Emerging Trends & Successful Strategies for the Planning and Design of Healthcare Facilities

This Educational Session Presented by:

The American College of Healthcare Architects

Improving medical care Environments through Specialty Certification of Healthcare Architects
Emerging Trends in Imaging Impacting Health Facility Design

Morris Stein, FAIA, FACHA – President, The Stein-Cox Group
Bill Rostenberg, FAIA, FACHA – Principal, Anshen+Allen

Part Three:
“Emerging Trends in Imaging, Impacting Health Facility Design”

Morris Stein, FAIA, FACHA
• Founding Partner: Stein-Cox Group, Phoenix, AZ
• 30 Years experience in Healthcare Architecture
• Frequent Presenter at RSNA’s Annual Conference

Bill Rostenberg, FAIA, FACHA
• Principal: Anshen+ Allen Architects, San Francisco, CA
• 30 Years experience in Healthcare Architecture
• Author & Presenter on Healthcare Technologies
No matter...

*What* the technology, *where* it is engaged, or *how* it impacts our work, there is a fundamental relationship with planning and design.
Why is this so important?

Explosion in new technology

One major manufacturer lists on its website:

21 new MRI systems and
16 new CT systems
85 total pre-installation guides
Why is this so important?

Transparent planning and carelessness

August 19, 2005

M.R.I.'s Strong Magnets Cited in Accidents

By DONALD G. McNEIL Jr.

The pictures and stories are the stuff of slapstick: wheelchairs, gurneys and even floor polishers jammed deep inside M.R.I. scanners whose powerful magnets grabbed them from the hands of careless hospital workers.

The police officer whose pistol flew out of his holster and shot a wall as it hit the magnet. The sprinkler repairman whose acetylene tank was yanked inside, breaking its valve and starting a fire that razed the building.

But the bigger picture is anything but funny, medical safety experts say. As the number of magnetic resonance imaging scanners in the country has soared from a handful in 1980 to about 10,000 today, and as magnets have quadrupled in power, careless accidents have become more frequent. Some have caused serious injuries and even death.

No one knows how many have occurred. But the safety experts say there is no doubt they are on the rise, and their growing frequency is prompting widespread calls for more regulation.
Why is this so important?

Increased patient expectations

Radiology featured in broad media, television and the internet.
Explore four trends that significantly determine how project design and implementation will be impacted:

• New Technology

• New Places

• New Work

• New Environments
“This is a race without a finish line. It is never complete. Every discovery suggests new directions.”

James Thrall, M.D.
Chief of Radiology
Massachusetts General Hospital
January 31, 2006
Just when you thought it was safe...

7T scanners move closer to use in clinical research

New breed of ultrahigh-field scanners offers interfaces to aid in translating protocols to 3T.

Philips and Siemens are delivering on promises made two years ago to develop ultrahigh-field MR systems. The companies are completing construction of several 7T clinical installations, each bearing the clinical front end of a mainstream MR scanner rather than the unsightly consoles that have marked previous installations. The ramifications for the MR community are enormous.

These types of open magnet interfaces promise quick and relatively painless translation of results from 7T to the growing installed base of 3T scanners. Their implementation and the publishing data they are expected to yield could help vendors fulfill their promise of advanced applications at 3T, which is a major reason customers buy 3T scanners.

The ethical goal for research conducted at 7T will be to gain a better idea of what may be achieved at lower fields. Structures and conditions resolved at ultrahigh field strength might be found at 3T if physicists knew where to look. Engineers could realize this possibility if they can rework the protocols.

A showcase for 7T opened in June at the Philips MRI research facility in Highland Heights, OH. The corporate facility is a demonstration and training ground for physicists and clinicians interested in obtaining ultrahigh-field scanners. The $10 million Achieva 7T system operating there is similar to one being installed at the Wright Center of Biomedical Imaging at Ohio State University. Research conducted on the Philips-operated Achieva 7T indicates that the increased susceptibility effects present at this field strength can be exploited to produce high-resolution vascular images, including Black Blood venous imaging. Three-dimensional magnetization-prepared turbo field-echo imaging demonstrates small anatomic structures in the brain, such as peduncular foci, lesions, and exceptional gray-white matter contrast at high resolution, revealing subtle anatomy such as white matter tracts. Studies at the Philips center have demonstrated the scanner's ability to conduct single-voxel spectroscopic imaging of metabolites, including peaks of N-acetylaspartate, creatine, and choline.

