



# An Administrator's Guide

## Philips X-ray Digital Radiography

### **Digital radiography: How to make it work for you**

The productivity and cost benefits of digital radiography are many and well-documented.

Many radiology departments report 30–40 percent improvement in technologist productivity and more efficient room utilization. By sharing digital images through information systems, they also note higher satisfaction levels with referring physicians and patients, which can impact a provider's competitive standing.

Because film is eliminated, going digital saves the cost of film itself, processing, related equipment, and storage. Working with digital images eliminates the problem of lost film and repeat examinations, resulting in better reimbursement and reduced medico-legal risk. Staff positions to handle and file film can also be eliminated.

But how do you create these advantages for your specific site? How do you make digital radiography work for you?

Many administrators may not be familiar with the process of managing a large, multi-faceted project like introducing digital technology into their departments. That includes creating the necessary understanding and buy-in from other key stakeholders.

This Guide is intended to help, by providing a detailed process – from evaluation through implementation – for making better decisions when evaluating and purchasing digital radiography technology. Whom should you involve on the team? How can you best evaluate your needs? What should you know about gathering information, evaluating options and awarding the contract? How should you plan for implementation? How can you maximize your return on investment?

While the Guide is geared toward administrators who are new to managing complex purchasing projects, it also can serve as a checklist for experienced administrators.

# PHILIPS

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The Mall at Dartmouth-Hitchcock Medical Center.  
Photo courtesy of Dartmouth-Hitchcock Medical Center

# The basics of digital radiography

## Film-based imaging: Why change?

Capturing radiology images has changed little since Roentgen's discovery of the X-ray in 1895. While there have been advances in how images are recorded – such as the move from glass to film – the fact that film-based imaging provides only a single set of images has always been a drawback.

This shortcoming results in a range of inefficiencies: Radiologists receive analog images manually and referring clinicians must come to the radiology department to view them. Lost files translate into repeat examinations, decreased revenue, dissatisfied patients, and increased medico-legal risk. Numerous personnel are required to sort, hang, and file the film. And to comply with record retention laws, years of film files have to be stored and maintained in large warehouses.

### Issues driving digital radiography

- Greater demand for high-performance diagnostic imaging systems with lower radiation dose
- Better staff productivity
- Higher number of PACS implementations
- Continued pressure to reduce healthcare costs and increase efficiencies
- Cost moving within reach of hospital budgets

Source: Frost & Sullivan, 2004, #A630-50; 3-4

## Digital radiography: What is it?

Digital radiography is basically a different way of capturing an image. Rather than film, images are recorded electronically on a digital receptor. The digital image can then be viewed on a display screen, printed on film, or transferred to a Picture Archive and Communications System, or PACS.

Once the image is on the PACS, it can easily be shared on information networks. Digital images can be recorded either through cassette-based computed radiography (CR) technology or direct radiography (DR) systems.

Digital radiography offers many valuable benefits, including quicker, easier, and more reliable management of images. A major advantage of digital technology is the ability to transmit images over information networks and electronically archive them.

In most cases, digital technology eliminates film, processing costs, and the purchase, maintenance, and staffing expenses associated with film processing equipment. Permanently archived images are never lost and rarely need to be repeated. And by using PACS, images can be viewed by multiple people in various locations at the same time.

### Benefits of digital radiography

- Better image quality
- Lower dose
- Greater productivity
- Faster throughput
- No film and related staffing, storage, and equipment costs
- Lower medico-legal risk
- Efficient image sharing over digital networks within and outside an organization when combined with PACS
- Cost moving within reach of hospital budgets

Source: Frost & Sullivan, 2004, #A630-50; 3-4, 3-5

### PACS: The driving force

For most organizations, the move to digital imaging is driven by the desire to leverage a PACS. A PACS requires that the original images (whether taken by X-ray, CT, or another modality) are in digital form. CT, MR, and ultrasound are already in a digital format, and can easily be incorporated into a PACS. In the same way, routine radiography images also need to be digitized before they can be incorporated into a PACS.

General radiography studies account for up to 65 percent of all procedures conducted in the radiology department. Radiography studies also put the highest demands on the department's infrastructure, require the most staff, and take up the largest amount of floor space. A typical radiology department stands to gain greater productivity by converting to digital radiography and PACS.

Direct radiography (DR) and computed radiography (CR) are the two alternatives for capturing digital images for routine radiography.

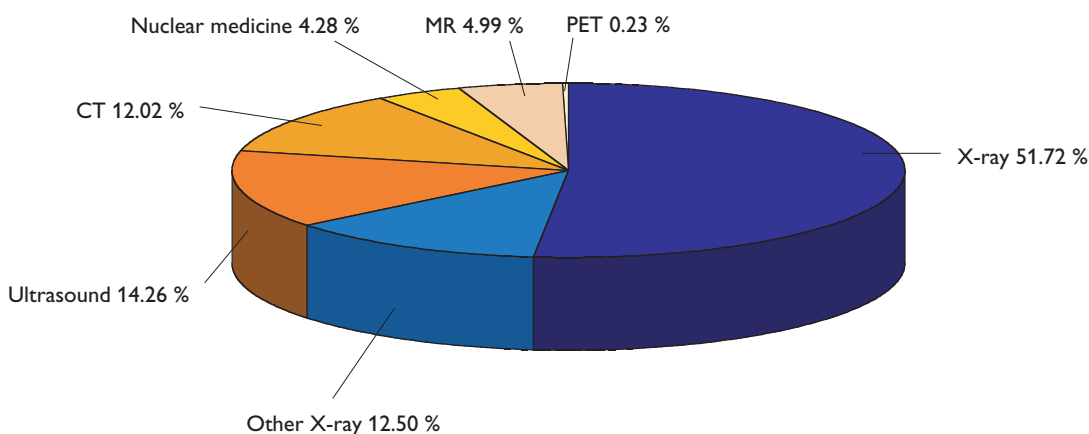
### What is direct radiography?

