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Agenda

• Motivation – Clinical Process Support

• Business Process Management

• Adaptive and Flexible Processes

• Mobile Process and Task Support
Motivation – Clinical Process Support

- hospitalization
- admission
- recording of services
- administration
- pre-/postoperative diagnostics
- in-patient treatment
- Operation
- intensive care
- discharge
- introduction to the anaesthetist

- Operation
Motivation – Clinical Process Support

Fundamental Goals:

- Continuity of care
- Patient-centered treatment
- Integrated care
- Process-awareness

provision of information and knowledge at the „point of care“

Urgent need for IT support:

- Frequent cause of medical errors ⇒ Missing information or knowledge
- Example: Medication errors
  - 29% due to missing patient-related information
  - 19% due to missing medical knowledge

Motivation – Clinical Process Support

Fundamental Goals:

- Continuity of care
- Patient-centered treatment
- Integrated care
- Process-awareness

provision of information and knowledge at the „point of care“

There is a discrepancy between the potential and actual usage of IT!

Committee on Quality of Healthcare in America (IoM)
Crossing the Quality Chasm: A New Health System for the 21st Century. IOM, 2001
Motivation – Clinical Process Support

Levels of Process Support

- **Organizational processes**
  - Interdisciplinary cooperation among different people and organizational units
  - Example: Order entry and result reporting

- **Knowledge-intensive processes (i.e. patient treatment processes)**
  - Guided by available patient information
  - Dependent on medical knowledge

Motivation – Clinical Process Support

Example of an Organizational Process

- Registration
  - HIS
  - patient information
  - Orders Placed

- Orders Filled
  - RIS
  - examination orders
  - Orders Filled

- Acquisition Modality
  - Acquisition completed
  - Acquisition worklist

- Image Manager & Archive
  - images stored
  - images retrieved

- Diagnostic Workstation
  - procedure scheduled
  - Prefetch any relevant prior studies

- PACS
  - images printed
  - Film Lightbox
  - Film Folder
  - Film

- Report Repository
  - report
  - report
Motivation – Clinical Process Support

Example of a Treatment Process

- **prehospital phase**
  - patient admission
  - anamnesis and clinical examination
    - clinical suspicion of proximal femoral fracture?
      - yes → imaging diagnostics
      - no → therapy depending on diagnosis / symptom
        - proximal femoral fracture & operation indicated?
          - yes → poststationary treatment
            - discharge & documentation
            - clarification of osteoporosis
            - ward / ICU and operative treatment
          - no → initial treatment (emergency area) and operation planning
        - no → therapy depending on diagnosis / symptom
      - no → therapy depending on diagnosis / symptom

- **poststationary treatment**
  - discharge & documentation
  - clarification of osteoporosis
  - ward / ICU and operative treatment
    - initial treatment (emergency area) and operation planning

IT support in routine use
Motivation – Clinical Process Support

M-Health: Mobile Process and Task Support
Motivation – Clinical Process Support

Process-aware information systems will allow for real-time process diagnostics

- Why do patients have to wait so long?
- Do doctors follow the guidelines?
- Can we predict waiting times?
- How much staff is needed tomorrow?
- How can we reduce costs?

In the end it is the (end-to-end) process that matters
Agenda

• Motivation – Clinical Process Support

• Business Process Management

• Adaptive and Flexible Processes

• Mobile Process and Task Support
Business Process Management

Business Process Management (BPM) is a discipline involving any combination of modeling, automation, execution, control, measurement, and optimization of business activity flows, in support of enterprise goals, spanning IT systems, employees, customers and partners within and beyond the enterprise boundaries.
Business Process Management: The Role of Process Models

Business Process Management: The Role of Process Models

Process Compliance

Generated counterexample:
Execution path and corresponding process context violating the constraint
Business Process Management: The Role of Process Models
Business Process Management: The Role of Process Models
Business Process Management: Process-Aware Information Systems

