“OPERATION LINDBERGH”

A World First in TeleSurgery:
The Surgical Act Crosses the Atlantic!

New York – Strasbourg

Press Conference
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Espace Multimedia
103 rue de Grenelle
75007 Paris

Contents

The Operation and the patient

Description: This is the first transatlantic surgical intervention performed on a human
Date: September 7, 2001
Locations: Operating block A, Strasbourg University Hospital, Place de l'Hôpital, Strasbourg / Equant building, Avenue of the Americas, New York
Team: Professor Jacques Marescaux, assisted by Professors J. Leroy and M. Gagner
Partners: IRCAD, France Telecom, Computer Motion

Description of surgical operation

The surgery was performed from a building in Manhattan, not from a hospital. Dr. Marescaux and his assistant Dr. Gagner were in New York. Doctors Leroy and Smith were in the operating room in the Strasbourg hospital, ready to intervene if necessary. The patient was operated on under a general anesthetic, as for conventional minimally-invasive surgery procedures. An optical link and a camera were inserted in the patient's stomach, along with two surgical instruments.

The surgical intervention consisted of a laparoscopic cholecystectomy (removal of the gall bladder using a minimally-invasive procedure) on a patient with chronic gall bladder problems. The choice of this procedure for the first transatlantic intervention was deliberate: gall bladder removal by a minimally-invasive procedure has become a recognized "gold standard" among the international surgical community. The surgical team in Strasbourg assessed the benefits of robotic surgery for this type of operation and published its results in the prestigious U.S. journal *Annals of Surgery*. Furthermore, this procedure can prove to be simple or sometimes difficult and even dangerous, providing an opportunity to demonstrate the possibility of sharing surgical actions in the event of complications or difficulties during the procedure.
The operation lasted 45 minutes, drawing on the combined skills of a tightly coordinated team of 40 people, spanning the medical team, France Telecom engineers, and robotic system specialists from Computer Motion.

The patient

The patient, a 68-year-old woman, was specially briefed prior to the operation on all the details of the operation. She toured IRCAD/EITS in Strasbourg, saw the robot function, and fully understood the concept telesurgery, with her surgeon working from New York while she was on the operating table in Strasbourg. She was informed of all the risks inherent to the use of this new technology (in conformity with France's Huriet law), as well as the favorable opinion issued by the Alsace CCPPRB patient rights board. The fact that she immediately accepted the idea reflects her personal interest in new technologies, her conviction that this sophisticated technology was completely safe, and the knowledge that she was participating in a major revolution in surgery.

The operation on September 7, 2001, marked the fruit of long years of research at IRCAD/EITS in Strasbourg. In 1993 Professor Marescaux submitted a project within the scope of Europe's Eureka "Master" research program, aimed at initiating and developing computer-aided surgery.

Trials

The first trial simulations of telesurgery took place in Strasbourg via Paris, a total distance (with return) of 1,000 km). These trials were successfully carried out in September 2000, with a transmission delay of about 200 milliseconds.

Subsequent work reduced the time delay to 150 milliseconds and in July 2001 several transcontinental trials between New York and Strasbourg were held, with data travelling a total route of about 15,000 kilometers. The success and reliability of these tests made it possible to begin planning an operation on a human patient.

A Successful Alliance of Three Unique Competencies

A long established expertise in tele-surgery: the IRCAD and the EITS

IRCAD (Institute for Research into Cancer of the Digestive System) and EITS (Institute European Institute of Telesurgery), have acquired international renown in the seven years since their creation, reflected in the large number of surgeons from around the world who enroll for training there. The facility welcomes more than 3,000 surgeons annually from three continents, who receive training thanks to the collaboration of an international team of 800 experts.

IRCAD-EITS ranks among the world's top surgical schools and EITS is a recognized world leader, since no other university structure of this scope exists worldwide.

