Conventional x-ray continues to develop amid digital explorations

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Developments in digital radiography (DR) may have held the high ground of x-ray imaging on the RSNA exhibit floor this year, but technical improvements in surgical C-arms, conventional radiography/fluoroscopy, and angiography equipment were exciting, even extraordinary in some cases. Advanced software applications in x-ray have flourished as well, particularly in 3D imaging and digital displays. (At least two vendors showed work on putting together full spinal digital shots for use in scoliosis applications.)

Phosphor-plate computed radiography (CR) suppliers continue to improve that technology, which is maintaining a digital niche alongside emerging DR products. Some new DR equipment was introduced by start-up firms at the show, including a whole-body trauma scanner out of South Africa and a portable DR system developed by a small R&D firm in conjunction with Canon.

**Agfa**

Reenergized under the Agfa HealthCare moniker, the company highlighted an array of CR developments.

A prototype CR panel that functions in a self-contained way, much like a DR detector, was displayed using radical CR scanhead technology still under development. The scanhead engine functions like a complete CR system on a circuit board that moves across the image plate in four seconds. Full cycles, including erasure, take just 20 seconds, and as many as 210 CR images may be processed in an hour. A final version of the new CR product could be 18 months from market.

Needle-based phosphor technology was displayed using cesium bromide. The new phosphor can be coated on more thickly and, as a result, has higher x-ray absorption. This drives up the DQE and CR image quality.

A scoliosis software package and full-spine-length cassette holder allow for simultaneous exposure of three to five CR cassettes. Images are stitched into one full image, allowing for more accurate measurements.

ADC Compact Plus is an upgrade to the ADC Compact automated plate digitizer. Robotics and the imaging chain developed for ADC Solo help boost scan time so that more than 90 plates are scanned per hour, up from 70.

**Canon Medical Systems**

The company is seeking to establish itself as a single source for the purchase of digital radiography and PACS. DR products revolve around the use of amorphous silicon flat panels.

CXDI 31 is a third-generation detector that provides portability by fitting into existing buckys for 9 x 12-inch film cassettes. A larger size is under development. The panel width is 2 cm.

Canon also showed the wares of R&D firm Trex Enterprises, specifically its PDX 2000 portable digital x-ray system. The unit uses Canon's CXDI DR technology. The package weighs about 170 pounds, including the plate, computer, and monitor. It can be set up in the field in 10 minutes, and images can be transmitted over phone lines to a central reading facility.

**Cares Built**

R/F offerings play second fiddle to the company's DR technology, which is only beginning to emerge as a market player.

The Clarity 7000 DR system, with 17 x 17-inch detector and resolution of seven line pairs per millimeter, received FDA clearance this year. The firm's premium system incorporates solid-state...
complementary metal-oxide semiconductor (CMOS) sensors, the same semiconductor technology used in Pentium processors. Each detector has 400 sensors.

In addition to the Clarity DR system, five standard x-ray devices received FDA clearance during the year, including the Atlas multi-purpose vascular room, the Athena remote R/F room, a portable x-ray system, a C-arm, and an ultrasound bone densitometry system. Eventually, the vendor hopes to expand its DR technology to the other products in its x-ray line.

PACS connectivity for the vendor’s x-ray line is being helped along by a new partnership with Merge Technologies.

**Del Medical Imaging**
Radiographic, mammographic, R/F, and x-ray portable equipment is marketed to hospitals and orthopedic and primary-care centers, as well as nursing homes and home healthcare services.

The vendor’s effort to market its RadView x-ray line to hospitals advanced at the show with a more complete dealer lineup in place and the revamping of equipment design to modernize the look.

Equipment was also upgraded to enable integration of CR and DR. This included a new partnership with Infimed to supply customers with DR upgrades.

**Eastman Kodak**
The company balances CR and DR offerings, hoping to capture both ends of the digital spectrum.

Two new amorphous selenium DR products were introduced at the show: the DirectView DR 7100 general radiography room and the DR 5100 dedicated chest DR system. Analogic is the vendor’s DR development partner. The chest unit has a redesigned detector housing that enables easier positioning of nonambulatory patients.

