



Advanced Multimodality Image Guided Operating Suite

AMIGO is a patient-friendly environment where physicians, engineers, surgeons, radiologists and nurses all work closely together

BWH Unveils “Unprecedented Opportunity and One-Of-A-Kind Setting”

On May 4, 2011, Brigham and Women’s leapt into the future of image guided therapy with the much anticipated unveiling of the AMIGO suite. After years in the making, AMIGO was finally ready to open its doors to the world. Inside this space, cutting-edge surgical procedures will be introduced, tested and perfected for the benefit of patients throughout the world.

There was a palpable air of anticipation on the morning of the ribbon-cutting ceremony. With the event scheduled to start at noon, AMIGO’s ambassadors and tour guides – people like Flow Coordinator Sean Jackson and Head Nurse Angela Kanan – bustled about, making sure the space would be shown in its finest to the day’s visiting dignitaries. Director of Surgical Services and Program Development and AMIGO Administrator, Rachel Rosenblum, conferred with Suzanne Leidel, the Development Office’s Event Coordinator, to review the planned activities one last time and make sure everything was in place. Anticipation spiked when Suzanne’s event team hung a royal blue ribbon across the doorway leading to AMIGO’s PET/CT room.

On the main floor of the Shapiro Cardiovascular Center, Danielle Chamberlain, Executive Assistant to Ferenc A. Jolesz, MD and Clare M. Tempany, co-Directors of the AMIGO surgical interventional suite, draped spotless white linen over the table where she would be checking in guests and having them complete the MR safety screening to be able to enter the suite. Around 11 o’clock, the first guests started to arrive. Befitting the magnitude of AMIGO’s anticipated impact on surgical care, the ribbon-cutting brought together some of the most influential people in the field of Image Guided Therapy. All told, close to 100 guests attended the ribbon-cutting.



As they arrived, the guests were put into small groups for guided tours of the three-room AMIGO facility. During one of the tours, Neurosurgeon and AMIGO Associate Medical Director Alexandra Golby, MD, spoke about the collaborative spirit that imbues everything about the AMIGO suite. The multidisciplinary nature of the project was critical in the planning stages, and will continue to be key to AMIGO’s success.

“From the beginning, this has been a multidisciplinary project, relying on expertise from clinicians, engineers, medical physicists, project managers, architects, contractors and facility supervisors,” Dr. Golby said. “And our expertise here at the Brigham will continue to drive us in this area. Everyone from nurses and technicians, to people in the research community, brings a huge amount of expertise that is critical to AMIGO’s success.”

When it was time for the speaking portion of the event to start, a handful of the guests remained in the suite itself. The rest watched from the control room, where screens displayed live images taken on AMIGO’s custom built A/V system. Steven E. Seltzer, MD, the Master of Ceremonies, stood in front of the blue ribbon and introduced the day’s speakers: BWH President Betsy Nabel, MD, Dr. Tempany and Dr. Jolesz.

Speaking first, Dr. Nabel highlighted hospital leadership’s ongoing institutional support for AMIGO. The work that will take place in the suite will maintain the Brigham’s leading international profile in the field of image guided therapy.

“The availability of advanced imaging modalities in AMIGO’s highly integrated environment represents an unprecedented opportunity and a one-of-a-kind setting,” said Dr. Nabel. “The investment in AMIGO further reflects BWH’s commitment to providing the highest quality health care to patients and their families and to expanding the boundaries of medicine through research.”

Dr. Tempany spoke next, sharing her appreciation for what the project team accomplished.

“I want to thank you all for being here for this special day. To get to where we are, celebrating the opening of the AMIGO suite, took years of planning and the unwavering focus and invaluable contributions of dozens of colleagues and co-workers,” said Dr. Tempany. “Knowing the work you all poured into this project, I hope you all hold your heads a little higher today. You have helped to create a space where image guided therapies will be tested and perfected and to be put into practice for the benefit of patients around the world.”

Dr. Jolesz was the final speaker (*turn to page 4 for the full text of Dr. Jolesz’s thank you speech*). Roundly considered the forefather of image guided therapy, it was his vision that pushed the project through the many challenges encountered along the way. The result is a first-of-its-kind surgical space.