The center was founded in 1994 at the initiative of Professor Jacques Marescaux, who in 1993 recognized that surgery was making a fast and ineluctable transition from the industrial era to the computer era. This innovative private sector organization is dedicated to leveraging the value of basic cancer research, with IRCAD, and to developing new computer-based technologies for surgery, with EITS.

Telesurgery thus figures at the core of the training and research work pursued at IRCAD-EITS, following the different revolutions that the world of surgery has seen in the past decade. The advent of minimally-invasive surgery, enabling a surgical procedure to be performed with guidance by a camera introduced without opening the abdomen or thorax, was subsequently joined computer-assisted surgery and artificial intelligence techniques that enhance the safety of operating procedures, rendering surgeon's movements more accurate. At the same time, these breakthroughs have introduced the concept of distance between the surgeon and the patient.

IRCAD-EITS has for several years focused on the challenges posed by distances between the surgeon and patient, extrapolating from the current few meters in an operating room to distances of several thousand kilometers. The team of *Operation Lindbergh* has now made this concept a reality.

France Telecom: Excellence in High-Speed Transmission

To support the success of this operation, France Telecom had to address compelling challenges in order to provide the surgical team with:

- Flawless quality service, totally reliable and secure, with end-to-end management.
- Guaranteed bandwidth of 10 megabits per second.
- Continuous transmission delays of less than 200 milliseconds — on both outbound and return links — previously considered impossible to achieve over this distance.

In addition to these technical challenges, the same service had to accommodate multiple types of use.

The successful deployment of this multiservice transmission network enabled France Telecom to bring two continents closer together at five levels (see diagram):

- the surgeon's actions, via the robot and data transmission
- voice, using Voice-over-IP
- the surgeon's eyes, using the endoscopic camera and the video monitor
- a videoconference link for visual coordination between the two rooms
- continuous control data exchanged between two PCs at each end.

To meet these challenges, the France Telecom group drew on multiple teams:

- The **Large Business Division** was responsible for coordination of Operation Lindbergh and provided the MultiLAN solution for the segment in France.
- **Equant** managed the international segment using the Equant ATM (Asynchronous Transfert Mode).

- **France Telecom's Networks Division** provided the physical infrastructure for the network, with fiberoptic links.
- **France Telecom Transpac** handled technical coordination for network operation and surveillance.
- **France Telecom R&D** engineers successfully reduced the time delay for coding/decoding of the video signal. They also deployed and operated service access equipment, and performed end-to-end supervision of service quality and reliability by inserting test cells in the ATM frame.

Operation Lindbergh enabled France Telecom to once again showcase the capabilities of its state-of-the-art network in an extremely demanding environment. These capabilities are applied daily to help businesses pursue innovation, swift responsiveness and enhanced productivity.

Computer Motion: Telesurgery and Robotics

This world's first in telesurgery was made possible thanks to an unparalleled alliance of robotic surgical systems and specially-developed software by R&D teams at Computer Motion, the world leader in surgical robotics. Computer Motion recently introduced its SOCRATES™ Telecollaborative System, as well as the new Microwrist™ technology and the ZEUS™ Robotic Surgical System. Operational Lindbergh has opened up exciting new possibilities thanks to this full-scale test. The results will energize further breakthroughs in telesurgery, real-time collaboration and distance training for surgeons.

