsius), all underground spaces, including metro stations, are accessible through an aboveground building. Only one metro entrance is accessible directly from the street, but in winter there is danger of snow accumulation and ice formation on the stairs. Therefore, such direct entrances are generally avoided. Entrance to the metro (or other underground spaces) is therefore provided through the halls of aboveground buildings, which are either office buildings, hotels or shops. Such a concept has other advantages as well:

- it increases safety since the entrances are better controlled;
- well maintained entrances and connections to metro stations (since the entrances are private property, it is in the owner’s interest to maintain them well);
- psychological effect of descending into the underground is somewhat reduced.

The first milestone project of the indoor city was “Place Ville-Marie” (Fig. 1). It is an office tower, 47 stories high, dating from 1962, whose base was linked with Central Station via well-designed pedestrian passages. It is a multi-functional complex consisting of office space, the underground shopping centre and parking facilities. The importance of co-operation between private developers and government is already visible in this project (Sijpkes and Brown, 1997). A better quality of underground spaces was accomplished by stimulating private investments.

Other complexes followed the example of Place Ville-Marie. These complexes mainly incorporated office space above ground with shops, café-restaurants, passages, cinemas and other recreational facilities below ground. They were all well connected to the underground transportation system and with each other. In such a way, the underground network was slowly but surely coming into existence. Even tunnels, which were not combined with other functions but merely served as connecting corridors between metro and buildings, were designed with care. One such example is the corridor leading to the World Trade Centre (Fig. 2).

Since each complex was developed by different clients and architects, a variety of spaces and atmospheres is present in these centres. Various materials and colours were used to prevent boredom and tiredness and natural light was introduced wherever possible. Using transparent surfaces (on a roof or the sides of an atrium) can sometimes give extra visual information of the “world above” and in such a way ease orientation and reduce the feeling of entrapment.

Eaton Centre is another example of an underground complex, built in the 1980s, which is connected to Sainte-Catherine, one of the most important shopping streets in Montreal. Eaton Centre has a lot of natural light from the glass-roof structure, reducing the feeling of being underground (Figs 3 and 4).

These are examples of “parallel” integration of subsurface space; in other words the underground was planned simultaneously with the aboveground. There are also successful underground projects, designed under already existing buildings. Such an example is “Les Promenades de la Cathédrale”. Such interventions are much more expensive, but from an engineering point of view they are possible. This project was realised underneath a church, since it was necessary to expand functions underground and at the same time provide a continuous pedestrian network. Underground works were planned in such a way that the church was never closed during the construction period. Another remarkable characteristic of this project is that the arcades were used as a design element in the underground space, as a reminder that the
church was above that space. Such strong, metaphorical architectural elements work positively to help our orientation in the underground. The rest of the underground space is spacious, with lot of metaphors that have something in common with church spaces (Figs 5 and 6).

All of the above mentioned complexes and each metro station were designed by different architects. For the metros, artists contributed their pieces, creating in a way an underground gallery. Each metro station has its own identity and atmosphere, thus a sense of space and place becomes stronger.

The success of underground Montreal lies partially in the fact that the underground spaces were well planned and were in most cases designed simultaneously with the aboveground buildings. In that way, construction was never a problem (an exception is the project Les Promenades de la Cathedrale).

Comparison of Montreal’s underground network with underground projects realised in Japan gives a clear difference regarding spatial organisation. In Japan these projects were generally placed underneath streets, while in Montreal they were created beneath buildings (Hirai, 1997). This is directly connected to the law on land ownership, which is very strict in Japan: when a piece of land is purchased, the buyer is the owner of that land, literally to the centre of the earth. Therefore, it is financially unattractive to invest in construction underneath buildings. Schematic representations of underground developments in Montreal and Japan are shown in Figs 7 and 8.

Briefly, some of the aspects discussed in the text
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Figure 3  The glass-roof structure that provides Eaton Centre with natural light

above, and lessons learned from the Montreal example are:

• significance of integrated planning of above and underground buildings;
• importance of co-operation between private developers and government;
• using different colours and materials to create various atmospheres;
• clear separation of pedestrians and vehicles;
• introducing natural light;
• “viewable” outside world contributes to better orientation;
• entering an underground space through an aboveground building;
• metro stations designed by different architects;

Other aspects of building underground

Even though building underground is not something new for mankind it still seems to be a taboo subject and in discussions it is referred to as one of the last frontiers. In different countries, cultures and periods, it has had different meanings and has been utilised according to the needs of the era. It has served as a shelter, storage place and a graveyard. Books have been written on the subject, exploring the psychological aspects and associations that one has with the underground. Some of the drawbacks and negative associations with the underground that are mentioned in Carmody and Sterling (1993) are:

• darkness combined with humid air;
• underground is also related to death and burial;
• fear of entrapment from structural collapse;
• disorientation;
• loss of connection with the natural world;
• lack of natural light and poor ventilation.

Today’s technology has been able to cope with and overcome many of the above mentioned aspects, and expectations are that in the future it will deal with such problems even more effectively and efficiently.