Direct radiography (DR) involves the direct capture of a digital image through a detector and digital display system. A major advantage of DR is that productivity can be increased for both the technologist and the imaging room as a whole. Boosting productivity is especially valuable to organizations where real estate is at a premium.

By using DR, the technologist conducts an examination, reviews the image quality, and approves the study without leaving the imaging room. Technologists save time by not having to handle cassettes.

Improving the productivity of technologists already on staff makes sense, of course, especially during times of technologist shortages. Through DR, hospitals report 30-40 percent gains in technologist productivity. These productivity benefits provide an excellent way to justify the higher cost of DR imaging rooms. In general, DR is a cost-effective alternative for higher-volume facilities.

### Imaging procedure breakdown by segment



Source: Frost & Sullivan, 2004, #A630-50, 1-7

### **What is computed radiography?**

Computed radiography (CR) captures the digital image on a receptor housed in a cassette. Although less expensive than DR, CR does not offer the same productivity gains achieved with DR, since the technologist must still handle cassettes.

CR is a good system for lower-volume facilities, where productivity gains may not be as critical or where existing radiography equipment will not be changed. CR also can supplement DR, which has limitations in certain specialized views. For example, CR enables non-Bucky imaging in the trauma room, OR, or ICU settings.

Some manufacturers are also producing DR units with more versatile detectors that can be positioned for table imaging (abdomen), upright (chest), and specialized views (cross-table lateral views), and therefore provide a similar application range as CR.

# Case study: The benefits of migrating to a filmless environment

By moving to a filmless environment, the radiology department of Marin General Hospital and Novato Community Hospital increased productivity and reduced costs. The hospitals, which are part of Sutter Health, a leading non-profit provider of health care in northern California, introduced two DR systems and a CR system. They were integrated with PACS and the department's other digital imaging modalities, including ultrasound and multislice CT.

After making the transition in 2002, the hospitals noted the following benefits:

- Higher throughput
- Fewer repeated scans
- Better room utilization
- Faster reporting and report turnaround
- No lost film
- Initial capital costs offset by film savings over five years

Implementation involved the larger hospital and physician communities. Setting up a PACS committee with representation from all of the user departments proved useful. Making sure radiology was represented in influential decision-making groups, such as the medical executive committee and surgery committee, was also helpful for facilitating communication.

Re-designing the radiology workflow was critical for success. To overcome habits formed with previous technologies, the radiology department learned the value of allotting enough time for the training of radiologists, referring physicians, technologists, and clerical staff. Radiologists and referring physicians took advantage of dedicated times for applications training, using a few readers. Technologists were trained by department key operators, supported by training materials.

## Comparisons between analog and digital radiography at Marin General and Novato Community Hospitals

	2000	2003
Total number of exams performed	24,000	36,000
Number of repeat exams	5.9 percent	1 percent
Emergency room reports turnaround time	24 hours	6 hours
Film costs	\$150,000	\$19,500
Staffing		
- Technologist positions	11.1	10.0
- Clerical positions	4.5	4.0

## Return on investment: Initial capital costs offset by film cost-savings

Capital costs over two years, including a secondary archive expense	Film savings over five years, in addition to savings in staffing and supplies
\$544,000	\$652,500



### Image quality and dose

The image quality of digital radiography is considered by many to be superior to analog X-ray systems, with the added benefit of lower radiation dose. Digital radiography also makes it possible to manipulate the image to obtain different information.

For example, an image can be manipulated to show both soft tissue and bony detail with one exposure, thus eliminating radiation exposure from the second image. Hospitals report dose reductions of nearly 50 percent, depending on patient and examination type, as compared to film-based imaging.

However, dose must be closely monitored since digital imaging offers no inherent automatic control mechanism, as compared to conventional film. With film, an overexposed study is visible on blackened film. With digital imaging, a study may be overexposed but still appear as an acceptable image, as the overexposure is electronically adjusted.

### Impact on physicians and patients

Digital images, when incorporated into a PACS, have been shown to improve the satisfaction and productivity of both radiologists and referring clinicians.

With a PACS, radiologists no longer manually sort films and handle images of varying size and quality. A PACS also enables radiologists to share images with colleagues in different geographic locations through information networks.

Referring clinicians no longer need to search for films or view images in the radiology department. They view the images in their own office, minutes after the study is completed, regardless of their location. PACS also enables referring clinicians to access any digital image in a patient's file from their own offices.

Patients also benefit, through faster scans and less waiting time, as well as greater portability of their images on CDs. More Internet-savvy patients expect instant access to their images.

# Case study: The workflow benefits of going digital

At the 200-bed Mount Auburn Hospital in Cambridge, Massachusetts, the benefits of going digital are experienced in the day-to-day radiology workflow. Technologists and physicians experience greater efficiency as a result of the highly automated, reliable, rapid diagnostic image capture with DR.

Workflow improved dramatically with the high performance DR system. When PACS was installed, the department got the full functionality for which the system was ultimately designed. With the digital radiography system and PACS, workflow efficiency took another leap forward for technologists and radiologists alike.

Now Mount Auburn technologists do not have to process film or run CR cassettes to a processor when using the digital radiography suites. Settings are

optimized so that 90 percent of the procedures merely require the push of a button after they position the patient. Time spent by patients waiting for room access has disappeared for the most part.

As a result, Mount Auburn has been able to perform a steadily increasing volume of CR, DR, and fluoro exams with no increase in staff. When the systems were first installed in the ER, the radiology department was understaffed by the equivalent of three FTE technologists. Annual procedure volumes totaled 55,478 in 2000; they grew to 70,312 in 2003.

In addition, dose has been reduced. Most exams today are performed at film equivalent speeds of 1200 to 800, compared to 300 or 400. Radiation exposure is reduced by a factor of two to four.



