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2B: Workflow, Process Redesign and Change Management

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Clinical Informatics
Board Review Course

Clinical Informatics Subspecialty Delineation of Practice (CIS DoP)

Domain 1: Fundamental Knowledge and Skills (no Tasks are associated with this Domain which is focused on fundamental knowledge and skills)

Clinical Informatics

K001. The discipline of informatics (e.g., definitions, history, careers, professional organizations)
K002. Fundamental informatics concepts, models, and theories
K003. Core clinical informatics literature (e.g., foundational literature, principle journals, critical analysis of literature, use of evidence to inform practice)
K004. Descriptive and inferential statistics
K005. Health Information Technology (HIT) principles and science
K006. Computer programming fundamentals and computational thinking
K007. Basic systems and network architectures
K008. Basic database structure, data retrieval and analytics techniques and tools
K009. Development and use of interoperability/exchange standards (e.g., Fast Health Interoperability Resources [FHIR], Digital Imaging and Communications in Medicine [DICOM])
K010. Development and use of transaction standards (e.g., American National Standards Institute X12)
K011. Development and use of messaging standards (e.g., Health Level Seven [HL7] v2)
K012. Development and use of ancillary data standards (e.g., imaging and Laboratory Information System[LIS])
K013. Development and use of data model standards
K014. Vocabularies, terminologies, and nomenclatures (e.g., Logical Observation Identifiers Names and Codes [LOINC], Systematized Nomenclature of Medicine --Clinical Terms [SNOMED-CT], RxNorm, International Classification Of Diseases[ICD], Current Procedural Terminology [CPT])
K015. Data taxonomies and ontologies
K016. Security, privacy, and confidentiality requirements and practices
K017. Legal and regulatory issues related to clinical data and information sharing
K018. Technical and non-technical approaches and barriers to interoperability
K019. Ethics and professionalism

The Health System

K020. Primary domains of health, organizational structures, cultures, and processes (e.g., health care delivery, public health, personal health, population health, education of health professionals, clinical research)
K021. Determinants of individual and population health
K022. Forces shaping health care delivery and considerations regarding health care access
K023. Health economics and financing
K024. Policy and regulatory frameworks related to the healthcare system
K025. The flow of data, information, and knowledge within the health system

Domain 2: Improving Care Delivery and Outcomes

K026. Decision science (e.g., Bayes theorem, decision analysis, probability theory, utility and preference assessment, test characteristics)
K027. Clinical decision support standards and processes for development, implementation, evaluation, and maintenance
K028. Five Rights of clinical decision support (i.e., information, person, intervention formats, channel, and point/time in workflow)
K029. Legal, regulatory, and ethical issues regarding clinical decision support
K030. Methods of workflow analysis
K031. Principles of workflow re-engineering
K032. Quality improvement principles and practices (e.g., Six Sigma, Lean, Plan-Do-Study-Act [PDSA] cycle, root cause analysis)
K033. User-centered design principles (e.g., iterative design process)
K034. Usability testing
K035. Definitions of measures (e.g., quality performance, regulatory, pay for performance, public health surveillance)
K036. Measure development and evaluation processes and criteria
K037. Key performance indicators (KPIs)
K038. Claims analytics and benchmarks
K039. Predictive analytic techniques, indications, and limitations
K040. Clinical and financial benchmarking sources (e.g., Gartner, Healthcare Information and Management Systems Society [HIMSS] Analytics, Centers for Medicare and Medicaid Services [CMS], Leapfrog)
K041. Quality standards and measures promulgated by quality organizations (e.g., National Quality Forum [NQF], Centers for Medicare and Medicaid Services [CMS], National Committee for Quality Assurance [NCQA])
K042. Facility accreditation quality and safety standards (e.g., The Joint Commission, Clinical Laboratory Improvement Amendments [CLIA])
K043. Clinical quality standards (e.g., Physician Quality Reporting System [PQRS], Agency for Healthcare Research and Quality [AHRQ], National Surgical Quality Improvement Program [NSQIP], Quality Reporting Document Architecture [QRDA], Health Quality Measure Format [HQMF], Council on Quality and Leadership [CQL], Fast Health Interoperability Resources [FHIR] Clinical Reasoning)
K044. Reporting requirements
K045. Methods to measure and report organizational performance
K046. Adoption metrics (e.g., Electronic Medical Records Adoption Model [EMRAM], Adoption Model for Analytics Maturity [AMAM])
K047. Social determinants of health
K048. Use of patient-generated data
K049. Prediction models
K050. Risk stratification and adjustment
K051. Concepts and tools for care coordination
K052. Care delivery and payment models

Domain 3: Enterprise Information Systems

K053. Health information technology landscape (e.g., innovation strategies, emerging technologies)
K054. Institutional governance of clinical information systems
K055. Information system maintenance requirements
K056. Information needs analysis and information system selection
K057. Information system implementation procedures
K058. Information system evaluation techniques and methods
K059. Information system and integration testing techniques and methodologies
K060. Enterprise architecture (databases, storage, application, interface engine)
K061. Methods of communication between various software components
K062. Network communications infrastructure and protocols between information systems (e.g., Transmission Control Protocol/Internet Protocol [TCP/IP], switches, routers)
K063. Types of settings (e.g., labs, ambulatory, radiology, home) where various systems are used
K064. Clinical system functional requirements
K065. Models and theories of human-computer (machine) interaction (HCI)
K066. HCI evaluation, usability engineering and testing, study design and methods
K067. HCI design standards and design principles
K068. Functionalities of clinical information systems (e.g., Electronic Health Records [EHR], Laboratory Information System [LIS], Picture Archiving and Communication System [PACS], Radiology Information System [RIS] vendor-neutral archive, pharmacy, revenue cycle)
K069. Consumer-facing health informatics applications (e.g., patient portals, mobile health apps and devices, disease management, patient education, behavior modification)
K070. User types and roles, institutional policy and access control
K071. Clinical communication channels and best practices for use (e.g., secure messaging, closed loop communication)
K072. Security threat assessment methods and mitigation strategies
K073. Security standards and safeguards
K074. Clinical impact of scheduled and unscheduled system downtimes
K075. Information system failure modes and downtime mitigation strategies (e.g., replicated data centers, log shipping)
K076. Approaches to knowledge repositories and their implementation and maintenance
K077. Data storage options and their implications
K078. Clinical registries
K079. Health information exchanges
K080. Patient matching strategies
K081. Master patient index
K082. Data reconciliation
K083. Regulated medical devices (e.g., pumps, telemetry monitors) that may be integrated into information systems
K084. Non-regulated medical devices (e.g., consumer devices)
K085. Telehealth workflows and resources (e.g., software, hardware, staff)

Domain 4: Data Governance and Data Analytics

K086. Stewardship of data
K087. Regulations, organizations, and best practice related to data access and sharing agreements, data use, privacy, security, and portability
K088. Metadata and data dictionaries
K089. Data life cycle
K090. Transactional and reporting/research databases
K091. Techniques for the storage of disparate data types
K092. Techniques to extract, transform, and load data
K093. Data associated with workflow processes and clinical context
K094. Data management and validation techniques
K095. Standards related to storage and retrieval from specialized and emerging data sources
K096. Types and uses of specialized and emerging data sources (e.g., imaging, bioinformatics, internet of things (IoT), patient-generated, social determinants)
K097. Issues related to integrating emerging data sources into business and clinical decision making
K098. Information architecture
K099. Query tools and techniques
K100. Flat files, relational and non-relational/NoSQL database structures, distributed file systems
K101. Definitions and appropriate use of descriptive, diagnostic, predictive, and prescriptive analytics
K102. Analytic tools and techniques (e.g., Boolean, Bayesian, statistical/mathematical modeling)
K103. Advanced modeling and algorithms
K104. Artificial intelligence
K105. Machine learning (e.g., neural networks, support vector machines, Bayesian network)
K106. Data visualization (e.g., graphical, geospatial, 3D modeling, dashboards, heat maps)
K107. Natural language processing
K108. Precision medicine (customized treatment plans based on patient-specific data)
K109. Knowledge management and archiving science
K110. Methods for knowledge persistence and sharing
K111. Methods and standards for data sharing across systems (e.g., health information exchanges, public health reporting)

Domain 5: Leadership and Professionalism

K112. Environmental scanning and assessment methods and techniques
K113. Consensus building, collaboration, and conflict management
K114. Business plan development for informatics projects and activities (e.g., return on investment, business case analysis, pro forma projections)
K115. Basic revenue cycle
K116. Basic managerial/cost accounting principles and concepts
K117. Capital and operating budgeting
K118. Strategy formulation and evaluation
K119. Approaches to establishing Health Information Technology (HIT) mission and objectives
K120. Communication strategies, including one-on-one, presentation to groups, and asynchronous communication
K121. Effective communication programs to support and sustain systems implementation
K122. Writing effectively for various audiences and goals
K123. Negotiation strategies, methods, and techniques
K124. Conflict management strategies, methods, and techniques
K125. Change management principles, models, and methods
K126. Assessment of organizational culture and behavior change theories
K127. Theory and methods for promoting the adoption and effective use of clinical information systems
K128. Motivational strategies, methods, and techniques
K129. Basic principles and practices of project management
K130. Project management tools and techniques
K131. Leadership principles, models, and methods
K132. Intergenerational communication techniques
K133. Coaching, mentoring, championing and cheerleading methods
K134. Adult learning theories, methods, and techniques
K135. Teaching modalities for individuals and groups
K136. Methods to assess the effectiveness of training and competency development
K137. Principles, models, and methods for building and managing effective interdisciplinary teams
K138. Team productivity and effectiveness (e.g., articulating team goals, defining rules of operation, clarifying individual roles, team management, identifying and addressing challenges)
K139. Group management processes (e.g., nominal group, consensus mapping, Delphi method)

