By Joseph L. Streich
and Jeffrey Schiller, MD

IN ORBIS

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As a commercial jetliner, the DC-8 passed into obsolescence a long time ago. The racket the aircraft produces rivals a Concorde; by today's noise standards, it would not even be allowed to land at U.S. airports. Yet, when the flying eye hospital known as Project ORBIS touches down on runways the world over, the plane is met with the heartfelt gratitude of the host country's doctors and health establishment.

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The ORBIS jet has been completely retrofitted as a self-contained ophthalmological surgical facility; on board, modern lasers and medical technology help restore sight to those suffering from treatable eye diseases. ORBIS also serves as a traveling teleproduction facility. The jet's video capabilities enable the ORBIS staff to document on-plane surgery, teach visiting physicians, and even provide entertainment to pre- and post-operative patients. Since its inception in 1982, ORBIS has flown over 58 missions to more than 40 countries, treating more than 4,000 patients aboard the plane. Its most recent travels have taken it through Malta, Egypt, Jamaica, Peru, and Ecuador.

"The symbol of the plane is very powerful," notes Penny Staples, ORBIS director of external affairs. "If a team of doctors simply arrived in a country, it might get mentioned in a column in the local paper. When that plane lands on the runway, it becomes front-page news—we've put a university on the tarmac for three weeks, and we get visits from politicians and heads of state."

Inspiration for ORBIS came from the historic floating hospital Project Hope. Dr. David Paton, a Houston ophthalmologist, conceived the idea of an airplane that could spread the latest techniques in his field to all corners of the earth. The figures are sobering: there are some 42 million blind people worldwide, while over half a billion suffer from various eye diseases. But what is truly shocking is that two-thirds of these people suffer needlessly, for the skills are present to cure or prevent blindness and must only be communicated to local health care professionals.

With the aid of Leonard F. McCollum, Project Hope's chairman of the board (and now co-chairman of Project ORBIS), Paton's dream took shape. The U.S. government gave ORBIS a $1 million grant toward start-up costs, while over 200 corporate donors proved even more generous, ranging from the gift of the DC-8 aircraft by United Airlines, to the plane's video equipment, electronic sight, donated by the Sony Corporation. (Ongoing government support comes from the U.S. Agency for International Development.)

Working with local ophthalmic groups and government health organizations, Mark Mahoney, of the ORBIS primary eye care office, and Meg Crabtree (assistant to Oliver Foot, the organization's executive director) set up a program designed to interface and expand upon existing eye care efforts in host nations. If no such efforts exist, they must then find an appropriate local organization to host the ORBIS visit. An advance team works with the sponsoring organization, establishing itineraries, preselecting a pool of patients for on-plane surgery, and arranging side trips to local medical facilities.

ORBIS' own staff is augmented by ophthalmologists and specialists from the U.S. and around the world who join the project as visiting faculty for one to two week stretches. These doctors do most of the actual teaching that takes place aboard the jet and share surgical duties with local host doctors. Staff ophthalmologists join ORBIS for a six-month

ORBIS crew responds to the typically warm welcome they receive from the host country.

fellowship; the Project seeks out young doctors sensitive to intercultural contacts and with foreign language skills. For them, it is an opportunity to further their training while, at the same time, seeing a decidedly nontourist view of the world. Between one and four fellows travel with ORBIS at any one time.

Ophthalmology is a particularly appropriate specialty for a traveling facility, since the current generation of that field's technology reflects an ambulatory approach to surgery. Only patients who are in otherwise healthy condition are included in the pool of candidates for surgery aboard ORBIS. If the patient cannot make the trip to the airport and climb the stairs to the plane with just minor assistance, he or she is not accepted. After a brief onboard postoperative period, the patient is released the same day, eliminating the need for extensive postoperative facilities.

The DC-8 has been completely retrofitted for its unprecedented joint role in aviation and medicine. Only the first class cabin resembles a standard passenger jet, but its three rows of seats face a television monitor. The cabin holds the ORBIS crew during flights and serves as a classroom when on the ground. The visiting physicians can view, on the TV screen, examinations and surgery taking place elsewhere on the plane. During these learning periods, microphones in the classroom and operating room permit two-way conversation between the local physicians and the visiting faculty conducting surgery.

Often, the staff ophthalmologist relays the questions from the local physicians to the doctors conducting surgery, or poses his or her own questions. While not all surgeons relish being peppered with questions during a tough case, the visiting faculty are often academics in their own right and, if they are not already used to it, they soon will be. The visiting surgeon may only be part of the ORBIS faculty for one week and should be talking as well as operating. After surgery, he or she may personally address the local doctors in the classroom, using slides and video playback to further explain new techniques and equipment.