End User Perspective

User Worklists

Selection

Automatic Invocation of the Corresponding Application Program (incl. Provision of Input Parameters)
Business Process Management: Process-Aware Information Systems

Actor A

Admissions
Maier, Frida
Schmied, Udo
Müller, Heinz
Peters, Franz

Actor B

Scheduling
Kramer, Gerd
Marx, Fred
Müller, Inge
Peters, Franz

Actor C

Medical Orders
Weber, Heinz
Schmidt, Ingo
Kramer, Ralf
Peters, Franz

End User Perspective
Business Process Management: Process-Aware Information Systems

System Perspective

- Human Tasks & Automated Steps
- Application Service Integration
Business Process Management: Process-Aware Information Systems

Process Composer
- Create Process Schema
- Modify Process Schema
- Check Process Schema
- ...

Process Repository
- Application Services
- Process Models

Process-aware Information System (PAIS)
- Late Modeling
- Web Clnt API
- Modeling API
- Dyn. Change API
- Admin. API
- Validation
- Authorization
- Time Mgmt
- Msg Queuing
- Exceptions
- Audit Trail
- ...

Process Execution Engine
- Instance 1
- Instance 2
- Instance 3
- Instance 4
- Instance 5
- Instance 6
- Instance 7
- Instance 8
- Instance 9
- Instance 10
- Instance 11
- Instance 12
- Instance 13
- Instance 14

Process Engineer
- Users
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Enforcement:
Guardrails (on a road) prevent deviation, but also prevent anything not predicted.

Guidance:
Guidelines (on a road) show people where to go, but do not prevent deviations if they are necessary.

“Planning is helpful. If you don’t know what you want, you’ll seldom get it. But, no matter how well you plan, you will fare better if you expect the unexpected. The unexpected, by nature, comes unseen, unthought, unenvisioned. All you can do is plan to go unplanned, prepare to be unprepared, make going with the flow part of your agenda, for the most successful among us envision, plan, and prepare, but cast all aside as needed, while those who are unable to go with the flow often suffer, if they survive.”

David W. Jones
Adaptive and Flexible Processes: Flexibility Needs

Variability

Evolution

Adaptation

Looseness
Adaptive and Flexible Processes: Flexibility Needs

Traditional Process Lifecycle Support

1. Schema S
2. Create Instances
3. Process Execution
4. Execution Log
5. Process Monitoring

Need for Process Evolution
Need for Process Adaptation (Support for Planned and Unplanned Exceptions)
Need for Variability Support
Need for Looseness of Process Specifications

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Adaptive and Flexible Processes: Flexibility Needs
## Adaptive and Flexible Processes: Flexibility Needs

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<th>Flexibility Need</th>
<th>Dimension</th>
<th>Technological Requirement</th>
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Adaptive and Flexible Processes: Addressing Variability by Configurable Process Models
Adaptive and Flexible Processes: Enabling Adaptation through Ad-hoc Changes

Examinations
- U Wallace, Edgar
- U Miller, Anne
- U Smith, Karl
- U Jones, Isabelle

Exception – We need an additional lab test!
Adaptive and Flexible Processes: Enabling Adaptation through Ad-hoc Changes

The ADEPT Framework

Solution for many fundamental research issues!

Formal foundation of the ADEPT technology!
Adaptive and Flexible Processes: A Scenario Requiring Adaptation at Different Levels

- **Domain specific knowledge**
- **Clinical guidelines**
  - Require consensus among medical experts (and scientific evidence)

- **Site specific knowledge**
- **Clinical pathways**
  - Require consensus among cooperating healthcare professionals

- **Individual patient treatment plan**
  - May deviate from medical pathway

- **Actual patient treatment process**
  - May deviate from individual treatment plan
Adaptive and Flexible Processes: Evolution

"It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change."