“This is the first suite in the world to bring all of these imaging modalities into one integrated operating room,” said Dr. Jolesz. “The three-room complex that you see today will be used by a multidisciplinary team of radiologists, surgeons, engineers, computer scientists and physicists. While the construction is over, the innovation is just beginning.”

The Friends of AMIGO newsletter brings you the first two in a series of articles highlighting individual staff and their contributions to AMIGO. In this issue, we introduce you to AMIGO Facilities Project Manager Brendan Whalen and Senior Engineer Dan Kacher.

Whalen Speaks of the “Project That Had No Predecessor”



To see the AMIGO suite now, brimming with unprecedented intraoperative imaging capabilities, is to gaze upon the proving ground where the future of Image Guided Therapy (IGT) will be tested, developed and put into practice. In time, surgical techniques will emerge from the work of the AMIGO suite specialists that could improve

outcomes for patients who suffer from any of a number of conditions. The excitement is palpable when the automatic doors open and grant access to the suite’s control room. Technologists and engineers have been busy testing and certifying the imaging and surgical equipment. The AMIGO core team has been conducting surgical dry-runs in an MRI environment.

Strolling down the central hall of the control room, the immensity of the AMIGO suite as an architectural, engineering and construction achievement is striking. The combined weight of just the ceiling-mounted equipment in the AMIGO suite is over 20 tons, all of which was delivered two levels underground to where the suite is situated beneath the hospital’s main entrance at 75 Francis Street.

Over 15 design firms, 50 contractors and countless clinical, surgical and imaging equipment vendors worked on any of the AMIGO suite’s many installed systems. Scores of individuals contributed to planning, coordinating and overseeing the work of the architects, engineers, contractors and equipment vendors. One of the core members of this team was AMIGO Project Manager Brendan Whalen.

“My role as the hospital’s Project Manager for AMIGO was to oversee the planning, design and construction of the facility,” said Whalen. “This included establishing and providing oversight for the construction and equipment delivery schedules and budgets to ensure the BWH and AMIGO leadership teams’ visions for the suite was brought to reality.”

Due to AMIGO’s unprecedented nature, Whalen had to navigate many challenges. The medical advisory team that headed the design and planning phase of the AMIGO project let its creativity run free, imagining a clinical operating space that could offer surgeons the full complement of image-guidance tools and navigation systems.

In 2008, the AMIGO project was approved as a three-room interconnected hybrid Operating Room with a floor-mounted MRI and PET/CT adjoining each side of the OR. These plans sited the 5,700 square foot AMIGO suite in the former Central Processing Department on Lower Level 2 of the Tower Building. Payette Associates was selected as the project’s architect and they submitted the final construction plan early in 2009.

With construction well under way, the project took a major turn, requiring some quick thinking by Whalen and his team to accommodate the changes. BWH reached an agreement with

IMRIS for the company to furnish a ceiling-mounted MRI that would run on rails between the MRI and OR rooms. IMRIS was also proposing putting the Angiography device on a ceiling mount inside the AMIGO OR. The challenge to Whalen and the project management team became two-fold. First, they had to devise a supplemental plan to fit the IMRIS equipment into the already agreed upon design for the rest of the suite. Second, they needed to accommodate the new plan while trying to maintain the construction schedule.

“Construction for AMIGO had already been underway for nine months when the decision was made to change to an IMRIS ceiling-mounted MRI and Angio machine. We had to integrate the new MRI installation into a design plan that took over a year to design, not to mention at a time when we were already so far into the construction phase. The challenge was to continue construction at the same time we were redesigning for the IMRIS installation.”

Whalen called a series of meetings attended by representatives from IMRIS and the architecture and construction firms to quickly and carefully incorporate the new design into the project plan. Through careful negotiation, Whalen and IMRIS agreed on a plan that would deliver the desired ceiling-mounted configuration while still allowing the construction crews to continue working on other parts of the space.

In the AMIGO suite, the ceiling-mounted configuration of the MR magnet and Angiography machine addresses a major issue common to IGT procedures: the need to transport patients during a surgical procedure. Even if the imaging suite is near the OR, there is still a risk of infection to which the patient is exposed during transport. In the AMIGO suite, this risk is all but removed: The patient remains on the procedure table while the MR magnet slides into place directly over him or her.