Knowledge Statements from the DoP

K030. Methods of workflow analysis
K031. Principles of workflow re-engineering
K125. Change management principles, models, and methods
K126. Assessment of organizational culture and behavior change theories
K127. Theory and methods for promoting the adoption and effective use of clinical information systems

K030. Methods of workflow analysis

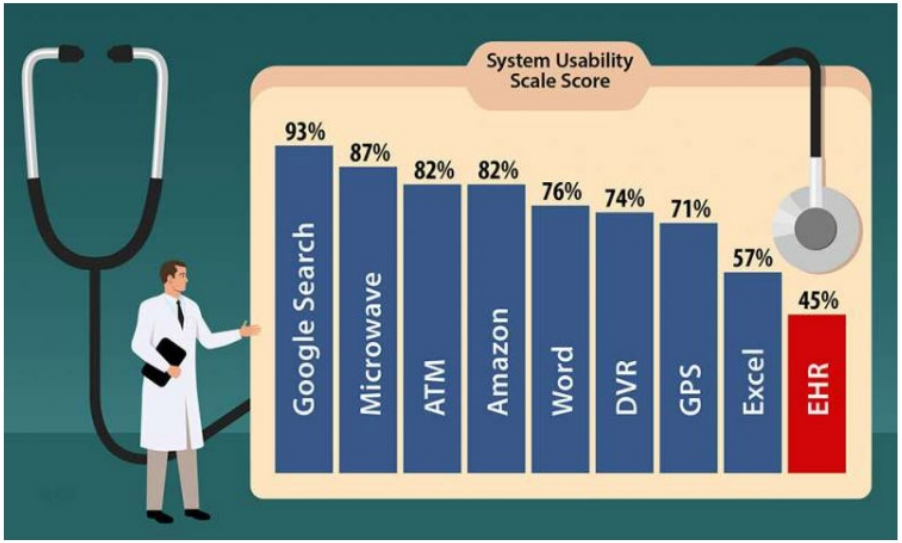
Definitions

Concept	Definition
Workflow	A process during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules [Sheehan 2012]
Workflow analysis	Study of the way documents, information and people related to a process move through an organization, in order to improve efficiency [Graban 2016]
Process Redesign **(a.k.a. Workflow Re-engineering)**	Examination and redesign of existing processes and workflows and putting them into action

Workflow

Study: Doctors give electronic health records an 'F'

by Brita Belli, Yale University



https://medicalxpress.com/news/2019-11-doctors-electronic-health.html

ORIGINAL ARTICLE | VOLUME 95, ISSUE 3, P476-487, MARCH 01, 2020

The Association Between Perceived Electronic Health Record Usability and Professional Burnout Among US Physicians

Edward R. Melnick, MD, MHS • Liselotte N. Dyrbye, MD, MHPE • Christine A. Sinsky, MD • ... Laurence Nedelec, PhD • Michael A. Tutty, PhD • Tait Shanafelt, MD • Show all authors

Open Access • Published: November 14, 2019 • DOI: https://doi.org/10.1016/j.mayocp.2019.09.024 •

https://www.mayoclinicproceedings.org/article/S0025-6196(19)30836-5/fulltext

Workflow

- Includes mental and physical tasks
- Occurs at three levels
  - Inter-organizational
  - Intra-organizational, interpersonal
  - Individually (intra-personal)
- Steps may occur sequentially or simultaneously [Sheehan 2012]
- Includes the movement of
  - People and their actions
  - Information
  - Objects
- Through space and time [AHRQ]

Workflow Analysis

- Study of an **existing** workflow
- Need to capture all aspects of workflow
  - People and their actions
  - Information
  - Objects
- Reduces complex process into individual components
- Creates visual representation of flow of people, information and objects
- Used to detect defects and waste
- May be high-level to very detailed
- Important to capture variations in addition to expected normal workflow

Lean is covered in a different lecture

Workflow Analysis: Data Collection

- How people interact with existing technology and their roles
- Temporal dependencies
- Existing system triggers for activity
- Conditional workflows
- Creative workarounds incentivized by gaps in functionality

- **Quantitative**
  - Collected via operational systems
  - Collected via detached human observer (e.g., counting events)
- **Qualitative**
  - Capture details of everyday work practices
  - Ethnographic Observation, including participant observation
    - Attends to meaning, goals, context
    - Attends to how people communicate

Workflow Analysis: Data Collection

Methods

- Ethnographic observation
- Interviews
- Structured observation
- Recording
- Focus groups
- Simulation
- Modeling
- Usability methods
- Diary
- Expert panel
- Participant observation
- Discourse Analysis
- Artifact collection
- Surveys
- Software extraction

Uses

- Quantitative and/or qualitative
- Open-ended vs. highly structured
- Workflow observers must check for interobserver reproducibility [Lopetegni et al 2015]
- **Hawthorne effect**: people perform differently when they know they are being watched
  - May lessen when observers are less visible (observe via camera; ethics)

Workflow Analysis: Data Collection

Grounded Theory

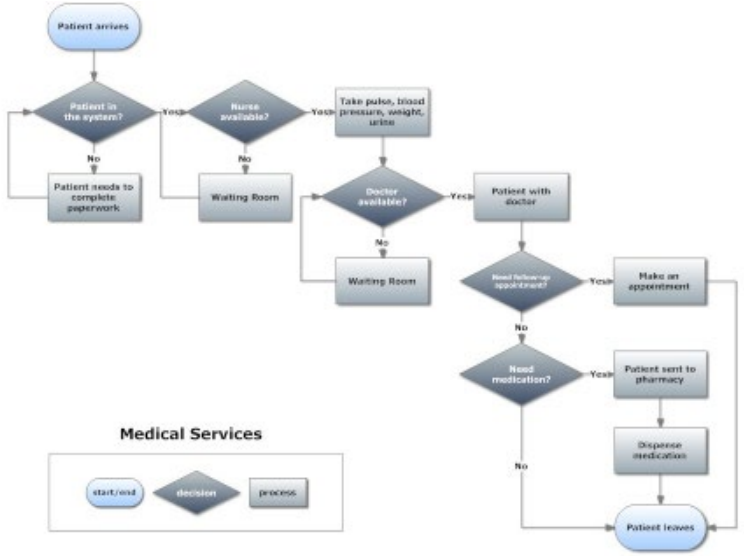
- Ethnographic method
- **Inductive analysis**
  - Opposite of deductive analysis; studies detailed data first *before* arriving at a hypothesis/theory
- Analysis occurs *in parallel* with data collection
- Break data down into much smaller components and code them
  - **Codes** are combined/related to **categories** (or concepts)
- Very helpful in uncovering hidden triggers or cultural taboos in workflows

Usability Testing

- **Usability** incorporates five attributes that must be evaluated on the information system
  1. **Learnability** – how easy is it to learn?
  2. **Efficiency** – can it make an experienced user very efficient?
  3. **Memorability** – how easily can users remember how to use it?
  4. **Errors** – are these minimized? Are they easily detected?
  5. **Satisfaction** – are users happy with it?

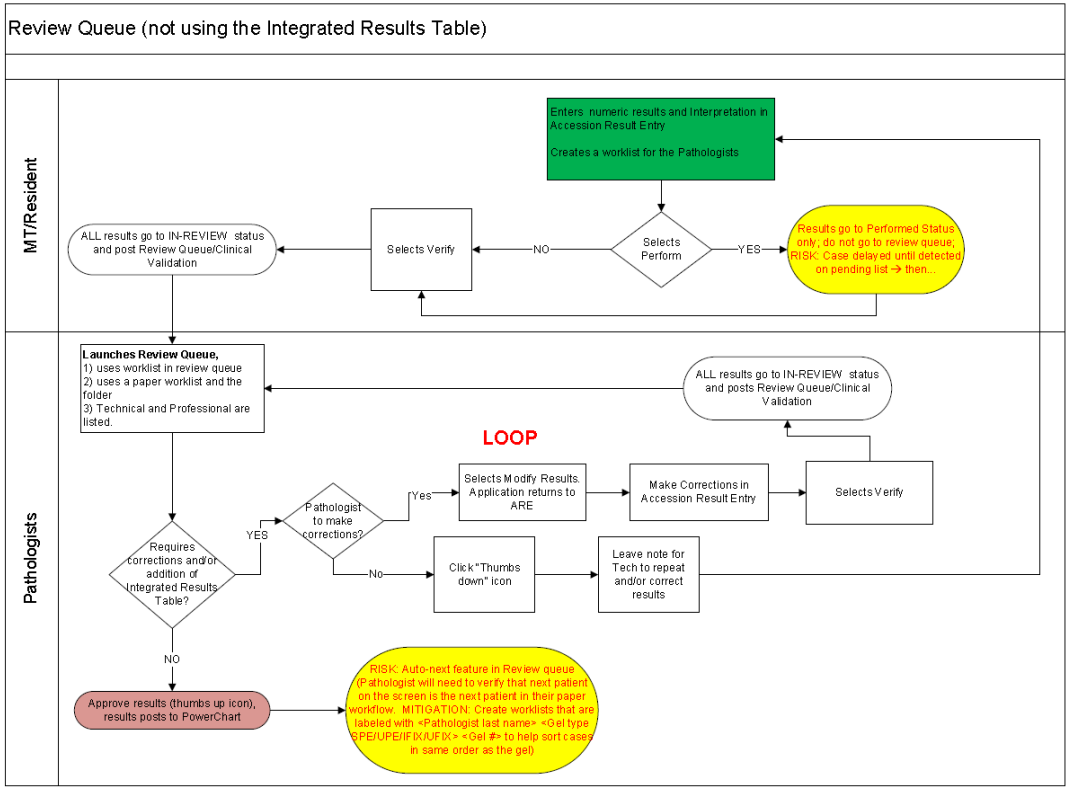
Workflow Analysis Tools

- **Simple flowchart**
  - Also known as a **process map**
  - Good at representing actions and decisions through time
  - Well-suited to high-level workflow analyses
  - Less good at detailed workflow analysis where specific people (roles) and their actions/decisions need to be shown