John L. Parker, Ph.D., Philips' director of business development for MR, expects that the company will install 15 to 20 7T whole-body clinical units. The purpose of their development is to expand the frontier of MR imaging while establishing Philips as a provider of leading-edge technology.

"We don't sell these systems to make a profit on them," Parker said. "We are spending in excess of $20 million in development on 7T, and even at the wildest price margins, we would never recoup our costs." Philips has contracted to install two units in the U.S., including the OSHU system, and two in Europe. Siemens has installed one 7T scanner in Europe and two in the U.S., and has orders for eight additional clinical units. A 7T system began operating in late spring at New York University, where researchers plan to focus particularly on the brain, but also the breast, ovaries, and prostate. Much of the work so far has been preliminary, as the research team is just beginning to work out the different imaging protocols.

"You appreciate how modern clinical scanners have come, because you realize this is how people started doing MR way back when nothing was written," said Dr. Yi-Feng Lee, a professor and vice-chair of research at NCTU School of Medicine.

Most of these ultrahigh-field systems are in the hands of researchers who don't mind doing a lot of tweaking and tuning to get what they want. Dr. Tatsunori Nakada, for instance, was recruited from the University of California, Davis (where he still holds a professorship in anatomy) to build a research institute for ultrahigh-field MRI in Japan. The Center for Integrated Neuroscience at the University of Niigata has been running a human 7T system and a 3T system for about a year.

Nakada, director of the center, believes the main advantage of 7T is its higher signal-to-noise ratio, which translates to better MR microscopy and MR spectroscopy. Preliminary studies on the 7T
MRI: 1.5T, 3.0T and Beyond

3.0T MRI fields are larger than 1.5T MRI fields but not twice the size.
MRI: 1.5T, 3.0T and Beyond

3.0T magnets are less susceptible to moving objects but more susceptible to non-homogeneity. Stable magnetic environments are critical.
Emerging Trends in Imaging
Emerging Trends in Imaging
Emerging Trends & Successful Strategies for Healthcare Facilities

Slide: 17

Emerging Trends in Imaging
MRI: 1.5T, 3.0T and Beyond

At least 50% of 3.0T MRI installations require magnetic shielding and 10–20% will require full room shielding.
Emerging Trends & Successful Strategies for Healthcare Facilities

Slide: 19

Emerging Trends in Imaging
Emerging Trends & Successful Strategies for Healthcare Facilities

Slide: 2020

Emerging Trends in Imaging
RF shielding degrades over time. 1.5 T to 3.0T upgrade may require a replacement RF shield.
MRI: 1.5T, 3.0T and Beyond

Acoustics is often overlooked. As gradient power increases, so does noise. Sound mitigating materials, panels and structural details are recommended.
64 Slice CT

Throughput is so fast, which equates to higher slice counts, and more patients.

More use + faster throughput = more shielding

Upgrade from 4 slice to 64 slice may require additional radiation protection.
64 Slice CT

Structural connections due to movement and vibration must be considered.

Slab investigation/preparation at any floor level should be anticipated.
PET and PET/CT

Extremely large doses have a major impact on PET or PET/CT shielding issues.

Quiet Rooms, Dressing Rooms, even Toilets may be shielded.

Many rooms are undershielded or improperly designed.
PET and PET/CT
PET and PET/CT
Upgrade Checklist

✓ Physical Impacts
✓ Shielding Impacts
✓ Power Requirements
✓ Heat Dissipation
✓ Remote Equipment
✓ Anchorage
✓ Sound and Vibration
Fusion Imaging

Imaging modalities not only emerge, but converge.

Innovative component allows development of PET/MR hybrid

Neurologic applications provide initial target as fusion strategy solves metal versus magnet issues and moves to implementation

The fact that metal and MRI do not mix has, until recently, thwarted attempts to develop hybrid PET/MRI scanners. Now engineers are experimenting around the problem by creating a metal-free imaging environment.

The main remaining obstacle has been the photomultiplier tube, an essential component of a PET system. PMTs cause enough metal to disturb the magnetic field of an MRI system. Because field distortions BLEED into other systems, attempts to combine PET and MRI have not succeeded.