The DR line adopted image-processing techniques, as well as a simplified user console operation, both brought from the CR side of the business. Data read from the DR detectors as well as data transmission had to be built up to a greater bit depth in order to implement the processing technology.

New quality control software was implemented for the CR line in an attempt to improve ease of use and avoid workflow interruptions.

The CR 900 multicassette reader was introduced at the beginning of this year. Four or five cassettes can be dropped in any slot in the system. These are then indexed and automatically processed, while the technologist can return to the patient.

Low-cost offerings were expanded with the addition of tabletop CR following the acquisition of Lumisys. These include the ACR 2000 and ACR 2000i. The latter includes an integrated screen-erase station.

**Edge Medical Devices**
SMART flat-panel detectors for digital radiography represent the company’s mainstay in x-ray.

The Quix DR line with amorphous selenium flat-panel detectors incorporates a scanned matrix array readout technology (SMART) instead of the active matrix array readout systems used in existing DR products. The vendor is negotiating OEM agreements as well as supplying its own finished products through dealers.

A motorized tilting radiographic wall stand was added to the Quix DR line. The system, incorporating a 17 x 17-inch detector, can be adjusted for upright, recumbent, and oblique patient exams using a single bucky.

A new automatic exposure control system is guided by software to choose sensors appropriate to a current exposure within a 20 x 20-element sensor matrix on the detector. This avoids the need to rotate the detector 90° when the system is tilted for horizontal table work.

**Fujifilm Medical Systems**
Specializing in electronic and radiographic imaging technologies, Fuji CR was highlighted.
ClearView-ES is a new cassetteless CR chest system combining a 17 x 17-inch field-of-view with Energy Subtraction processing technology. In the past, throughput took a hit when ES was performed on the CR image. The vendor¹s ES processing requires only one exposure. Artifacts or inconsistencies due to cardiac or patient movement are avoided.

**GE Medical Systems**

One of the earliest pioneers of digital radiography, GE has sought to extend flat-panel technology into all aspects of x-ray. Radiography is the cornerstone of this strategy.

The Revolution XR/d two-detector digital rad room was shown at the 2000 RSNA meeting as a work-in-progress and this year as a commercial product. Dual-energy subtraction is one advantage of the amorphous silicon detector. When imaging for lung cancer is performed, nodules are often hidden by the ribs. The dual-energy subtraction takes two images in rapid sequence: one at high energy for soft tissue and one at low energy for bone. Digital subtraction takes the ribs out of the image and increases potential cancer detection.

Image pasting was shown as a work-in-progress application. This processing technique brings different areas of interest together in a single image. Simplified acquisition protocols aid in aligning the image. A full-body view can be produced for use in analyzing scoliosis.

Precision 500D was shown as an upgrade to the vendor¹s R/F line. Using a charge-coupled device (CCD) digital imaging system rather than flat panel, the unit lowers dose, improves image quality, and streamlines workflow. The improved user interface is expected to become standard for all the vendor¹s R/F platforms. A single handle allows for control of positioning and imaging at tabletop.

FlexiView 8800 is a new surgical C-arm provided by the vendor¹s OEC operations. Based on the 1K x 1K fluoroscopic imaging technology used in the existing 9800 C-arm, this unit provides enhanced maneuverability, a smaller footprint, and lower price point for use as a second or third system, in smaller surgery centers, and in global markets.

A 3D application is being developed for surgical guidance under OEC tutelage. Stents, clips, and coils, as well as plaque, might be visualized in 3D.

**Hologic**

Once exclusively a bone densitometry firm, this vendor has grown rapidly through acquisitions and is now having to trim down and regain focus. As part of this effort, a decision was made late in 2001 to stop supplying standard radiographic equipment, largely the systems purchased with Continental and Bennett X-ray. Focus is now being put on DR, and women¹s health products.

The DirectRay DR business is starting to grow, with a backlog of some $8 million and 26 systems as of September. Amorphous selenium plates are provided to OEMs and built into the vendor¹s own DR products.

A DirectRay digital chest system for high-volume upright chest imaging became the third product in the vendor¹s digital x-ray line after the Epex and Radex general radiography DR systems.

Topography software is part of a new operating system for the DirectRay Console. Presentation of both bone and soft tissue is optimized in the same image.