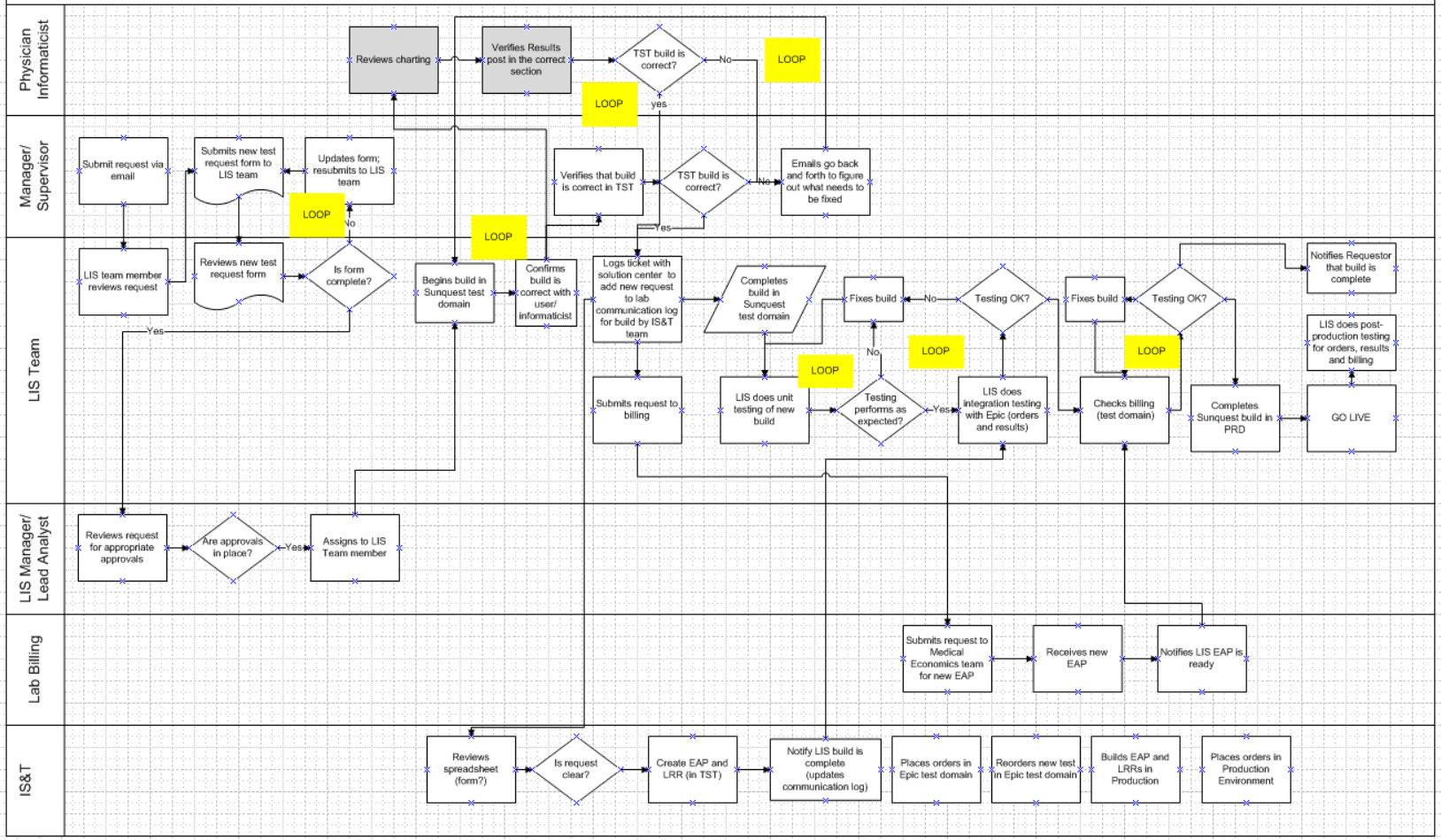


Workflow Analysis Tools

- **Swimlane Flowchart**
  - Uses swimlanes to represent the various functions of each person's role in a workflow
  - Great tool for picking up redundancies and inefficiencies



New Test Request Process – Current state



Question

A swimlane flowchart differs from a simple flowchart in that it:

A. Focuses on the value stream
B. Is a physical map of movements of people in the workflow
C. Visually represents the actions taken by various roles
D. Maps out the steps in the process

Answer

A swimlane flowchart differs from a simple flowchart in that it:

A. Focuses on the value stream
B. Is a physical map of movements of people in the workflow
C. Visually represents the actions taken by various roles
D. Maps out the steps in the process

A swim lane flowchart visually represents the actions taken by various roles, and it is the roles that are represented by swim lanes. Both swim lane flowcharts and simple flow charts map out the steps in the process. A value stream map focuses on the value stream, while a spaghetti diagram is a physical map of movements of people in the workflow.

K031. Principles of workflow re-engineering

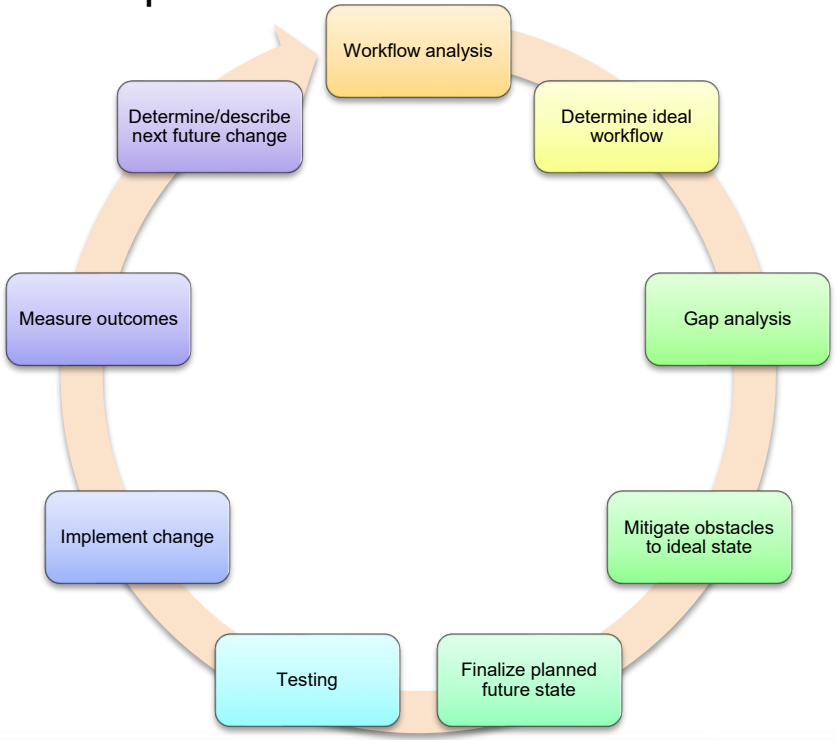
Workflow re-engineering

- Also known as **process redesign**
- Examination and redesign of existing processes and workflows and putting them into action
- Fundamental component of
  - Continuous Quality Improvement (CQI)
  - Total Quality Management (TQM)
  - Process Improvement