Available photoelectric crystals are helping overcome the problem; however, APDs can play the same role as PMTs in recombining the imaging and location of abnormalities even as an MRI system’s crystal structure is maintained that information into clinical practice.

APDs consist of silicon, which poses less of a problem than a PET field homogenizer, and they are extremely small, which is a plus for a PET detector array that most likely consists of an MRI magnet.

Siemens Health Solutions engineers based in Erlangen, Germany, are working with colleagues at the former CTS PET Systems in Innsbruck, Austria to create a prototype PET/MRI scanner. The system will consist of a subassemblies PET, scanners, APDs detectors in lieu of photomultiplier tubes, inserted into the bore of a commercially available MRI superconductor.

PET and MRI images will provide anatomic and physiological data, similar to fusion imaging with PET/CT, said Dr. Arne Hengsten, director of Siemens MRI/MR molecular imaging program.

Siemens’ prototype and the first clinical scanner based on the platform will address interventional applications, according to lead project engineer Harald Liedelbach. The prototype is expected to be completed in 2009.
Functional Imaging

Physiologic – not structural.

If we can detect it here,
it may never appear here.

GE Healthcare

Now or later? fMRI shows why

You're offered tickets to the Super Bowl, but you have an anniversary getaway planned for that week. Whatever your choice, two separate brain areas will battle it out.

Sticking with the vacation—essentially, choosing long-term happiness over immediate gratification—will activate the brain's frontoparietal region, associated with cognitive thinking. Choosing the Super Bowl tickets will trigger the limbic system, which is associated with emotion.

Samuel McClure, Ph.D., and colleagues at Princeton University asked 14 volunteers to choose a gift certificate ranging in value from $5 to $40, with the caveat that the larger amounts would be available only weeks later (Science 2004;306[5695]:503-507).

Functional MRI showed that all decisions activated the lateral prefrontal cortex and posterior parietal cortex, both associated with abstract thinking. Longer term options, however, fueled the frontoparietal area, while short-term choices triggered the limbic system.

Emotions won out over abstract thinking when the reward was closer at hand, McClure said.

BY MERRILIN TREVINO

Emerging Trends & Successful Strategies for Healthcare Facilities
New Work

Radiologist becomes information specialist

(Why, what, where, how)

Diagnostic → Therapeutic
New Environments

Increasing expectation that environmental design is directly related to patient satisfaction and staff performance.
Perils and Pitfalls

Architecture (and architects) may be forgiving, but technology never is.
Perils and Pitfalls

Building a room for one vendor’s system, regardless of modality, does not mean the room will be adequate for another vendor’s equipment.
Perils and Pitfalls

Think 3-D siting for every modality in any room.
Perils and Pitfalls

The days of “plug and play” replacements may be coming to an end.

Ultimate flexibility  Multiple upgrades
Perils and Pitfalls

Design teamwork is more important than ever.

Nothing should surprise you—be prepared.
Don’t be Surprised When...

You convert an operating suite to a Cath Lab,
and a Cath Lab to MRA or CTA.
Don’t be Surprised When...

CT becomes the dominant imaging modality.

DR and CR utilization declines to less than 50% imaging volume.
Don’t be Surprised When...

IT advances are equally crucial as slices and Images.
Don’t be Surprised When...

Average imaging study data volume increases to 10.0 gigabyte (1000%).
Don’t be Surprised When...

We finally have advances in shielding materials and applications.
“The notion of architecture is an effective reminder that design is only one part of the process.”

-Marc Gerstein
Emerging Trends in Imaging Impacting Health Facility Design

Imaging Beyond the Radiology Department

Bill Rostenberg, FAIA, FACHA – Principal, Anshen+Allen

Learning Objectives

1. Understand how departmental boundaries are eroding and how facility design can influence multi-specialist collaboration.

2. Recognize where imaging has the greatest impact on facility design beyond the radiology department.

3. Become familiar with design concepts that anticipate future convergence of imaging and surgery.
Emerging Trends & Successful Strategies for Healthcare Facilities

Presentation Outline

1. ………………..Drivers Influencing New Planning Concepts

2. ………………..Imaging in the Operating Room

3. ……………Planning for Future Flexibility and Adaptability
Imaging Beyond the Radiology Department

Drivers Influencing New Planning Concepts
The Staffing Crisis will continue at many levels:

- nurses
- technologists
- physicians
- IT, etc.

