IDIS1 – Fluoroscopy Equipment
A manufacturers perspective

Changes in Fluoroscopic Imaging since the Introduction of Digital Fluoroscopy Equipment
**Application - Bandwidth**
Demands of a multipurpose fluoro room

![Diagram showing bandwidth demands for different diagnostic procedures]

**Pre - digital imaging chain**

1. X ray tube……..I.I./TV camera/TV monitor for Positioning(fluoroscopy)

2. X ray Tube exposure to Cassette(fluorography)
Digital Imaging Chain

Xray tube……I.I/TV camera/TV monitor/analog-digital conversion to Image for Processing/reporting or filming.

Pre- digital?

Cassettes
Small Image Intensifier sizes

High Film usage
Time to change cassettes between exposures
Pre - digital Impact on Radiographers

1. Radiographers with sore feet due to walking to & fro.
2. Longer patient exam times.
3. Potentially more staff required.
4. Multitasking - change exposures/change cassettes/overcouch films

Pre-digital Impact on Patients

Typically longer examinations longer time in the room/on exam table
Dose per examination?
Pre-digital impact on Radiologists

Report from film

The Manufacturers Goal

- Connectivity
- Ease of Use
- Image Quality
- Care (Reduced Exposure)
The Challenge: Optimize Care and Maximize Efficiency in the Radiology Department

- optimizing decision making in patient care
- relieving the physician from administrative tasks
- increasing the departmental effectiveness
- optimizing clinical and administrative data handling
- extending internal and external communication
- improving archiving and retrieval of pertinent patient data

Undercouch Fluoroscopy Units
Examinations without limits

Wide range of applications

- Esophagus, Larynx, Pharynx
- Gastro-intestinal tract
- Cholangiography (ERCP)
- Bronchography
- Hysterosalpingography
- Arthrography
- General Radiography
- Linear tomography

- Urology
- Myelography
- Pediatric applications:
  - Digital subtraction angiography
  - Peripheral angiography
  - Venography
  - Lymphography
  - Intervention

Innovative And Efficient – For Universal Application

- Control of entire Fluoro procedure at table side
- Use of large field I.I.
- Optimized patient and procedure management
- Integrated design for excellent image quality
**OPTIX**
- Tableside Control An Innovative and Optimized System of Operation

**OPTI-Grip**
Efficient tableside control

**OPTI-Touch**
Tableside integrated system control and selection

**OPTI-Display**
Examination parameters at a glance

Faster Fluoro procedures
Reduced overall examination time
Improved procedural and clinical management

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**Today's Digital Imaging System**

**Hardware**
- Intel ® processor min. 1.5GHz
- Minm 128 MByte RAM
- Windows NT ® operating system
- CD-R* local archive DICOM format
- 2000 image hard disk (2000 images)
- 7500 image hard disk*

**Operating Modes**
- Continuous Fluoro, 1024 x 512, 10 Bit
- Pulsed Fluoroscopy*
- Single image, 1024, 10 Bit
- Series exp 0.5,1,2,3,4,6 & 8/s
- Videoloop* (incl.256 MB RAM)
- DSA*

* option
Today’s Digital Imaging system

Data & Image processing
- Patient Directory
- RIS interface*
- Windowing (Brightness/Contrast)
- Zoom (2x) / Pan
- Magic Eye
- B&W Reversal
- Filter (Edge Enhancement)

- Image Flip (H, V)
- Electronic Shutter (H, V)
- Store Fluoro from Monitor
- Harmonisation (DDO)
- Distance measurement
- Annotation & comment line
- Graphics

Options* (with DSA)
- Remask
- Pixel shift
- Landmarking
- Peak Opacification

Remote Control Tables - Benefit from extra versatility
Examinations without limits

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Optimizing Your Valuable Time

Ergonomics designed for improved workflow

- 4-way tabletop movement for full patient coverage - no repositioning
- Ergonomically grouped functions on the remote console
- Easily accessible tableside functions, including FOV selection
Keeping the Focus on the Patient

A workplace that makes life easier for you and the patient

- Complete access to the patient from all sides of the unit, including the back
- Optimum unit position for patient transfer at the touch of a button
- Heavy and demanding workflow is never a problem with the innovative and robust design

Examinations Without Limitations

A full spectrum of exam needs are met

- Complete exam coverage, i.e., GI, GU, venography, arthrography, etc.
- Tabletop, bedside, and wall bucky exposures
- Tomography*, both digital and cassette, and any table angle
- Peripheral stepping Angio* - evaluation of vascular flow from pelvis to feet, with one series of exposures and one contrast injection

* Option
Digital Remote Control Units - Disadvantages?

- Operator may be away from the patient (behind screen)
- If operator in room, potential for higher radiation exposure from primary beam (primary scatter) due to position of x ray tube above patient.
- Potential need for additional lead protection devices in room - space and cost.
Multipurpose Systems

Universal C Arm Systems.

