

European and World's firsts: Live 3D-stereo full-HD retransmission of a surgical operation!

A major popular success for a technological feat

Press release – 19 March 2010 – TWIST asbl (npo)

In the framework of the 9th edition of the *ImagéSanté* festival, an operation of neurosurgery was captured and retransmitted live and in 3D stereo (and in full HD). This technological feat took place on 18 March 2010 in Liège, Belgium.

This event is a European first and, if one takes into account the particular technology used for the coding and transmission of the images, a World's first.

The surgical operation was carried out at the University Hospital ("Centre Hospitalier Universitaire or C.H.U.") of Liège and was watched by a mesmerized public in the movie theater Sauvenière, in downtown Liège, 16 km (10 miles) away from the hospital. The numerous spectators, in an overcrowded theater, were able to interact live with the neurosurgeon throughout the operation thanks to an audio duplex system linking the two sites. The surgeon was Prof. Didier Martin, also the President of the Belgian Society of Neurosurgery.

A lady spectator interviewed by the National Belgian Radio and Television indicated upon exiting the theater that "she thought this was better than Avatar" ... the ultimate compliment of course!

This success is the fruit of a close collaboration between a dynamic set of 16 companies and a university, mainly from Wallonia (the french-speaking part of Belgium outside Brussels) and members of TWIST, the walloon network for audiovisual and multimedia technologies.

Photos in 2D et ... in 3D!

YOU CAN DOWNLOAD PICTURES ON THE FOLLOWING LINK :
www.twist-cluster.com/imagesante_3D

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The *ImagéSanté* festival

The International Health Film Festival, called *ImagéSanté*, is held once every two years in Liège, Belgium, and is at its 9th edition (<http://www.imagesante.org>).

ImagéSanté is presided by *Professor Philippe Kolh* from the Medical School of the University of Liège (ULg), and is organized by the University Hospital ("Centre Hospitalier Universitaire or C.H.U.") of Liège (on the Sart-Tilman campus), the University of Liège (ULg), and the Province of Liège.

The technical realization of this ambitious project

The capture and retransmission of a surgical operation is far from corresponding to the classical conditions of a movie set. Managing the lighting (such as maintaining a proper balance between the ambient lights and the powerful lights above the surgical table), the positioning of the cameras that must capture the scene without disturbing the actions of the surgical team, the duration of an operation, and the travelling in the customary maze of hallways of a hospital (especially big and complicated in a building such as the C.H.U. of Liège) are among the many elements that must be taken into account.

By adding a transmission going beyond the boundaries of the University and the use of the **third dimension**, the organizers of *ImagéSanté* placed the bar one notch higher.

The capture of the images and the sound

Binocle, a french company specialized in the capture of 3D stereoscopic images, and the expertise of which no longer needs to be proven in the mastering of 3D stereo (stereography), took care of the acquisition of the 3D images.

The tools for image capture and the related machinery (including an Aerocrane on pneumatic wheels) were provided by **Arc-Cinevideo**.

Both companies worked in close collaboration to allow the camera operators, trained for this type of shooting, to operate the big 3D cameras within the limited space available, and in rigorous conditions of sterility.

From the broadcast van of **notele** located in a parking lot of the C.H.U., about five stories below the surgical block, the (movie) director mixed the images coming from the operating room, while the stereographer, *Yves Pupulin* (from **Binocle**), analyzed in the cinema the images projected on the screen to check the quality of the 3D stereo and the absence of artifacts such as disturbing highlights and ghosts.

This was not the first production in 3D stereo for *Dominique Durand*, the director, but it was the first time he participated to the 3D capture of a surgical operation. The adjustment to the new conditions was demanding because it was difficult, in particular, to work in the most discrete way possible within the confined space of the operating room, and among the many members of the surgical team.

Still in the broadcast van, the **EVS** team recorded all stereoscopic images via their XT-2 server.

On the lighting side, **Arc-cinevideo** managed to balance the lights of the operating room despite the constraints of the surgical environment, this under the direction of their director of photography, *Donat Mailleux*.

All the technical issues related to sound were handled by **WNM**, which also provided the majority of the necessary audio equipment.

Two independent systems provided the duplex audio communications between the C.H.U. and the cinema: one connection via optical fiber using the voice-over-IP technology, and one redundant connection via telephone cable using the digital ISDN technology.