New types of personnel are evolving in the procedural environment:

- Surgical Technologists
- Surgical IT Managers
- Non-surgical Interventionalists
Productivity Drivers
During the 6 months following CMS’s 2001 PET reimbursement approval for certain oncology use, PET utilization grew by over 50% .... and continues ....
Technology Drivers

.... can accelerate or disrupt collaboration ....

Image courtesy of Brigham and Women’s Hospital
Political Drivers

- Competition among surgeons, interventional radiologists and cardiologists continues…..

- Visionary leaders are beginning to mandate multi-specialty collaboration

- Many specialists are willing to collaborate rather than compete
Market Drivers / Brand & Image
Imaging Beyond the Radiology Department

Imaging in the Operating Room

Emerging Trends & Successful Strategies for Healthcare Facilities
Growth of Minimally Invasive Surgery (MIS)

- Minimal surgical incisions
- Redefinition of “Sterile Field”
- Many procedures similar to interventional radiology
- Increasing reliance on “image guidance”
Greater Interventional Utilization of IR & Cath Suite

- Historic IR/Cath utilization: 60-70% = diagnostic procedures
- Many diagnostic IR/Cath procedures now replaced by less-invasive modalities (CT, MR, SPECT, PET/CT, etc.)
- Future utilization will focus on more interventional procedures
Interventional Procedures Require a “Surgery-like” Environment

- Surgical-quality Heating, Ventilation and Air Conditioning (HVAC) requirements
- “Surgical-like” restricted workflow requirements
- Increased Prep / Recovery needs
Emerging Trends & Successful Strategies for Healthcare Facilities

PACS in the OR

DESIGN IMPLICATIONS

- Operating Rooms often have sub-optimal lighting conditions

- Surgeons may need to view medical images at a distance

- PACS workstations provide an interface for computer-assisted surgical applications which are used during surgery
Information Technology in the OR

DESIGN IMPLICATIONS
MRI in the OR

DESIGN IMPLICATIONS

MAGNET TYPES
- Stationary
- Pivoting
- Traveling
- Portable

ROOM TYPES
- Single Room
- Dual Room
- Many Rooms

Emerging Trends & Successful Strategies for Healthcare Facilities
MRI/OR in One Integrated Room

RF shield entire room

Imaging and Procedure Zone (MR compatible surgical instruments)

Stationary Magnet

Image: courtesy of Brigham and Women’s Hospital

Emerging Trends & Successful Strategies for Healthcare Facilities
MRI/OR in One Integrated Room

“Pivoting” Magnet Couch

RF shield entire room

Imaging Zone

Procedure Zone

Image: BrainLab
MRI/OR in One Integrated Room

RF shield entire room

Imaging Zone

Procedure Zone

Traveling Patient

Image: University of Minnesota

Emerging Trends & Successful Strategies for Healthcare Facilities
Separate MRI and OR Rooms

RF shield magnet room only

Imaging Zone

Procedure Zone

Traveling Patient

Image: University of California – San Francisco

Source: ETS/Lindgren

Emerging Trends & Successful Strategies for Healthcare Facilities
MRI/OR in One Integrated Room

RF shield entire room (or only the surgical zone)

Imaging and Procedure Zone (MR compatible surgical instruments)

Portable Magnet

Emerging Trends & Successful Strategies for Healthcare Facilities
MRI/OR in One Integrated Room

RF shield entire room

Traveling Magnet

Foothills Medical Centre, Calgary Alberta
Courtesy of Stantec Architects, Ltd. Calgary, AB
MRI/OR in One Integrated Room

RF shield entire room

Traveling Magnet

Courtesy of Stantec Architects, Ltd. Calgary, AB
Integrated MR / OR / PET Rooms

RF shield magnet room only
MR Imaging Zone
Procedure Zone
PET Imaging Zone
Traveling Patient
Integrated MR / OR / PET Rooms

**DESIGN IMPLICATIONS:**

- Design for MRI safety (ACR safety guidelines)
- Locate MRI for either “scrubbed” or “street clothes” access
- Protect against RF and/or magnetic interactions with adjacent occupants
- Increase structural, air and cooling capacities