- Models
  - Lean
  - Six Sigma
  - ISO
  - Baldrige
  - VA-TAMMCS
  - others

Workflow re-engineering

- Steps common to all methods

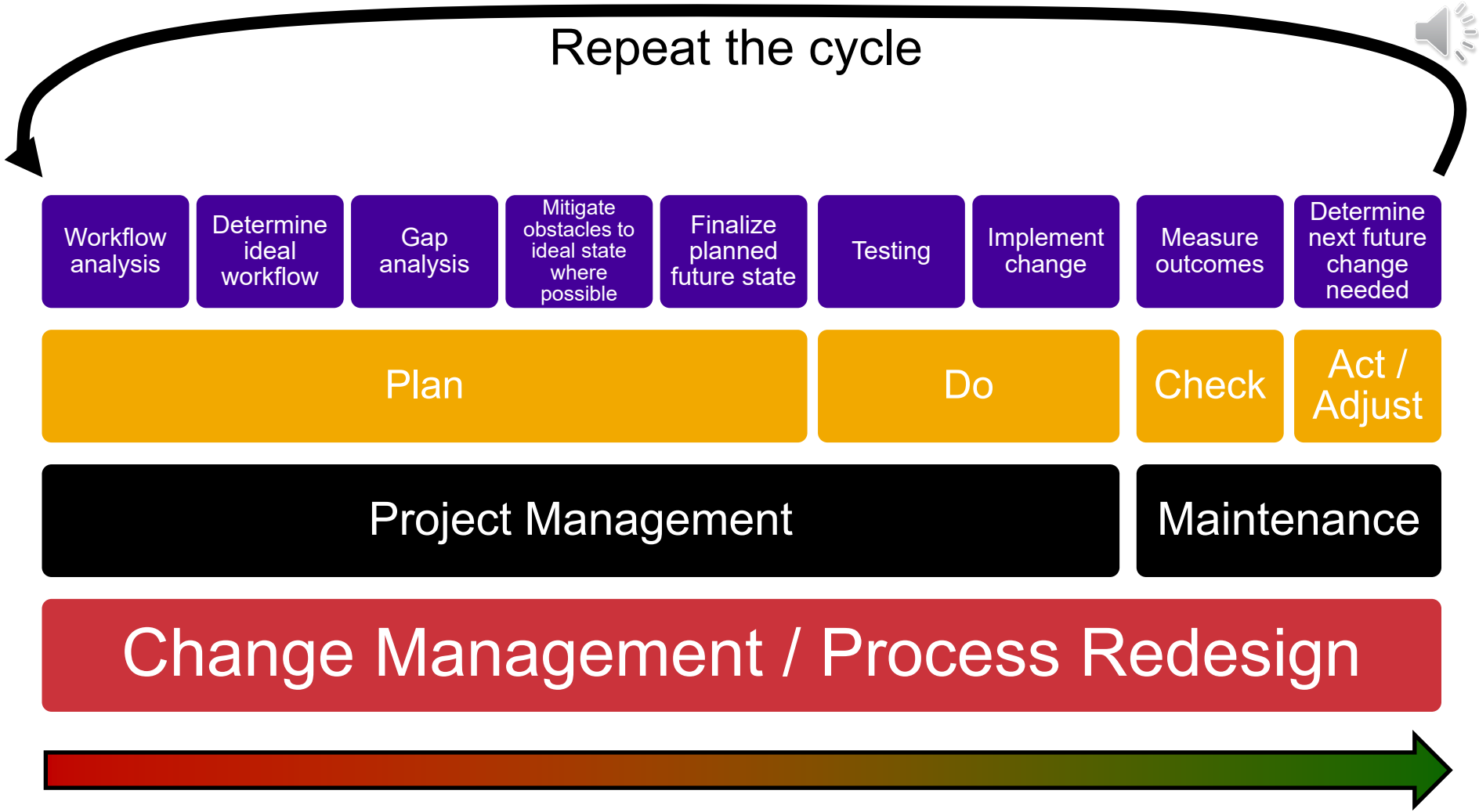


- Determine ideal workflow
  - Should be based on evidence and best practice
  - Ideal may not always be practical or feasible
- Gap analysis
  - Identify gaps between current state and your ideal future state
  - Evaluate how to close the gaps
    - Are there obstacles/barriers to the ideal future state?
  - Action plans to mitigate obstacles, where possible (not all can be resolved)
  - Use of published tools is helpful [AHRQ]

Planning the next change [Milstein 2016]

- **Logic model**
  - Picture of how the next change is supposed to work (before workflow analysis or other steps have occurred)
  - A.k.a. theory of change, road map
  - Components

Purpose (mission)	Context	Inputs	Activities	Outputs	Effects • Short term • Mid-term • Long term


Repeat the cycle
Workflow analysis
Determine ideal workflow
Gap analysis
Mitigate obstacles to ideal state where possible
Finalize planned future state
Testing
Implement change
Measure outcomes
Determine next future change needed
Plan
Do
Check
Act / Adjust
Project Management
Maintenance
Change Management / Process Redesign

Reasons Why Workflow Re-engineering Can Fail

- Failure to undergo all steps of process redesign
  - Failure to map current workflow
- Lack of sustained leadership support
- Misaligned incentives
- Lack of communication
- Inadequate people, time or money
- Poor usability of system
- Inadequate training
- Underestimation of complexity
- Lack of robust measurement and data feedback systems
- Cultural resistance to change or hostility toward information systems
- **Inadequate or no use of Change Management strategies**

[Hagg 2008; Lorenzi 2000]

K125. Change management principles, models, and methods

Change Management

- Definition
  - Approach to transitioning individuals, teams and organizations to a desired future state
- Successful process redesign *requires* the use of change management

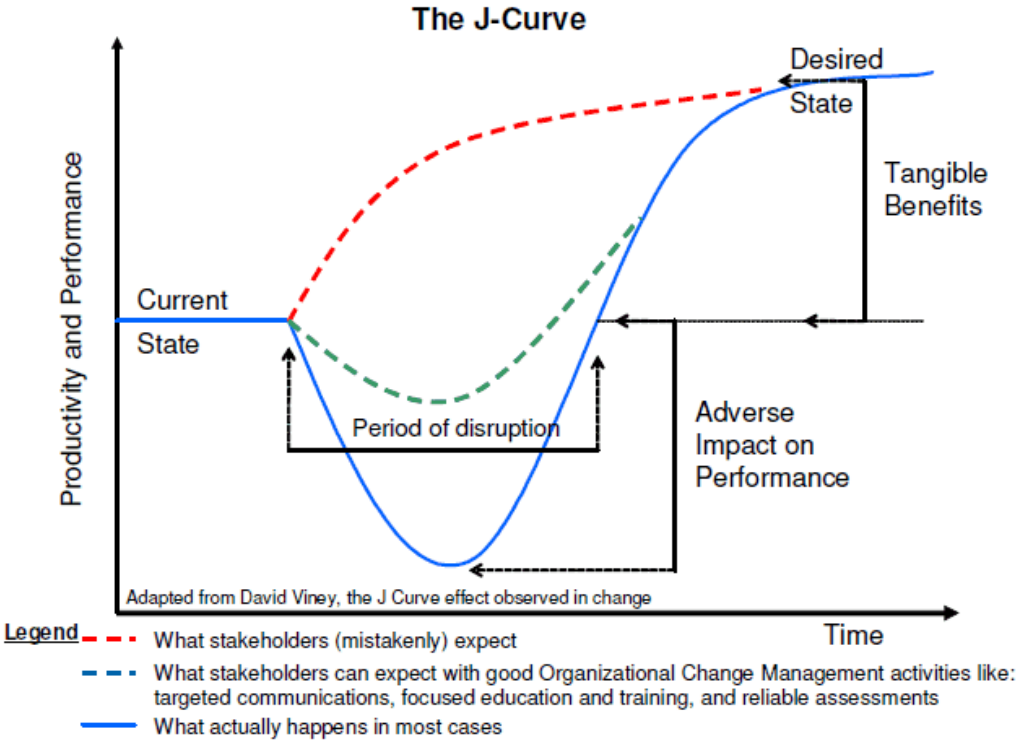
K126. Assessment of organizational culture and behavior change theories

Assessing Readiness for Change

- Change is more rapid now than ever before
  - Can increase level of resistance, especially if system already stressed
- Some organizational cultures embrace information technology more than others
- Change is possible in **any** organization
  - Resistance requires more use of change management strategies
- Lack of engagement → failure
- Change theories focus on **people**

- Change managers must assess:
  - the level of organizational stress
  - the amount of resources available (human, financial)
    - Existing resource constraints
  - the degree to which organizational leadership embraces change
  - Recent organizational change history
    - Leadership
    - Affected end-users
    - What decisions did people make when problems arose?
  - Conflicting organizational priorities

Expectation vs. Reality



https://www.interfacett.com/blogs/pmp-beyond-self-actualization-leading-change-part-1/

Change Theories

- **PRECEDE-PROCEED** [Community ToolBox 2016]
  - Typically used in community and public health settings for **health improvement initiatives**
    - Getting patients (or the general public) to **change** in order to improve their health
  - Advantages
    - Planning process is very prescriptive; unlikely to leave things or people out
    - Uses a ranking system to facilitate determinants for change at the individual (patient), provider and system levels
  - Philips JL et al; 2012

Change Theories

PRECEDE-PROCEED

- Predisposing, Reinforcing, and Enabling Constructs in Educational/Environmental Diagnosis and Evaluation
- Diagnostic phase (5 subphases)
  1. Social Assessment
  2. Epidemiological Assessment
  3. Behavioral and Environmental Assessment
  4. Educational and Ecological Assessment
  5. Administrative and Policy Assessment

PRECEDE-PROCEED

- Policy, Regulatory, and Organizational Constructs in Educational and Environmental Development
- Evaluation phase (4 subphases)
  1. Implementation of the intervention
  2. Process evaluation (Is workflow moving as expected?)
  3. Impact evaluation (Change has the expected impact?)
  4. Outcome evaluation
  5. Does the planned outcome = actual outcome?

