Enhancing the planner’s toolkit – New display technologies for planning support

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ABSTRACT: Classic planning instruments have reached their limits in terms of information processing and usage in today’s intricate planning processes. Single workspace environments have serious limitations when it comes to displaying all the required information simultaneously without losing context. Limited resolution and restricted screen real estate on a single user workplace, unsuitable for collaborative work, make new display technologies an appealing option.
Emerging display technologies such as tiled display setups and 3D projection technologies are designed to overcome these shortcomings. They combine large screen real area, high resolution screens, and room for establishing a collaborative workspace environment in a cost-efficient solution.
In this paper, we will present a tiled high resolution display wall setup for planning and decision-making support. We visualize geospatial information through high resolution imagery, synthesized with ancillary planning-relevant data to assist planners in their daily analysis and planning tasks. Furthermore we give an insight in which way 3D display approaches enhance spatial cognition and can so create a collaborative workspace environment enhancing the planning process and how it is also suitable for participatory planning.

Conference Topic: 5 Cross cutting themes
Keywords: Visualization and GIS, Human Computer Interaction; knowledge transfer, public awareness and information dissemination

1. INTRODUCTION

New requirements, based on more and more extensive criteria to be considered in planning, leads to complex planning processes. This fact leads to the question if it is time to rethink the classic planning instruments to be on hand of today's planners. Are these instruments sufficient to process the enormous data and to handle the new requirements? With the change of the planning insight to sustainable planning, even more new criteria have to be regarded. So new tools are needed to give support to planners, helping them organize complex data and providing decision support.

But not only the increasing complexity is a challenge, the integration of citizens into the planning is also an important challenge. Civic participation and different actors make collaboration during the planning process vital.

In this paper we want to introduce both software and hardware approaches to enhance the classic toolkit of planners.

On the software side we were aware of the diverse standard of knowledge. So the visualization is straight forward, allowing an easy access to the desired information, which is very difficult with databases and tables only. It is essential that visualization supports the perception, helps to understand the presented data more easily.

Concerning hardware we will give an insight in actual 3-D display setups and large high resolution displays. New display technologies are suitable to support planners, especially in the field of collaborative work (e.g. civic participation, planning and decision support). We will introduce 2 actual research examples out of the field of display technologies.

2. RELATED WORK

In the field of civic participation some research has been done by Kwartler [7]. With 3 examples the value of computer simulations/visualization is shown. The examples are used to demonstrate how citizen can be integrated into the planning process. One reason for the wish for more civic participation was the negative image of planning; experience so far was that planners dictated what's good for the citizen without asking. This lead to serious problems loss; of open space (Baltimore), urban sprawl, gated communities and the loss of regional identity (Santa Fe), pedestrian adverse planning (Houston). Goal of the 3 model projects was the governance of growth. All 3 projects were quite diverse, so different requirements regarding simulation and visualization were needed. All examples revealed the usability of certain software to provide support in planning support and decision making as well as in civic participation. It showed that acceptance for planning was boosted, the process was more transparent and comprehensible.

As to the regard of software, Google Earth [12] is evolving into a favored visualization tool for planners. High-resolution aerial photographs streamed into the geobrowser not only offer the opportunity to conduct off-site regional surveys, but also allow for an overlay of arbitrary heterogeneous spatial data sets. The gCensus Project [13], displays US Census 2000 data as 2D color-coded polygons in Google Earth. An overlay of multidimensional demographic data, visually encoded as 3D glyphs, is presented by Middel, Guhathakurta, Hagen, Olech, & Höpel [8]. The UCL Centre for Advances Spatial Analysis (CASA) set up a GmapCreator [15] to thematically map data from a GIS shapefile import to Google Earth. In order to enhance the geobrowser with GIS functionality, Middel, Pahle, Olech, & Hagen [9] choose a different approach. The authors set up a framework where they link a geodatabase and QuantumGIS to Google Earth. The aim is to visualize building form parameters resulting from Form-based Code regulations for a better informed decision-making, communication of design, and public participation. Especially in participatory planning, Google Earth offers auspicious potential, since it is freely accessible over the internet. The Maine Department of Environmental Protection (DEP) GIS Unit is now offering selected data, geographically referenced, from a number of the department's databases to the public via Google Earth [11]. From these examples we see that the geobrowser's benefit is threefold in terms of possible planning applications: Google Earth can provide planning support, assists in the process of decision-making, and facilitates participatory planning.