Multipurpose Fluoro Unit
**Multipurpose C- Arm Remote Control Fluoro Units**

- Designed as a universal unit for departments who have limited resources but varied examinations. Use of large field I.I.
- Scope of Examinations from Barium Swallow/Meal/Enema to Interventional and General Angiographic procedures.
- C- Arm provides extra versatility
- Typically variable height
- Digital Acquisition only (no cassettes)
New C-arm and Table Concept
designed for angiography and fluoroscopy

- The table design with workflow in mind
- High speed movements and user-programmable positions
- 60° LAO and 90° RAO projection
- 4-way panning tabletop
- OT and UT position of the I.I.

New C-arm and Table Concept
designed for angiography and interventions

- Projection flexibility for daily routine work as well as for special procedures
- PERISTEPPING, native stepping mode with preprogrammed settings
- PERIVISION, on-line DSA-stepping mode with preprogrammed settings
New C-arm and Table Concept extends the multipurpose system to an interventional system

- Angle triggered rotational angiography in DSA-technique
- Increased capabilities for interventions like angioplasty of carotids, renal stenosis, vertebroplasty and cerebral coiling
New C-arm and Table Concept
with the unique powergrip a perfect fluoroscopy system

- +/- 90° tilting table
- full table- and c-arm control with the powergrip
- release of fluoro and acquisition plus I.I. inputfield selection integrated in powergrip

New C-arm and Table Concept
simplified operation by preprogrammable positions

- 6 system positions for fast table preparation
- 50 user programmable positions dedicated to examinations
- stored parameters: c-arm positions, table positions plus I.I input field
Newest High-Frequency-Generator technology combined with Intelligent SDM (Selective Dominant Measurement) ensures best overall image quality.

- Choice of different field shapes, dedicated to the organ region
- Storing the most appropriate field with the organ programs ensures best results
- Sensing areas automatically adjust to zoom factor

Best visibility of finest structures with a new 1024 x 1024 matrix - 12 bit digital imaging system

- Automatic functions like Auto-Pixelshift in DSA make brilliant image quality available without additional postprocessing
- New motion detection algorithm for better noise reduction
Goals for revolutionary imaging chain

**Exceptional sharpness and resolution**

- Single shot and series acquisition with 0.5 p/s up to 30 f/s for all vascular applications
  - Abdominal
  - Peripheral
  - Neuro
  - Cardiovascular

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Advances in imaging chain

**Advanced DDO (Dynamic Densitiy Optimization)**

- Real-time on-line pre-processing algorithm
- Giving a harmonic greyscale distribution even in areas with large density differences
- Applicable to fluoroscopy and acquisition
Goals in revolutionary imaging chain – Multipurpose Unit

Convenient interventional tools

Real time overlay fade
- Variable superimposition of reference image with live fluoroscopy
- Avoids the motion artefacts normally seen using trace subtraction (roadmap)
- Perfect for abdominal and peripheral interventions
- Using reference images from previously acquired DSA runs saves contrast agent

Goals for revolutionary imaging chain

Low Dose documentation via Store Fluoro

- Store Fluoro
- Ability to keep fluoro runs for further usage
- Navigation, archival, filming just with a normal scene
- Dose saving by avoiding extra acquisition runs
- Increasing safety, decreasing dose
Dose reduction with the new Siemens fluoro systems

..... more safety for user and patient

carbon fibre grid and table top
removable grid
light beam for collimation without radiation
remote control units.
individual selectable dose rates / image
individual selectable curves for fluoroscopy
fluoroscopy dose display on the monitor
CAREFILTER - (automatic insertion of copper filtration - when required)
CAREPROFILE* - (collimation without radiation)
CAREVISION* - (Pulsed Fluoroscopy)

Pulsed Fluoroscopy with SIEMENS fluoro Systems

..... the effective solution for maximum dose reduction

<table>
<thead>
<tr>
<th>dose</th>
<th>100</th>
<th>55</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 B/s</td>
<td>0.2 mm Cu</td>
<td>7.5 B/s</td>
<td>0.2 mm Cu</td>
</tr>
<tr>
<td>continuous fluoroscopy</td>
<td>100% System dose</td>
<td>Integration for 1 image period</td>
<td>Display on the monitor</td>
</tr>
<tr>
<td>fluoroscopy with CAREVISION</td>
<td>X-Ray Pulse</td>
<td>Integration over 1 pulse width</td>
<td>Display on the monitor</td>
</tr>
</tbody>
</table>
Pulsed fluoroscopy with flexible pulsing rates

- Pulsing frequency (temporal resolution) can be adapted to the clinical needs, from 30 P/s in various steps even down to 0.5 P/s
- Flexible dose settings for each pulsing frequency, for example; keeping the dose/pulse constant halves the fluoro dose each time the pulse frequency is cut by half
- Short pulse time reduces motion artefacts on fast moving structures