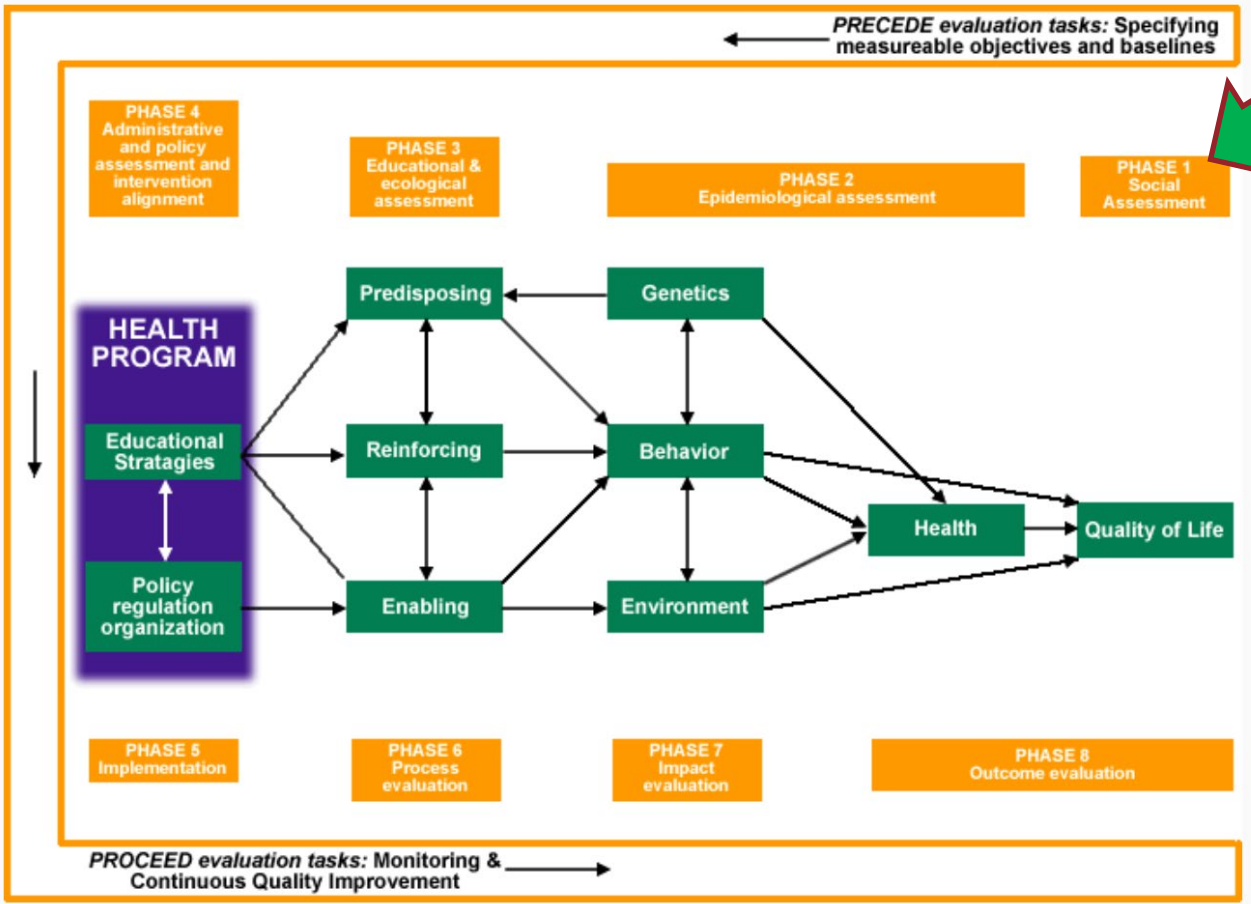


FIGURE 1. GENERIC REPRESENTATION OF THE PRECEDE-PROCEED MODEL. FROM L. GREEN AND M. KREUTER. (2005). HEALTH PROMOTION PLANNING: AN EDUCATIONAL AND ECOLOGICAL APPROACH (4 TH ED.). MOUNTAIN VIEW , CA : MAYFIELD PUBLISHERS.

PRECEDE-PROCEED

https://ctb.ku.edu/en/table-contents/overview/other-models-promoting-community-health-and-development/preceder-proceder/main

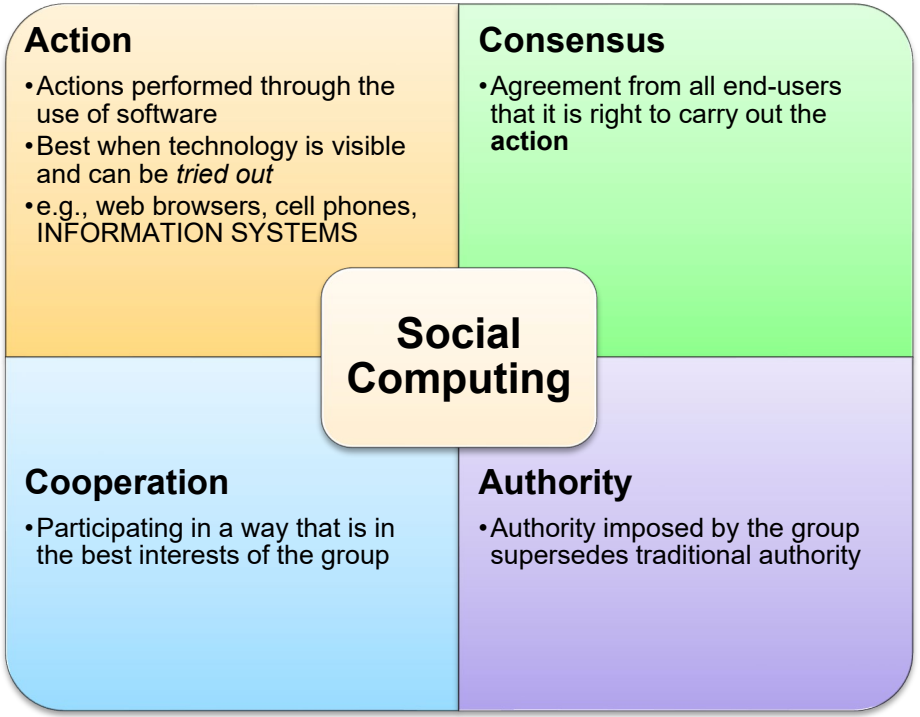
Change Theories

- **Social Influence Definitions** [Straker 2016]

Term	Definition
Social influence	change in behavior that one person causes in another, intentionally or unintentionally, as a result of the way the changed person perceives themselves in relationship to the influencer, other people and society in general
Conformity	changing how you behave to be more like others
Compliance	where a person does something that they are asked to do by another; decision to comply may be influenced by thoughts of social reward or punishment; person believes that he/she has a choice
Obedience	obeying an order from someone that you accept as an authority figure; person believes that he/she does **not** have a choice

Change Theories

- **Social Influence Model of Technology Adoption** [Vannoy 2010]
  - Conformance to subjective norms play a central role in technology adoption
    - In other words: an individual ***often acts, not as an individual, but as a member of a group with whom he/she identifies***
  - Social influence is at the confluence of 4 social computing phenomena
  - Requires leadership, vision
  - Group (community) >> individual



Change Theories

Social Influence Model of Technology Adoption - Examples

Product	Barriers	How Social Influence used overcome barriers
Apple	Very low percentage of market in 1980s and 1990s	Users of Apple devices are hip, cool, mobile → huge adoption increase over Microsoft
Twitter	In 2008, only **5%** of US public aware of platform; limited perceived utility/purpose; cryptic @ and # → low adoption (1%)	Constant marketing "how/why to use Twitter" & "get news fast"

Year	% people in US aware of Twitter	% people in US using Twitter
2008	5%	1%
2011	92%	<no data>
2014	<no data>	27.8%
2017	~100%	33.2%
2021	~100%	21%

https://www.statista.com/statistics/265647/share-of-us-internet-users-who-use-twitter-by-age-group/
https://www.statista.com/statistics/183466/share-of-adult-us-population-on-twitter/

Change Theories

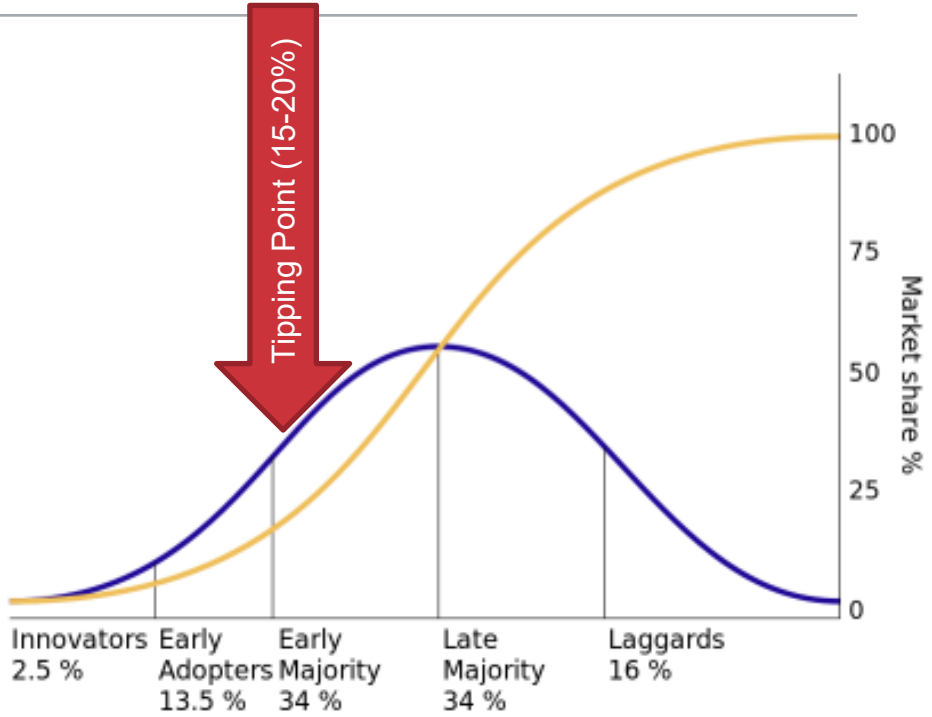
- **Complex Adaptive Systems** [Rouse 2008; Diment 2009]
  - Complexity Theory; Systems Theory
  - Individuals are to organizations as organisms are to ecosystems
    - Individuals/organisms coexist and depend on each other for system survival
  - Characteristics
    - Nonlinear, dynamic, unpredictable
    - Composed of independent intelligent agents
    - Goals and behaviors of a single person/organism often ***conflict***
    - Adaptation and learning → **self-organization**
    - No single point of control
  - E.g., healthcare, internet, embryo

Change Theories

- **Complex Adaptive Systems**
  [Rowe 2005]
  - Analyzes complex relationships between components of a system
  - Often tries to apply mathematics to systems
  - Ease of access to information will improve performance of the complex adaptive system
  - Incentives are essential to productivity and wellness
    - More likely to be intrinsic than extrinsic (see section 4A on motivation)
  - Focuses on *creating the conditions* that foster adoption of change iteratively
  - Helpful most when in the planning phase of a change; also helpful at early implementation
  - Prepares for unpredictable behavior and fosters adaptations to it

Change Theories

- **Diffusion of Innovation Theory**
  [Hagg 2008]
  - Innovation = change
  - Five most influential characteristics of innovations for affected end-users
    1. Perceived benefit of change
    2. Observability of the innovation
    3. Compatibility of the change with current organizational culture and personal beliefs
    4. Level of simplicity of the innovation
    5. Trialability of the innovation (can you test it?)