# Assessing your imaging needs

## The importance of strategic planning

Virtually every healthcare organization has a strategic plan that provides a guide to the organization's future directions: outlining projections for new buildings, marketing strategies, new services, added satellites, and estimates for the number and kind of patients that the organization will serve in the future.

The strategic plan is critically important in evaluating the transition to digital radiography, since almost everything the healthcare facility does in the future will affect radiology.

While the organization's strategic plan serves as a guide for the future plans of the radiology department, it also forms the basis for the needs assessment for the move to digital imaging. To conduct a thorough needs assessment, you will need to assess your current imaging program as well as what you plan to do in the future.

## Needs assessment for routine radiography

A good starting point is to assess your current and anticipated film-based routine radiography program, including:

### Current and anticipated volume and workflow

- Analyze image volume trends, by exam, over the previous three to four years
- Evaluate current site-specific technologies to determine future workflow needs (for example, identifying the number of processors currently in each location and their usage by film-size will help determine the appropriate number, type, and location of CR readers for the future)

- Assess staffing productivity (number of exams per FTE)
- Evaluate imaging room utilization (number of exams per imaging room)
- Calculate volume variations, by time and day of the week
- Plot your department's current workflow (Microsoft's® Visio® program is helpful in documenting key work processes in flow chart form)
- Assess anticipated growth by clinical area (for example, a new pediatric satellite) or patient population (based on current trends like the growing aging population and the institution's strategic plan)
- Formulate volume projections by exam for the next three to four years (based on current trends and the institution's strategic plan)
- Calculate the turn-around time for readings and reports
- Evaluate the current utilization patterns of referring physicians by modality (providing the benefits of digital radiography may create additional demand from referring physicians who already are coming to you for CT, MR, and ultrasound)

## Competitive challenges

- Evaluate your major competitors (services they offer, available technologies, how they are perceived by referring physicians and general public, for example)
- Analyze how your organization compares to competitors (referring physician satisfaction, exam wait times, latest technology, quality/accuracy/speed of results, patient satisfaction, convenient hours and location, for example)

### From system experience to total experience

The importance of patient satisfaction in creating competitive advantages continues to grow. Moving patients from a system experience to new levels of overall satisfaction and comfort can have a significant impact on your site's ability to attract and maintain referrals.

Current "experience research" is exploring ways to address patient issues such as long waiting times for short procedures, a lack of information while waiting, and cold and impersonal spaces in patient areas. This research indicates that patients value comfort, personalization, reassurance, and personal contact.

Consider improving the overall experience for your patients by:

- Evaluating the main waiting area. Provide a comfortable space and relevant information and distraction; this is where patients spend most of their time.
- Looking at the paths patients travel. Provide clear signage and simplified guidance to and from changing and examination rooms.
- Thinking about privacy. Create a positive experience in the changing area.
- Improving confidence levels. Hide clutter in the exam room, including cables and other technical elements, if possible.

Source: Philips Design – ambient experience research programs



### Determining your goals

The outcome of your needs assessment will help to more clearly define what you need to achieve in the transition from analog to digital. For example, your goals may include:

- Providing a platform for PACS
- Boosting staff productivity
- Improving examination throughput
- Reducing patient waiting time
- Increasing your capacity to do more examinations
- Improving room utilization
- Enhancing radiologist productivity and satisfaction
- Increasing referring clinician and patient satisfaction
- Improving your marketing position

Once you have a good assessment of your current program, you may find that there are operational changes that can be made immediately to level out workflow, better utilize under-performing imaging rooms, and coach staff members on how to improve their productivity.

### Choosing the right configurations

The most difficult decision when considering a move from analog to digital imaging is what equipment to buy. Your site's strategic plan and needs assessment play a major role in determining which digital radiology systems will work best for your organization.

How do you know which systems are right for your organization – DR, CR, or a combination of both? Unfortunately, there is no magic formula for determining the number of digital units required to replace a specific number of analog film units.

The goal is to identify digital radiography capabilities that will meet your needs in the short, medium, and long run. Administrators will need to do a cost-benefit analysis, starting with an evaluation of each digital modality.

Comparing the benefits of DR and CR	
DR Advantages	CR Advantages
Enhances staff productivity	Lower cost
Reduces number of rooms required	Works with existing analog equipment and workflow to minimize department disruption
Reduces physical labor for staff	Good for non-Bucky imaging
Enables staff to stay with patient	Good for portable trauma, ICU, and OR work
Eliminates film and cassette handling	

Workload comparison – film-based radiography, CR, and DR*		
Film-based radiography	CR	DR
60	80	More than 150

\* Source: Philips Medical Systems. Estimated number of radiography exams (images) that can be performed in an eight-hour day (two-detector room, with two exams per patient and six minutes total handling time). Minimum exam time is two minutes. Actual number depends on exam mix and patient condition.

# Case study: CR or DR?

After months of analysis, Dartmouth-Hitchcock Medical Center in Lebanon, New Hampshire, decided to replace eight analog radiographic rooms that were operating at capacity with six DR rooms. The six DR rooms now easily handle the current workload and provide an additional 36 percent capacity.

Initially, Dartmouth-Hitchcock Medical Center planned to move from film to CR. However, the assessment team realized that it would not achieve its major objectives with CR. These objectives included:

- Improving examination throughput
- Reducing patient waiting time
- Increasing capacity to do more examinations
- Boosting staff productivity
- Improving referring clinician satisfaction

With this realization, the team made a mid-course change by moving from analog directly to DR, supplemented by CR for cross-table, portable, and OR work.

