★ In this exclusive article Doctor **André Stork,** Head of Department for Industrial Applications at the Fraunhofer Institute for Computer Graphics Research in Darmstadt writes about how the 'Improve' project accelerates the development of display technology for virtual environments

Virtual environments can provide real benefits

In the modern world the margins between business success and failure are miniscule. There is no shortage of choice in the modern marketplace, which means that companies feel an increasing need to canvass a wide range of views and opinions in order to ensure that their products respond to public needs. In such a situation evaluation tools acquire increasing importance. If manufacturers, designers and consumers can work together, regardless of location, to evaluate proposed design modifications and their effect, then the products chances of success are greatly increased.

We at the Fraunhofer Institute are working with our partners in the 'Improve' Project to develop improved lightweight near-to-the-eye displays and tiled stereoscopic large size displays in order to fulfil this growing need for a collaborative design modification platform. For tiled stereoscopic large-screen displays we are developing improved calibration techniques to ease and accelerate the technology's use, while for the near-to-the-eye displays the main improvements come in the fidelity of the content to be displayed. The two technologies are closely related but nevertheless there are clear differences: with the near-to-the-eye display the user has a pair of glasses and is mobile, with the tiled display the user is sitting in front of it and sees a full 1:1 scale image.

Aiding design through collaboration

Our research was prompted by a growing desire, particularly among the vehicle and architecture industries, for a virtual-reality tool to aid design. The two industries have slightly different needs; architects are particularly concerned about cost-efficiency, certainly more so than the big car-makers who can afford larger and more expensive installations, but their needs are not enormously dissimilar. With architects having told us at the beginning of the process that affordability was a major issue for them we tried to change the price-performance ratio for Head Mounted Displays (HMDs). We are now at a stage where we have developed lightweight HMDs that are readily accepted by end users. Our technology has been designed as a design review tool where each user can actively contribute to the model, for this we need advanced tracking technology whereby we can be sure where people are located, what they are looking at and how they want to interact.

During the design review process users will have a 360° perspective on the installation they are viewing. For example, if you have an HMD, are completely tracked and are free to move within certain boundaries, then you can look around, look under, turn around and look into the interior and underbelly of a virtual car. Our aim is that people should be able to interact with the virtual car in the same way as they interact with the real one.

This is not the case at the moment as there are big differences between virtual reality (VR) interaction and real interaction. Currently mechanics move around the car, but with our technology users will be able to rotate the car around them, which is an important distinction. Not only do we want to give individual reviewers more power, but we also want to enable all of them to have a multi-user experience, to be able to connect and disconnect when they want to. People will be able to add their annotations, to contribute their criticisms, to comment on the current design and record their views.

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All the comments will be recorded in digital form and then the technicians will work on their suggestions, ready for another review session when the time comes around.

Augmented reality: Bringing the virtual and the real together

Although VR has been historically under-utilised by architects, we have recently had a lot more interest from the sector as a whole. VR has been used as a promotional tool by architects when presenting their work but not as fully in a practical sense as it could have been. We believe that augmented reality (AR) will be of particular interest to the profession, by melding the virtual environment with the real one AR allows us to measure a far greater range of impacts than previous technologies did. For example, as the technology is bi-directional architects can see how the external lighting affects the look of the building as well as where shadows will fall. The technology is

now so advanced that the real and virtual worlds are becoming more and more similar, and indeed our eventual aim is to make them indistinguishable.

Our work has very much been guided by the wishes of the end users, something which I believe is one of our strengths. A good example of the collaborative nature of our project was demonstrated following one of our initial meetings with a group of interested architects. They brought forward a whole range of further ideas which greatly complicated the project, one of them was the idea of going to the construction site and trying to sketch the building while merely standing in a field. This would be done using a PC for sketching and using HMDs to give a realistic impression of the sketch in the real environment. This certainly created more work for us but it meant that we were able to respond to the industry's exact needs.

Looking to the future

Our technologies have a wide range of possible uses for manufacturers and certainly won't be limited to high-end companies. In terms of car manufacturers, those who have spent the lowest initial amount on the car will be equally keen for their vehicle to undergo rigorous analysis as those at the higher end of the market, and indeed the initial response from the industry has been very enthusiastic. By the same token, architecture is a discipline in which all angles must be looked at, and this is an area where we can make an important contribution.

We have also identified some other industries that we think might be interested in our work. We are very hopeful that once it has been adopted by a number of architects then the benefits will become clear and prompt large-scale adoption. Meanwhile the whole transportation sector, be it trains, planes or ships, holds definite possibilities for us. There are also other things like product configurators for kitchens and bathrooms, various computer games and the like. In fact there are bits and pieces in the 'Improve' project that could interest many areas of industry.

It is a long-commented upon trend that in modern business value is added through careful innovation and small-scale changes rather than by revolutionary steps. Change is a constant, ongoing process, and in the relentless search for improvement there is a clear need for interested parties to be able to communicate their opinions and suggested modifications to manufacturers. Our technologies will provide an interactive, efficient platform where innovation and the exchange of ideas is actively encouraged. Not only will this lead to a mode of business where a greater number of views are taken into account than ever before, but it will also mean that the interests of the end user are paramount, something I think we would all welcome! ★

AR rendering of building

Model courtesy of Page\Park Architects

At a Glance

Core Technologies:
- Optical see-through Head Mounted Displays
- Multi-tile display calibration
- Physically-based rendering
- Marker-based and marker-less optical tracking
- Innovative mixed reality interaction techniques
- Stereoscopic real-time video transmission

Partners:
- Fraunhofer-IGD (GER)
- TU-Darmstadt (GER
- Triviso Prototyping GmbH (GER)
- MicroEmissive Displays Ltd (GBR)
- VICOMTech (ESP)
- STT Ingenieria y Sistemas (ESP)
- GraphiTech (ITA)
- Elasis S.C.P.A (ITA)
- Page/Park Architects (GBR)
- The Lighthouse (GBR)
- INESC-ID (POR)

IMPROVE will result in ground-breaking technologies which will greatly assist architects and automotive desgners. by bringing together virtual and real objects.

Contact:
Fraunhofer IGD
Dr. Ing. André Stork
Fraunhoferstr. 5
D-64283 Darmstadt
t: +49-6151-155-469
f: +49-6151-155-139
andre.stork@igd.fraunhofer.de
www.improve-eu.info

Dr Andre Stork

Head of Department for
Industrial Applications
Fraunhofer Institute for Computer Grpahics Research

Dr Stork received his doctorate from the Darmstadt University of Technology in 2000 and has worked in image classification, neuronal networks and animation. He has been head of department since 2002