Adapted from Wikipedia. https://en.wikipedia.org/wiki/Diffusion_of_innovations

Change Theories

Kübler-Ross Grief Cycle

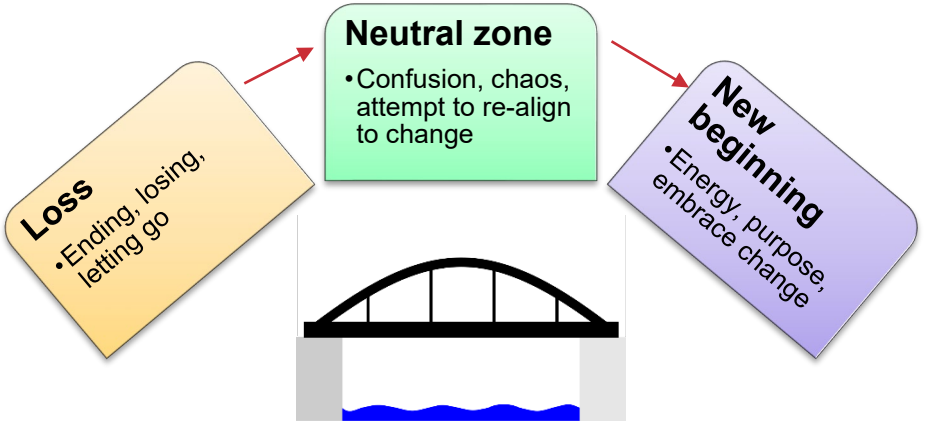
- For some end-users, letting go of old workflows may cause significant grief
- Grief expressed in the following sequence ("dabda")
  1. Denial
  2. Anger
  3. Bargaining
  4. Depression
  5. Acceptance

Lewin's Change Theory

- Kurt Lewin, 1930s
- Unfreeze
  - Prepare for change, overcome inertia and resistance
- Change
  - Uncomfortable confusion and transition
- Re-freeze
  - Post-change circumstances crystallize; increasing comfort with outcome

Change Theories

- **Bridges' Transition Theory**
  - "Managing Transitions" by William Bridges, PhD (1991)
  - Psychological transitions of people are more difficult than the technology change itself
    - Think 80-20 rule (80% people; 20% technology)
    - Informatics is 80% sociology (Homer Warner, MD, PhD)
  - Three phases of change



K127. Theory and methods for promoting the adoption and effective use of clinical information systems

Change Management Strategies for Systems

Diagnose Resistance

- Four most common reasons
  - Parochial self-interest
  - Misunderstanding and lack of trust
  - Different assessments of perceived benefit
  - Low tolerance for change

Deal with Resistance

- Education and communication
- Participation and involvement
- Facilitation and support
- Negotiation and agreement
- Manipulation
  - **Co-optation**
    - Form of manipulation
    - Giving a key role in change design or implementation
- Explicit and implicit coercion

Choose Strategy

- Fast vs. slow implementation
- Factors affecting decision depend on data from organizational culture/behavior assessment
  - Amount and type of expected resistance
  - Power and political capital of initiators vs. resisters
  - The amount of energy needed to implement
  - Stakes (consequences of not making change)

Kotter and Schlesinger [Kotter 2008]

Change Management Strategies for Systems

Phase 1: Creating a Climate for Change	• Establish Sense of Urgency • Build a Coalition (team to lead/guide change) • Create a vision for the Future State
Phase 2: Engaging & Enabling the Organization	• Communicate Future State • Empower others→action toward Future State • Plan for and create short-term wins
Phase 3: Implementing and Sustaining the Changes	• Focus: problems, solutions, behavior change • Training, retraining, technical assistance • Celebrate Successes

Change Management in EHR Implementation Primer. Health Information Technology Research Center, for National Learning Consortium. Version 1.0. April 13, 2013. Pages 2-3. Available online http://www.healthit.gov/sites/default/files/tools/nlc_changemanagementprimer.pdf

Change Management Strategies for Systems

- Kruse et al 2016 systematic review (Kruse 2016)
  - Percent of studies citing barriers and facilitators to adoption are listed below

Barriers to Adoption	
Cost	17%
Time consuming	6%
Perceived lack of utility	6%
Transition of data	6%
Facility characteristics (e.g., small)	6%
Implementation issues	5%
User/patient resistance	5%
Lack of technical experience/help	5%

Facilitators to Adoption	
Efficiency	12%
Organization size (e.g., large)	9%
Improved quality	9%
Access to patient care	7%
Perceived utility	6%
Ability to transfer information	6%
Incentives	5%
Error reduction	4%

Change Management Strategies for Systems

- Qualis Health experience in primary care settings [Hummel 2012]
- Six barriers to effective implementation (adoption)

Barrier	Mitigation Strategy
Leadership	Engagement, clear communication, dedicated time
Workflow	Standardize BEFORE implementation, allocate time for process redesign, appropriate assignment of data entry responsibilities
Provider	Champions, engagement, reduce waste, avoid errors
Training	Allocate enough people and time, realistic scenarios
Data Interface	Must have full lab interface, scan/migrate only what is needed
User Interface	Use templates/favorites/order sets for faster entry, testing is critical, prioritize fixes after go-live

> The first rule of any technology used in a business is that automation applied to an efficient operation will magnify the efficiency. The second is that automation applied to an inefficient operation will magnify the inefficiency.
>
> - Bill Gates

Question

The terms early adopters and laggards are most commonly associated with which Change Management Theory?

A. Diffusion of Innovations
B. Transition Theory
C. Social Influence
D. Kubler-Ross Grief Cycle

Answer

The terms early adopters and laggards are most commonly associated with which Change Management Theory?

A. Diffusion of Innovations

B. Transition Theory

C. Social Influence

D. Kubler-Ross Grief Cycle

The terms “early adopters” and “laggards” are most commonly associated with Everett Rogers’s Diffusion of Innovations theory which describes people within a social system as falling into one of 5 categories with respect to adoption of innovations: Innovators, Early adopters, Early Majority, Late Majority, and Laggards.

Question

Which of the following are among Kotter and Schlesinger's change management strategies to deal with resistance?

A. Innovation, Communication channels, Time, Social system
B. Manipulation and Co-optation
C. Unfreeze, Change, Re-freeze
D. Compliance, Identification, Internalization, Conformity

Question

Which of the following are among Kotter and Schlesinger's change management strategies to deal with resistance?

A. Innovation, Communication channels, Time, Social system

B. Manipulation and Co-optation

C. Unfreeze, Change, Re-freeze

D. Compliance, Identification, Internalization, Conformity

Kotter and Schlesinger describe six ways of dealing with resistance: Education and communication, Participation and involvement, Facilitation and support, Negotiation and agreement, Manipulation and Co-optation, and Explicit and implicit coercion.

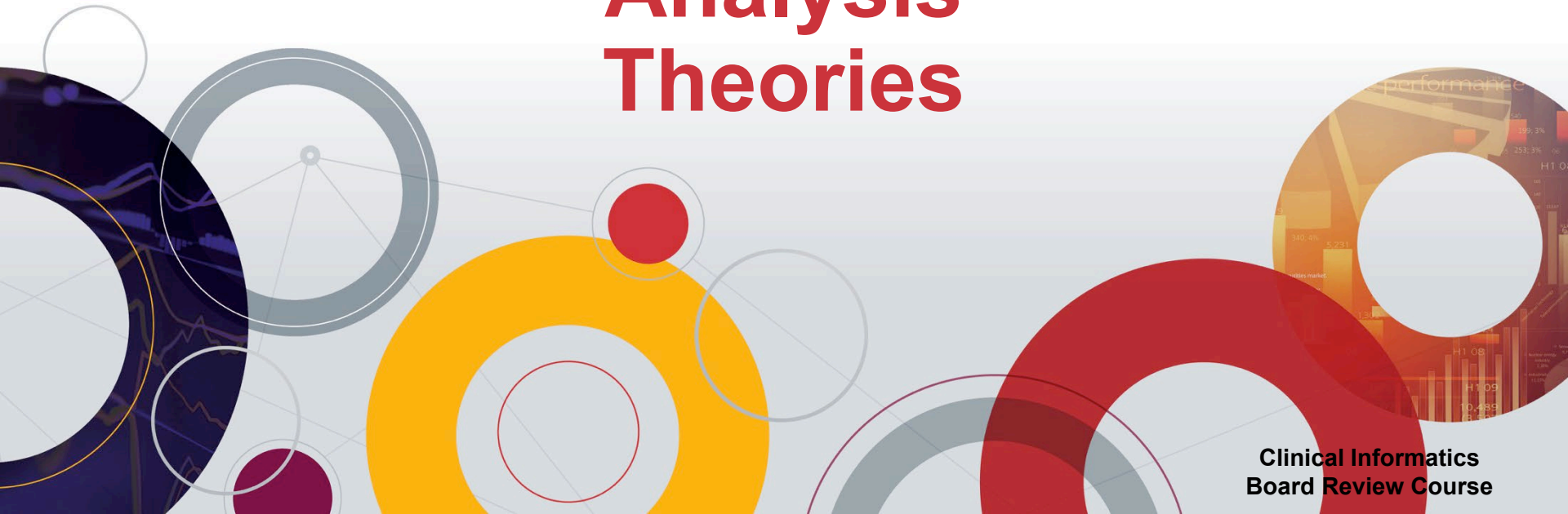
Key Readings

- Sheehan B, Bakken S. Approaches to workflow analysis in healthcare settings. NI 2012 (2012). 2012;2012:371. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3799136/pdf/amia_2012_ni_371.pdf
- Graban M. Lean Healthcare and Lean Design. 2011; http://www.slideshare.net/mgraban/lean-healthcare-lean-design. Accessed July 8, 2016.
- Hagg HW, Workman-Germann J, Flanagan M, et al. Implementation of Systems Redesign: Approaches to Spread and Sustain Adoption. In: Henriksen K, Battles JB, Keyes MA, Grady ML, eds. Advances in Patient Safety: New Directions and Alternative Approaches (Vol. 2: Culture and Redesign). Rockville (MD)2008. https://www.ncbi.nlm.nih.gov/books/NBK43727/
- Lorenzi NM, Riley RT. Managing change: an overview. J Am Med Inform Assoc. 2000;7(2):116-124. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC61464/
- Kruse CS, Kothman K, Anerobi K, Abanaka L. Adoption Factors of the Electronic Health Record: A Systematic Review. JMIR Med Inform. 2016;4(2):e19. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4909978/