Building underground in the Netherlands

To some people this may seem to be a very curious phenomenon due to the fact that a large part of the Netherlands is situated below sea level, so one may wonder: why go even deeper? In the Randstad area (most populated part of the Netherlands) the cities
converged and thus terminated further growth. For these cities, there should be an alternative solution which allows further growth and at the same time facilitates the acquisition of desirable qualities of urban life. The solution for Randstad could be to build more compactly. This does not mean that the number of people living in a square kilometre would increase, but that the city’s vertical line would be used more efficiently such that the underground would be fully integrated with the aboveground. Some advantages of the compact city were mentioned earlier.

Over the centuries, the Dutch have learned to reclaim land from the sea and to build new cities on this artificial land in order to provide more space. It is a small country (around 41,160 km²), with a density of 365 people per km² (Bartolomew, 1995). Therefore, locating particular functions underground (such as traffic infrastructure, cinemas, theatres, museums and shops) will create more space aboveground for recreation and social activities, improving the quality of life. Perhaps building underground seems to be yet another challenge for engineers, but for urban planners it is not only a challenge but perhaps the only way out. In order to preserve historical city centres and also provide the infrastructure and other facilities necessary for modern cities, it seems logical to integrate subsurface space to relieve pressure from the surface area.

In the most global context, underground can be planned (Durmisevic and Durmisevic, 1998) as:

1. under an already built environment;
2. part of city reconstruction;
3. part of new urban complexes (either empty areas within urban fabric or outside the city’s boundary).

A great number of the underground projects that are currently being realised in the Netherlands are built under the existing streets or open spaces and squares. This is logical, considering costs, but one should bear in mind that these projects should not remain isolated.
“underground islands”, but should be integrated in the whole planning of the underground for the future.

Two recently completed projects will be explained in more detail. These are the Metro station “Wilhelminaplein”, and the shopping centre “Beursplein”.

The Metro station “Wilhelminaplein” at “Kop van Zuid” is situated in the southern part of Rotterdam. It is an interesting project both from an engineering and an architectural point of view. The station is part of a larger project planned for this area that will include a business centre, apartment buildings and recreation facilities (the whole area covers about 125 ha).

There was an existing metro tunnel, consisting of two tubes, but due to the planned future development of the area a new station was considered necessary. The existing tunnel was 10 m wide and 6.5 m high. It was necessary to widen the existing tunnel and to connect it with the surface. The total length of the station was planned to be 130 m, and its width to vary between 28 and 17 m. A deal was made with the metro company to build a station without obstructing daily traffic, which was a real engineering challenge.

Platforms have a 4% slope, that was taken over from the existing tunnel (Feijen, 1995) (Fig 9).

The wall that once separated the two tunnels was partially broken with circle openings (Figs 10 and 11) in order to provide visual contact between platforms and to increase social control.

Reflective materials were applied to different surfaces, giving the illusion that each of these surfaces is a source of light (Fig. 12). There are two levels below ground where one of them represents a “split” level. That level stretches out in such a way to provide an overview of the level below, which increases the feeling of safety (to be able to see and to be seen). Platforms are very spacious due to the width and double height provided by a short length of a split level.

From an architectural point of view this station is well integrated with the aboveground surrounding buildings. The bright colours and reflective materials, together with the spacious design of the platforms, reduce the feeling of being in an enclosed, underground space.

“Beursplein” is situated in Rotterdam city centre and is one of the locations that is planned to expand the existing functions (ten Cate and van Deelen, 1995). It is a major shopping area in downtown. The
whole project consists of around 30 500 m² new shopping space, a high-rise apartment building (108 apartments) and 460 parking places. An interesting aspect of the complex is a sunken shopping street of around 10 000 m². It is connected to the underground metro station, which had to undergo some changes to sustain increased capacity, so both platforms were widened by 2.5 m (Booij and Nijhout, 1996).

The sunken, spacious street (Figs 13 and 14) is encircled by shops on both sides and represents an extension of a shopping street that gradually descends underneath a very busy street (Coolsingel) and again slowly rises to street level. To gain extra space for shops the most logical solution was to let pedestrians pass underneath the street, using the sides as entrances for shops so that entrance to the aboveground major shopping malls is possible from the underground level as well.

The main idea was to separate pedestrians and traffic or in other words to avoid crossings at the same level. In such a way, two independent levels of circulation were established and a continuous pedestrian shopping route was accomplished by passing underneath the Coolsingel.

Building underground is a new frontier for the Netherlands, and only in the last decade has it gained more attention. Due to a high water table and very soft soil, only utilisation of a near subsurface area would be lucrative (two to three levels below ground). A wish to introduce natural light as much as possible also plays a role in the decision to exploit only a few levels below ground.

From the above discussed realised projects, the following aspects regarding the planning and design of underground spaces can be summarised.

**Planning aspects**
- Co-operation between private developers and
government made it possible to realise larger underground projects (case of Montreal).