APEX provided the voice-over-IP equipment.

A state-of-the-art technological architecture

Professor Jacques G. Verly and his team from the **Laboratory for Signal and Image Exploitation (INTELSIG) of the Department of Electrical Engineering and Computer Science (Institut Montefiore) of the University of Liège (ULg)** designed the architecture of the entire chain of capture, transmission, and projection, and provided the technical management of this 3D event.

The **ULg-INTELSIG** team also developed, in collaboration with **IntoPIX**, a solution for 3D-stereo full-HD retransmission in JPEG 2000 (http://en.wikipedia.org/wiki/JPEG_2000), guaranteeing the spectators a quality of visualization never yet achieved in the conditions of interest.

The transmission of the images and the sound was performed using a set of optical fibers capable of 1 Gbit/s, this thanks to the participation of the **SOFICO**. This company had to complete its network over 300 m right in the center of the city to bring the fibers to the cinema. The fibers were entirely dedicated to the project and had to be fusion-spliced to provide a continuous glass conduit over the 16 km between the C.H.U. and the cinema.

The **Department of Information and Communication Technology (SEGI) of the ULg** also played a key role in the installation of the optical fibers and of the electrical/optical converters, and in the management of the Ethernet service.

The transmission system managed to maintain the required throughput of 500 Mbit/s continuously during the three hours of the event. The two powerful computers equipped with the top-of-the-line "PRISTINE" electronic boards from IntoPIX were custom designed by the **ULg-INTELSIG** team in cooperation with its consultant *Benoît Michel* from **StereoscopyNews.com**.

The projection of the 3D-stereo images

At the far end of the chain, the 3D-stereo visualization system consisted of a DP2000 projector, manufactured by the Belgian company **BARCO**, and provided by **XDC** from Liège, and of active 3D glasses provided by **XpanD** from Slovenia.

The complete projection system was installed by **ACQI**, which also provided the technical management of the 3D-stereo projection during the live retransmission.

EVS was also present in the projection booth to ensure the synchronisation of the stereo streams and to play out auxiliary 3D contents. De-interleavers having proven to be necessary, these were provided by the French subsidiary of **DOREMI**.

Last February the 23rd, a general rehearsal had taken place at the C.H.U., where a first operation of neurosurgery had been captured in 3D stereo and recorded. The local TV station **RTC-Liège**, in collaboration with **EVS**, had performed the editing of the recorded images. The finalised movie was shown to the public at the cinema Sauvenière in the form of clips shown at various moments during the live operation on the 18th of March.

XDC, the **Institut Montefiore (ULg)**, the **C.H.U. of Liège**, the **cinéma Sauvenière**, and **EVS** gave a wide access to their facilities over several months to carry out the numerous tests of the various links of the transmission chain.

Finally, the production of this very particular event and the logistical coordination of the teams were entrusted to **Buena Onda Pictures** and **Injoy Productions**.

The Walloon Region can be proud of the know-how of its companies and university having taken part in this unique project and having taken up this technological challenge: the majority of the complete transmission chain has indeed been implemented by Walloon actors and talents! The TWIST network, active in the area of audiovisual and multimedia technologies, can also take part in this pride since most of the participating companies and university are members of TWIST!

Both a European first and a World's first !

Capturing, recording, and/or visualizing a surgical operation in 3D stereo locally are not, by themselves, new things. By contrast, capturing a surgical operation in 3D stereo and retransmitting it live over a long distance is something that is much less common. As such, the 3D retransmission event described above constitutes **a European first**.

It is also certain that the event constitutes **a world's first** on the basis of the type of technology used, in particular the electronic boards PRISTINE from IntoPIX (implementing the JPEG 2000 standard), one of which was acquired by the ULg.

These cards and the computers conceived at the ULg allowed one to perform the transmission by maintaining the left and right stereoscopic streams separated, and by compressing them simultaneously for a total transmission rate of 500 Mbit/s, i.e. 500,000,000 bits per second. This corresponds to half of the capacity of each optical fiber used. It is useful to indicate that, for example, the rate at the input of the encoding board, thus before compression, is on the order of 2.6 Gbit/s. One should note that the conventional strategy for this type of live 3D transmission is to mix the two streams (while reducing their resolution) to allow the use of traditional transmission channels, which was not the case here.