With the team ably accommodating the design change to the magnet configuration, Whalen turned to another challenging aspect of the project. New construction at hospitals in Massachusetts must be reviewed by the state’s Department of Public Health and can only move forward with their approval. For the majority of hospital-based construction projects, this process is fairly straightforward. However, as Whalen had by now discovered, not much about the AMIGO project was straightforward.

“DPH works off previously established guidelines from past projects as the basis for its review. But how do you approve a project that has no predecessor? DPH had many concerns over the project but their biggest concern was having the rails for the ceiling mounted MRI over the patient in the OR and the effect this would have on air circulation directly above the patient. BWH had to quantitatively show through 3D computer modeling that the design of the AMIGO OR would not put open surgery patients at risk of acquiring airborne infections in order for DPH to grant final approval of the plan,” said Whalen.

Computer modeling enabled the AMIGO team to show how the space guards against airborne infection. Nothing short of careful negotiating and close collaboration with AMIGO’s industry partners

could help Whalen solve the challenge common to almost any large-scale construction project: an equipment delivery schedule that hinged on external factors over which Whalen had minimal control.

“There were two issues that affected the timing and delivery of the MR magnet,” said Whalen. “Because the MRI was funded through a High End Instrumentation Grant from the NIH, the MRI had to be delivered to the site by April 30, 2010. The problem was that the suite’s magnet bay would not be complete until November, so this meant that we had to supply power and chilled water to where the PET/CT would be housed.”

Outfitting the Suite: AMIGO Equipment Reflects Years of Hard Work

When talking about the unprecedented image-guidance capabilities made available in the AMIGO suite, its medical directors and clinical staff refer to it as the fully realized sum of its parts. As BWH President Betsy Nabel, MD, said at the ribbon-cutting ceremony, it is “AMIGO’s highly integrated environment” that makes AMIGO a truly one-of-a-kind facility. A decade ago, BWH’s image-guided interventionists saw the improved outcomes intraoperative Magnetic Resonance imaging offered to patients with conditions ranging from brain tumors to uterine fibroids. Now, with the AMIGO suite putting PET/CT imaging, MRI, ultrasound and angiography at surgeons’ fingertips, hope runs high that groundbreaking surgical treatments will emerge from the underground suite.

Insight into the history of image-guided therapy at BWH, an account of the incredible effort that went into the design and construction of the site, and the impressive equipment array in the AMIGO suite leads to a deeper appreciation for the potential contained within this state-of-the-art clinical space. There is no one better to tell the equipment story than AMIGO’s lead engineer, Dan Kacher.

Kacher was part of the Magnetic Resonance Therapy team – the group that worked on the “double donut” MRI magnet that was the precursor to the AMIGO suite – back in the late 90s. Working as the senior engineer on the MRT, he was involved in the initial planning to grow the Image Guided Therapy (IGT) program.

“We began discussing ways to expand the program in 1999,” said Kacher. “At the time, hospitals around the world were looking at the success we were having with the MRT and were installing their own MR magnets for use in image guided surgeries. We knew that if we were to differentiate from the hospitals building MRT suites and continue into the next phase of innovation in IGT, we would need to build a specially designed surgical space that incorporated the use of PET/CT imaging along with MR.”

Kacher helped write the project proposal and solicit bids from architectural and construction firms to work on the AMIGO project. Those contracts were awarded to Payette Associates for the design part of the project and William A. Berry (Suffolk) Construction to build the suite.

With that part of the project secured, Kacher turned his attention to outfitting the AMIGO suite. He was responsible for selecting the suite’s multimodality imaging devices, navigational and tracking equipment, surgical tools, and advanced computer integration systems. As discussion about this ambitious project began to circulate among top representatives of device manufacturers, Kacher’s office became the place to be heard for representatives

Eventually, the magnet was delivered without a hitch. This was a major milestone for the project. As the AMIGO project neared completion after two years of construction, safety testing and housekeeping teams gradually began replacing construction and installation crews. The din of power saws gave way to the hum of an MRI scanner.