An examination room is positioned just behind the cockpit. There, two Cooper Lasersonics lasers—a 7500 argon and 2500 YAG (yttrium aluminum garnet)—are used as examining slit lamps. A Coopervision Pro CMC 200 camera is attached, providing a video record of the procedure. An ultrasonic unit provides important information on the eyes being treated. This device reveals conditions within the eye that might be obscured by cataracts upon direct examination. Together with a keratometer (which measures the curvature of the cornea), the lens power needed to produce proper focus can be calculated so that a proper lens can be selected for implantation during surgery. Another argon laser, manufactured by HGM, is used exclusively in the operating theater. This instrument is used as a cauterizing tool during surgery: it conducts a small, air-cooled beam of light into the eye through a slender fiber and is used to stop hemorrhaging that might otherwise obscure visualization within the eye and bring surgery to a halt. A modified Zeiss surgical microscope carries a low-light video camera. The microscope can be controlled in surgery by a doctor or nurse, or by the audiovisual producer from the plane's control room.

ORBIS was the first to use the Sony model 1850 medical camera; the serial numbers on their units read 1 through 12. These single-tube cameras are placed throughout the aircraft, and remote-controlled from a rack in the plane's AV room. There, producer Ozzie Font can select shots to be patched into monitors throughout the aircraft or for inclusion in the videotaped record of the surgery. Three of the cameras are mounted in the OR: one provides a wide-angle view of surgery, while the other two are on remote-controlled pan-and-tilt heads. A CCD camera from MP Video with a one-inch cube camera head is also used in the OR, attached to an ophthalmoscope or worn by a doctor during a retinal exam. A recovery room toward the rear of the jet can handle up to three patients at once. The room also serves as a pre-op facility, where anesthesia is administered to patients.

The video equipment is broadcast quality wherever possible. Its ¾-inch video recorders are Sony BVU-800s, used by many stations for news gathering and editing. A Grass Valley 1600 switcher selects shots and creates split-screen images, simultaneously showing the

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Being There

The job of staff ophthalmologist on Project ORBIS involves an unusual spectrum of duties, ranging from mopping the OR floor to giving a speech to high level government officials. The work includes screening patients presented for surgery by the host doctors, organizing and overseeing pre-op and post-op routines, and facilitating the activities of the OR. But the heart of the job, and of the project, involves the surgical teaching aboard the aircraft. The live surgery is always shared by local host doctors and the visiting faculty of ORBIS, and is virtually always presented via video to a lively and enthusiastic audience. My job, and that of my fellow staff ophthalmologists, when not actually participating in the surgery, was to make sure that the presentation that was coming through to the audience was as cogent, stimulating, and comprehensive as possible. After all, in the three weeks of a mission, there are usually only twelve surgical days, and sometimes only eight of these would be on the airplane with its extensive audio/video equipment.

Sometimes I shared the video production tasks with the video technician, which meant learning to control the complex system. The Grass Valley video mixing board is like the mixing board of any TV production studio. It allows switching among 3 cameras by fades or wipes and the mixing of two images on the screen. One image can be compressed into a number of shapes and sizes and placed at a chosen spot on the screen. This allows the simultaneous transmission of the view through the microscope and of the surgeons' technique in handling the instrument, or the addition of a sketch drawn on the board in the classroom illustrating the principle of a new technique.

The plane's slit lamp for microscopic examination of the eye and for laser delivery is also equipped with a camera, and one of my most dramatic moments occurred during laser surgery. The plane had just received a YAG laser, which allows opaque membranes that sometimes occur after surgery or trauma to be cut open, instantly restoring sight. Such a device exists only in Beijing, and its use was extremely limited. We were operating in Shanghai, with a daily audience of about 150 doctors in an airport building nearby watching the large screen transmission, and about 20 doctors crowded into the classroom on the plane. The sight of a dense white membrane deep inside the eye being punctured by the laser in an awake patient in street clothes elicited a symphony of gasps and exclamations. I should add that such high technology wizardry is definitely *not* a goal of Project ORBIS, which in underdeveloped countries strives to present advanced ideas of diagnosis and surgery in a manner appropriate to the technical level of the host country.

In Pakistan our field work involved documenting the work of cataract camps. These "camps" are an answer to the most common cause of blindness in the third world: cataracts. Because of the shortage of trained personnel as well as the virtual absence of the medical infrastructure required to support even rudimentary intraocular surgery, *the world's* cataract blindness is steadily increasing. Cataract camps are temporary field hospitals set up in a local school or health center where for a few days or weeks, hundreds of cataract operations are performed per day by teams from a city-based medical center.