**Infimed**

Retrofitting conventional systems with digital imaging chains has become a primary business at Infimed. The Stingray DR technology, fashioned around an amorphous silicon flat-panel detector supplied by Trixell, is the enabler.

Image processing and workflow improvements were made to the vendor¹s StingRay DR system, a digital retrofit package for radiographic rooms. Changes involved simplifying control, magnification features, and tabletop adjustments.

**Instrumentarium Imaging**

Although best known for mammographic products, the company also provides surgical C-arm (Ziehm) and maxillofacial (Orthopantomograph, Sigma digital sensors) products.
The Ziehm product line was revamped with new Vision and Vista mobile C-arms, offering a 1K x 1K camera. A new user interface, Vision Center, provides touchscreen functionality. Users are guided through setup and imaging procedures. Monitors can be operated from the C-arm, eliminating the need to walk back and forth to the monitor cart. A high-resolution flat-panel display is available in black and white or color. Images may be imported and exported with DICOM compatibility.

**Konica**
Films provide the base for this company, but CR technology is taking an increasingly high profile.

Regius Model 350 is a work-in-progress upgrade to the vendor’s CR line. Deliveries of the sealed phosphor-based system are anticipated in the first quarter of 2002.

A 17 x 17-inch exposure field is larger than that offered with predecessor Model 330. Both cost and cycle time have been reduced.

The Hybrid Processing Technique software package balances edge and equalization processing for optimized images. Direct Read allows for a reading of the x-ray detector as the optical fiber assembly moves.

**Lodox Industrial Development**
This start-up firm is focused on developing a new full-body CCD-based DR system for trauma applications. The system, called Lodox, was originally developed to detect diamond thieves exiting South African mines. Three prototype systems have been produced and sited, all in South Africa.

Twelve overlapping CCD cameras scan the patient. A full-body exam takes 13 seconds, producing an image in two minutes. The technology is likely to sell in the area of $250,000. Because it uses slot scanning, no grid is necessary. This reduces the dose by 20% to 25% of that in conventional x-ray.

**Orex CR Technologies**
Formerly known as Digident, the company makes “personal” CR systems for customers with budget constraints.

The compact PcCR 1417 system, unveiled at the 2000 RSNA meeting, is ready to ship. The firm received venture funding prior to the 2001 RSNA meeting that should assist in marketing and continued R&D. PcCR, a compact tabletop CR system, will sell for about $50,000. PcCR provides for automated plate loading. Cassettes are inserted in the machine, and then the phosphor plate is scanned, erased, and reinserted back in the cassette.

**Philips Medical Systems**
The company’s investment in Trixell, a joint venture with Siemens and Thales, is the foundation for its DR offerings.

Deliveries of the Digital Diagnost DR system, launched in 2000 with a Trixell flat panel, rose by about 150% in 2001. The vendor had shipped 35 units in the U.S. by the opening day of the RSNA meeting. Shipments are expected to reach 40 or more by year end.

DigitalDiagnost VR, a dedicated chest DR unit with a 17 x 17-inch detector, began deliveries in the second quarter of 2001, expanding the DR line from the single general radiographic table. Tube tracking function allows for the recentering of radiation collimation. The x-ray tube automatically tracks to where the operator is collimating, for instance at the top of the lungs. This feature was transferred from the vendor’s standard chest x-ray offering.

An image processing software package labeled Unique that uses a Harmonized Contrast technique to deliver optimum contrast over the whole image was demonstrated. This technology will be integrated into both the vendor’s CR and DR product lines in 2002.

An intelligent digital exposure control was introduced in the R/F area. IOX is an extension to the radiographic side of the vendor’s grid-controlled fluoroscopy technique, which is used to set up multiple radiographic exposures during digital dynamic studies. Within a single pulse, the x-ray exposure is reset to optimize image quality and reduce dosage. This minimizes the effects of motion and provides sharper image detail.

**Shimadzu Medical Systems**
X-ray devices provide the base for this multimodality company, whose corporate involvement in
radiography goes back more than a century.