- Integrated planning of above and underground building reduces significantly investment costs.
- Partial placement of public transport (highways and railways) underground provides more continuous city development (no physical barrier or spatial segregation).
- Planning underground public transport inside city centres can be a stimulant for placing other public functions underground which in return would:
  - ennoble, animate and give an extra quality to underground spaces;
  - enable capacity extension of functions in city centre;
  - improve the quality of aboveground area (possibility for more green areas, less crowd, doubling function capacity, etc.).
- Clear separation of pedestrians and traffic provides less confusion and better mobility of each group.

**Design aspects**

- Using different colours and materials introduces variety in atmospheres and creates dynamic in underground spaces.
- Using natural light as much as possible has a positive effect, since it gives information about the outside world, brings dynamic in underground due to light intensity changes and in some cases can contribute to better orientation.
- Entering underground spaces through aboveground buildings can have many advantages, such as increased social control, in a psychological sense the inconvenience of descending into the underground is somewhat reduced, etc.
Spaciousness reduces the feeling of entrapment, especially if there is large concentration of people, but if not used in a correct way it can have the opposite effect, since it may create a feeling of disorientation.

Proportions (depending on function) and variety in height are important tools for underground design.

Using reflective materials creates a feeling of spaciousness by reflecting light in different directions, but should be used carefully not to overload space with light and thus cause temporary “blindness” and irritation.

**Information and communication technology**

We are living in an age of information and, moreover, in an era of communication and information/knowledge exchange. Today it is difficult to imagine life without the tools that make this feasible. Information footprints of different civilisations are everywhere to be found. The first sketches on cave walls tried to hand over information and knowledge of that time. Thanks to these drawings and archaeological findings, we can understand history and the ways in which our contemporary world is being shaped. That was perhaps, in the most abstract way, the beginning of Information and Communication Technology (ICT).

Later, written text was inscribed on stones and walls, papyrus, then on paper. With the development of printing technology, newspapers were created, followed by magazines, the invention of television, telephones and fax machines. In short, information started to globalise.

Development of computer technology happened and a real breakthrough in ICT was the Internet. It is not actual physical presence that is so important, but the telepresence. Being connected to the information superhighway we can reach and can be reached everywhere. Exchanging and obtaining information and knowledge happens within few seconds. Actual, physical place is of less importance (Mitchel, 1995).

Dependency upon information has become very high and the idea of being able to gain that information from our home may influence the development of new concepts for our urban environment. This means that a working and home environment will be influenced. Teleworking, video-conferencing, distance learning and “virtual offices, commerce and universities” are becoming more common. With further developments of ICT, people will work and spend
more time in general in their own homes so that the need for office buildings will diminish, but direct social contact with people will still happen outside homes (Volker et al., 1996). The need for travel and physical mobility will remain very important.

On the one hand it seems that the development of ICT would stimulate decentralisation, for example dispersal of offices and working places, since it is possible that offices will leave the city centres. This is already happening in Japan, where satellite offices have been created on the edges of overcrowded Tokyo (de Pous, 1995). But on the other hand, it may stimulate concentration and the creation of smaller communities that are well connected with each other and with a main central core of the city. The centre of a city will in future represent not so much a business centre, but a recreational centre and concentration can be expected around major transport stations.

It is self-evident that ICT already has an influence on transportation and therefore on mobility as well. In the main ports, such technology is applied to improve the logic of the transport sector. This has in a way an impact on mobility and environment. It may be expected that in the near future transport of goods will be automatically operated by computer systems and preferably that will be done through underground tunnels. Realisation of such concepts is only possible due to technological developments of both tunnel construction as well as control and automatically operated systems.

In short, some areas where changes can be expected due to the development and implementation of ICT are:

1. medical care;
2. education;
3. transport and mobility;
4. recreation and free-time entertainment;
5. spatial planning of cities.

Bringing changes into the above mentioned areas will influence our daily life in different aspects and therefore it can be expected that the organisation of our cities will undergo modifications as well (Durmisevic, 1998).

Conclusion

Concern for our environment has wrought changes in city planning and building design which were necessary for maintaining the quality of life in urban areas. Architects, planners and engineers have a great responsibility which lies in the fact that they are constantly taking actions in the environment and in a way stimulating new technological innovations, but at the same time implementing already available technologies. In all their actions, the main concern should be the human aspect and the wellbeing of mankind in designed environments because, after all, humans are the final users of a product whether it is a chair, house, public space, road or city. On our way to achieve a more liveable and pleasant environment, we should monitor carefully the way we achieve our final goals. How we get there remains the main question. Protecting the natural environment as much as possible, reducing pollution, supporting existing ecosystems in our environments are only some actions that need to be taken care of.

Building underground can improve our urban environment by relieving the pressure on the surface, developing better public-transport networks, reducing noise, leaving more green areas in city centres intact and reducing distances by better concentration of functions. Achieving more compact cities can become an important part of sustainable development. At the same time, it is necessary to keep in mind the developments of ICT because it may become one of the major triggers of change in city planning that will guide and dictate future transformations (Durmisevic, 1998).

References