That’s a wrap!

Supplemental Material

Workflow Analysis Theories



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Workflow Analysis Theories and Strategies

Computer science-based approaches

- Petri-nets
- Contextual Design

Computer-Supported Cooperative Work (CSCW)

- Activity Theory
- Coordination Theory

Cognitive Science

- Cognitive Task Analysis
- Distributed Cognition and UFuRT

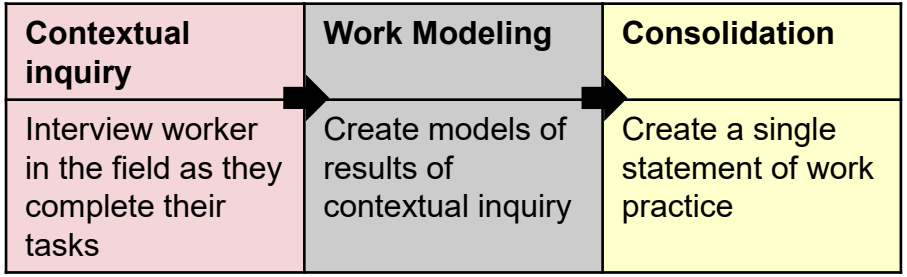
Organizational Science

Computer Science-Based Approaches

- **Petri-nets** [Sheehan 2012]
  - Electronic capture of workflow where it touches the information system
  - Requires system use data and a workflow management system to understand workflow
  - Limited detection of interpersonal or non-system related elements of workflow
  - Example: **Process mining**
    - Uses system log file data to construct event-based depictions of processes using an information system

Computer Science-Based Approaches

- **Contextual Design** [Sheehan 2012]
  - Provides framework and techniques for *software designers* to understand primarily the human elements of workflow
  - Useful for organizational as well as individual workflow



Goal of Contextual Inquiry: Uncover 4 aspects of work

1. Motive behind tasks
2. Patterns used in carrying out tasks
3. Structure that enables task completion
4. Conceptual distinctions between aspects of work

Computer-Supported Cooperative Work (CSCW)

- Goal: to understand the activities of *groups* engaged in collaborative work activities for the purposes of software design [Sheehan 2012]

Activity Theory

- Humans engage in purposeful activities which are goal-directed and context-specific
- Useful for individual as well as group workflow

Coordination Theory

- Task-interdependencies among workers result in harmonious goal-achievement
- Useful for group workflow analysis but *not* for individual workflow analysis

Activity Theory [Kaptelinin 2020]

- **Activity** is the interaction of an **actor** with the world (**objects**)
  - Performed with intention
  - Desire to achieve predetermined goal
- **Activity theory** studies these interactions with focus on the actors' purpose and desired outcomes
  - Computers may be **mediating artifacts** instead of objects (i.e., humans interact with objects through computers)

Activity Theory

- **Activity Analysis and Development Framework (ActAD)** [Korpela et al 2002, Mursu et al 2004]
  - Designed for information system development
  - Goal → focus software developers on elements which contribute to desired outcomes
  - **Work activity**
    - **Entire** workflow with multiple elements that fit together to produce **outcome**
  - **Mode of operation**
    - Systemic nature of activity and relative fit between elements
  - **Misfit**
    - Contradictions between elements

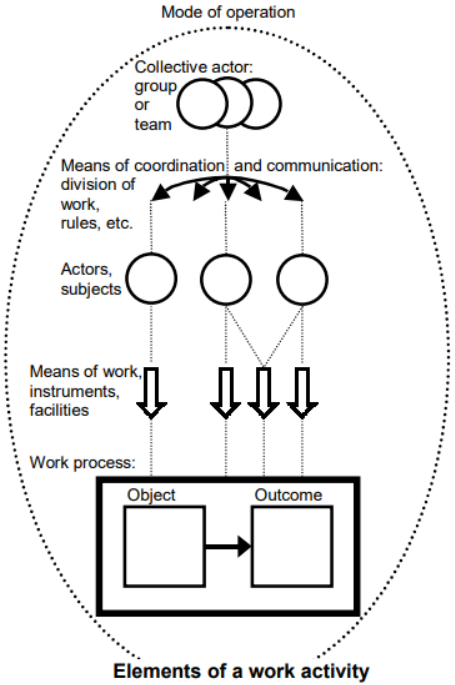


Figure 1: Collective work activity as a systemic entity.

https://www.ics.uci.edu/~redmiles/activity/revised-submissions/korpela.pdf

Activity Theory [Kaptelinin 2020]

Activity Checklists

- Researchers create checklists to be answered by activity actors
- Designed to uncover…
  - What the actor is doing
  - Why they are doing it (desired outcome)
  - Determination of fit (or misfit)
- Checklists are intended to be **activity-specific**

Checklist Item Categories

Means/ends	Focuses on hierarchical structure of activities
Environment	Context of activities
Learning, cognition, articulation	Internal cognitive components related to activities External actions related to activities
Development	Anticipate changes to actions related to use of the new technology

Coordination Theory

- Task-interdependencies among workers result in harmonious goal-achievement
- Uncovering task interdependencies can result in identifying new ways to manage them
- Focus on
  - Pre-requisite tasks
  - Tasks which require shared resources
  - Tasks that require synchronization

- Examines four processes underlying coordination and their components
  1. Coordination
  2. Group decision-making
  3. Communication
  4. Perception of common objects
- May involve tagging an object to map out process followed where it is used (**tracer method**)

Cognitive Science

- Multidisciplinary field
- Concentrates on understanding human thought processes
- Includes knowledge attainment, memory and problem solving
- Patel et al in Shortliffe, 2014; Sheehan 2012

- **Cognitive Task Analysis (CTA)**
  - Group of methods to examine *individual* human tasks
  - **Cognitive walkthrough (CW)**
  - **Think-aloud protocol (TA)**
- **Distributed Cognition**
  - **UFuRT**

Cognitive Task Analysis (CTA)

Cognitive walkthrough (CW)

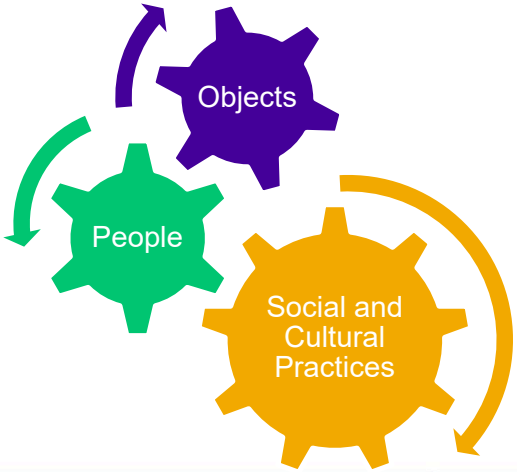
- Performed by a systems *analyst*
- Is a form of workflow *inspection*
- May be performed in the presence of system users (who verify the cognitive walkthrough by the analyst)
- Simulates a user's cognitive processes as they engage in tasks

Think-aloud protocol (TA)

- Performed by a system *user*
- Is a form of workflow *testing*
- The user verbalizes thought processes as tasks are carried out
- Analyst records the verbalization into a visual representation of the user's mental model

Distributed Cognition

- Studies the collaborative nature of human cognition
- People and objects constantly interact within a framework of social and cultural practices



- **UFuRT** (Zhang 2009)
  - **U**ser, **Fu**nctional, **R**epresentational and **T**ask Analysis
  - Can be used for workflow analysis at all levels
  - Four phases
    1. Distributed user analysis
    2. Distributed functional analysis
    3. Distributed task analysis
    4. Distributed representational analysis

Organizational Science

- Aims to clarify internal organizational structures to influence change and direct process re-design
- Two components of organizational routines
  - **Ostensive aspect**: general pattern of the routine
  - **Performative aspect**: specific actions performed by individual people within specific contexts
- **Artifacts**: physical manifestations of the routine

Question

Petri-nets are distinct from other types of workflow analysis because they…

A. Require the use of process mining
B. Require the use of software to capture data
C. Are better than other approaches at detecting interpersonal and non-system related elements of workflow
D. Are a computer science-based approach

Answer

Petri-nets are distinct from other types of workflow analysis because they…

A. Require the use of process mining

B. Require the use of software to capture data

C. Are better than other approaches at detecting interpersonal and non-system related elements of workflow

D. Are a computer science-based approach

Petri-nets are computer science-based approach which requires system use data and a workflow management system (software) to understand workflow. There is limited detection of interpersonal or nonsystem related elements of workflow. While process mining can be used as part of this approach, it is not required. Other computer science-based approaches also exist (e.g., contextual design).