Sonialvision, a digital remote R/F system, eliminates spot film by using the image intensifier (I.I.) to capture single images. The I.I. can be brought closer to the patient, reducing distortions. This also reduces x-ray dose to the patient.

The MH-300 vascular/cardiac C-arm provides a special design innovation that allows for a floor-mounted configuration. A pivoting elbow on the gantry provides a cantilevered effect that keeps space free for the interventionalist on either side of the table. Mounting the gantry on the floor provides additional stability to support the 60° per-second rotation for digital subtraction angiography. This industry-high speed aids in volume rendering and tracking contrast.

Siemens Medical Systems
A multinational provider of x-ray equipment, Siemens highlighted advances in x-ray angiography.

Two new C-arms with full-sized CCDs were introduced for general-purpose imaging and angiography. Axiom Artis FA is a floor-mounted angiography unit. Axiom Artis MP is the multiuse system, which can be used for angiography, R/F, and interventional work. Both systems come with a new user interface incorporating the vendor’s multimodality Syngo display and processing software.

Axiom Artis FA offers increased flexibility in positioning the C-arm. This provides better side access and peripheral coverage. Four different tables are available with FA: a regular tilt (up and down), regular and cradle tilt, plain stepping, and traditional angio. This table is used in cardiac cath applications and elsewhere.

Axiom Artis MP system has been made more compact and faster than its predecessor, increasing siting flexibility and providing an added attraction for interventional radiologists.

A new 3D processing package running on the vendor’s Leonardo workstation was demonstrated. The program includes interaction with the C-arm in its display, which allows for the determination of correct arm positioning.

SwissRay International
A major proponent of digital radiography, SwissRay focuses most advanced R&D efforts into its proprietary direct digital radiography (ddR) systems.

The vendor showed the third improvement made over the past 18 months to its digital optical detector technology. This foundation of the company’s CCD-based DR technology offers improved image quality and reduced dosage.

SwissVision software for the vendor’s technologist workstation allows for optional interface to CR and hookups to HIS/RIS, PACS, and printers. It also offers processing functions such as the ability to adjust brightness and contrast after image acquisition.

Expert 4000 is a system management and communications product that automates motorized systems in its DR products. It also serves as a portal through which the vendor can offer remote diagnostics, service, and applications support.

Toshiba America Medical Systems
The multimodality vendor is refocusing its business to accentuate in-house development, while bringing in suppliers to cover weaknesses. X-ray remains one of the strengths of the company.

A rolling tabletop was added this year to Ultimax, its all-digital multipurpose x-ray system. The table helps improve system performance in angiographic cases.

The EPS Plus workstation was upgraded to add processor speed and enough disk capacity to hold 15,000 x-ray images. Online archives with fast recall of images can boost productivity and smooth workflow.

Efficiency Plus is an upgrade to the Efficiency R/F system. Enhancements to the image intensifier help deal with S-curve distortions, providing clearer images.
The Infinix i series of vascular x-ray systems was introduced for angiography. Its Windows-based PC platform should improve commonality with other equipment and ease future software upgrades. C-arm rotation is faster at 50° per second, aiding 3D angiography reconstruction. The Infinix i system is upgradable to the vendor’s direct-conversion flat-panel detector technology currently under development.

**Varian Medical Systems**
Varian X-ray Tube Products produces high-performance tubes for a range of modalities, including CT, mammography, R/F, and special procedures. Varian Imaging Products is developing large area sensing technology (LAST) imagers based on amorphous silicon sensor panels.

A work-in-process DR system for neonatal intensive care applications was shown. The system marks a branching out of the DR plate and x-ray component supplier with turnkey systems that will be sold to OEMs. Currently under evaluation at the Medical College of South Carolina, the neonatal DR system provides an image in three to four seconds. Dosage may be reduced by 75%.

**Wuestec**
The DR vendor has initiated a per-scan DR service, including seven-year storage of images for about $3 per scan, or less than the $4 to $5 normally spent on film and chemicals per scan. The manufacturer would maintain ownership of the DR system, allowing hospital users to enter DR with no capital-cost risks.

A new series of CCD-based DR systems was introduced at the show, including the Trauma Digital system with universal stand, Dedicated Chest DR, and the DX 2000 DR retrofit package.

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