Societal change is often claimed to be one of the driving forces behind urban development and the definition of urban projects. In the 20th century, the economy changed from industrial production and distribution to knowledge-based service and creation. The rapid development in modern times of the economy and technology have expanded the operating scale from local to global. During this 'process of modernisation', the physical presence of our urban configurations and networks has become both a product of and a witness to these historical forces of change. This is exemplified in urban development by aspects such as scale-enlargement and functional specialisation. Take for instance a European city like Amsterdam and analyse a square mile of historic texture. It will be seen that within this historic texture, there as many jobs as there are beds. Take the same square mile of 20th century texture and you will most likely end up counting only jobs or only beds, as is shown in figure 1.
On observing the deindustrialisation of Western cities, the process of spatial and functional segregation in the Netherlands can be seen to be proceeding at an ever-increasing speed. (Louw 2005). This is often explained along the lines of rudimentary ‘modernist’ planning principles which are in fact products of the industrial revolution. At the same time, new types of urban projects are emerging in the peripheries of 20th century cities where the mono-functional territories of industrial areas, fit for either housing, production or recreation, are transformed into territories of a new kind. Examples of such projects in Amsterdam are the IJbever, the Eastern Harbour islands, the Metropolitan South-axis, Amstel Two and so on. All these urban transformations have in common the fact that they aim to create attractive urban environments reminiscent of the classical European city with equal amounts of housing, residential amenities, employment and public space within a walkable territory with a view to creating liveliness, urbanness and dynamic diversity. The working facilities in these new urban projects target the knowledge-based economic sector and examples of the new emphasis on the ‘creative class’. The housing programme is no longer aimed at emancipating the blue-collar worker, but seeks to provide an attractive, communicative environment for the knowledge workers and creative professionals of the 21st century. As Richard Florida puts it in his new book ‘Who is your city’, professionals of the creative class are drawn to the mixed districts he calls ‘design gigs’ and ‘urban mosaics’ (Florida 2008).

Among the quintessential dynamics of European cities is the simultaneous transformation of many centrally located low-density mono-functional industrial territories into high-density mixed-use urban districts. It could be said that regardless of the number of ways in which these interventions can be designed or can appear, this type of urban project is the product of a societal change from an industrial to a knowledge-based economy. The main actors in this transformation are no longer the omnipotent, post-war city governments, but to an increasing degree, public-private partnerships and even privately owned companies engaged in city development (Meyer 2005). The role played by residents or ‘consumers’ today is more emancipated than in the past. The modernist perspective on residents as victims in need of care in the form of increased hygiene and daylight has dramatically evolved into a perspective on residents as spoilt, highly-individualised consumers in pursuit of an ‘all inclusive’ metropolitan lifestyle. Seen from a global perspective, the keywords of the new urban European dynamics could be formulated as quality, wealth, individuality and sustainability. These are quite different characteristics than those of the post-war period or for instance the contemporary Asian urban dynamics which are to some extent defined by quantity rather than quality and improvement rather than emancipation.

As pointed out by the French urban theorist Francois Ascher (Ascher 2005), our current processes of urbanisation are determined by deindustrialisation and a reflexive modernisation. These are accompanied by the reappreciation of the mixing of uses in order to create the right conditions for urbancy, economy and consumerism and a striving for compactness contributing to sustainability. The problem however is that the theoretical framework on mixed use from a perspective on planning and development is ambiguous, fragmented (Louw 2004), and fails to provide answers to questions as to how to define mixed use, what is a good mix, the nature of the scales of relevance and especially how mixed-use development can be made instrumental by planning policies. On regarding current planning policies and talking to planning officials, urban designers and other developmental actors, it could be concluded that the reappreciation and implementation of mixed use is largely an empirical and practical matter and by no means positioned within the academic or theoretical debate. One of the standard works on the history of the European City, ‘The rational City’ (Castex 1990), notes solely that starting at the late 19th century, the mix of uses on the level of the block has gradually disappeared, failing to analyse what this has meant for the functioning of the urban realm. A framework integrating the history, the definition and the instrumentality of mixed-use development would contribute greatly to a better understanding and a more appropriate modification of our urban environments.

The starting point for this paper is the spatial and programmatic organisation of our projects and cities as can be seen in the historically evolved environments of cities such as Amsterdam. The central focus will be the physical disposition and proportioning of different functions within built substance in building blocks and districts. The definition of mixed use and urban development by the distribution of different functions within the built mass creates a platform for an interdisciplinary discussion and comparison, ultimately resulting in a better understanding of urbancy, opening a gateway to new operational approaches. This paper advocates the conception of an index for mixed-use development that is comparable to other generic indexes for urban development such as FSI, OSR and GSI. These are commonly implemented around the globe to define the outlines of urban planning dynamics. In order to arrive at this indexation, this paper takes a few necessary steps with a view to conceiving a mixed-use framework: an historical overview (3) an analysis of actors and factors (4), a description of the physical and spatial aspects (5,6) the definition of an index (7) and the testing of this index in the city of Amsterdam (8,9).