The team – Who did what?

The *ImagéSanté* Festival is organized by the University Hospital ("Centre Hospitalier Universitaire or C.H.U.") of Liège, Belgium, the University of Liège (ULg), and the Department of Health & Quality of Life of the Province of Liège.

President of the Festival:

Professor Philippe KOLH, Cardiac Surgeon,
University of Liège and University Hospital (C.H.U.) of Liège, Belgium

Coordinator of the Festival:

Dorothee DRADON, ENJEU asbl (npo), Liège

Trainee for logistics:

JEANNE HEBBELINCK, ENJEU asbl (npo), Liège

The captures, live transmissions, and projections in 3D stereo and full-HD of neurosurgical operations of the 25 February and 18 March 2010 in Liège, Belgium, were made possible by the close collaboration between the following numerous partners:

NEUROSURGERY

**University of Liège, Faculty of Medicine, and
University Hospital (Centre Hospitalier Universitaire or C.H.U.) of Liège,
Service of Neurosurgery**

Professor Didier MARTIN, Neurosurgeon

and his medical team in the operating theater:

Dr. Tudor RACARU, Neurosurgeon

Dr. Minh-Tuan NGUYEN KHAC, Assistant of Neurosurgery

Dr. Collette FRANSEN, Anesthesiologist

Frédéric HERBILLON, Instrumentist

Thierry STILMANT, Nurse

Béatrice TOURNEUR, Nurse and Instrumentist

Eric MACLOT, Chief of Service of the Operating Theaters

Audrey DUBOIS, Chief Nurse (Matron)

DESIGN OF THE GENERAL ARCHITECTURE OF CAPTURE, TRANSMISSION, AND PROJECTION, AND SCIENTIFIC AND TECHNICAL MANAGEMENT OF THE PROJECT

**University of Liège,
Faculty of Applied Sciences (Engineering School),
Department of Electrical Engineering and Computer Science (Institut Montefiore),
Laboratory for Signal and Image Exploitation (INTELSIG)**

Professeur Jacques G. VERLY, Electrical Engineer

and his team of researchers:

Jérôme LEENS, Engineer

Pierre THIRION, Electrical Engineer

David GROGNA, Computer Scientist

Cédric ANDRE, Electrical Engineer

(With the support of the MEDIATIC 3D-MEDIA project of the European Regional Development Fund - ERDF)

TECHNICAL CONSULTANTS

StereoscopyNews.com

Benoit MICHEL, Electrical Engineer

ACQUI

Pierre AUDRIT, Engineer

PRODUCTION & COORDINATION

BUENA ONDA Pictures

Pierre COLLIN, Delegated Producer

INJOY Productions

Inge ROCHETTE, Executive Producer

Camille VAN DE WALLE, Production Assistant

IMAGE ACQUISITION

ACQUISITION OF 3D STEREOSCOPIIC IMAGES AND STEREOGRAPHY

BINOCLE 3D

Yves PUPULIN, Stereographer

Christophe GURY, Technical Director

Dominique DURAND, Movie Director

Thomas BRESARD, Camera Operator

Thomas VILLEPOUX, Camera Operator

Alix WANONI, Camera Operator

Jeanne GUILLOT, Technician Stereographer
Benoît MORVAN, Technician Stereographer
Fabienne DELALEAU, Technician Stereographer
Thierry LEBIGRE, Technician Stereographer

Alexandre SINN, 3D-Stereo Vision Engineer

*SUPPLYING OF SHOOTING EQUIPMENT, LIGHTING AND
PROVIDING OF SERVICES*

ARC-CINEVIDEO

Hakime KAMEL, Chief Technician

Donat MAILLEUX, Technical Coordinator and Director of Photography

Hicham BOUKHROUF, Trainee
Richard DESMARLIERES, Trainee

OUTSIDE BROADCAST (OB) VAN

NOTELE

Jean-Pierre WINBERG, CEO
Céline VANSCHOORISSE, Production Assistant

Stanislas TEVESZ, Van Manager
Gregory CALAIS, Shader
Laurent BUSINE, FX & Mixer
Fabien LEBRUN, Technician