In the work of Ball et al. the advantages of tiled displays, LCD based, is evaluated. In [1] and [2] the benefits when using to navigate maps on a tiled display is shown by Ball, Varghese, Carstensen, Cox, Fierer, Peterson and North. The results are obvious: 70% less mouse clicks, 90% less window management, which means better performance and accuracy. Ball and North evaluate the use of tiled displays for Visual Analytic tasks, against the background of embodied resources in [3]. In this evaluation the results were clear, also: physical navigation in front of the tiled display was preferred over virtual navigation with the classic pan & zoom operations by 100% of the guinea pigs. To summarize: large high resolution displays offer an efficient way to work with large datasets/ high detail datasets, which make them also suitable for planning purposes.

The work of Baudisch, Good, Bellotti, and Schraedley [4] presents a focus and context display as a solution for limitations of single display setups and large datasets. The focus and context approach provides a large context area (low resolution), combined with a focus area (high resolution), making a detailed examination of the dataset possible without losing context information.

Ebert, Thelen, Olech and Hagen introduce a hybrid approach of a tiled display wall to overcome the undesired effects of the bezels [5]. A 3x3 LCD based tiled wall is enhanced with a computer projector which projects missing image information onto the LCD frames (bezel area). With this approach a nearly seamless image is created.

3. NEW APPLICATIONS - THE EXAMPLE APPLICATION (DATABASE VISUALZATION AND FORM BASED CODE)

As of late, Google Earth has gained much popularity in the planning community as a convenient and easy-to use tool for analysis and visualization (Middel, Olech, & Hagen, [10]). Information visualized in Google Earth can be dynamically and interactively explored online from any location. This unprecedented opportunity for public access to geodata and the option of publishing additional datasets as a visual synthesis motivates planners to visualize and share their datasets. Google Earth as a visualization platform for planning-related content improves communication among the actors involved in planning processes and facilitates collaborative work. In the following, we will present two Google Earth applications for planning support which are by design suitable for collaborative work over the Internet.

The first application, introduced by Middel, Guhathakurta, Hagen, Olech, & Höpel [8], is an example of database visualization for planning support. The application visually encodes multidimensional data from a geodatabase as abstract scalable 3D geometries. In this process, the data attributes are mapped to different visual variables of the geometries, e.g., color, transparency, and geometric form. The implemented geometries range from boxes and polygons to more complex glyphs, such as 3D polygonal representations of typical building types. The visually encoded information is superimposed on top of Google Earth aerial photographs and provides a spatial synthesis of abstract representations of geo-referenced statistical data in real world context. **Error! Reference source not found.** shows an example Mashup illustrating grid cells in Phoenix, AZ, and associated attributes.

Figure 1: Google Earth Mashup: Visualization of average income (color-coded grid cells), building types (geometry), population density (size of footprint), and uncertainty of building type prediction (transparency) (Middel, Guhathakurta, Hagen, Olech, & Hoepel, 2008)

A 3-dimensional representation of abstract data in real context helps the user to get a fast impression of the database's contents and to recognize relative patterns and hidden correlations within the data. The designed Google Earth Mashup is served to the user as KML file, Google's file format for exchanging geographic information and mapping spatial content. KML is an XML-based language schema and became an official OGC standard in 2008. As an internationally standardized file format, KML is particularly suitable for sharing database visualizations over the Internet. Therefore, the presented application can be used to support participatory planning for enhanced civic participation and facilitates problem solving and decision-making in collaborative work environments.