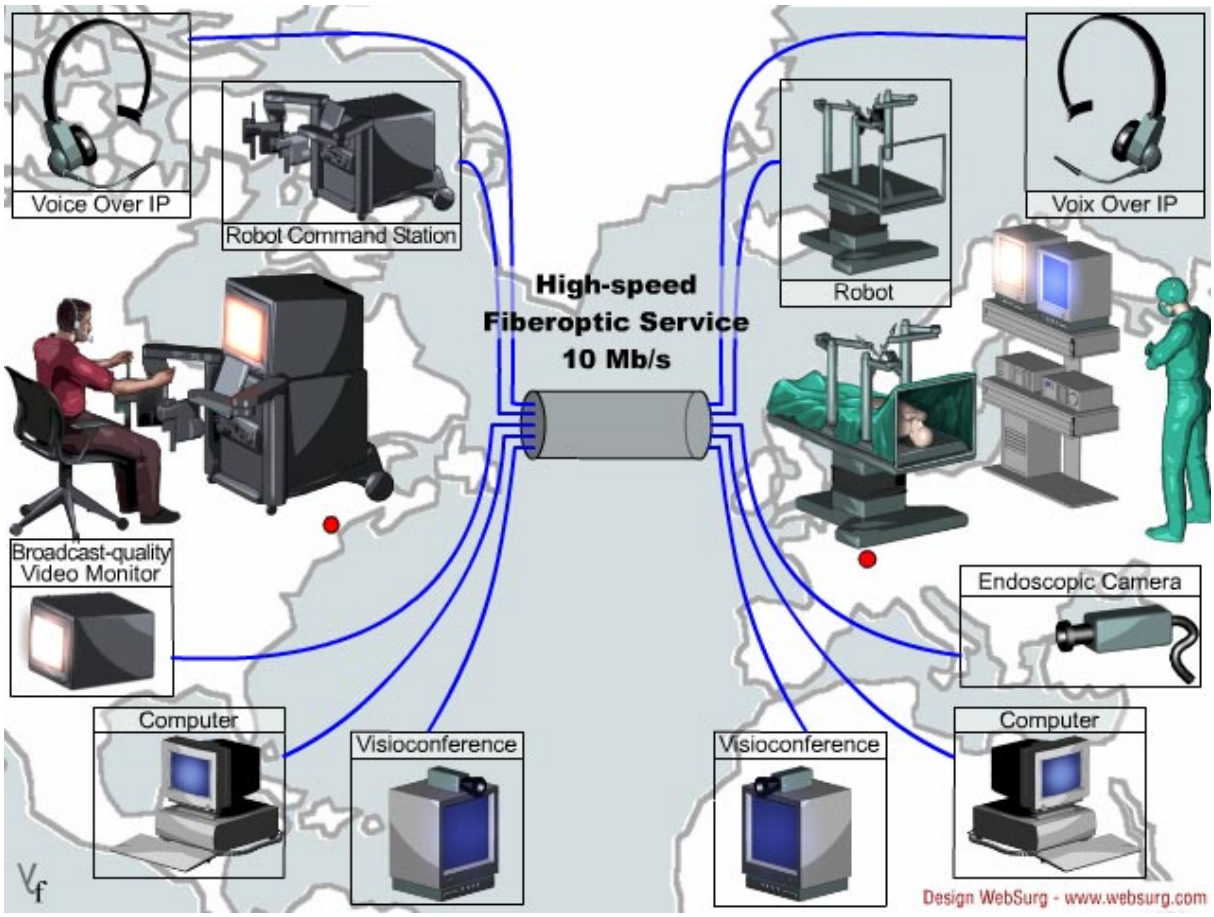
The adoption of advanced minimally invasive surgical procedures continues to drive research and development efforts at Computer Motion. The company aims to enhance the outcome of operations and the quality of life of patients across a broad range of surgical disciplines. This provides an excellent opportunity to apply this progress to a broader population of patients by overcoming constraints related to time and space.

The Operation Lindbergh telesurgery procedure was done using the Zeus™ robotic surgical system, initially developed in 1995 for endoscopic microsurgery. It quickly became apparent that the system could be efficiently employed for a broad variety of surgical disciplines, including general surgery, thoracic surgery, gynecology, urology, etc.

The Zeus™ system consists of three robotic arms (two to manipulate instruments, in reaction to the surgeon's hands, and one voice-controlled arm controlling the endocscope), and a surgical console (where the surgeon is seated and manipulates the joysticks that control the two instruments held by the robot arms).

Each articulation on the robotic arms of the Zeus™ system is equipped with a dual security system. Signals are checked more than 1,000 times per second. Our robotics technology results in a totally reliable platform.

Graphic of Operation Lindbergh



Code Name: Operation Lindbergh

Charles Lindbergh's Exploit: First Solo, Nonstop Transatlantic Flight

In 1927, aviator Charles Lindbergh became the first person to make a solo, nonstop flight across the Atlantic, flying from New York to Paris aboard his plane the *Spirit of Saint Louis.* The 33-hour flight marked the success of major undertaking.

Inspired by this feat, Operation Lindbergh represents a major advance in both communications technology and surgical techniques. Today, it is the surgical act that has crossed the Atlantic.

Charles Lindbergh was born on February 4, 1902 in Detroit. He saw his first plane at the age of eight, flown by another pioneer in aviation, Lincoln Beachey. Lindbergh's fascination for planes continued to grow. In 1922 he left the University of Wisconsin, where he was studying engineering, to pursue his passion. Taking every opportunity to build his skills as a pilot, he joined an airline in Nebraska and in 1923 made his first solo flight. In the spring of 1926 he flew the first airmail pilot on the Chicago-Saint Louis route.

Lindbergh was 25 when he set out to fly across the North Atlantic. On the morning of May 20, 1927, he set out solo for Europe. All eyes were on this "world first", which earned Lindbergh the nickname of "the lone eagle". His plane, a Ryan NYP (New York Paris) was called the **Spirit of Saint Louis** in recognition of the businessmen from the city who had helped finance his plane. It was powered by a new 220-horsepower Wright motor. Lindbergh took neither parachute, nor radio onboard in order to economize on weight and carry extra fuel.

After a flight of more than 3,600 miles — several hundred longer than planned — he landed at Le Bourget airport on May 21 at 10:22 p.m., after a flight lasting 33 hours and 30 minutes. He found himself surrounded by a cheering crowd, who rushed towards his plane to try to get a piece as a souvenir of his historic flight. Back in New York he received a hero's welcome from Americans. On March 21, 1929, President Coolidge awarded Lindbergh the Congressional Medal of Honor. For the rest of his life he continued to serve his country, flying missions over the Pacific during the Second World War. Charles Lindbergh died on August 26, 1974.

Charles Lindbergh's flight across the Atlantic was the culmination of his spirit for adventure. Today, Operation Lindbergh is a symbol of another transatlantic conquest, made possible thanks to the cooperation of partners with a shared commitment to progress.

150 Years of Progress in Transatlantic Communications

When Charles Lindbergh flew across the Atlantic, his feat represented a conquest over the distance separating the United States from the "Old Continent". Today, the challenges facing communications are radically different: how can information — voice and images — be transmitted almost instantly. As distances are progressively overcome, the focus shifts to enhancing quality and achieving higher speeds, energized by new technologies and greater capacities available on transatlantic links.

April 1, 1792: An **optical telegraph** is presented by Claude Chappe (1763-1805) to the French legislative assembly on March 22, 1792 and approved by the lawmakers. This first telecommunications network enables the government to transmit orders across French as quickly as possible.

1851: First submarine telegraph link between France (Calais) and Britain (Dover).

1858: First transatlantic telegraph cable. At the time, ships took three weeks to cross the Atlantic with mail. The initial transmission code selected was the Recorder code, which enabled a theoretical speed of 2.75 words per minute. Telegraph terminals used for land networks (Morse code, with a speed of 25 words per minute and then Hughes code at 42 words per minute) were not used on these transatlantic links. Between 1858 and 1869, four lines were laid (Brest/St. Pierre et Miquelon link).

1875: first duplex technology application, enabling one message to be transmitted simultaneously in each direction. This increased capacity to 80 words per minute.

1928: first radio mobile links opened by major companies. These systems ran on short-wave, with distances of less than 100 meters. They prefigured the development of a full-fledged global over-the-air network.

1956: first intercontinental submarine telephone cable laid between Europe and the United States, TAT-1 (for Trans-Atlantic 1).

On the night of **July 10-11, 1962**, the first **video images** were transmitted between Andover, in the United States, and Pleumer Bodou, in Brittany, France, using a station installed by the CNET research center (now France Telecom R&D). Shortly afterwards, the **first intercontinental satellite communications links** were inaugurated with the Telstar low-altitude satellite, offering an entirely new service: television. The cost of building a transatlantic link with analog coaxial cables quadrupled, but transmission capacity increased ten-fold.

1998, the first fiberoptic transatlantic cable, TAT-8 is build, with a capacity of 40,000 simultaneous phone calls using digital technology. Between 1988 and 1995, links built are equipped with repeaters and regenerators. Subscriber equipment is largely digital and customers are connected to digital switches. Some carriers, including France Telecom, promote "all-digital" systems for businesses, including France Telecom's Numeris ISDN network.

1997, installation of TAT-12/TAT-13 systems. As of 1997, new systems are equipped with repeater/amplifiers. Explosive demand of dedicated lines and the Internet require a boost in system capacity.

2000, inauguration of the TAT-14 submarine cable system. This transatlantic self-healing ring network has seven segments linking Europe and the United States. France Telecom is one of the principal sponsors of the system. TAT-14 offers 64 times more capacity than the previous system. Some 80 percent of this capacity will be dedicated to Internet and multimedia traffic, enabling routing of the equivalent of eight million simultaneous calls. At the same time, wireless communications are experiencing tremendous growth.

About Telesurgery

Definition

Telesurgery: from the Greek *tele,* "far off" and *kheirourgia* " "working by hand"

There is often a certain amount of confusion associated with the term “telesurgery”. It has been applied to computer-assisted surgery, since there is indeed a distance of one or two meters between the surgeon and the patient.
It has also been used as a surgical equivalent of “telemedicine”, meaning guiding the surgeon performing the procedure (“telementoring” or “teleprotectoring”). For “telementoring” applications, the remote contribution to the surgical actions consists only in providing recommendations.

On the other hand, Project Lindbergh involves what the Americans refer to as “remote surgery”, which consists in performing the entire procedure remotely. No team had previously successfully met this challenge due to the latency, or time delay, between transmission of surgical actions and images, which was incompatible with reliable coordination of the surgeon’s acts.

Advances in surgical procedures

The past decade has seen several revolutions in surgical techniques.

- **1988: Minimally-invasive surgery** enables surgical procedures to be guided by introducing a camera without requiring opening of the abdomen or thorax.
- **1996: Computer-assisted surgery.** This type of surgery involves inserting a computer interface between the surgeon and the patient, enabling an analysis of the surgeon's actions in order to repeat them, ensure their safety and then transmit them to a remote manipulation device that performs the actual surgical manipulation. Artificial intelligence enhances the safety of operating actions and renders them more precise.
- **September 7, 2001**: **Telesurgery.**

The remote manipulation was previously performed using a cable just several meters in length in the same operating room as the surgeon and patient. The challenge was to conceive how this type of surgery could overcome the limits of distance.

However, researchers constantly encountered technical limits, since it was impossible to reduce the latency, or time delay, between the surgeon's action and the return image of the action performed by the remote manipulation device. A satellite link, for example, introduces a time delay of 600 milliseconds, making a reliable surgical manipulation impossible.

Future challenges

This technological sea change in the world of surgery ushers in a host of possible future developments :

- To start with, it makes possible collaborative telesurgery, one of the most positive concrete applications of "globalization".
- It also revolutionizes the concept of surgical training, since a sort of "umbilical cord" could be created between a young surgeon and more experienced teacher-surgeons.
- It would also make it possible for developing nations to benefit from the expertise of world-renowned surgeons in order to enhance care in their country.
- This breakthrough also makes it possible to imagine future surgical procedures being done in space.
- Finally, by combining virtual reality techniques with pre-operatory simulations, this could lead to an entirely new era of semi-automated or even automated telesurgery.