**PROBLEM DEFINITION**

Taking physical reality and the way it is used and appears as a point of departure for research and analysis is a commonly used technique (Boomkens 2005). In the same way as studying the city to arrive at conclusions about societal transformations, this paper takes a mixed-use perspective on urban development with a view to drawing conclusions on the urban transformations of our time. In order to render these transformations visible and measurable, an index is created to analyse the distribution of housing and work within our build-
ings, districts, cities and projects, assessed by the physical space they occupy. This paper is structured on the basis of the following questions:

- How has the mix of uses evolved from a historical perspective?
- What actors are involved in the creation of mixed-use environments?
- How can mixed use be defined in terms of function and space?
- How can the mix of uses be reduced to elementary terms?
- Can the mixed-use character of districts be expressed by an generic index?
- Is there a relationship between the mixed-use index, the positioning, the working and the developmental history of urban districts?
- How can a mixed-use index be used in urban planning and analysis?

MIXED USE FROM THE PERSPECTIVE OF THE 20TH CENTURY

In the classical city of Amsterdam, the diversity of the urban mix in terms of programming and social-economic categories was a natural given (Wagenaar 1991). Descriptions of mercantile Amsterdam in the 18th century present a picture of a city where production and consumption, rich and poor, administration and commerce were neatly interwoven. The transformation of a mercantile economy into an industrial economy led to scale enlargement and specialization also in terms of urban space and functions. A rudimentary system of zoning and the separation of functions has existed in Dutch cities since medieval times, especially with regard to patient care for contagious diseases, the storage of explosives and activities requiring large amounts of space or the proximity of open water for instance in connection with windmills and shipyards. An early example of the concentration of production dates back to the 15th century where a whole district within the city walls of Leiden was appointed for the production of textiles (Taverne 1978). The phenomena of mixed-use urban tissue was self evident and did not in fact become a theme until the introduction of modernist city planning.

In most reviews on mixed-use planning, the separation of functions is proclaimed as a product of the ideology of Le Corbusier and the CIAM charter of Athens (Van der Woud 1983). The Charter of Athens does indeed argue strongly for the separation of functions of living, working and recreation into appropriate specialised districts. However, as it has been disputed by planning historians, by arguing for separation, in retrospect, the modernist movement embraced a development that had already proved itself to be irreversible and disputed by planning historians, by arguing for separation, in retrospect, the modernist movement was that it made the implacable separation of functions an aesthetical goal with a view to creating urban projects that at least appeared to be clean, efficient and well-organised, in contrast to the dirty and messy cities of the late 19th century. The first person to criticise on a global scale the results of the separation of urban functions gone awry, destroying civilised city life, was the much acclaimed Jane Jacobs (Jacobs 1961). Looking back at ‘the life and death of great American cities’, we can conclude that the argument for mixing primary and secondary uses was her focal message. It was in the 1950s that the concept of mixed use, which before modernity had been self evident, was officially introduced and became a relevant issue.

The introduction of the mix of uses in modernist city planning can be pinpointed as a critical moment. The second critical moment in the life of mixed use was after the oil crisis in the 1970s, when the concept of the ‘compact city’ entered the stage (DRO 1984). The preconception of the compact city had its origin in the notion that a concentration of people and activities could contribute to lowering energy consumption by reducing the amount of commuter traffic, thus enhancing densities and bringing workplaces and the city into relative proximity. One of the fundaments underlying this relatively naive idea was that before the notion of the ‘network city’ was introduced, it was assumed that most people lived in neighbourhoods close to their workplaces. The striving for a mix of uses generally resulted in a better provision of amenities required in housing areas on the basis of a social perspective, such as shopping centres and community centres. At the same time, in the 70s, many corporate offices and urban amenities withdrew from the city centres. A substantial mix of work and housing in new developments was out of the question. In Amsterdam for instance, the rising demand for office buildings as the production platform for the service economy was met by the construction of mono-functional office parks (DRO 1980) in a manner analogous to the positioning of factory complexes next to newly built ring roads, without reflecting on how mixing these offices with residential areas could contribute to the urban quality or the urban lifestyle.

The mixed-use ideology reappeared in yet a third form in the late 90s. Creating vibrant new urban concentrations in the global competition for the information economy was inspired by the belief that to stand a chance on the global stage as an urban area, a concentrated mix of as many urban activities as conceivable was required. This belief was expressed in projects such as the Docklands in London or Potsdamerplatz in Berlin. In response to the master-plan for the Amsterdam South Axis (DRO 1998), the concept of a mixed-use environments on both a district and a city block level re-emerged as an issue in the Netherlands. The notion of attractive urban environments with an intense mix of different attractions in close proximity to each other had been set out by Richard Florida in his book ‘The rise of the creative class’ (Florida 2002). The writer argues that positioning in an attractive urban conglomeration where economy, leisure, entertainment and living are interactively organised has become one of the key elements for economic success in the information age. In the information age, the key capital is comprised of intellect and talent and only companies located in top class urban environments can attract the best minds and people to work for them. A mediocre highway office park without amenities will simply not do anymore.
as professionals of the information age wish to bike to their offices, go to lunch in designer restaurants and end the day at a gallery, a museum or a concert.

It can ultimately also be argued that urban diversity is always a product of a process of cyclical transformation, since almost no quarter or district displays rich diversity immediately after being built. Considered from this perspective, mixed-use urbanity can be seen as the urban patina after numerous steps of transformation and redevelopment, resulting in richness and diversity. One could debate whether the creation of mixed-use high-density urban districts in compliance with the requirements of the information age and the information economy is unique to our era or rather a historical phenomena that is bound to take place in the long run. It could be that a return to a more classical mixed urban tissue in the 21st century is a correction of the modernity of the 20th century. Nowadays, classical urban environments and inner cities are more popular than ever (NRC 2008). The mixed-use character of city districts will be the subject of analysis in paragraph 8 and 9 following a more investigative approach to the theoretical framework of mixed-use development.

MIXED-USE ACCORDING TO PROFESSIONAL ACTORS

The traditional problem in urbanism is that urban development is a product of multi-actor processes and the refined interaction between the reflexes of politics, administration, law, economy, culture and technology (Boelens 2006). Within this broad spectrum, the theme of mixed use can be approached along the lines of many actors and factors, all imposing constraints of a conflicting nature. Something that often occurs in the debate on mixed-use planning is that by focusing on an individual actor or factor, the complete picture is lost. In figure 2, the realisation of mixed-use environments is represented as a cyclical process where many aspects of mixed-use are identified and classified in the realms in which they belong, namely factors, actors, programmes, designs and effects. The interaction between these realms gives rise to the context within which the mixed-use environment originates.

The author’s professional experience as well as conversations with a number of different actors involved in mixed-use development in the Amsterdam region in the fields of public policy, project development and urban design have been translated into both arguments in favour of mixed-use development and obstacles to achieving it. One of the main sources is urban planner Pi de Bruijn, who acted as the supervisor of large scale Amsterdam planning projects for many years. According to him, in terms of the final result, it is design that is instrumental, but the willingness and ability of non-design actors is decisive in achieving attractive mixed-use projects. The pros and cons can be divided into multiple categories referring to different time and space perspectives. In figure 3, the most frequently heard arguments put forward by professionals relating to mixed use are organised and classified around common denominators.

<table>
<thead>
<tr>
<th>Arguments in favour</th>
<th>Obstacles against</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Functionally diverse environments create liveliness and conveniently accommodate the spectrum of daily human activities.</td>
<td>1. Due to economic performance, different approaches for working areas and housing development are required, resulting in a geographical separation.</td>
</tr>
<tr>
<td>2. Mixing housing and work gives rise to increased around the clock human activity, resulting in more controlled, efficient and safe environments.</td>
<td>2. A single person or commercial or corporate entity rarely has developmental knowledge with regard to different functions and programmes.</td>
</tr>
<tr>
<td>3. Mixing work and housing can greatly raise the potential for amenities from both the perspectives of consumers and entrepreneurs.</td>
<td>3. Developers, consumers and end-users always fear in advance that other activities will harm the real-estate values of their property. Mixed use is seen as a risk.</td>
</tr>
<tr>
<td>4. Different functions lead to different building types resulting in greater spatial differentiation, diversity and richness.</td>
<td>4. Policy-makers are afraid to introduce mixed use as a principle as it is harder to control and manage its development.</td>
</tr>
<tr>
<td>5. Mixed use leads to the optimisation of land use by using roads, public space and parking for both working and living during the day and in the evening.</td>
<td>5. Modernist remnants of the functional city which lead to separation prevail in developmental processes.</td>
</tr>
<tr>
<td>6. Mixed use in high density environments potentially reduces commuter traffic and increases the potential for public transport, thus contributing to sustainability.</td>
<td>6. Legal planning documents are not able to deal properly with mixing categories. An instrumental description is lacking.</td>
</tr>
<tr>
<td>7. Mixed-use environments are more sustainable since they can change incrementally by transforming functions in individual buildings over time.</td>
<td>7. The perspective on mixed use is actor related, as when making plans, the different actors involved discuss different things on different scales.</td>
</tr>
<tr>
<td>8. Mixed-use developments provide flexibility in developmental strategies as housing and offices can be exchanged within a single development due to market demands.</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2
Actors, factors, programmes, designs and effects in mixed-use development.

Figure 3
Arguments and obstacles concerning mixed-use development.
After examining the pros and cons, it is evident that from an ideological point of view, the goals of mixed-use development are very clear. At the level of practical implementation however, there are many obstacles to be overcome. Points of attention hereby are risk avoidance, scale enlargement, the rationalisation of developing corporations and the segmentation of public policy. Many reflections on mixed use are lost in a single-aspect analysis. A good overview is required to understand the complexity of mixed-use development.

Conversations conducted with professional actors have made it clear that a generic definition of mixed use related to scale and programme is lacking and that increased control and the development of mutual understanding is required. It has also become clear that for the definition of a theoretical framework for mixed-use development, an analysis of the spatial and programmatic content of our physically built substance is a good start. Taking the built substance as a point of departure, this analysis of mixed use should include a clear understanding of physical aspects like scale, functions, development and grains.

DEFINITIONS AND SCALES OF MIXED-USE DEVELOPMENT

With the cyclical reoccurrence of the mixed-use theme, many definitions and descriptions have been introduced by, for instance, Jane Jacobs and the Urban Land Institute (ULI) and more empirically in the practical documents of DRO Amsterdam city planning. As was concluded by Rowley (Rowley 1996), none of these are very precise or conclusive. It could be said that although all these definitions touch upon the same subject from an urban planning and design point of view, there are still a number of definition problems.

The following gives an idea of source book definitions put forward:

Jane Jacobs (Jacobs 1961) argues that mixed-use urbanity within the public realm is produced through a fine-grained mix of uses. This mix consists of primary uses and secondary uses, whereby the primary use creates the potential for the existence of the secondary use. Main activities considered are for instance working or living, while the purpose of the secondary use is to service the primary use. Examples of secondary uses are shops in a living district or repro-services in an office park. A mixed-use area is an area with a mix of primary and secondary uses, and a living district with only shops is therefore not considered ‘mixed’. The same applies to a cafeteria in an office park which is also not considered mixed use.

The definition of mixed use put forward by the ULI (ULI 1987) determines a mixed-use project as having at least three different revenue-producing uses physically and functionally integrated into its design. The definition clearly focuses on mixed use within an architectural project. The planning council of Amsterdam defines mixed use (‘functiemenging’) as the simultaneous presence of for instance working and housing, or a strong differentiation of economic categories within the domain of working or housing. The council recognises three aspects of mixed use, namely concentration, dispersal and a diversity of uses (DRO 2007).

It is noticeable that especially a definition of scale is absent in the discussion on mixed use. For Jane Jacobs, the relevant scale level is the neighbourhood. For the ULI, it is obviously the level of the building which is relevant, while the Amsterdam planning office mainly focuses on the disposition of uses within a district. The serial progression of scale levels is thus: building/ block/ neighbourhood/ district/ city/ region. The afore-mentioned definitions each refer to another scale. If a mix is achieved on the district level, this does not mean that there is also a mix on the block level and vice versa. One could say that the level of ‘mixedness’ depends on the scale of perceiving. From a societal point of view, there has always been a mix of human activities in the areas of working and living in the city, but over time, as a product of mobility, the distance between these complementary activities has grown dramatically. At the same time, the scale level of the physical mix and the grain size of working and living activities has also increased. Simply put, one can say that during the period of industrial modernization, the scale level and grain size of mixed use expanded from a mix on a building level to a mix on the level of the district. In the densely occupied 19th century city, in apartment-buildings, each floor was occupied by housing combined with small businesses. The late 20th century, whole city districts were gradually occupied by a single type of housing or a single type of production facility. In the course of time, the mix evolved from the scale of a building to the level of the city itself. It may well appear to be the case that in the network city, the most prominent mix of activities can be found at the grain size of the region, the nation or the continent.

One of the essential results of mixing uses within the framework of the walkable scale of the block and the neighbourhood is the generation of a public realm. The flow of people, all with a different destination, moving through the built substance within a limited amount of public space gives rise to a feeling of urbanity. The dynamics of seeing the unexpected or the surprising is the decisive quality of mixed urban environments. The spontaneous social and commercial potential of the city and city life is a product of a specific mix of activities and their appropriate grain sizes that converge within a limited spatial boundary. This is the scale level to be considered in this paper.

It has become important to identify the relevant uses (functions) and the way their combinations result in mixes and mix-typologies. When regarding a return of mixed-use development as a planning principle, it is essential to define the main functions and the functions that can be mixed to result in certain effects. In most discussions on mixed use, the diversity of functions is limited to housing and amenities, but this view is too narrow. As stated in the Charter of Athens (Van der Woud 1983), the four basic urban functions are housing, working, recreation and infrastructure. Obviously not all functions are mixable; a significant
amount of all land use is designated for the purposes of production or storage that bring with them the potential danger of explosions or injuries or that simply produce polluted air and a great deal of noise. These functions cannot be integrated within an urban function from a safety point of view. In most countries, the zoning law prohibits the proximity of such functions to living or working areas.

Besides the specific risks attached to certain uses, another decisive denominator is the difference between use for private and use for business activities and between working and living. One could say that these are the cutting edges between uses as they relate to different space-time perspectives. In the same way that living territory is returned to after work, work is what one goes out to for a specific period and for a specific purpose. The difference in the appearance of buildings for working and housing and the specific flows of goods and people these activities induce, districts specialised in either use look totally different in appearance and atmosphere. Although we are aware of the difficulties of creating mixed environments, from an ideological perspective, there is no reason why offices and housing should be kept within their designated territories. The preeminent argument for increasing the urban mix on a block and neighbourhood level in the information age is the fact that the production in this age is relatively clean and sustainable as most people work in offices. Of the urban mix on a block and neighbourhood level in the information age is the fact that the appearance and atmosphere. Although we are aware of the difficulties of creating mixed environments, from an ideological perspective, there is no reason why offices and housing should be kept within their designated territories. The preeminent argument for increasing the urban mix on a block and neighbourhood level in the information age is the fact that the production in this age is relatively clean and sustainable as most people work in offices. Offices mix easily with surrounding housing functions and vice versa. Combining them adds to more liveliness and social safety. Figure 4 makes an exemplary division between unmixable and mixable urban programmes.

### Figure 4

#### ‘Mixable’ and ‘Unmixable’ urban functions.

1. **Non-housing**
   - Energy production
   - Waste management
   - Industrial plant production
   - Harbour
   - Airport
   - Distribution
   - Oil refinery
   - Etc.

2. **Non-housing**
   - Offices
   - Arts and Crafts
   - Retail
   - Restaurants
   - Bars
   - Hotel
   - Leisure
   - Care
   - Culture
   - Media
   - Religion
   - Education
   - Sports
   - Etc.

3. **Housing**
   - Apartments
   - Row houses
   - Detached houses
   - Villas
   - Flats
   - Etc.

### URBAN MIX-TYPLOGIES

As in the last ten years Amsterdam flagship projects have shown to an increasing degree, urban projects can be considered ‘mixed’, while the grain sizes of housing, offices and amenities within these projects are diminishing, resulting in lively urban environments. One of the essential questions however is what a good mix should entail with a view to creating the benefits of mixed use on district scale. Take for instance the IJburg project, an artificial island east of Amsterdam with over 20,000 houses, a relatively high-density project with a very small proportion of non-housing functions. Based on what facts did the planners choose this mix proportion? How is a mix generally defined within new urban projects? Is it solely based on market expectations or demographic extrapolations or can a mix be proportioned according to values that result in beneficial effects based on experience and reference districts?

In order to get a grip on mix proportions, two examples of urban mixes are analysed, the poor mix of office parks and the rich mix of metropolitan downtowns. On considering the land use of our cities, one can see that many offices are still located in mono-functional areas. Not surprisingly, rent levels for the relatively low amount of office space located in mixed areas are usually substantially higher than elsewhere (Van den Hoek 2007). In the Netherlands where massive office vacancies are prevalent on the office market, vacancies are concentrated within mono-functional office parks, whereas all offices at mixed locations have vacancies representing less than 5% of the total floor space, which is considered to be a healthy rate. On asking office end-users, it becomes clear that it is not the buildings itself that are the problem, but that they simply prefer to be accommodated at a location providing civic quality and a public realm. It is obviously the mix or better put the lack of a mix in these areas that make them unattractive. Judging by these facts, one could assume that there is a great potential for the further integration of office space within mixed urban districts and developmental projects, especially when one realises that 85% of all working locations are still in mono-functional territory.

The second example can be seen when we shift our attention to metropolitan centres. The common-sense approach in these areas dictates that the proportion of residential and non-residential use should be 50/50 with a view to creating urbanity. In the Amsterdam canal zone, the residential/non-residential ratio has been 50/50 for a long time. Non-residential floor space is occupied by a heterogeneous mixture of institutions, amenities, offices, shops, restaurants, etc. To quickly check the validity of this 50/50 division in the Amsterdam city centre, literature on other metropolitan city centres, for instance Barcelona, is studied. It does not come as a surprise that inside the city ring of Barcelona, the ratio of residential to that of non-residential use has been around 50/50 since the beginning of the 19th century (Busquets 2005). The metropolitan urbanity of Barcelona within the ring and the canal zone
of Amsterdam provide experience-based proof that in order to create a lively and vibrant city centre, the 50/50 ratio works. After citing these two examples, the question arises as to how this mix proportions should be defined for other city districts in order to create an apt mixed use giving rise to an urbanity fit for the location.