The second Google Earth application we present is based on a framework that was developed in the Digital Phoenix Project at Arizona State University by Middel, Pahle, Olech, & Hagen [9]. The application generates 3D bounding volumes resulting from Form-based Code (FBC) regulations, stored in a geodatabase, for display in

Google Earth (see Figure 2). FBC is a land development regulatory tool which focuses on the physical layout of the built environment, in particular, the form of buildings and the arrangement of streets and sidewalks. The 3D visual representations of building form parameters resulting from FBC are superimposed on Google Earth satellite imagery to showcase FBC regulations in real context. Additionally, policy parameters can be modified and re-displayed in Google Earth on-the-fly via QuantumGIS which is linked to the geodatabase.

As simplified visualization of a set of complex regulations, the policy-driven tool facilitates the understanding of how policy decisions affect urban form. The application can assist planners, architects, and decision-makers in designing new urban developments and in evaluating whether the new developments are compliant with current building codes. Moreover, the tool offers Internet-based planning support in public participations. Urban forms resulting from FBC regulations as well as newly planned developments can be showcased in real context to the general public over the Internet for discussion.

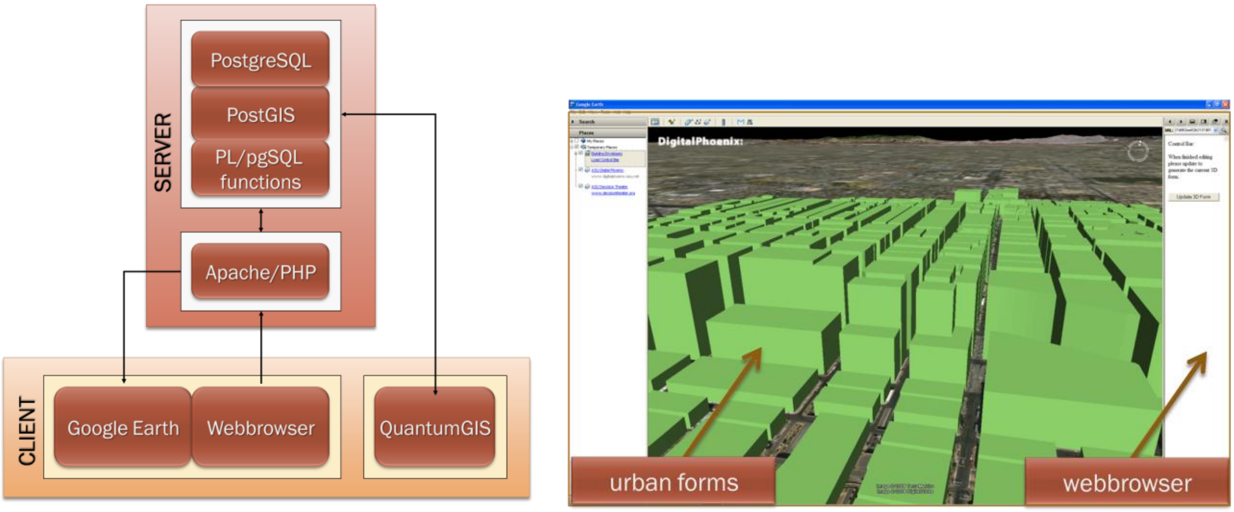

Figure 2: Application Framework (left), Application Screenshot (right) (Middel, Pahle, Olech, & Hagen, 2008)

The presented examples for Google Earth applications show that Google's geobrowser can be used as comprehensive planning tool for planning support, decision support, and participatory planning. Google Earth is a geo-analytically powerful environment, freely accessible over the Internet, which can be handled by anybody – computer scientist, planner, or non-expert user.

4. DISPLAY SETUPS

In this chapter we want to give a basic introduction to display systems with relevance of planning. First we give an overview to 3D display setups, giving users a spatial impression, helping to comprehend e.g. building masses. Hereafter we present tiled display setups, combining moderate to high resolution with large screen real estate.

4.1 3D DISPLAY SETUPS

3-dimensional vision is possible due to the fact that left eye/right eye capture an object from slightly different angels. This image information is processed by the brain and stereoscopic vision is enabled. Binocular vision enables the acquisition of depth perception.