**RF shield magnet room only**

Images: courtesy of Brigham and Women’s Hospital

Emerging Trends & Successful Strategies for Healthcare Facilities
Imaging Beyond the Radiology Department

Planning for Future Flexibility & Adaptability
Integrated Interventional Platform

Endoscopy  IR / Cath  Surgery

Level 2 Recovery  Intake/Prep  PACU

Shared prep/recovery
"Clean Core" or "Staff Core"
Flexible Rooms & Procedure “Pods”
Flexible “Red Line”
Flexible “Prep/PACU”
Flexible “Prep/PACU”
Flexible “Prep/PACU”
Flexible “Prep/PACU”
ORs with Control Rooms
ORs with Control Rooms

- OR/IR/Cath
- Sub-sterile
- Supply Room
- OR/IR/Cath
- OR/IR/Cath
- Sub-sterile

Emerging Trends & Successful Strategies for Healthcare Facilities
ORs with Control Rooms
Emerging Trends & Successful Strategies for Healthcare Facilities

ORs with Control Rooms

Support Team

Patient

Scrubbed Team

Supplies

Control Room

Sub-sterile
Flexible Procedure Room Clusters

- OR
- C. Supply
- Control
- Sub-Ster
- OR
- OR
- OR
Flexible Procedure Room Clusters

Emerging Trends & Successful Strategies for Healthcare Facilities
Flexible Procedure Room Clusters

- OR
- Control
- C. Supply
- Sub-Ster
- OR
- MRI

Emerging Trends & Successful Strategies for Healthcare Facilities
Flexible Procedure Room Clusters

OR

C. Supply

Control

Sub-Ster

OR

OR

C. Supply

Control

Sub-Ster

OR

Emerging Trends & Successful Strategies for Healthcare Facilities
Flexible Procedure Room Clusters

Emerging Trends & Successful Strategies for Healthcare Facilities
“Continuity-of-care extends from the patient’s first encounter until discharge.

With current scanning technology it is possible to get an information representation of the patient.” * 

*source: Satava, RM: The Operating Room of the Future: Observations and Commentary”; Seminars in Laparoscopic Surgery; vol. 10; no 3; 2003 pp. 99-105 
Image: courtesy of R. Satava, MD
“…..then pushes the “operate” button and a “perfect” operation is performed, with all the errors edited out.” *

OR of the Future (Richard Satava, MD)

OR personnel of the future..............

Surgeon       Assistant       Scrub Nurse       Circulating Nurse

..... In the OR of the future, there are no people
(except the anesthetized patient).....

(source: Satava, RM: The Operating Room of the Future: Observations and Commentary"; Seminars in Laparoscopic Surgery; vol. 10; no 3; 2003 pp. 99-105
Image: courtesy of R. Satava, MD

Emerging Trends & Successful Strategies for Healthcare Facilities
Slide: 91
Conclusions

1. Architectural design must anticipate new types of personnel and new workflow patterns, as traditional departmental boundaries erode.

2. Innovative design that incorporates advanced communications technology can sometimes compensate for staff shortages and improve operational efficiency.

3. Future flexibility is best accommodated by identifying a “future technology zone,” rather than by detailed planning for future technology.
Emerging Trends & Successful Strategies for the Planning and Design of Healthcare Facilities

Bibliography: Imaging & Facility Planning

The Architecture of Medical Imaging, John Wiley and Sons, June 2006, Bill Rostenberg

Surgology is Coming, Health Facility Management, June 2005, Bill Rostenberg

Imaging Evolution: Meeting the Department's Changing Design Requirement, Health Facility Management, March 2003, Morris A. Stein and Bill Rostenberg.


Emerging Trends & Successful Strategies for the Planning and Design of Healthcare Facilities

Speaker Contact Information:

**Morris Stein**, FAIA, FACHA
The Stein-Cox Group
821 North Central Avenue Phoenix, AZ, 85004-2004
(602) 462-0966
mostein@stein-cox.com

**Bill Rostenberg**, FAIA, FACHA
Anshen + Allen
901 Market Street San Francisco, CA, 94103
415-281-5459
bill.rostenberg@anshen.com