“I’m really proud to be a part of the AMIGO project team and to know that what we contributed will be a part of the future of interventional medicine,” said Whalen.

of these industry partners eager to have their products featured in the AMIGO suite.

“Several collaborative partnerships were spawned when vendors realized they couldn’t afford to not be a part of this endeavor. Most of the talks were with the major players in the medical imaging industry, such as GE (during the early stages), then with Siemens and IMRIS. But many other conversations occurred with smaller firms that built very specialized products, such as BrainLab, the company that provided the suite’s navigation system used in tracking hand-held tools,” said Kacher.

Because each of these companies was so eager to be included in equipping the AMIGO suite and to be a part of ushering in the next era of IGT, many of them offered favorable discounts on their products.



“Financing for the project was secured through a unique public-private partnership,” said Kacher. “As the NIH’s National Center for Image Guided Therapy, BWH received sizable supplements to assist with the construction, to which the hospital also directed funds. In order to achieve the full image guidance capabilities we envisioned for the suite, we negotiated in good faith in order to maximize the return on our equipment budget.”

Kacher and the AMIGO team were able to secure a combined total of over \$7 million worth of discounts from the suite’s industry partners, enabling them to outfit the suite with most of the devices on the top of their wish list.

“One of our major industrial partners, Siemens, manufactured the MRI, angiography system, ultrasound and PET/CT. Our other partner, IMRIS, incorporated the equipment into the surgical setting. They integrated the video system and room controls, enabled the MRI to be mounted on a ceiling track and provided the MR receiver coils, which are ideal for use during procedures,” said Kacher. “BrainLab’s product enables images acquired from the MR and PET/CT scanners to be registered to the patient’s coordinate system and interactively viewed based on where the tool is pointed in the body. This system will primarily aid in optimal brain tumor resection.”

An engineer and researcher, Kacher enjoys poring over the specs

for high field strength MR magnets, multi-slice CT scanners and complex, sophisticated software navigation systems. Prior to his involvement with the AMIGO project, Kacher was assisting with basic science research endeavors. His role with the AMIGO project necessitated a lot of on-the-fly learning.

“Throughout this process, I have had the privilege of learning the languages of facilities planning and operations personnel. When everyone realized AMIGO was becoming a reality, it was metaphorically as though our small start-up company from Radiology Research had been bought by a major corporation.”

These are exciting times for Kacher. With the first patients soon to be treated in the suite, the occasion will be a testament to all those years of designing, planning and contributing oversight to

this challenging, one-of-a-kind project.

“The AMIGO suite is an environment rich in both equipment resources and brain power. These are the necessary ingredients for invention,” says Kacher, continuing, “the space is intended to be a clinical laboratory for the hospital and the alchemy that will come out of it has not yet been imagined by all of us who began this project so many years ago.”

Text of Dr. Jolesz’s Speech

They say “dreams come true” when something happens that you had only hoped for. “Dreams are made true” when you succeed, after working on it and striving for it, in achieving or accomplishing something that you had wished for. AMIGO is not a dream and has never been a dream. It was something that we envisioned, planned, designed and eventually built. It has been a goal that was hard to achieve but was always possible to reach, something you can almost have in your hands but it slips through at the last minute. Finally, we can touch it and feel it and it is even better than we ever could have imagined. It took a long time and required lots of patience and endurance. The history of AMIGO has had several chapters with a seemingly hopeless ending but we never gave up and at last completed the final chapter with a happy conclusion.

AMIGO means “friend” and it is not ironic that it was with friends’ support that AMIGO has become a success. We enjoyed the support of the Department and Dr. Seltzer from the beginning, but during the years, more and more people became friends of AMIGO. Without these friends in the hospital leadership, especially Dr. Gottlieb and the leadership at the National Center for Research Resources of the NIH and our Program Director, Abraham Levy, we would have only a dream. Without their help in funding and constructing this unique infrastructure, we wouldn’t be able to maintain our leadership in the field of Image Guided Therapy and continue the journey that we started 20 years ago when we installed the world’s first intraoperative MRI here at the Brigham. Since then, we’ve established the NIH-supported National Center of Image Guided Therapy for which AMIGO will provide a clinical test bed to develop and validate new and innovative ideas in treating various diseases with less invasive, less complex strategies that will enable better and safer outcomes.