Stereoscopic displays can be structured into 3 areas: auto stereoscopic displays, passive stereoscopic displays and active stereoscopic displays.

When using auto stereoscopic displays, the users do not need glasses to have depth perception. The 3-dimensional effect is achieved by orientating light rays onto the eyes of the user. Vertical pixel rows are divided to the eyes of the users (left eye: odd pixel rows, right eye: even pixel rows). With the help of software drivers a 3-dimensional image is created. Older displays have a very small stereo zone, a zone in which the user can have depth perception. One can differentiate between single-view and multi-view displays, single-view providing 3D for a single user (problem stereo zones, outside the zone no depth perception is possible), multi-view displays providing depth perception for more users in front of the display, making them suitable for signage, advertisement and collaborative work.

With passive stereoscopic displays the users need glasses to assign images to the eyes, like the classic 3D glasses in cinemas.

Active stereoscopic displays are head-mounted-displays (HMD) and shutter glasses, which are not very comfortable to wear.

Stereo projection is another example for a 3-dimensional display setup. 2 special projectors project content onto a back projection canvas. With special glasses multiple users are able to see 3-dimensional images or animations, making this setup, providing large screen real estate, applicable for collaborative work or immerse scenarios.

4.2 TILED DISPLAY SETUPS

Tiled display setups can divided into two groups: LCD based tiled display setups (very early: CRT based systems were tested, no relevance now) and projector based tiled display setups. Projector based tiled display setups are the less favourable setups due to the difficulty to calibrate them, regarding colours and brightness. Additionally each projector has to be adjusted very precise, without an advanced rack a real problem. Beyond that, they are expensive and only offer moderate resolution.

LCD based tiled display setups are easier to calibrate, regarding colour and brightness. They provide large screen real estate combined with high resolution at reasonable cost. The LCD based setup is scaleable, additional displays can be added without problems. Also they are suitable for collaborative work in front of the display, which is a problem with projector based setups (solving this is a lot of work and means additional costs).

Having the work of Ball et al. in mind [1][2][3] LCD based tiled display setups are very suitable for collaborative work, making them ideal for civic participation purposes, the displaying of large datasets for analysis and to discuss planning alternatives with different actors.

5. EXAMPLES SECTION NEW DISPLAY TECHNOLOGIES AND THEIR USE IN PLANNING

In this examples section we want to present 2 different display setups running for planning applications. The first example shows an auto stereoscopic display, providing 3-dimensionl perception of the shown content.

The second example introduces a 200 megapixel tiled wall. This example gives an insight how it can improve working with large datasets.

5.1 AN AUTOSTEREOSCOPIC 3D DISPLAY

In this project, a collaboration of computer science and architecture, planning alternatives are visualized in 3D, using a given land-use plan. The plans can be imported from various CAD applications, e.g. the AutoCAD dxf format. It is possible to export the 3d models in any 3d model format supported by OpenSceneGraph.

The application enables the user to build parameterized, editable test houses and compare them with restrictions of the plan. Violation of building restriction can be visualized in this way. It is also possible to create houses, consistent according to the plan semi-automatic. The visualization is displayed on an auto stereoscopic Philips 42" 3D display (providing full HD resolution) using a render framework which supports additional 4 display types, e.g. the PowerWall, a stereo projection display.

The Philips 3D display is a multi-view display, allowing multiple users to examine the model and discuss different planning alternatives.

Additionally the 3d models, displayed on screen can be used as output to create a physical classic 3d model via a 3d printer.

Figure 3: Philips 42" auto stereoscopic display with example application.

5.2 HIPerWall

When working with a single-user display setup (e. g. one regular display on a single user workplace) one has certain limitation regarding screen real estate and resolution. For exploring large datasets permanent zooming and panning is necessary to stay on top of things. This permanent pan & zoom slows down the workflow dramatically and at cost of computing powers wastes resources which leads to delay times. Collaborative work at a single user workplace (like a cubicle) does not make sense, when or more than two people are involved. Increasing the screen real estate, by using a computer projector for collaborative work does not solve the problem at all, because the resolution still is limited.

LCD based tiled display systems are a cost efficient solution. They combine large screen real estate with a high resolution, making collaborative work for a larger user group reasonable.

In the following we will introduce a 200 megapixel tiled wall setup, the HIPerWall. This high resolution tiled display setup at UC Irvine, consisting of 50 single 30" Apple Cinema LCD displays (each with an individual resolution of 2560 x 1600, arranged in a 10 x 5 setup, driven by a 25 Mac render cluster) can be used for visualizing large data sets, where large screen real estate combined with a high resolution is needed [14].

Even with large datasets the users can access the context information, they can overview the whole dataset, so a permanent zoom & pan operation is not necessary. Interaction with the display is more natural. If a more detailed view is needed, the users can physically navigate to the point of interest to approach the desired high resolution information. So more users can access the same information at the same time, making it possible to discuss their thoughts. This kind of natural "interaction" is comfortable, even for inexperienced/non-expert users, which might be an important factor for the use for civic participation.

Our example shows that different information of a large database (example: database visualization) can be displayed on the HIPerWall. So users are able to compare different database information without the need to switch between "screens". So various information can be analyzed and discussed immediately by multiple users.

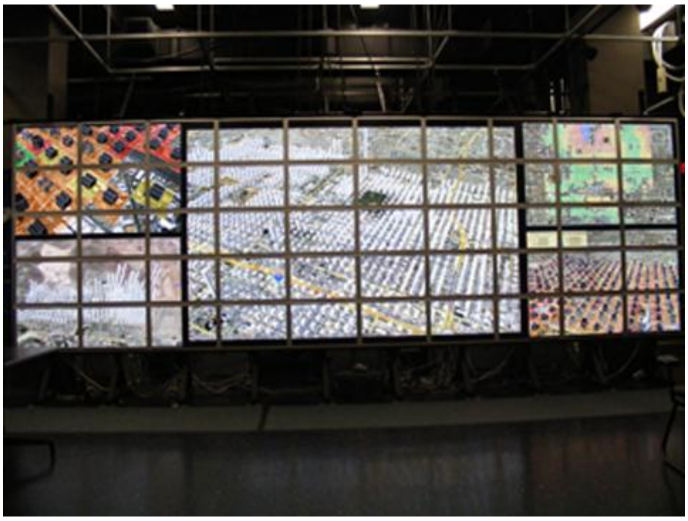

Figure 4: HIPerWall.

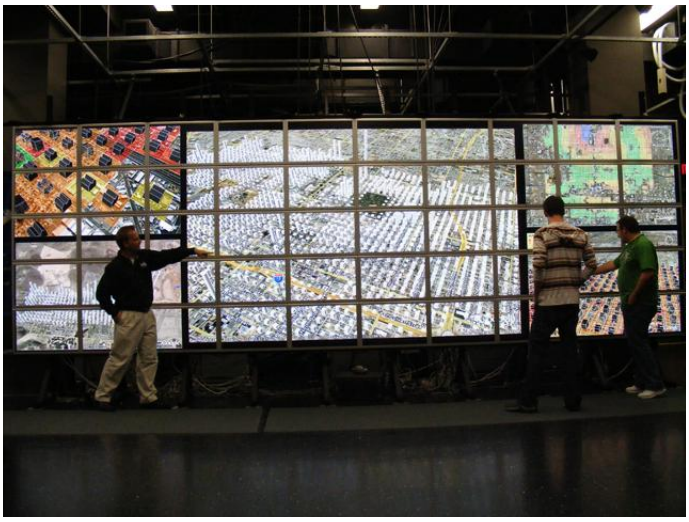

Figure 5: Discussing the visualization in front of the HIPerWall.

Figure 6: Discussing the visualization. Database visualization shown on HIPerWall.

Figure 7: High resolution and large screen real estate make collaborative work in front of the HIPerWall constructive.

Another example is the Form Based Code Visualization. The users are able to operate the application and immediately can see the changes they made. So they are able to see different scenarios in real time, can control and analyse violations of the building code within the 3D visualization window. This feature makes large high resolution displays applicable for decision support, if planners have to find consensus (discussing planning alternatives or showing alternatives to citizen).

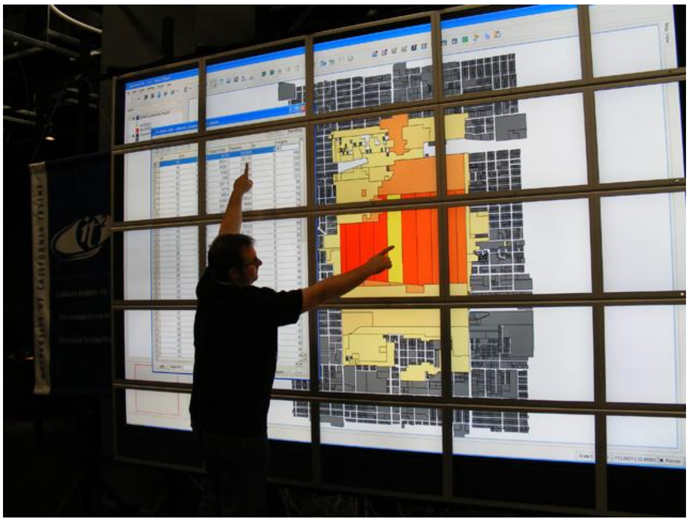

Figure 8: HIPerWall displaying QuantumGIS.

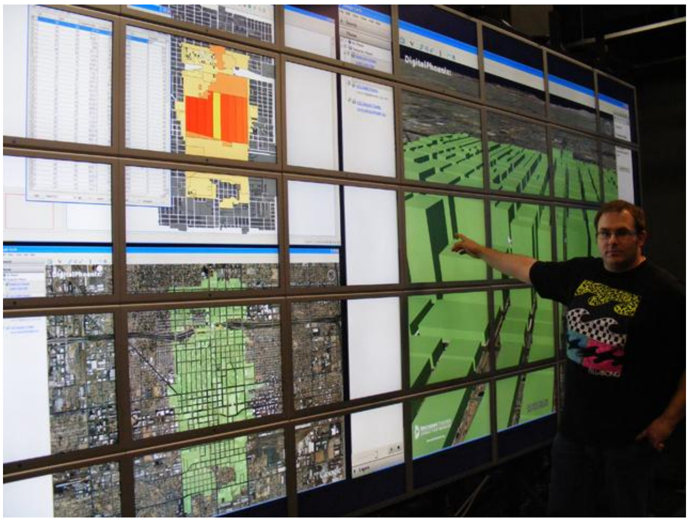

Figure 9: HIPerWall showing the Form Based Code application. Height zones can be manipulated in Quantum GIS and then updated in Google Earth.

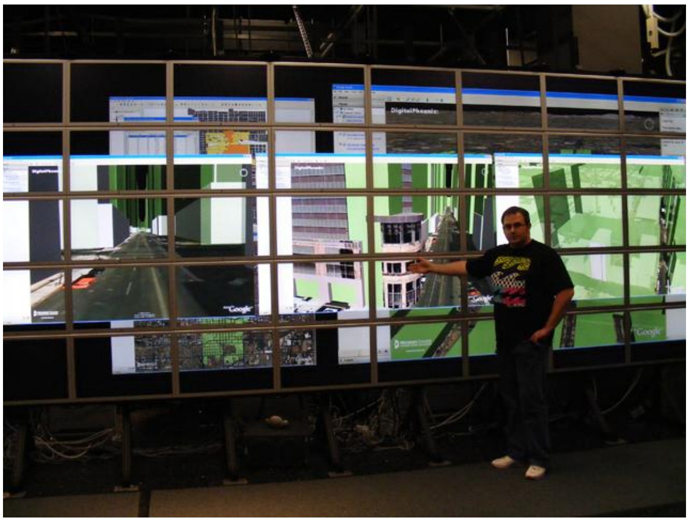

Figure 10: HIPerWall: Violations shown with overlay of existing buildings and visualization consistent with building code. For better visibility transparency can be added. Multiple windows can be examined and analyzed by multiple users.

An undesired effect, which comes with LCD based tiled display systems, is the bezel effect. This effect is caused by the monitor frames which are a necessity to drive the displays. In [8] we presented an enhanced tiled display setup, augmenting the bezel area with a regular computer projector. With this approach we were able to create a nearly seamless hybrid tiled wall system, combining LCD high resolution displays with low resolution image information projected onto the bezel area. The result was a vice versa focus and context display: large areas providing detailed information (focus area) and small areas supplying the user with otherwise missing low resolution information (context).

Figure 11: Tiled++ approach shown on HIPerWall. On the right, an user enters the projection area of the HIPerWall, causing a shadow. When examining focus information (details), the context information is secondary.

With the Tiled++ approach the natural interaction metaphor human zoom can be explained more clearly.

When stepping back the users can see the context information, stepping towards the display the users can access the detailed information. As seen in Fig. 11 an user walks toward the enhanced HIPerWall, creating a shadow. This effect, when a user enters the projection area, can be avoided by mounting the computer projector higher. Nevertheless having the human zoom and the vice versa focus and context approach in mind the effect is not severe at all: the user can examine the context information from a distance, is able to perceive a seamless image of the displayed content. When stepping forward to examine detail information, the low resolution context information projected onto the bezel area becomes secondary.

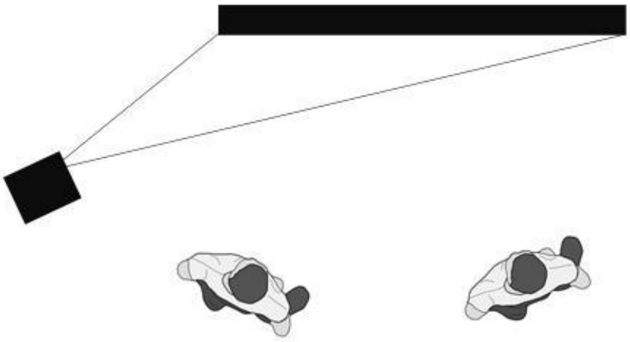

Figure 12: Accessing context information from a distant position. the disrupted image is enhanced with low resolution image information, resulting in a seamless image for superior perception.

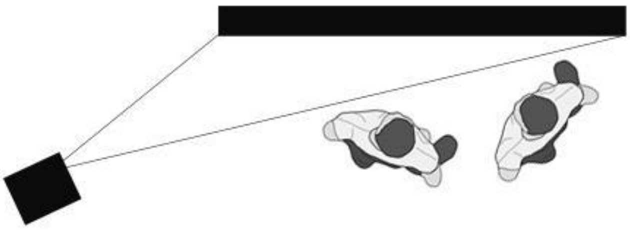

Figure 13: Examining focus information by stepping toward the display.

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6. CONCLUSIONS AND FUTURE WORK

New display technologies combined with new software applications are suitable to support the planning process. These new techniques, hardware as well as software, can help adding transparency to the complex planning processes, which is important for communicating planning decisions to citizens and increase acceptance for planning decisions. Also this new tools can be used for integrating the citizens in the planning process, making them actors instead of a passive audience.

On the one hand smart visualization can help in understanding complex coherences. For example a large, complex database is very hard to understand for non-expert users, not used to work with them. A visualization of database content can make complex coherences transparent; users can perceive the content more easily.

All the same with the visualization of Form Based Code: non-expert users will have problems to follow building codes/building policies. With simplifying complex contents, by using simple geometry, transparency is added.

On the other hand new display technologies add value to the planning process. When using physical navigation (human zoom) the user can access information more rapid. The users make use of their spatial memory, contents are a lot easier to find, compared to a single display setup. Examining the content displayed on the HIPerWall (e.g. Fig. 5) would result in permanent pan & zoom operations on single display setups. More and more information is needed to progress in the planning process, larger datasets needed to process during decision making, making new technologies necessary.

In future we want to evaluate the benefits of planners using new display technologies and new visualization approaches.

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