Question

Which workflow analysis approach is specifically designed for software designers to understand the individual human's actions in the workflow for which they are trying to design software?

A. Petri-nets
B. Computer-Supported Cooperative Work
C. Lean technology
D. Contextual design

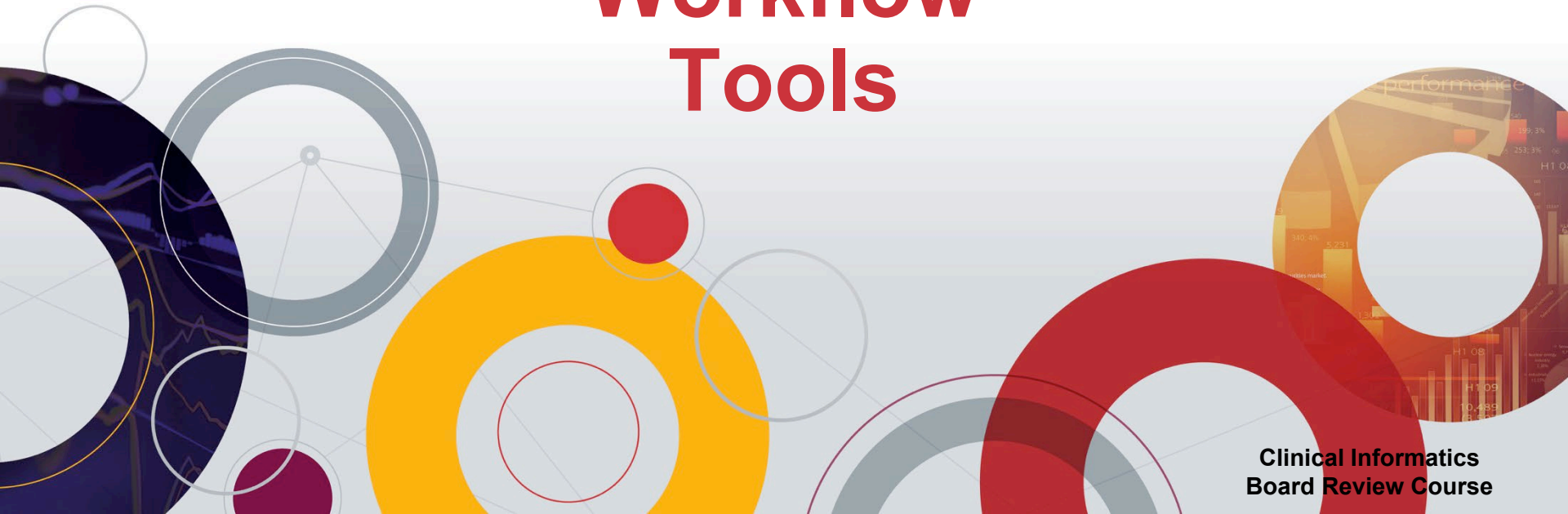
Question

Which workflow analysis approach is specifically designed for software designers to understand the individual human's actions in the workflow for which they are trying to design software?

A. Petri-nets
B. Computer-Supported Cooperative Work
C. Lean technology
D. Contextual design

Petri-nets are more focused on capturing data from the system that is being used rather than human actions within a specific context. Computer-Supported Cooperative Work (CSCW) has the primary goal of understanding activities of groups engaged in collaborative work for the purposes of software design. While activity theory (a component of CSCW) can be used for individuals, neither it nor Lean technology are specifically designed for that purpose.

Lean Workflow Tools



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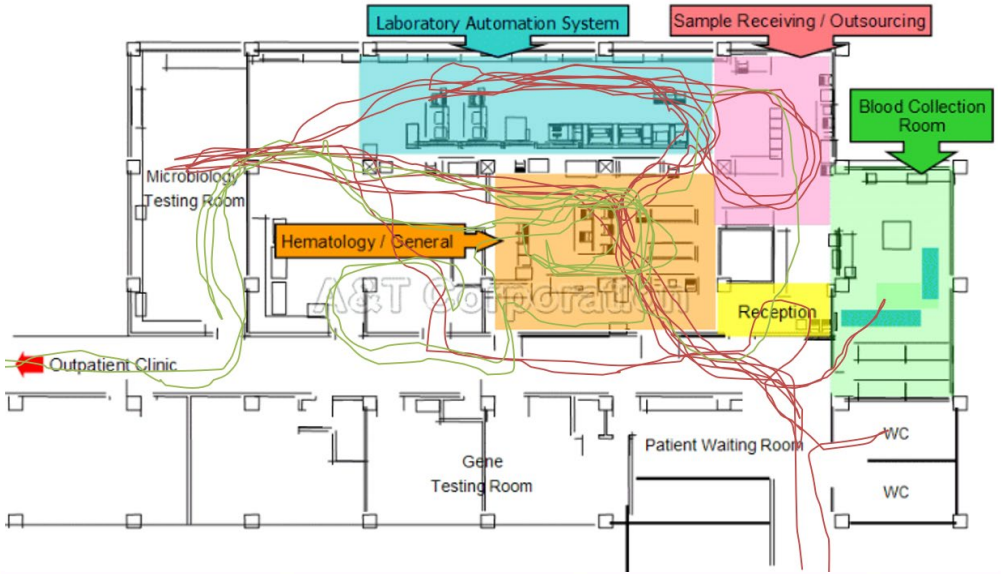
Lean Workflow Tools

- **Spaghetti diagrams**
  - Physical map of movements of people in the workflow
  - Walking = waste
  - Poorly configured information systems create a lot of waste

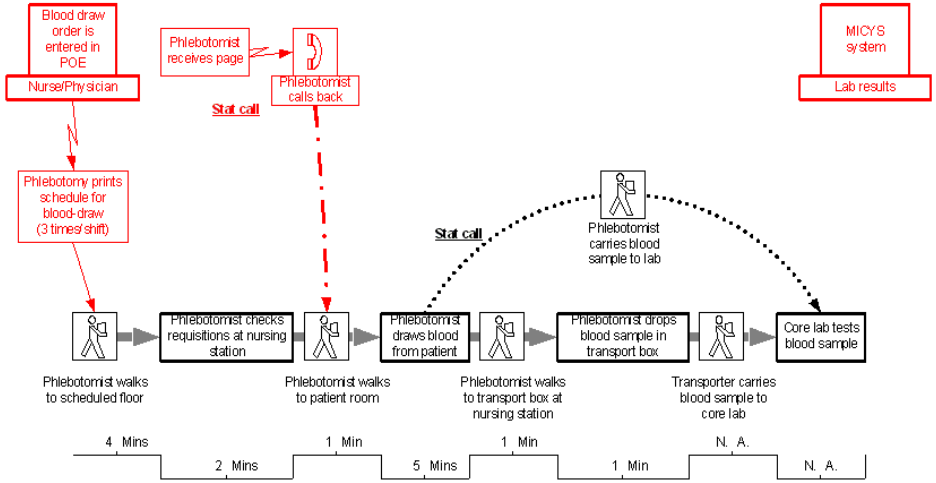


Lean Workflow Tools

Value Stream Analysis

- Document all steps required to complete a service from beginning to end
  - Include both steps with and without value
  - Document time between steps
  - Creates a **value stream map (VSM)**

Value Stream Map



http://archive.ahrq.gov/professionals/quality-patient-safety/patient-safety-resources/resources/toolkit/tkfig6.html

Pre-Reading Material (5)

1. Hagg HW, Workman-Germann J, Flanagan M, et al. Implementation of Systems Redesign: Approaches to Spread and Sustain Adoption. In: Henriksen K, Battles JB, Keyes MA, Grady ML, eds. *Advances in Patient Safety: New Directions and Alternative Approaches (Vol. 2: Culture and Redesign).* Rockville (MD)2008. https://www.ncbi.nlm.nih.gov/pubmed/21249910.
2. Kruse CS, Kothman K, Anerobi K, Abanaka L. Adoption Factors of the Electronic Health Record: A Systematic Review. *JMIR Med Inform.* 2016;4(2):e19. https://www.ncbi.nlm.nih.gov/pubmed/27251559.
3. Lorenzi NM, Riley RT. Managing change: an overview. *J Am Med Inform Assoc.* 2000;7(2):116-124. https://www.ncbi.nlm.nih.gov/pubmed/10730594.
4. Sheehan B, Bakken S. Approaches to workflow analysis in healthcare settings. *NI 2012 (2012).* 2012;2012:371. https://www.ncbi.nlm.nih.gov/pubmed/24199123.
5. Stanley D. Raising a Well-Supported Workflow. 2016; https://www.youtube.com/watch?v=dAXXl4SHOrs. Accessed August 18, 2021.

Change Management (free resources) (17)

1. Chapter 2. Section 2. PRECEDE/PROCEED. In. *Community Tool Box*: The University of Kansas; 2021. https://ctb.ku.edu/en/table-contents/overview/other-models-promoting-community-health-and-development/preceder-proceder/main.
2. Diffusion of innovations. *Wikipedia* 2021; https://en.wikipedia.org/wiki/Diffusion_of_innovations. Accessed August 18, 2021.
3. Social Influence. *Changing Minds* 2021; http://changingminds.org/explanations/theories/social_influence.htm. Accessed August 18, 2021.
4. Diment K, