Abstract
The historical city has been represented over time using various ways of drawing, modelling and simulation. Using different kinds of visual information as a basis, computer visualisation techniques are used in this presentation to reconstruct the urban development in the twentieth century of the town of Heusden and other towns. The resulting visualisation provides us with a tool for a better understanding of the dynamics of urban transformation processes, typologies and morphological changes. Though for most of these rather specific research questions the computer images proved adequate and useful, some morphological studies can well be carried out using more traditional techniques.

Introduction
In what way can computer visualisation help us to study our historical urban environment? The image and structure of a town are constantly subject to a dynamic process of change and continuity. Repairs, replacement, rehabilitation, redevelopment, demolition, and urban renewal take place in every town, while some areas, however, are left untouched for periods of time. Visual material, such as photographs, historical maps, town plans, drawings and prints, show us the impact of these changes on the image of a town. The question is of how this process of change and continuity is visually detectable in a town or city. Computer visualisation techniques and animation can help us recreate the historical city and giving us an idea of how it used to look. Although this presentation mostly deals with computer visualisation of the historical urban environment, before we get to that point I will tackle some aspects of architectural representation methods in general.

Representation of architecture
The architectural drawing itself can be considered a means to communicate aspects of buildings in different architectural projections, for instance, plans, elevations, roof plans, sections, perspectives, axonometrics and isometrics. In architectural practice, an architectural object is mostly represented by orthogonal projections: a plan, elevations, and sections. Orthogonal projections represent objects without optical distortion. Agreements are made on the way walls, doors, windows, and other elements are represented in drawings. Because of these conventions, one usually has to learn how to read them. In the architectural analysis of buildings, other kinds of visual material are added, such as reconstruction drawings involving (all) phases of a building, photographs, paintings, and drawings of details.

Benefit of abstraction
In order to be able to graphically represent a building, a decomposition of the idea of a building into different parts needs to be made. An unavoidable consequence of this process of abstraction is the loss of information. Loss of information is, however, not always a negative consequence. Abstraction forces one to focus on the subject under study without being distracted by elements that are not relevant for a specific study. It allows one to ignore unnecessary details so that a selection of relevant elements, essential for carrying out a certain project, becomes apparent. If applied consistently, abstraction allows us to analyze different architectural objects in a uniform way, since all elements can be viewed at the same level of detail and at the same scale.

The fact that beautifully refurbished drawings had the effect of distracting the attention from the main structural appearance of a building was already recognised by Jean Nicolas Louis Durand in his *Recueil et parallèle des edifices* (1800). In this book he juxtaposed line-drawings of buildings of the same type. The drawings were mostly at the same scale, therefore they can be compared in form on the same level of detail, producing a catalogue of forms of each type. He wished to do away with all unnecessary extravagance and decoration in architecture. In this way, he reduced architecture and its representation to its structural and formal geometry. As an engineer he was more in favour of technical, abstract line-drawings than the refurbished drawings which were acceptable at the time, such as watercolors from the Ecole des Beaux-Arts. Beaux-Arts representations mainly consisted of plans and elevations which were later lavishly rendered with shadows, colours, and decorative elements. In Durand's view, these refurbished drawings concealed the essential geometry of forms and buildings would be represented more objectively by orthogonal line-drawings stripped from superfluous details.

At the end of the 19th century, the notion of objective, abstract line drawings, as opposed to subjective perspective projections, led to the reintroduction of the axonometric projection. The axonometric projection became popular after Auguste Choisy had illustrated his book *Histoire de l'Architecture* (1899) with axonometrics. The axonometrics provide information about both the three-dimensional structure, the plan, and the elevations of buildings. There are no optical distortions, parallel lines remain parallel until infinity. It was probably because of these qualities that *The Style and the Modern Movement* and more recently, Bruno Fortier, made extensive use of the axonometric, since it conveyed several kinds of information in a single image.

**Scale models and computer models**

The difference between a scale model (made of cardboard, wood, stone, paper, etc.) and a computer model is that the physical model can be touched and made on a certain scale, while a computer model consists of virtual lines, surfaces or solids, which suggest spatiality. It can also be given any required scale and can be viewed from any viewpoint. Three-dimensional computer models are made combining geometrical primitives forming virtual space. Given enough time, any detailed, coloured scale model could be created. In the same way, several ways of electronic elaboration of computer models are possible to enhance the idea of reality. The kind of elaboration needed depends on the purpose the model has to serve. The models can be rendered photo-realistically using texture maps and colour, shadow, and other special effects. CAD models can be merged with video images or images captured by scanning. In this way one can speak of *synthetic images* which can in fact be very close to the refurbished drawings of the Ecole des Beaux-Arts.

In the urban planning process of evaluating the aesthetic qualities of a new building in the townscape with respect to proportions and scale, these simple geometrical models appear very effective. Especially, the possibility to make animations of these urban models in which one can *walk through* the streets at eye-level and at walking speed, or *fly over* the town provides a way to survey the morphology of the urban environment. In fact, an *animated walk through* a town is nothing more than the computerised and intensified version of Cullen's *serial vision*.

**Reconstruction of the past**

The existing or lost city increasingly attracts the attention of archaeologists, architects and architectural historians. In order to tackle the complexity of the townscape one needs to focus on the research of the transformation of the spatial structure of the townscape. This being the case, we need to know how the process of change and continuation of the townscape can be represented and made understandable by means of visualisation techniques. In connection with this, the question needs to be answered what kind of and how much visual information is necessary for the computer models of a town to provide a basis for interpreting the changes over time.

To study the transformation of the architecture of an existing city means to work with imperfect, heterogeneous
and often incomplete sources. Hypermedia systems which are able to manage and integrate different kinds of visual sources (photographs, text, digitised maps, plans, elevations, and sections) as well as computer models, animations and video are becoming increasingly important in the research of the historical environment.

**Visualization of the Historical Town of Heusden, the Netherlands.**

To study the transformation of an existing city, research has been carried out to the town of Heusden in The Netherlands. Heusden, enclosed in its system of fortifications, is a well-defined coherent unity, small enough to be studied in its entirety. Different planning strategies have determined Heusden's image and form in the twentieth century. The focus will therefore be on the urban developments in the twentieth century, a period that is richly documented.

Heusden was founded near a castle probably in the 13th century. It was fortified at the end of the 16th and again at the beginning of the 17th centuries by a fortification system which was modern for its time. During the Dutch Golden Age (17th century) it was a famous garrison town. Heusden, which had been part of the province of Holland from 1357, became part of the much poorer province of Brabant in 1813. After the fortifications had been dismantled in 1816, prosperity declined due to economic factors and the definitive departure of the garrison in 1879. In 1904 the old Town Harbor was filled in and turned into public gardens. Towards the end of World War II, part of the town was destroyed, including the Town Hall and part of the Church. During the reconstruction period after the war (1945-1965), a new town hall and a number of council houses were built. Modernist plans in the sixties to level the fortifications and to build multi-story apartment blocks on the outskirts of town were never realised. Instead, a radical restoration plan (Development Plan) was adopted in 1965, involving repair of the fortifications, reconstruction of the historical street structure and restoration and reconstruction of buildings. The Town Harbor was re-excavated. During this restoration and reconstruction, an old map by Joan Blaeu (1649) played an important role for the realisation of the reconstructed 17th-century image of Heusden. While the restoration had not yet been finished, Heusden was officially given the status of Protected Townscape in 1972. The restoration campaign was finished around 1990.

Three-dimensional computer models were made representing six significant periods in the 20th century: 1900, 1943, 1946, 1965, 1975, and 1990. From each of these reference dates the changes in the ground plan, the building masses and the façades were visualised. These computer images were needed to be able to analyse, among other things, the approaches to restoration. The volumes of the houses are modelled as simply as possible in order to be able to enhance recognition and reduce the computer storage space needed to a minimum. Dormers, chimneys, porches, and other three-dimensional objects are therefore absent in the computer models.

By simulating a walk through, urban spaces can, depending on the level of realism, almost be physically experienced. This was done with the 1943 model of Heusden in which a walk from the harbour, via the main street leads through a narrow alleyway to the marketplace.

Another option is to make still images of each period from the same viewpoint which allows for a uniform analysis. It is also possible to study the extent of scaling-up or down, the difference of heights or proportions in the townscape. These images show the larger structural changes in the morphology of the town, the increasing density of the urban texture and the use of different area's.

**Some other uses of the same computer models**

Once computer models are made they can be used for various kinds of research. Since any viewpoint in a three-dimensional model shows only part of the façades, it is difficult to analyse the transformation of the façades. From the existing three-dimensional model, images of the façades were extracted, ordered per century and displaying the six reference dates. These were used to examine the changes in and the treatment of the façades in the 20th century or the work of a particular architect. In this way, the façades forming the street walls seen in elevation were formed. When the six street walls are displayed in a single image, the often subtle changes in the façades can be read from top to bottom. It should be noted, though, that these images still need to be interpreted and that the computer does not tell us what has been changed.

The images show us that only the houses around the harbour and Fishmarket were deplastered to a certain extent. Small changes, such as the use of mullioned windows can have an important impact on the appearance of the streets. It also appeared that houses were rebuilt in their old form.
In the 60's the fortifications were reconstructed 1.5 meters lower than they used to be, and the houses are nowadays higher than they were in the 17th century. As a consequence, comparison of the images shows that much more of the roofs can be seen from a distance than the map by Matham (1625), for example, shows us.

The changing area around the Town Hall can easily be followed in the various periods of the models. The gap left after its destruction in 1944 and the construction of the new Town Hall (1956) constituted an important structural change at the very heart of the town. The old Town Hall had literally been the centre of the town, and seen from the Veer Poort its tower used to be a focal point. The new Town Hall is much lower than its predecessor and of a more horizontal character. Only part of the building is visible from the same vantage point, providing a less interesting town view than before 1944. As a typical Town Hall of the reconstruction period, a corner square was created leading to a different use of space and opening up the town block.

Even in a town as small as Heusden one finds areas distinct in character. In order to make the computer images better understandable, these areas have been given different colours, thus linking up with thematic cartography. We can distinguish the following areas as shown in the theme map:
1. Botermarkt, Hoogstraat, Waterpoort, Engstraat and Vismarkt, are characterised by relatively high, narrow, deep plots. They form the main historic area.
2. Putterstraat is a typical back street with various kinds of buildings, mostly residential, which are usually lower in height than buildings in the main street 3. The area near the former castle, Burchtterrein, is marked by open rows of houses from the reconstruction period which have no relation to the former urban texture.
3. The complete fortifications and the waterfront in particular (Town Harbor, marina) is a recreation area.
4. The area south-east of the Demer Canal is characterised by urban renewal social housing in adapted style.

Conclusions
The question is whether to use still images or rather to show animations simulating for example a walk through a street. Since, in the Heusden project regular pc's were used, the calculation of an animation appeared to require far too much computer power. Therefore we refrained from finishing an animation. The still images I just showed have proved to be equally effective for the analysis, since they allow the viewer to leisurely study each image or the model on the computer screen.

Since these computer models still rely very much on the traditional model maker's art, the still images of Heusden convey information in a comprehensible, clear way. Though movement definitely enhances the idea of realism it does not allow the user to view each individual building or the city as a whole. Even when an animation of a city exists, such as in the case of Edinburgh, the still images are impressive and functional in their own right.

For the same reason I have deliberately not shown the newest materials available in the field of computer visualisation and animation. Elaboration of computer images at an almost photo-realistic level such as was done with some Italian cities, is very useful and attractive for presentation purposes, but in the Heusden and Edinburgh research abstraction served a specific purpose for which refurbishment would turn out to be a burden.

Though more and more tools for interactive rendering and animation and virtual reality become available for pc's, we should resist the challenge to keep running away with the newest tools and developments and not giving enough thought about the scholarly deployment of the tools already developed. In connection with this, we should always keep in mind that approaching an object, according to our perception, more details will have to become visible, which is not possible with most scale models or computer models. Though the newest tools based on wavelet technology seem to have found a solution in providing the possibility to seamless zooming in on details based on the calculation of the distance or the zoom-level, all those details still need to be entered into the computer model, which requires a great deal of work and computer power and storage space.

In the Heusden research, the computer models were used to show the transformation over time and many other aspects of the city. Almost all the drawing or modelling work can, in principle, be done manually, but it would certainly take much more time. Although using computer visualisation techniques in research and analysis is time-consuming, it allows a more flexible way of studying the dynamics of the built environment. Visualisation can be a powerful tool in representing a townscape in three dimensions from different angles. It allows for a better understanding of the components of the city, their distribution, formal analysis, relation with the context, proportions and their process of change and continuity. In addition, it provides the possibility of exploring many alternatives.
However, photo realism in computer visualisation should not always be the default purpose for evaluation: although computer visualisation provides more possibilities and is more flexible for carrying out specific research tasks, using simple scale models may turn out to be quicker to realise and easier to create. If possible, using a combination of traditional and computer techniques appears to be the best approach. The purpose is, after all, to be able to communicate and evaluate spatial information. In order to achieve that goal, one should use the most appropriate medium available.

Figure 1: View in small alley in Heusden in 1943. [see 06p01.tif]
Figure 2: Vismarkt in 1943. [see 06p02.tif]
Figure 3: Bird’s eye view in 1943. [see 06p03.tif]
Figure 4: Bird’s eye view in 1990. [see 06p04.tif]
Figure 5: Heusden in 1943. [see 06p05.tif]
Figure 6: Heusden in 1965. [see 06p06.tif]
Figure 7: Heusden in 1990. [see 06p07.tif]
Figure 8: Comparison of facades. [see 06p08.tif]
Figure 9: Comparison of facades. [see 06p09.tif]

Notes
COMPUTER VISUALISATION AS A TOOL IN ARCHITECTURAL
HISTORICAL RESEARCH: REPRESENTATION AND RESEARCH OF THE HISTORICAL URBAN
ENVIRONMENT

Dr. Patricia Alkhoven
Koninklijke Bibliotheek / National Library of the Netherlands

ABSTRACT The historical city has been represented over time using various ways of drawing, modelling and simulation. Using different kinds of visual information as a basis, computer visualisation techniques are used in this presentation to reconstruct the urban development in the twentieth century of the town of Heusden and other towns. The resulting visualisation provides us with a tool for a better understanding of the dynamics of urban transformation processes, typologies and morphological changes. Though for most of these rather specific research questions the computer images proved adequate and useful, some morphological studies can well be carried out using more traditional techniques.

INTRODUCTION In what way can computer visualisation help us to study our historical urban environment? The image and structure of a town are constantly subject to a dynamic process of change and continuity. Repairs, replacement, rehabilitation, redevelopment, demolition, and urban renewal take place in every town, while some areas, however, are left untouched for periods of time. Visual material, such as photographs, historical maps, town plans, drawings and prints, show us the impact of these changes on the image of a town. The question is of how this process of change and continuity is visually detectable in a town or city. Computer visualisation techniques and animation can help us recreate the historical city and give us an idea of how it used to look. Although this presentation mostly deals with computer visualisation of the historical urban environment, before we get to that point I will tackle some aspects of architectural representation methods in general.

REPRESENTATION OF ARCHITECTURE The architectural drawing itself can be considered a means to communicate aspects of buildings in different architectural projections, for instance, plans, elevations, roof plans, sections, perspectives, axonometrics and isometrics. In architectural practice, an architectural object is mostly represented by orthogonal projections: a plan, elevations and sections. Orthogonal projections represent objects without optical distortion. Agreements are made on the way walls, doors, windows, and other elements are represented in drawings. Because of these conventions, one usually has to learn how to read them. In the architectural analysis of buildings, other kinds of visual material are added, such as reconstruction drawings involving (all) phases of a building, photographs, paintings, and drawings of details. Whereas the more technical, orthogonal representations in architecture function to convey information as "facts", clients of architects usually base their decisions on the perspective projection. Contrary to orthogonal projections, which are more difficult to interpret because of their conventions, the perspective projection is closer to the human perception and therefore easier to understand and interpret. For instance, Gordon Cullen's Townscape contains nothing but perspectives as seen through the human eye (approximately 1.60 meters). He also presents walks through towns to grasp the fourth dimension (movement) by means of a series of different viewpoints, which he calls serial vision. In presentation drawings, buildings are also often represented in perspective in order to convey spatial information at a level understandable for many people.

BENEFIT OF ABSTRACTION In order to be able to graphically represent a building, a decomposition of the idea of a building into different parts needs to be made. An unavoidable consequence of this process of abstraction is the loss of information. Loss of information is, however, not always a negative consequence. Abstraction forces one to focus on the subject under study without being distracted by elements that are not relevant for a specific study. It allows one to ignore unnecessary details so that a selection of relevant elements, essential for carrying out a certain project, becomes apparent. If applied consistently, abstraction allows us to analyze different architectural objects in a uniform way, since all elements can be viewed at the same level of detail and at the same scale. The fact that beautifully refurbished drawings had the effect of distracting the attention from the main structural appearance of a building was already recognized by Jean Nicolas Louis Durand in his Recueil et parallèle des edifices (1808). In this book he juxtaposed line-drawings of buildings of the same type. The drawings were mostly at the same scale, therefore they can be compared in form on the same level of detail, producing a catalogue of forms of each type. He wished to do away with all unnecessary extravagance and decoration in architecture. In this way, he reduced architecture and its representation to its structural and formal geometry. As an engineer he was more in favour of technical, abstract line-drawings than the refurbished drawings which were acceptable at the time, such as watercolors from the Ecole des Beaux-Arts. Beaux-Arts representations mainly consisted of plans and elevations which were later lavishly rendered with shadows, colours, and decorative elements. In Durand's view, these refurbished drawings concealed the essential geometry of forms and buildings would be represented more objectively by orthogonal line-drawings stripped from superfluous details.

At the end of the 19th century, the notion of objective, abstract line drawings, as opposed to subjective perspective projections, led to the reintroduction of the axonometric projection. The axonometric projection became popular after Auguste Choisy had illustrated his book Histoire de l'Architecture (1899) with axonometrics. The axonometric provide information about both the three-dimensional structure, the plan, and the elevations of buildings. There are no optical distortions, parallel lines remain parallel until infinity. It was probably because of these qualities that The Style and the Modern Movement and more recently, Bruno Fortier, made extensive use of the axonometric, since it conveyed several kinds of information in a single image.

SCALE MODELS AND COMPUTER MODELS The difference between a scale model (made of cardboard, wood, stone, paper, etc.) and a computer model is that the physical model can be touched and made on a certain scale, while a computer model consists of virtual lines, surfaces or solids, which suggest spatially. It can also be given any required scale and can
be viewed from any viewpoint. Three-dimensional computer models are made combining geometrical primitives forming virtual space. Given enough time, any detailed, coloured scale model could be created. In the same way, several ways of electronic elaboration of computer models are possible to enhance the idea of reality. The kind of elaboration needed depends on the purpose the model has to serve. The models can be rendered photo-realistically using texture maps and colour, shadow, and other special effects. CAD models can be merged with video images or images captured by scanning. In this way one can speak of synthetic images which can in fact be very close to the refurnished drawings of the Ecole des Beaux-Arts.\footnote{1}

In the urban planning process of evaluating the aesthetic qualities of a new building in the townscape with respect to proportions and scale, these simple geometrical models appear very effective. Especially, the possibility to make animations of these urban models in which one can \textit{walk through} the streets at eye-level and at walking speed, or fly over the town provides a way to survey the morphology of the urban environment. In fact, an \textit{animated walk through a town} is nothing more than the computerised and intensified version of Culler's serial vision.

\textbf{RECONSTRUCTION OF THE PAST} The existing or lost city increasingly attracts the attention of archaeologists, architects and architectural historians.\footnote{2} In order to tackle the complexity of the townscape one needs to focus on the research of the transformation of the spatial structure of the townscape. This being the case, we need to know how the process of change and continuation of the townscape can be represented and made understandable by means of visualization techniques. In connection with this, the question needs to be answered what kind of and how much visual information is necessary for the computer models of a town to provide a basis for interpreting the changes over time.

To study the transformation of the architecture of an existing city means to work with imperfect, heterogeneous and often incomplete sources. Hypermedia systems which are able to manage and integrate different kinds of visual sources (photographs, text, digitised maps, plans, elevations, and sections) as well as computer models, animations and video are becoming increasingly important in the research of the historical environment.

\textbf{VISUALIZATION OF THE HISTORICAL TOWN OF HEUSDEN, THE NETHERLANDS} To study the transformation of an existing city, research has been carried out to the town of Heusden in The Netherlands. Heusden, enclosed in its system of fortifications, is a well-defined coherent unity, small enough to be studied in its entirety. Different planning strategies have determined Heusden's image and form in the twentieth century. The focus will therefore be on the urban developments in the twentieth century, a period that is richly documented.

Heusden was founded near a castle probably in the 13th century. It was fortified at the end of the 16th and again at the beginning of the 17th centuries by a fortification system which was modern for its time. During the Dutch Golden Age (17th century) it was a famous garrison town. Heusden, which had been part of the province of Holland from 1357, became part of the much poorer province of Brabant in 1839. After the fortifications had been dismantled in 1856, prosperity declined due to economic factors and the definitive departure of the garrison in 1879. In 1904 the old Town Harbor was filled in and turned into public gardens.

Towards the end of World War II, part of the town was destroyed, including the Town Hall and part of the Church. During the reconstruction period after the war (1945-1965), a new town hall and a number of council houses were built. Modernist plans in the sixties to level the fortifications and to build multi-story apartment blocks on the outskirts of town were never realised. Instead, a radical restoration plan (Development Plan) was adopted in 1965, involving repair of the fortifications, reconstruction of the historical street structure and restoration and reconstruction of buildings. The Town Harbor was re-excavated. During this restoration and reconstruction, an old map by Joan Blaeu (1669) played an important role for the realisation of the reconstructed 17th-century image of Heusden. While the restoration had not yet been finished, Heusden was officially given the status of Protected Townscape in 1972. The restoration campaign was finished around 1990.

Three-dimensional computer models were made representing six significant periods in the 20th century: 1900, 1943, 1966, 1965, 1975, and 1990. From each of these reference dates the changes in the ground plan, the building masses and the façades were visualised. These computer images were needed to be able to analyse, among other things, the approaches to restoration. The volumes of the houses are modelled as simply as possible in order to be able to enhance recognition and reduce the computer storage space needed to a minimum. Dormers, chimneys, porches, and other three-dimensional objects are therefore absent in the computer models.

By simulating a walk through, urban spaces can, depending on the level of realism, almost be physically experienced. This was done with the 1965 model of Heusden in which a walk from the harbour via the main street leads through a narrow alleyway to the marketplace. Another option is to make still images of each period from the same viewpoint which allows for a uniform analysis. It is also possible to study the extent of scaling-up or down, the difference of heights or proportions in the townscape. These images show the larger structural changes in the morphology of the town, the increasing density of the urban texture and the use of different areas.

\begin{figure}[h]
\centering
\includegraphics[width=0.4\textwidth]{figure1a.png}
\caption{Figure 1a: View from a hill in Heusden in 1966.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.4\textwidth]{figure1b.png}
\caption{Figure 1b: View from a hill in 1990.}
\end{figure}
The images show us that only the houses around the harbour and Fishmarket were unplastered to a certain extent. Small changes, such as the use of muilleioned windows, can have an important impact on the appearance of the streets. It also appeared that houses were rebuilt in their old form.

In the 60's the fortifications were reconstructed 1.5 meters lower than they used to be, and the houses are nowadays higher than they were in the 17th century. As a consequence, comparison of the images shows that much more of the roofs can be seen from a distance than the map by Matham (1623), for example, shows us.

The changing area around the Town Hall can easily be followed in the various periods of the models. The gap left after its destruction in 1944 and the construction of the new Town Hall (1956) constituted an important structural change at the very heart of the town. The old Town Hall had literally been the centre of the town, and seen from the Veer Peert its tower used to be a focal point. The new Town Hall is much lower than its predecessor and of a more horizontal character. Only part of the building is visible from the same vantage point, providing a less interesting town view than before 1944. As a typical Town Hall of the reconstruction period, a corner square was created leading to a different use of space and opening up the town block.

Even in a town as small as Heusden one finds areas distinct in character. In order to make the computer images better understandable, these areas have been given different colours, thus linking up with thematic cartography. We can distinguish the following areas as shown in the theme map:

1. Betermarkt, Hooogstraat, Waterpoort, Engstraat and Vilstraat, are characterised by relatively high, narrow, deep plots. They form the main historic area.
2. Puuttenstraat is a typical back street with various kinds of buildings, mostly residential, which are usually lower in height than buildings in the main street.
3. The area near the former castle, Burchtterrein, is marked by open rows of houses from the reconstruction period which have no relation to the former urban texture.
4. The complete fortifications and the waterfront in particular (Town Harbor, marina) is a recreation area.
5. The area south-east of the Demer Canal is characterised by urban renewal social housing in adapted style.
CONCLUSIONS  The question is whether to use still images or rather to show animations simulating for example a walk through a street. Since, in the Heusden project regular PCs were used, the calculation of an animation appeared to require far too much computer power. Therefore we refrained from finishing an animation. The still images I showed have proved to be equally effective for the analysis, since they allow the viewer to leisurely study each image or the model on the computer screen.

Since these computer models still rely very much on the traditional model maker's art, the still images of Heusden convey information in a comprehensive, clear way. Though movement definitely enhances the idea of realism it does not allow the user to view individual buildings or the city as a whole. Even when an animation of a city exists, as such as in the case of Edinburgh, the still images are impressive and functional in their own right.

For the same reason I have deliberately not shown the newest materials available in the field of computer visualisation and animation. Elaboration of computer images at an almost photo-realistic level such as was done with some Italian cities, is very useful and attractive for presentation purposes, but in the Heusden and Edinburgh research abstraction served a specific purpose for which refinement would turn out to be a burden.

Though more and more tools for interactive rendering and animation and virtual reality become available for PCs, we should resist the challenge to keep running away with the newest tools and developments and not giving enough thought about the scholarly deployment of the tools already developed. In connection with this, we should always keep in mind that approaching an object, according to our perception, more details will have to become visible, which is not possible with most scale models or computer models. Though the newest tools based on wavelet technology seem to have found a solution in providing the possibility for seamless zooming in on details based on the calculation of the distance or the zoom-level, all those details still need to be entered into the computer model, which requires a great deal of work and computer power and storage space.

In the Heusden research, the computer models were used to show the transformation over time and many other aspects of the city. Almost all the drawing or modelling work can, in principle, be done manually, but it would certainly take much more time. Although using computer visualisation techniques in research and analysis is time-consuming, it allows a more flexible way of studying the dynamics of the built environment. Visualisation can be a powerful tool in representing a townscape in three dimensions from different angles. It allows for a better understanding of the components of the city, their distribution, formal analysis, relation with the context, proportions and their process of change and continuity. In addition, it provides the possibility of exploring many alternatives.

However, photo realism in computer visualisation should not always be the default purpose for evaluation: although computer visualisation provides more possibilities and is more flexible for carrying out specific research tasks, using simple scale models may turn out to be quicker to realise and easier to create. If possible, using a combination of traditional and computer techniques appears to be the best approach. The purpose is, after all, to be able to communicate and evaluate spatial information. In order to achieve that goal, one should use the most appropriate medium available.