CAREWATCH (Siemens)
Dose Display in the Examination Room

**Prerequisite for CAREWATCH:** DIAMENTOR*

Example:

<table>
<thead>
<tr>
<th>During Fluoroscopy:</th>
<th>Dose Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 mGy/min</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>During radiation off:</th>
<th>Cumulative Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>630 mGy</td>
<td></td>
</tr>
</tbody>
</table>

Percent of dose with reference to a maximum configurable limit

<table>
<thead>
<tr>
<th>Percent of dose</th>
<th>Accumulated Area Dose Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>31 %</td>
<td>75 cGy x cm²</td>
</tr>
</tbody>
</table>

or

<table>
<thead>
<tr>
<th>Accumulated Area Dose Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 mGy</td>
</tr>
</tbody>
</table>

* Option
**Dose Reduction**
Precise collimation without radiation

LIH-image

Control of collimator blades in LIH-image only via graphical elements without any radiation

Precise collimation for fluoroscopy and acquisition

* Option

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**Adaptive Filters**
Improves image quality with less dose

- Copper Pre-filtration (0.1; 0.2; 0.3 mm)
- Semi-transparent wedge filters for side compensation
- Semi-transparent finger filter for peripherals and carotids

11° 11° 7° 20° 20° 7°
CAREFILTER
Minimum Skin Dose through Cu-prefiltration

- Additional Cu-filters reduce the skin doses by more than 70%
- The variable filter (0.2mm - 0.9mm) is automatically set according to patient weight and angulation of the machine
- Automatic filter insertion always keeps the dose as low as possible without degrading image quality
- A visual indication of filter selection is given in the examination room but no user interaction is required

CAREPOSITION
Patient positioning without radiation

Patient positioning without any radiation by moving a virtual, graphically displayed x-ray field over the live monitor
MULTIPRINT*
Individual hardcopy layout independent of HCC

Examples of film subdivisions

Drag

* Option

The Effect on departmental workflow

Following the 5 steps for an examination or intervention in terms of clinical data management
1. Central patient registration (RIS/HIS)
2. Patient data retrieval at the multipurpose system
3. Retrieval and viewing of previous images
4. Archival of new scenes and images
5. Feed back of patient data into RIS/HIS
The Effect on departmental workflow

- 3rd step
  **Accessing previous images directly at the multipurpose system via DICOM Query/Retrieval**
  - Images can be loaded into Siemens Multipurpose fluoro unit from central archive, from Siemens 2nd Console or from other modalities
  - Display even in the examination room possible.
  ➔ *Efficient, fast diagnosis for safe interventions with multi modality display.*

- 4th step
  **Archiving of scenes and images**
  - DICOM Print
    individual layouts and easy arrangement on the virtual filmsheet.
  - DICOM CD
    the DICOM off-line media.
  - DICOM Send
    Archiving to a network or workstation.
  - DICOM Storage Commitment
    Confidence in a network environment
  ➔ *Archiving and Documentation adapted to the requirements of the hospital.*
Seamless DICOM integration, fully featured for the modern fluoro system

- Connectivity
- Ease of Use
- Image Quality
- Care

Optimized processes for efficient and cost-effective diagnosis

- Optimized workflow for fast, convenient, and cost-effective working conditions that provide a high degree of diagnostic confidence
- High cost-effectiveness with digital imaging system: no cassette handling, quick access to digital images
- Improved departmental efficiency
- UPTIME service concept and remote diagnostics for high system uptime
- Ready for the digital hospital with DICOM 3
The Next Step?

Probably Flat Plate Technology to replace the current imaging chain

Final Timescales dependent on suitable technology to match the dose efficiency required on a large FOV.

The will lead to Universal units delivering sufficient resolution - capable of all exams.

Effect of Digital Imaging on Radiographer

- Less Walking
- Role of Radiographer now extended due to efficiency of systems/ single handed operation.
- Pre-programmed protocols for Image review
- Automatic exposure parameters improve speed & no. retakes
Effect of Digital Imaging on Radiographer

- Immediate Image - positioning/exposure
- results in higher patient throughput
- with extended role, responsibilities have increased eg. Ba enema techs/ patient injections etc.
- more time with patient, radiographer can remain in the room
- Potentially less dose per exam

Effect of digital imaging on the patients

- Faster exams
- Potential for improved diagnosis
- less dose per exam
- improved patient comfort from shorter exam times
- more patients examined- shorter waiting lists
Effect of Digital Imaging for Radiologist

- Faster improved diagnosis
- Image post processing, windowing etc aids ability to diagnosis
- Potentially less dose per exam
- Images can be stored digitally in an archive for review at later date - may reduce film bill in a ‘PACS’ hospital
- Improved consistent image quality
- Soft copy reporting

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