Because of the higher cost of DR, not all the rooms were replaced with the more versatile dual-detector imaging rooms. Instead, Dartmouth-Hitchcock purchased a

combination that put digital capability in each of the six rooms. The six rooms are configured as follows:

- Two single-detector upright units, which also can be repositioned to do supine extremity examinations
- Two single-detector table units
- One dual-detector (upright and table) unit
- One single-detector/multi-functional unit

By putting digital capability in each of the six rooms, the organization has the flexibility to add the upright or table detector to the single-detector rooms.

In terms of teaching technologists how to use the new technology, Dartmouth-Hitchcock has discovered that training several key operators by the vendor's application specialist works best. These key operators then teach the remainder of the staff. They also help to train new staff members or students as they come to the facility.

Based on experience at Dartmouth-Hitchcock's busy radiology department, the time required to adequately train a technologist is approximately four hours for a DR system, and about eight hours for a CR system.



# Gathering information and budgeting

## Requesting information (RFI)

Now that you have identified your goals and requirements, you can explore the various systems offered by different vendors through a formal request for information (RFI).

The RFI is generally done in a specific format so that each vendor gets the same information request. It also provides vendors with basic information about your imaging department and your goals. In the RFI, you will request information about the products you specify, i.e., DR and CR equipment.

In addition to finding out more about each vendor's equipment, the RFI will enable you to narrow the list of companies capable of fulfilling your needs. Later in the process, these companies will receive the formal request for proposal (RFP).

Depending on the size of your department, you may also consider securing the services of an outside consultant whose expertise may add value, particularly when an outside perspective helps to break through internal politics.

## Items to remember

- Develop a standard RFI outlining your equipment needs
- Include specific details about your department, including:
  - Number of annual examinations listed by modality
  - Inpatient and outpatient volumes
  - Why new equipment is needed:
    - Desire the latest technology
    - Moving to PACS and need digital format
    - Replacing old equipment
    - Increasing volume
    - Must improve staff productivity
    - Number of units you are considering
- Select at least four vendors
- Contact each vendor's sales representative to identify who should receive the RFI
- Set a specific deadline when RFI is to be returned
- Your review of the RFI will help you select the best vendors to receive the RFP

### Securing cost estimates

As you can imagine, the cost of equipment can vary considerably depending on the features, model, and vendor. When contemplating a major equipment purchase, you have an opportunity to optimize your buying power. You may also consider working with your facility's group purchasing organizations (GPOs), or a service that provides additional information on comparing products.

Through the RFI, your goal is to get a cost estimate of your total purchase. You will need this in order to budget for capital equipment and to get approval from your organization's management to proceed. Your final price will be in the RFP response, which will be covered later.

### Obtaining management approvals

The decision to change from film-based imaging to digital imaging will have a major impact on your department's future. This will also be a major investment for your institution that will require careful analysis and planning.

Your job is to assess your options for digital imaging, projecting future examination volumes, staffing requirements, and digital equipment options. You also need to project the financial ramifications, marketing impact, and the ability of your department to handle the current and future workload.

At this point you will need to present a proposal to your senior management demonstrating why your recommendation is the right one for your institution.

Your proposal needs to include the following:

- Project the costs associated with the new equipment
  - Equipment costs, including options and networking
  - Construction or renovation costs for the new imaging room(s)
  - Service costs after warranty

### Items to remember

- Get an estimate of the unit cost of the desired equipment
  - Invite the vendor to view the equipment location
  - Make sure the vendor is aware of any building or site limitations (adequate electrical power, etc.)
  - The initial cost estimate can be a verbal estimate from the vendor's representative
  - The estimate should include a separate price for all components and options
  - Networking and interface costs should be listed separately
  - Ask for an estimate of the service cost after warranty
  - The cost estimate should be for a fully functional unit
- 
- Quantify the savings in transitioning from film to digital imaging
    - Film and processing cost-savings
    - Reduction of film library staff and related savings
    - Elimination of film-related equipment services
    - Elimination of space required to handle and store film
    - Productivity savings, illustrating how more studies can be done in fewer imaging rooms
  - Explain the positive impact on staff productivity
    - Technologist
    - Radiologist
    - Other departmental support or administrative staff
  - Demonstrate the positive impact on patients and referring clinicians
    - Saves time when coupled with PACS
    - Eliminates lost film and the need to repeat studies
    - Reduces radiation dose (critical with pediatric patients)
    - Decreases patient waiting time
  - Indicate how reimbursements will improve
    - Lost film equals lost revenue or costly repeats
  - Make the case for reducing medico-legal risk resulting from lost film

Pro forma model		
Efficiency improvement resulting from transition from traditional radiography to DR (min.): 30%		
Revenue	Traditional RAD Room	DR System
# of procedures per year	15,000	15,000
Procedure volume growth rate	5%	5%
Avg. reimbursement per procedure	\$ 50.00	\$ 50.00
Reimbursement inflation rate	2%	2%
Bad debt expense %	5%	5%
Other revenues	0%	0%
Expenses	Traditional RAD Room	DR System
Technologist FTE cost per study	\$ 9.09	\$ 6.36
FTE inflation rate	5%	5%
Dark room FTE cost per study	\$ 0.21	\$ –
File room FTE cost per study	\$ 2.60	\$ –
Annual rent / facility charge	\$ 100,000	\$ 100,000
Annual utilities cost	\$ 10,000	\$ 10,000
Equipment cost	\$ 85,000	\$ 390,000
Site prep / installation	\$ 5,000	\$ 5,000
Annual service cost	\$ 8,000	\$ 37,000
# of years required to maintain records	6–7	6–7
Annual storage cost per record	\$ 0.05	\$ 0.05
General inflation rate	3%	3%
Processor cost per study	\$ 0.69	\$ –
Film/supplies cost per study	\$ 4.08	\$ –
Annual courier costs per study	\$ 0.15	\$ –
Other expenses	\$ 100.00	\$ –

Source: Philips Medical Systems

### Simplifying the budgeting process

Every healthcare facility has different requirements for the capital budgeting process. Budgeting for the change from film to digital imaging can be a complex task because of the variety of considerations involved in the purchase of digital equipment.