In a mission hospital in Taxila, a village in northern Pakistan, I switched to the other side of the camera to conduct an interview with an American missionary doctor, Norvall Christy, who has spent years doing between 60 and 150 cataracts per day. We sat in his yard near the Himalayas with the birds singing and had a lovely conversation about the problems and rewards of his work, as well as the technical details of his hospital's ophthalmological services which even included the grinding of lenses. This is one of my fondest memories from my time with ORBIS.

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view through the microscope and the surgery.

The staff ophthalmologist may be asked to share production tasks with the video producer. While a sharp lay observer of eye surgery, Font may not have the same grasp of the nuances of what is interesting or important during an operation. In these situations, the staff doctor works with him like a director in the control booth at a football game, choosing shots and controlling the exact positioning of the remote cameras.

The video setup on board ORBIS was designed for maximum flexibility and minimum inconvenience to medical procedures. A matrix switcher at each primary monitor throughout the plane allows different programs to be viewed, simultaneously. Cartoons from the plane's video library can play in the recovery room for a waiting child; while another channel might display surgery taking place in the OR. ORBIS carries a portable projection video setup and can broadcast on-plane procedures via a UHF transmitter, enabling larger groups to view surgery from a nearby airport building.

Videotapes can be edited directly on board, using two of the BVU-800 machines. Many procedures performed on ORBIS become part of the jet's permanent medical video library. Two Sony BVU-200 recorders and a model 500 edit control unit comprise a secondary editing system that travels off plane when additional work must be done. ORBIS creates a video journal of each mission, combining the medical viewpoint with the human side of their efforts, documenting the people-to-people contacts and the indigenous culture.

These journals are also used to capture local ophthalmological practices that may be of interest to eye specialists in other countries. On one such trip, the co-author traveled with Font to the back country of the Ivory Coast, where a United Nations team had launched an anti-onchocerciasis program. This disease, known as river blindness, has made some of the most fertile land of Africa virtually uninhabitable. In many villages within the endemic area, one-third to one-half of the adults are blind. The videotape shot during the trip documented a helicopter spraying the breeding areas of the flies that carry the parasite, together with the work of a field epidemiology team studying the local population's health.

New surgical techniques are demonstrated in the plane's OR while other doctors share the experience on video from their cabin seats.

ORBIS' video facilities have also been used to create educational messages for host countries. Both Guatemala and Costa Rica are now airing public health announcements produced with the assistance of the ORBIS video facilities. "It was very gratifying," remembers Jim Hannigan, the technical services director. "We taught them how to script, select people, and find locations. In the future, they'll be able to produce public service announcements without going to expensive producers—all they'll need is to find a local videotaper. Remember, even in what we consider less advanced countries, over 70 percent of the population is still exposed to video."

ORBIS' video equipment is exclusively NTSC (American) standard: Font and Hannigan have found that when local hospitals and health organizations have video equipment, it is usually multistandard decks and monitors that can handle the ORBIS tapes in addition to their local broadcasts. In situations where an NTSC tape cannot be used by a local organization, the tape in question is copied onto the appropriate standard by a special New York facility.

While traveling to exotic locations, ORBIS' resources may have been stretched, and the staff's ingenuity taxed, but they have yet to be caught empty-handed. "Having people come out on a weekly basis makes it easy for us to resupply," says Hannigan. "If we need a part, we order through the office in New York, get it shipped to a surgeon who is scheduled to join us in the field, and he carries it out to us. In effect, we have a supply network with a turnaround of four to five days.

"We try to carry as many spare parts as we can—we get a lot of support from medical and AV sources, both our vendors and donors. In the year and a half I've been with ORBIS, we've been lucky; nothing crucial has happened, and there's certainly failures that could happen that we couldn't deal with in the field. Our laser systems are subject to a lot of movement, and occasionally we have problems with the fiber optics—I once used a diamond surgical knife to cleave a fiber. We managed to get the thing working well enough to conduct operations until we got a replacement."

How long can the staff keep a 30-year-old aircraft flying? Patrick Healy, ORBIS' operations director, feels the plane can make it into the 21st century. Hannigan agrees, noting that the DC-8 was the first commercial jetliner and engineered to take far greater stress and strain than subsequent designs.

In any event, ORBIS' efforts are beginning to grow beyond the jet itself; land-based, follow-up programs to ORBIS visits that took place in 1985 are now under way in Singapore and Thailand. Meanwhile, their 1987 itinerary has already been mapped out, with stopovers in Central and South America, Africa, and the Middle East. ORBIS' noisy arrival may strain a few local ears, but its presence will return and protect the gift of vision to countless local eyes. □