IN COLLABORATION WITH **RTC-TELE-LIEGE**

SOUND AND SOUND TRANSMISSION

SOUND MANAGEMENT AND SOUND TRANSMISSION

WNM

Mathieu LANTIN, Sound Engineer
François REMACLE, Sound Engineer
Clément NOIRET, Trainee

AV BRAHLER

Jean-Claude ROSSEZ, Sound Engineer

RECORDING AND PLAYBACK

EVS

Henry ALEXANDER, General Manager EMEA

Yves ROLUS, Tradeshow Manager

Jean-Yves RORIVE, Audiovisual Technician and Marketing Support

Bruno RAGATUSO, Customer Support Engineer

Michel COLLIGNON, Audiovisual Engineer

Wim VAN ROY, Freelance LSM Operator

ELECTRICAL POWER CONNECTION

COFELY SERVICES (GDF SUEZ)

Jean-Pierre OVART

TRANSMISSION

*COMPUTER NETWORK (OPTICAL FIBERS AND ETHERNET)
OF ULg AND OF UNIVERSITY HOSPITAL (C.H.U.) OF LIÈGE*

University of Liège

Department of Information and Communication Technology (SEGI)

Christophe LEJEUNE, Director of C.H.U. Computer Network, Electrical Engineer

Nicolas DEMONTY, Electrical Engineer

VPA Systems

Didier LEROY

*OPTICAL FIBER NETWORK FROM UNIVERSITY HOSPITAL (C.H.U.) TO CINEMA SAUVENIERE
(16 KM – 10 MILES)*

SOFICO

Frank CHENOT, Director

SPW Wallonie

Eric BADA

COMPUTERS AND JPEG-2000 ENCODING AND DECODING ELECTRONIC BOARDS AT THE UNIVERSITY HOSPITAL (C.H.U.) AND AT THE CINEMA SAUVENIERE

INTOPIX

Jérôme MEESEN, Electrical Engineer, Marketing Manager

Jean-François NIVART, Electrical Engineer, CEO

Marc VANDENBOSCH, Computer Scientist

Charles BUYSSCHAERT, Electro-Mechanical Engineer

University of Liège,

Faculty of Applied Sciences (Engineering School),

Department of Electrical Engineering and Computer Science (Institut Montefiore),

Laboratory for Signal and Image Exploitation (INTELSIG)

Professeur Jacques G. VERLY, Electrical Engineer

and his team of researchers:

Jérôme LEENS, Engineer

Pierre THIRION, Electrical Engineer

David GROGNA, Computer Scientist

Cédric ANDRE, Electrical Engineer

(With the support of the MEDIATIC 3D-MEDIA project of the European Regional Development Fund - ERDF)

AUDIO TRANSMISSION (ISDN CONNECTION)

ULg-SEGI et UNIVERSITY HOSPITAL (C.H.U.) of Liège

Vincent GARROY, Manager of Phone Network

ULg-INTELSIG

Pierre THIRION, Electrical Engineer

VOICE-OVER-IP

APEX AUDIO

Geert VAN DEN BOSSCHE

POST-PRODUCTION

RTC-TELE-LIEGE

Jean-Louis RADOUX, General Director

Sébastien SCHLESSER, Editor

3D STEREO PROJECTION

MOVIE THEATER

Cinéma Sauvenière (Les Grignoux)

Jean-Marie HERMAND, CEO
Aldo PAGLIARELLO, Technical Manager

*DESIGN AND INSTALLATION OF THE 3D-STEREO PROJECTION SYSTEM
AND MANAGEMENT OF PROJECTION*

ACQI

Pierre AUDRIT, Engineer

EQUIPMENTS

Servers (XT-2)

EVS

VIDEO DE-INTERLACERS AND SYNCHRONIZERS

DOREMI Technologies

Patrick ZUCCHETTA, EMEA Business Development
Jordy PIGOT, D-Cinema and Test Manager

DIGITAL 3D-STEREOSCOPIIC PROJECTOR (BARCO DP2000)

XDC

ACTIVE 3D-STEREO GLASSES

XPAND

MANAGEMENT OF PROJECTION PARTNERS, AND CONDUCTING OF EVENT EVENING

EVENTIS
Alain GALLEZ, CEO

PRESENTER OF THE EVENT EVENING

Claire GILISSEN, RTBF