Generally, once the budget is approved you cannot go back and ask for more funding. Your budget projections must be reasonably accurate but with sufficient flexibility to allow changes when the final price is obtained.

The RFP response from the vendor, which comes later in the process, will provide the final price.

### Items to remember

- In general, budget for the vendor's cost estimate; factor in all options and networking costs
- Incorporate construction costs, which generally are included under a separate category within the capital budget
- Any warranty should cover the first year of use. Obtain a firm quote of the service costs for the year(s) after the warranty

# Evaluating your options and awarding the contract

## Creating an evaluation team

For every major equipment purchase, your organization needs a team to evaluate the systems, options, functionality, and service requirements.

The team should consist of the radiology administrator, who is responsible for making the purchase recommendation to senior management; the clinical operations manager, who manages staff members using the equipment; the asset manager, who oversees service and maintenance; and a technologist, who actually will use the equipment.

Each person brings his or her unique perspective to the process that together will help the institution make the best possible decision. Led by the radiology administrator, the team needs to have credibility with the radiology chairperson, radiology staff, and your facility's senior management. Here is the team's mandate:

- Assist with the needs assessment, RFI, and RFP
- Attend all site visits at other institutions
- Meet with each vendor invited to bid
- With purchasing's help evaluate the quotation responses to the RFP
- Make the final recommendation to senior management

## Working with vendors

The vendor's representative is the best source of information about their company's products. In some cases, the company may also provide a product specialist who is knowledgeable about specific equipment, such as CR and DR. The vendor's representative and the product specialist should work together to make certain you have all the information you need.

Federal anti-kickback laws require that purchases be made in a fair and objective manner so all participants are given an equal opportunity. Each vendor should be treated the same. These laws also restrict vendor gifts to customers. Your facility also may have rules concerning gifts.

### Items to remember

- The evaluation team should participate in all vendor discussions
- Your purchasing department may also participate in vendor discussions – invite them to attend
- The evaluation team should attend all vendor site visits
- Avoid any perception of giving one vendor preferential treatment

### What to look for in product offerings

Not all offerings are the same. Here are some guidelines to begin your discussions with vendors, comparing products and services.

#### Ease of use

All digital radiography systems will provide some improvement in efficiency. To get maximum benefit, consider:

- Software that integrates the generator and patient management systems, making them less dependent on operator involvement. Once a patient is selected from the DICOM modality work list, system settings are chosen automatically. After the image is taken, processing is automatic. Eliminating extra steps for the technologist means faster throughput and less opportunity for error.
- Productivity and ergonomic enhancements: easy-to-move patient tables with adjustable height, X-ray tube carrier with ceiling suspension, tiltable and moveable vertical stands, portable detectors, and easy collimation. Up to 83 percent of technologists suffer from back pain, according to the *Journal of Industrial Ergonomics* (January 2004, vol. 33:1, pp. 29-40).
- Systems designed the way users want to work. Are the workstations and user interfaces intuitive and easy to use?

#### Image quality

Most will agree that the quality of digital images is superior to conventional X-rays. In particular, DR produces higher quality images at lower speed with greater sensitivity. Also, detectors with a high matrix size produce images with higher spatial resolution. You will get more from vendors who provide:

- Solid experience in how the imaging chain works. That experience translates into better image capture and processing techniques.
- Examples of sequencing images for easier viewing, manipulation to get desired views, and magnification of fine anatomic detail.

#### Detector size

Detector size does matter, especially as the population's girth increases. Large detectors, such as 17-by-17, will help you avoid having to image larger patients in sections, resulting in unnecessary exposure to radiation and slower throughput. You may be used to working with standard 14-by-17 size film or cassette. With a 17-by-17 digital detector, you will always have full coverage to image any type of patient without turning the detector.

#### Upgradeability

Regardless of what system you purchase, it should be designed to be upgraded. If you are buying a conventional radiography room now, be sure there is an upgrade path. You need to be ready to upgrade if your application mix changes or when your budget allows. Be sure that the system can be customized, with modules that are interchangeable.

### Utilization

Your vendor should have a large installed base with experience in a variety of settings and circumstances. Vendors that have been in the industry the longest have the benefit of knowing where medical imaging has been and where it is going. Evaluate your vendor's experience in the following areas:

- Reliability and dependability built into product development. Ask how each system is designed to last.
- A variety of service offerings to fit your needs. Good service makes the difference between success and failure. What is the availability of parts and how fast can they be delivered?
- Proactively prevent downtime through clinical education and support, remote and online resources, service contracts, and system updates. If your system does go down, your vendor needs to provide fast response and service delivery.
- Some vendors offer additional management reports that indicate where you can improve asset performance and operations on an ongoing basis.

### Bridging imaging and IT

The worlds of imaging and information technologies are increasingly interrelated. Vendors with the widest portfolio will do a better job of integrating imaging and IT information, creating improvements in workflow and patient care.

Organizations that have made the transition to digital radiography report greater success when radiology and IT are working collaboratively. Choose a vendor that has depth of understanding in medical imaging as well as medical IT.

For example, organizations that use CR and DR will want the same diagnostic quality when looking at both images on PACS. Look for multi-resolution image processing that enhances details of CR and DR images with the same quality and appearance. The images should look virtually indistinguishable through enhanced contrast, which is especially useful in applications where high-definition detail is essential.

# Case study: Going digital – words of advice from a radiologist

When considering digital radiography, there are benefits in learning from those who have already made the transition. Ralph Koenker, M.D., Radiology Director at Novato Community Hospital and Marin General Hospital in Novato, California, shared major lessons learned when his organization switched to digital radiography.