Charles Darwin
Adaptive and Flexible Processes: Evolution

External
- Changing Business Context
- Changing Technological Context
- Changing Legal Context
- Organizational Learning

Real-world Process

represented in

Internal
- Design Errors
- Technical Problems
- Poor Internal Quality

PAIS

provide feedback to
Adaptive and Flexible Processes: Evolution

Adaptive Process-Aware Information System

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<th>Dyn. Change API</th>
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Process Engine

ADEPT Process Composer
- Create Process Template
- Modify Process Template
- Check Process Template

Repository
- Process Templates
- Application Components

Check Instance Status
- 4,377 instances can be automatically migrated
- 1,117 instances have proceeded too far
- 123 instances cannot be automatically migrated

Users

Process Designer / Process Administrator
Medical Guideline (narrative)

Formalization

Change pathway schema

Create new pathway schema

Dissemination

Disseminated medical guideline G

Site-specific Configuration

Process instantiation

Actual treatment process for patient p1

Start instance

Individual treatment plan for patient p1

Process instance adaptation

Process instances (with ad-hoc deviations)

Notify process engineer

Medical Staff

Application Example
Adaptive and Flexible Processes: Research Transfer

Adaptive and Flexible Processes: Research Transfer

Flexible Support of Clinical Pathways with AristaFlow

Partners:
Jan Neuhaus, Claudia Reuter
Fraunhoferinstitut Dortmund
Adaptive and Flexible Processes: Research Transfer

Process-aware, Cooperative Emergency Management for Water Infrastructures
Partner: TU Darmstadt

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MARPLE – Mobile Process and Task Execution (1)
MARPLE – Mobile Process and Task Execution (2)

- Process Management System controls
- Context-specific execution of mobile activities, offline mode...
- Assignment of mobile activities (protocol-based)
- Connection abortion, device error, user behavior, resources

GSM, GPRS, UMTS W-LAN

Patient treatment
MEDo – Mobile Task Definition and Execution in Ward Rounds

- Support ward rounds using smart mobile devices
  - document „on the fly“ while examining patients
  - start processes based on sensor data
  - mobile „task management“ for each user
  - connect hospital information system for additional patient data
QuestionSys – End-User Development of Mobile Questionnaires

- provide a framework to support domain experts designing electronic questionnaires for flexible data collection
- domain specific modeling notation
- process-driven approach
- collect data using smart mobile devices
- provide rules to automatically evaluate the data collected
QuestionSys – Process-Driven Mobile Data Collection
Blood Sugar Diary – Mobile Sensing

• Enable patients to fully track their blood sugar level after measurement
  • customizable wizard to guide user through the measurement process
  • connects with external sensors (via bluetooth) to collect data
  • extensible framework to integrate other sensors
  • enrich data collected with meta information
  • diagrams and pdf export functionality
TrackYourTinnitus – Mobile Crowd Sensing
AREA – Location-Based Augmented Reality

• Augmented Reality to enrich the camera view of Smartphone with different information, e.g.,
  ➢ Points of interest (POI) Tourism Apps
  ➢ Trails Tourism Apps (e.g. guiding hikers)
  ➢ Goods in a warehouse Logistics
AREA – Process-Driven Asset Tracking
AR 3D – Augmented Reality Enabled Process Model Configuration
Inhouse Navigation
Mobile Access to ERP Systems

- Example: SAP Mobile Infrastructure
Connected Health Opportunities

- 2.4GHz ISM band (Zigbee/802.15.4/BT/BLE)
- Passive non-battery operated RF/RFID
- WLAN (802.11a/b/g/n)
- GSM/GPRS
- Bluetooth®/Bluetooth low-energy (BLE)
- ANT/ANT+
- Zigbee/802.15.4
- Sub-1GHz ISM band (433MHz/868MHz/915MHz)

- Clinical patient monitoring
- Health and chronic disease management
- Vital signs monitoring
  - Blood pressure monitor
  - Smart bandage
  - Weight scale
Connected Health Opportunities
Thank you for your kind attention – Questions?