The central assumption in this paper is that the contrast in uses of a working and a residential nature organised in a city district on a walkable scale creates an atmosphere of urbanity. Hence, the character of an urban district is highly defined by the ration of housing to non-residential use in a district, and the way these opposites are mixed in terms of grain size. The residential part represents the homogeneous mix of housing programmes, ranging from canal houses to high-rise apartments. The non-residential part covers the whole spectrum of amenities, retail trade, shops, offices, production, administration and so on. Could it be that from a historical perspective, all types of urban districts have their own mix-typology defined by the division between housing and non-housing, which to some extent is a product of the historical period in which they were conceived? In order to get a grip on the differentiation of mix-typologies, a number of districts in the Amsterdam context will be analysed regarding their mix in terms of housing versus non-housing.

CONCEPTION OF A MIXED-USE INDEX (MXI)

Generally, urban projects are defined in qualitative terms that are strongly related to their urban design, their architecture and their intended allure and identity. When discussing urbanity with design and planning professionals, urbanity is seen rather as a product of design than as the result of programmatic ingredients. A quantitative approach to urban planning and the definition of urban projects is still underdeveloped in the Netherlands, especially when it comes to mixed use. Well-known indexes such as FSI, OSR and GSI are commonly used around the globe (Berghauser Pont 2004). They refer to the physical aspects of plan dimensions projects such as the site area the floor size of buildings, the footprints of buildings, the size of the public space and the number of floors. However, these indexations do not describe the distribution of different uses within an urban project. What the indexes do is predict and indicate the volume or the massiveness of a project. On discussing residential projects, the afore-mentioned indexes can indicate the housing typology (Berghauser Pont 2004). When it comes to describing the urbanity or functional diversity of a project, indexes such as FSI, OSR and GSI do not really have a predictive value.

In order to render urban mixes and mix-typologies suitable subjects of debate, comparable and ultimately instrumental, it is vital that the mix and mix-typologies are made measurable and can be easily indexed. The question is the way in which the complexity of the functional mix of an urban district can be reduced to a simple index. This requires a reduction of all aspects of a mix to the simplest of terms. In this paper, the urban mix will be reduced to the proportion of residential and that of non-residential use. This has proven to be instrumental for at least a number of city centres where the balance between residential and non-residential use is 50/50, so that they thus retain a certain urbanity. This proportion can be described in terms of people, by the number of workers versus the number of residents as assessed by the city government of Amsterdam (DRO 2007). Such a ratio can also be explained by counting desks versus sleeping places, which says something about the intensity of the use. In this paper however, in order to contribute to the series of indexes of FSI, GSI and OSR, the proportion of housing versus that of non-housing is expressed in terms of floor space. The physical entity of floor space is very precisely measurable in any planning project and is less dependent on temporary fluctuations of actual use when counting numbers of people. As an indirect consequence of use over a prolonged period of time, it is a relevant indication.

The index is referred to as MXI, standing for mixed-use index. In this index, the floor space with a residential use is expressed as a percentage of the total amount of floor space within a specific area. This results in a dimensionless quantity that expresses a proportion analogous to density, a building percentage and an open space ratio using physical parameters such as floor space and plot size in the same manner. In a project in which MXI = 100, there is only residential use and subsequently, a project with an MXI = 0 has no residential use. Hence, the MXI of mono-functional areas will either be 0 or 100 and the MXI of a city centre in Amsterdam or Barcelona will be around 50 since it has equal parts of housing and non-housing (figure 5).

<table>
<thead>
<tr>
<th>MXI value</th>
<th>0</th>
<th>50</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meaning</td>
<td>No housing present</td>
<td>50/50 balance housing non-housing</td>
<td>100 % residential use</td>
</tr>
<tr>
<td>District type</td>
<td>Single use</td>
<td>Mixed use</td>
<td>Single use</td>
</tr>
<tr>
<td>Examples</td>
<td>Office park</td>
<td>City Centre</td>
<td>Newtown</td>
</tr>
<tr>
<td></td>
<td>Factory Complex</td>
<td>Semi Central</td>
<td>The projects</td>
</tr>
<tr>
<td></td>
<td>Harbour district</td>
<td>Airport</td>
<td>Suburbia</td>
</tr>
<tr>
<td></td>
<td>Shopping centre</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When the MXI is defined in this abstract way as a proportional figure and relates to known reference environments, the instrumental and organisational value of the index can be compared with the FSI. On one hand it is a fundamental index when it comes to dimensioning, yet is does not describe the actual reality. Obviously when it comes to describe an actual mix, one would also like to know the exact composition of the mix in terms of different uses, the grain size of these uses and the way the different elements of the mix are physically...
positioned. This refinement of the mix index via a sub-index will be the subject of further research. Any comment that can be made on the limitations of the descriptive power of the FSI can also be applied to the MXI. Yet the FSI is a global standard.

INDEXING MIXED USE IN AMSTERDAM BY THE MXI

To establish the relationship between the MXI and the character of a district, a variety of urban districts of Amsterdam were taken as study objects. Following west/east lines of historical growth, Amsterdam districts were analysed using the MXI. Since Amsterdam developed as a typical compact European city in a concentric manner according to the model of the ‘Lobbenstad’, (De Hoog 2005), this east/west section organises districts in a historical order. The oldest districts are in the centre and the greater the distance from the historic city centre, the newer the districts.

Twelve districts were selected along the east/west section which are representative for a specific era of city development. The boundaries of the selected areas were chosen in such a way that the development of the district can be described as a product of a specific plan or a condition. The selected districts can each be described as products of a specific moment in the developmental history of Amsterdam, ranging from the late 15th century to the late 20th century. The section line stretches from the garden cities in the west to the garden cities in the east as is shown by the diagram. The chosen districts were analysed on two scale levels, the level of the district itself and the level of a typical building block within the district. The building blocks were analysed concerning residential versus non-residential use on the ground floor level of the different individual buildings within the block. The data required for the analysis of the floor space in m² to generate the MXI was provided by Klaas Bindert de Haan of the Amsterdam DRO.

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Name</th>
<th>Period</th>
<th>Developmental grain</th>
<th>Style</th>
<th>Position</th>
<th>MXI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Westelijke tuinsteden</td>
<td>1950</td>
<td>5000 m²</td>
<td>Open blocks, slab development</td>
<td>Peripheral</td>
<td>94</td>
</tr>
<tr>
<td>2</td>
<td>Admiraal Buurt</td>
<td>1900</td>
<td>2000 m²</td>
<td>Classical blocks, large grains</td>
<td>Semi peripheral</td>
<td>87</td>
</tr>
<tr>
<td>3</td>
<td>Oud west</td>
<td>1850</td>
<td>1000 m²</td>
<td>Classical block, incremental grain</td>
<td>Semi central</td>
<td>74</td>
</tr>
<tr>
<td>4</td>
<td>Jordaan</td>
<td>1750</td>
<td>250 m²</td>
<td>Traditional block, incremental grain</td>
<td>Semi central</td>
<td>79</td>
</tr>
<tr>
<td>5</td>
<td>Grachtengordel</td>
<td>1700</td>
<td>250 m²</td>
<td>Traditional block, incremental grain</td>
<td>Central</td>
<td>53</td>
</tr>
<tr>
<td>6</td>
<td>Dam</td>
<td>1550</td>
<td>250 m²</td>
<td>Traditional block, incremental grain</td>
<td>Central</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>Wallen</td>
<td>1600</td>
<td>250 m²</td>
<td>Traditional block, incremental grain</td>
<td>Central</td>
<td>48</td>
</tr>
<tr>
<td>8</td>
<td>Rapenburg</td>
<td>1650</td>
<td>250 m²</td>
<td>Traditional block, incremental grain</td>
<td>Semi central</td>
<td>32</td>
</tr>
<tr>
<td>9</td>
<td>Plantage</td>
<td>1750</td>
<td>500 m²</td>
<td>Traditional block, incremental grain</td>
<td>Semi central</td>
<td>34</td>
</tr>
<tr>
<td>10</td>
<td>Dapperbuurt</td>
<td>1875</td>
<td>1000 m²</td>
<td>Classical blocks, large grain</td>
<td>Semi peripheral</td>
<td>75</td>
</tr>
<tr>
<td>11</td>
<td>Watergraafsmeer</td>
<td>1925</td>
<td>1000 m²</td>
<td>Classical blocks, large grain</td>
<td>Semi peripheral</td>
<td>80</td>
</tr>
<tr>
<td>12</td>
<td>Nieuwe Meer</td>
<td>2000</td>
<td>5000 m²</td>
<td>Open blocks, slab development</td>
<td>Peripheral</td>
<td>96</td>
</tr>
</tbody>
</table>

The assumption to be tested was that as the result of a specific time and a specific distance to the city centre, each district has its own typical MXI. In order to understand the way the MXI develops throughout the city, the next diagram was created. This diagram can be understood as a functional section of the city whereby the ratio of housing to non-housing becomes visible by moving from one district to another. The area in red shows the percentage of housing, comprising both apartments and houses. In different grayscales, the subdivision into different types of non-housing are represented, e.g. office, retail trade, administrative, care, public transport etc. A more detailed explanation of the division of different uses with the domains of housing and non-housing is beyond the scope of this paper.
THE INSTRUMENTAL VALUE OF THE MXI?