## Ensure image quality control

Although image quality from digital techniques should theoretically outperform the older analog film-screen techniques, it still remains possible to see inconsistency in the quality of your radiograph. It is critically important that the initial processing algorithms be correctly set up for the preferences of your institution. This means that careful collaboration between the radiologist and the vendor's application specialist takes place early in the implementation. The images need to look acceptable to the physicians viewing your studies.

Digital radiographs can be manipulated, in ways similar to digital photography. However, providing a wide variety of possible algorithm manipulations makes for inconsistency and confusion amongst the X-ray technologists. Therefore, it is advisable to settle on preferred algorithm settings early in the implementation, keeping those settings permanent.

Digital radiography systems with the best image quality have specific settings for every single body part and X-ray view. Linking the CR system with the radiology information system (RIS) charge master can be helpful in identifying an anatomy database that contains the pre-loaded optimized algorithm settings.

## Take time to train technologists

Invest enough time to train technologists – about four hours for a DR system and eight hours for CR. Although the basics of X-ray production and X-ray interaction with biologic tissues are not changed, there are some key differences in the way digital detectors respond.

Centering the anatomy in the middle of the cassette is more important than it was with film-screen. Also, collimation has a double importance now:



first to minimize scatter within the body, but also to optimize a definable “exposure field” on the cassette. The computer generates histograms after first identifying an exposed area on the detector sheet or plate. Without proper collimation, the exposed field may not be properly identified and optimized.

## Don't expect digital to fix poor workflow

Going digital doesn't automatically improve your radiology workflow processes. In fact, if your workflow rules don't work in the analog realm, digitizing them will produce even greater disorder. There is an old saying among project engineers for digital implementations: “If your workflow was a mess before going digital, and you do nothing to change that, then after going fully digital, all you end up with is an automated mess.”

For example, patient order entry must be performed correctly the first time, especially when working with PACS. A patient entered as “John J. Smith” in one visit, and then as “John Jay Smith” the next, will lead to confusion and difficulties, since the images will be housed in separate patient digital master folders. Although it is theoretically impossible to “lose” a digital radiograph, in practice the most common source of “lost” studies involves naming inconsistencies of the digital X-ray file. The solution is to carefully integrate your RIS system with the digital radiography system through a feature called modality work list. With consistent use of this feature, technologists pick the patient name from a

presented list. Since the data entry is not manually typed, name inconsistencies are not a problem when modality work list is used regularly.

### **Be aware of operating room challenges**

The high-intensity environment of the OR represents one of the most challenging areas for digital radiography. Some of the issues you may confront are CR reader adjustments in exposure field detection since collimation and image centering are sub-optimal in operating room situations. Accordingly, you may wish to convert your operating room to digital only after fully implementing and stabilizing the digital conversion within your X-ray department. For surgery cases, make the transition when your technologists are completely trained and comfortable with the new technology. For many sites, this might be appropriate after roughly six months' experience.

In orthopedics, the need to provide images for orthopedic device templates is crucial to allow correct sizing of hip and knee replacements. In the film/screen realm, this sizing involved transparent templates physically laid over X-ray films. At a minimum, you will need the capability to provide life-size anatomic printed copy of your digital images so that the transparency template techniques can continue to be employed.

There are soft-copy software options to provide sizing and selection of ortho implantable devices, but this software should be implemented with the assistance of your orthopedic surgeons so that they become stakeholders in the overall project. Some orthopedic surgeons find that software methods for templating take too much time, so you will need to coordinate with your surgeons to find the right solution for your organization.

Be sure to also manage referring physician expectations appropriately in terms of turnaround. Some will expect image turnaround time similar to digital photography. In DR, images can be produced in 20-30 seconds. However, a CR image can take five minutes between exposure and presentation of the image in the OR because the cassette needs to be developed in the CR reader and sent through the network.

### **Be mindful of workflow ergonomics**

When trying to decide where to place workstations, especially in busy emergency departments, you may be inclined to put them in the busiest areas for the convenience of referring physicians and ER physicians. This will lead to greater acceptance of your new system. However, having a workstation in a high-traffic area might present issues of medical record privacy and "lines of sight" between public areas and computer monitors. Sites that allow ER doctors to determine the location of their workstations generally get through the transition with greater ease.

### **Take charge of safety and legal issues**

Digital radiography may decrease a hospital's exposure to legal liabilities, since lost film is no longer an issue. However, radiology departments may still face legal exposure. It is important to document and maintain records that the CR reader and selenium plate detector have undergone and passed proper calibration tests.

Moreover, if you have made the move to soft-copy reading of your digital X-rays, it also is useful to maintain records of the calibration of the display monitors, noting the luminance and resolution tests. Quality checks, performed at intervals deemed appropriate by each institution, provide a documented service record that ensures optimal image quality and protects your patients' safety.

### **Narrowing your vendor choice: Request for proposal (RFP)**

Through the RFI process, you created a shortlist of vendors that can help you reach your digital imaging goals. Now you need to invite these selected vendors to submit more detailed information in a formal request for proposal (RFP).

Each vendor is given an identical RFP so each company can be evaluated fairly against the others. RFPs should only be given to vendors with whom you are willing to work.

Since the RFP has specific legal verbiage that will protect your facility from error or unexpected problems in the purchase contract, it is very important to have your purchasing department involved in the RFP development. Frequently, purchasing will have an institutionally approved format that must be followed. The RFP should always require line-item pricing, so that the cost of each equipment feature can be assessed as to its benefit versus cost.

Some institutions have a “bidders meeting” shortly after the RFPs are distributed to vendors. This meeting consists of representatives from each vendor, purchasing representatives, and the evaluation team members. This enables you to review the project and vendors to ask for RFP clarification. By having a group meeting, all of the vendors hear the same answers, at the same time, avoiding any perception of vendor bias.