Despite its high tech nature, AMIGO will present a friendly environment for patients and pave a path for partnership between physicians across disciplines. In AMIGO, surgeons and radiologists, cardiologists and radiation oncologists and other specialists will work side by side, collaborating together. Medical and technical personnel, nurses, radiology technologists, engineers and scientists will also work closely as a unified team of friends. Our industrial collaborators, mainly IMRIS and Siemens and all the other vendors who contributed to AMIGO, are also our friends in achieving the success of AMIGO. Without their tools and equipment, we would be hopeless. In the end, our success is their success also.

I do not want to give an Oscar acceptance speech and individually thank everybody who became friends of the AMIGO project. The list is long and extensive and includes people with whom this all began two decades ago and those who have recently come on board. Nevertheless, I have to mention two very close friends and colleagues who helped me to build our research program while keeping me under control: Clare Tempany and Ron Kikinis. There are other colleagues, administrative and supporting staff architects, project managers and construction workers, even family members to thank, and we will. We know all of them by name and position and we will recognize them as founding members of our recently established Friends of AMIGO organization. Their contribution will not be forgotten and they will remain our friends forever.

Thank you to all who have come to participate in this great event. Enjoy the rest of the celebration. Enjoy AMIGO as we have come to enjoy it. Thank you very much!

BWH Radiology’s Lead Gift Seeds Development

The opening ceremony was further marked by a generous donation from the Department of Radiology to kick off AMIGO’s on-going funding effort.

“To celebrate the grand opening of the AMIGO suite and to recognize the contributions of dozens of hard working individuals who made the project possible, the Brigham and Women’s Department of Radiology made a lead gift of \$100,000 to the Friends of AMIGO fund,” said Radiology Department Chairman Steven Seltzer, MD.

AMIGO’s medical and operations directors will administer the fund, apportioning the money to two primary needs: supporting the long-term viability of the suite’s clinical and research programs and establishing AMIGO’s sub-specialty training programs.

“The Friends of AMIGO program was designed to be a source of funds for the education and training of the next generation of users of image guided surgery techniques. In addition, the program can provide seed grants to new research projects,” continued Dr. Seltzer.

Anyone can become a funding partner of the Friends of AMIGO. Brigham and Women’s seeks the support of donors who possess the vision and desire to advance the field of image guided therapy into a new era of less-invasive, more patient-centered procedural medicine. For more information on opportunities to support the cutting edge of work of AMIGO, please contact Judi Mullen in the Development office at (617) 424-4351 or jmullen2@partners.org.

The AMIGO Suite Equipment Array

MRI: Siemens 3T Verio 70 cm Wide Bore: This ceiling-mounted MRI moves into the operating room and over the patient for pre- or intraoperative imaging. Its 3T field strength arms clinicians with the highest resolution MR imaging possible.

PET/CT: Siemens mCT 40 Slice/4 Ring: Combining structural and functional imaging, the dual PET and CT scanner will be used as a stand-alone system and in pre- and intraoperative circumstances under research protocols to better locate and characterize disease and any needed treatment. This PET/CT will also be the device used for the BWH to investigate new radiotracers, under research protocols, that have never before used in medicine. The BWH's nearby Cyclotron can produce these agents for safe intravenous administration.

BrainLAB Navigation: This neurosurgical system uses a GPS-like device to track hand-held tools. MRI and PET/CT images are registered to the patient's coordinate system and interactively viewed based on where in the body the clinician is pointing with a tool.

Zeiss Pentero Surgical Microscope: Used in delicate brain tumor resections and vascular surgery, the scope is equipped with a feature to visualize dyes in the blood stream that help to identify blood vessels. AMIGO clinicians can track the scope with the BrainLAB navigation system to display MRI or PET/CT images in the focal plane of the scope.

Integra Ultrasonic Aspirator: Used in delicate brain tumor resection, AMIGO researchers plan to capture the intact cells liberated by this device and analyze them to determine if any tumor tissue remains in the brain following an intervention.

IntraMedical Imaging Node Seeker and Beta Probe: This device assesses whether a surgical procedure has been fully completed by detecting traces of a radioactive isotope that is injected into the bloodstream after a tumor is removed. If radiation is detected from the excised tumor specimen, the surgeon can conclude that there is still tumor in the body and surgery should continue.

Visualase Medical Laser: This laser will be used to remove cancerous tumors and diseased tissues. A laser fiber is placed through the skin into the target, and real-time MR images let the interventionist monitor the devices heat deposition to determine when the target is successfully treated.

Galil Medical Cryohit: Used for intervention with cold temperatures, a needle-like probe is placed into the tumor through the skin. Radiologists monitor the frozen area of tissue with either MRI and/or CT as targeted tissue is destroyed.

B-K Medical Systems Ultrasound: Unlike conventional ultrasound systems, the B-K Medical Systems device has unique probes that can go inside the abdomen to aid in endoscopic-guided surgery or through an opening in the skull or the sinuses to aid in brain tumor resection.

Siemens S2000 Ultrasound: For all other ultrasound applications, the Siemens S2000 will be used for both tumor identification and targeting.

Sentinel Medical (Hologic) Aegis Navigation Workstation: This system enables the clinician to track probes from either of the

ultrasound systems. Previously-acquired MRI or PET/CT images can be displayed in the same plane as the real-time ultrasound image.

Sentinel Medical (Hologic) Aegis Ultrasound: This device will enhance MR image quality for interventional treatment of prostate and cervical cancer.

Robin Medical Endoscout: Using dynamic magnetic fields produced during MR imaging to track needles and probes, this device gives clinicians the ability to visualize device location on MR images when the patient is inside the scanner, facilitating real-time MRI-guided procedures.

Northern Digital Polaris Vicra Optical Tracking System, Aurora Electromagnetic Measurement System and Ascension Technology 3D Guidance MedSAFE Electronic Unit: These systems allow BWH researchers to build navigation applications based on the in-house image processing software, which is called the 3D Slicer.

Cardiac Equipment: While intra-procedural MRI is the novel aspect of catheter-based MRI-guided cardiac ablation, which is why it finds a home in AMIGO, much specialized cardiac equipment must join it to allow for successful outcomes. These devices and components include: a **St. Jude Medical Mapping and Navigation System** that enables the clinician to identify the source of the arrhythmia and guide the catheter to the target location; a **Fischer Bloom Stimulator** that is used to pace the heart in conjunction with the **GE CardioLab Hemodynamic** recording system that is used to monitor the heart to determine when the ablation is complete. **Boston Scientific** and **Stockert** RF ablation generators will both be used for their unique abilities to deliver therapeutic energy to the target heart tissue. Boston Scientific and **Siemens Intra-Cardiac Echo** will be used to visualize the myriad of catheters in the chambers of the heart. Finally, **OptoAcoustics MRI Compatible Communication Headsets** will facilitate communication between the clinicians and the technologists' operating equipment in the control room. **In Vivo Vital Signs Monitor** and **GE Datex-Ohmeda Anesthesia Gas Delivery Machine:** These systems are both MRI-compatible and are critical in caring for the patient during operations.

AMIGO Infrastructure: ETS-Lindgren provided shielding for use of the MRI in the suite and provided the industry's widest doors to enable the MRI scanner to travel between the MRI room and the OR. Nelco provided the rooms' lead shielding to safely use radioisotopes for PET imaging and x-ray for CT and angiography imaging. Trumpf provided the AMIGO OR's lights and booms. The lights are LED, providing a range of light colors to suit a particular surgery without generating heat that could make it uncomfortable for clinicians and other staff.

The video integration is provided by **Black Diamond Video**. Images can be routed to monitors in our control room or procedures room via a touchscreen. Recording and streaming is also possible. The most important aspect of the Black Diamond system is that it solves a critical space problem. These same touchscreens become the user interface for several different workstations that would not have all fit in the packed control rooms. A 56" monitor suspended from a boom creates a montage of images from different sources to visualize all available information at a glance.



Pictures of the AMIGO Ribbon Cutting Ceremony