Looking at figure 8, which describes the relationship between the MXI and the geographical disposition of the analysed samples, it is evident that there is a relationship between the centrality of the district, the character of the district and the MXI. In the city centre, the analysed samples have an average MXI of around 50. The most centrally located one at the Dam even has a value of 7 due to its limited perimeter which mostly includes retail trade and offices. Close to the city centre, the MXI fluctuates between 40 and 60. In the plantage area for instance, where the ZOO defines a large part of the district, the MXI reaches 40. Moving away from the (historical) city centre, the MXI gradually increases in steps. When entering the 19th century areas, the MXI starts to reach around 70-80. The typical late 19th century Neighbourhoods have an MXI of around 85. When entering the more peripheral samples in the modernist garden cities, the MXI climbs to 90-95.

Assuming that there is a relationship between the MXI and the character and position of the district, districts could be organised according to value categories of the MXI. Based on experience with the first MXI analysis, it is possible to conceive of distinguishing five typologies of districts as is shown in the next table. The method would have to be repeated in many cross-sections throughout the city in order to establish absolute insight into the development of the MXI in relation to centrality and district character. It would be interesting in future research to see whether the MXI only behaves according to the pattern established in Amsterdam or whether it is a pattern that also applies to other European cities.

<table>
<thead>
<tr>
<th>MXI</th>
<th>0-20</th>
<th>20-40</th>
<th>40-60</th>
<th>60-80</th>
<th>80-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>District character</td>
<td>Factory complexes</td>
<td>Office parks</td>
<td>Central business &amp; leisure districts</td>
<td>City centre metropolitan downtown</td>
<td>19th century city extensions</td>
</tr>
</tbody>
</table>

The conception of the mix-use index is currently in its initial stages. It would be interesting and it is moreover necessary to reformulate the index in the next phase using a more precise definition. It is conceivable for instance that the mixed-use index not only refers to the percentage of housing, but can be defined as the percentage of working/housing and service floors. The index will be conceived of in this way in 3 figures. Furthermore, a recombination of the MXI and FSI will be required to define correlations between densities and the mix.
CONCLUSIONS

In this paper, urban development is analysed from a mixed-use perspective. Starting with a short historical overview and an actor analysis, different meanings and implications of the mixed use concept are analysed. This analysis results in a reduction of the urban mix to the ratio of housing to non-housing in terms of floor space. This ratio is translated into an index referred to as the MXI. Analysing Amsterdam districts in east/west sections using the MXI shows that there is a strong relation between the MXI and the centrality and character of the districts. The following conclusions can be put forward:

1. After the functional segregation of the city as a product of the industrial economy, the theme of mixed use in urban planning is once again becoming relevant as the economy is becoming information based and service based.

2. The emphasis on mixed use at the beginning of 21st century has another significance and requires another implementation than emphasis on mixed use in the 50s and the 80s of the 20th century.

3. Different actors in urban development use conflicting definitions of mixed use; a neutral definition could start with the division of different uses within the built mass of urban districts.

4. The relevant scale of mixed use is the walkable scale of urban blocks within an urban district.

5. The mix of uses can ultimately be reduced to the ratio of housing to non-housing floor space within an urban district and result in the mixed-use index MXI.

6. The MXI of typical urban districts is related to the historic period of the conception and the centrality of the district.

7. Combining FSI and MXI potentially ensures a strong determining of district characters.

8. Although further research is required to provide an apt categorisation of urban district indexation by the MXI, one can predict the future instrumentality of this index in the fields of urban design, planning policy, urban analysis and real-estate development.

The goals to be achieved with the introduction of the mixed-use index MXI are fourfold:

1. On an ideological level, the MXI combines different uses within one index, making the discussion and categorisation of mixed-use environments more natural. This is a subtle but important step in terms of urban planning since mostly developments are described in terms of single uses instead of mixes. This is especially the case in the Netherlands where the modernist legacy of mono-functionality is still dominant in connection with ideas with regard to urban planning.

2. On the level of design, the MXI provides a new frame of reference within the scope of the conception of urban environments, since different MXIs represent different types of urbanities.

3. On a policy level, the MXI can become instrumental for the government in defining the conditions within which real-estate corporations can develop plots of land. In Amsterdam for instance, for projects such as the IJ oevers or the SouthAxis, the MXI would make it clear to all parties involved how to use the land and what is expected from a policy point of view.

4. On an urban analysis level, the combination of MXI and FSI makes it possible to conceive numerous typologies of urban environments in just two single figures.

LITERATURE

- De Hoog M (2005) 4 keer Amsterdam, ontwerpen aan de stad, Thoth.
- Taverne E (1978) In ‘t land van belofte, de stadstegel in de republiek, Gary Schwartz uitgeverij.