Vendors should be advised that their responses must follow the format of the RFP, or they will be rejected. This format will facilitate product and feature comparison between vendors.

Because RFPs require a considerable amount of work for vendors, they should be given adequate time to complete the bid process. A standard time is generally between four and six weeks. The RFP will specify a deadline, detailing when and where the bids must be returned (generally, to the purchasing department).

The bids are opened at the same time in accordance with your institution’s policy. This will avoid any possible litigation if impropriety is perceived by any of the vendors.

#### **Items to remember**

- The RFP is a legal document subject to audit by federal authorities
- Vendors should be given adequate time to respond – four to six weeks
- RFP responses are confidential and must not be shared among vendors
- The bid response is generally subject to final negotiation
- Vendors are not permitted to resubmit or alter their bid for any reason
- Be specific. Do not assume that an application, hand grip or special table feature is included

### Making site visits

Site visits are an important part of the assessment of any major purchase. Generally the assessment team only makes site visits with vendors that have been invited to bid. Usually these visits take place soon after the bids have been sent to vendors.

Selection of the site is the prerogative of the vendor. Ask the vendor for a list of facilities that have the equipment you are evaluating. Make sure the vendor knows that you may call these sites as references, to request information about their experiences and their satisfaction with the equipment.

The date and time of the site visit is generally determined at the discretion of the facility being visited to ensure that the equipment is available. A good vendor will permit, if not encourage, private time between the evaluation team and their counterparts at other institutions.

#### Items to remember

- Conduct site visits only with vendors who have been invited to bid
- All evaluation team members should go on each site visit
- The specific site to be visited is the prerogative of the vendor
- Date and time of the visit is the prerogative of the host site
- Make sure you know your institution's policy regarding who pays for off-site visits
- The vendor should provide private time for discussion only between the evaluation team members and their host counterparts

### Analyzing RFP responses

By requiring vendors to follow a specific RFP format, the analysis that follows is logical and systematic. In most cases, the evaluation team is given this responsibility.

Since the results of the RFP evaluation process are subject to federal audit (the equipment will be used on Medicare patients), the evaluation needs to be documented in a systematic way. You will need to conduct the evaluation by identifying the factors that are most important to your organization. There are tools available to help you compare vendors and their offerings.

Some facilities have found it helpful to evaluate the bids using a set of criteria and a weighting system that addresses the important aspects of the equipment. The criteria may differ for each organization.

Criteria	Typical Weight
Reliability and service	20 percent
Image quality	25 percent
Price	20 percent
Features	15 percent
Upgradeability	10 percent
Company stability	5 percent
Value-added concessions	5 percent

An evaluation system using criteria and weighting is helpful for evaluating bids in a structured manner

### Assessing vendor ranking

To arrive at your final vendor choice, ask team members to assess vendors on each criterion.

For example, on a scale of 1-10, with 1 being the worst and 10 being the best, each team member evaluates vendor X according to each criterion. Next, the team determines the average ranking for that vendor for each criterion. Then the average ranking score is multiplied by the weight assigned to that criterion; for example, vendor X's average ranking of 8 for reliability and service would be multiplied by 20 percent, giving vendor X a final score of 160. The vendor with the highest overall score wins.

Since the ranking by team members is subjective, the final result should be negotiated through consensus of the team. This is a fair, objective system that will pass any audit.

#### Items to remember

- Invite the purchasing department to monitor the process
- Use a systematic, objective evaluation process
- Select criteria that the team most needs to evaluate
- Weigh the importance of each criterion
- Score each vendor on each criterion

### Negotiating the contract

The final contract negotiation should be handled by your facility's purchasing department, which will promote your organization's best interests. The vendor's attorneys will represent the company's interests. Both you and your vendor should gain from the negotiation; view the relationship with your vendor as a long-term partnership.

Purchasing should be aware of the features and options that are important to include in the contract. In addition to price, there are frequently other aspects of the contract that can also be negotiated with the vendor. Once the contract is signed, you cannot go back and make modifications.

Some facilities have their own engineers or technicians in radiology who will take over maintenance responsibilities when the warranty expires. If your department plans to do its own maintenance, include vendor training of your staff in the contract.

#### Items to remember

- Leave the negotiation to your purchasing professionals
- Make sure purchasing includes the features and options you want
- Give purchasing a list of acceptable value-added features to negotiate
- Include the training of your maintenance staff and service manuals in the contract, if applicable
- Payment terms are generally specified in accordance with the facility's standard policies
- This should be a win – win agreement between the vendor and your facility

### **Awarding the contract**

Awarding the contract will occur at the end of the negotiation. It is important that purchasing reviews the final contract with you before it is awarded. If any changes or modifications are needed, they should be completed before the contract is signed.

When finalizing the details, you may consider various financing options offered by your vendor. Ask your vendor about financing alternatives.

Operating leases, graduated payments, lease with service, and an upgrade program are just some of the possibilities that may be right for your organization.

To finalize the contract, purchasing will need to get administrative (CEO) and finance (CFO) approval, in most cases.

#### **Items to remember**

- Be sure that purchasing reviews the negotiated contract with you before it is signed
- Compare the contract with the bid – they should closely match
- Frequently, the contract will contain a clause that says, “In accordance with bid quotation # XXXXX, dated January 1, 200\*.” This assures the legal binding of the bid and contract
- Purchasing will award the contract after management approvals
- Celebrate the agreement with the vendor and purchasing
- Now the work begins

# Implementation: Final phases

## Phasing the installation

The planning for delivery and installation should start immediately after the signing of the contract. The vendor's representative will give you detailed specifications of the equipment, which will include power, heating, ventilation, and cooling (HVAC), and data networks and telephone connections.

Most vendors have an engineering staff that will assist you in planning the modifications required for existing space to accommodate the equipment. This needs to be closely coordinated with your facility's engineering staff. An accredited physicist is required to make the shielding calculations for radiation protection.

Your state and local authorities have regulations that need to be followed in order for your organization to legally operate the equipment. Most states require the vendor to submit a report to the state's bureau of radiation control, indicating that the equipment has been installed.

## Ensuring a smooth delivery

Developing a working time line agreed upon by you and the vendor will be helpful in planning construction and delivery.

The date of delivery needs to be coordinated with the vendor's trucking company and your receiving department to ensure that a loading dock will be available on the day and time of delivery. The delivery point can be either your loading dock or the finished room where the equipment will be installed. You can specify where you want the system delivered.

In some cases, the trucking company will only deliver to the loading dock, and the vendor's installation staff will move it to the finished room.

Be sure to do a "route run-through" so the vendor and your institution are assured that the equipment will fit through all corridors, elevators, and doorways (accounting for the size and weight of shipping crates in which the equipment is delivered).

Your vendor will be able to give you an accurate estimate of the installation time. For DR units, installation time is typically less than a week.

### Items to remember

- Obtain detailed equipment and room modification specifications from the vendor
- Coordinate the construction requirements with your engineering department
- Shielding requirements must be developed by a physicist
- Coordinate delivery and internal transport with the vendor, the trucking company, and your receiving department

### **Training the staff**

After the installation is complete, the vendor will send an application specialist to train the technologists who will operate the equipment. The application specialist is a technologist experienced in the operation of the equipment. The amount of time the application specialist spends at your facility will be specified in the contract – generally one to three days. Usually this training is provided for each unit purchased.

The change from analog to digital imaging should not come as a surprise to your staff. During this entire process, you should keep your staff informed of what you are doing and why. This can be done at regular staff meetings and through newsletters. Working on new technology usually is an exciting time for the technologists.

Training time varies by institution, but in general it takes technologists about four hours to learn how to use a DR system, and about eight hours for a CR system. Some organizations first train key operators who serve as advocates for the new technology, train remaining staff members, and trouble-shoot when necessary.

#### **Items to remember**

- Keep staff informed during the entire process, emphasizing the benefits
- Vendor's application specialist will train your key operators
- Key operators will train the remainder of your staff

# Case study: CR/DR implementation at a specialty hospital

The Hospital for Special Surgery (HSS), a premier university-affiliated hospital specializing in orthopaedics and rheumatology in New York City, New York, planned very carefully before, during, and after the installation of CR and DR. The hospital aimed to maximize room utilization, workflow, and image quality.

HSS took time to articulate its expectations in detail with the vendor prior to and during implementation. In particular, it was helpful to contact the vendor's application specialist prior to arrival to troubleshoot anticipated problems, e.g., collimation, image quality, etc.

Thinking through how to set up the database was time consuming. However, this critical investment of time on the front end paid dividends. The hospital took great care to create a customized anatomy database tailored to its specific needs. Particularly essential was developing a customized anatomy database using the radiology department's exam charge master and positioning protocols as a cross reference. With this information available up front, the application specialist was better prepared to enter the key information. As a result, HSS made better use of training time and developed more appropriate processing protocols.

The training of key operators by the vendor also played a key role. The key operators then trained the remaining staff members, ensuring that they possessed appropriate skill levels in using the systems. At the same time, the organization documented how staff was trained to use the digital systems, resulting in proof of their competency for regulatory agencies that require such documentation, such as the Joint Commission for the Accreditation of Healthcare Organizations (JCAHO).

Although good positioning, shielding, and technique are vital in ensuring high-quality images, digital systems also allow technologists to manipulate digital images. Because these digital post-processing techniques may actually hide or misrepresent pathology, HSS prohibited this type of manipulation.

Overall, the specialty hospital reminded technologists that they needed to continue to use all of their "Tech 101" skills in the transition to going digital. Up-front planning initiatives and ongoing supervision has enabled the transition to be positive in terms of department morale and overall improved efficiency.



### Implementing your plan

Now that the equipment evaluation, negotiation, planning and training is complete, it is time to implement your digital imaging program.

The vendor's application specialist will calibrate the unit to produce the exact image your radiologists prefer. While each of your radiologists may prefer a slightly different image – some may want more latitude, others more contrast – they must decide on one acceptable image. This may change by body part but the equipment will not permit the same body part to be calibrated in different ways.

You can help the application specialist by showing him or her acceptable image quality on film studies.

Once you have achieved the exact images you want on one unit, the calibrated factors from that unit will be used to populate any other CR or DR units you have purchased. The goal is to have standardized images for every body part regardless of where the study is taken.

## Case study: Tested implementation tips

Dartmouth-Hitchcock Medical Center found that a phased implementation works best. This enables the vendor's service engineer or application specialist to customize the equipment's software to the site's specifications. Each examination done on the unit must be separately loaded into the CR or DR control. Each vendor will have default settings but these settings may have to be adjusted to meet the organization's needs.

Dartmouth-Hitchcock archived images for 90 days prior to the switch over to PACS. This allowed the medical center to build up an archive of old studies, which eliminated much of the need to compare digital images with previous images on film.

When Dartmouth-Hitchcock purchased six DR units, the installation was phased in over a period of several months. As each DR unit came on line, images were printed on film and handled in the usual manner. After all the units were installed, the next step was to integrate the digital units (DR or CR) into the PACS.

### **Celebrating success**

Making the move from film-based to digital imaging is a challenging task that requires a considerable amount of analysis, planning, training, and collaboration with a variety of people. Following the steps in this Guide will give you a good start on planning for your institution's future.

Once you have made the transition, celebrate your success with your team as well as the numerous people from inside and outside your organization who made this project happen. The teamwork will be helpful in the future as adjustments may need to be made in the transition to digital technology. This also is a good time to invite your management to see the digital investment they have made.

Through hard work, your organization is positioned to recoup the benefits of digital radiography now and in the future.



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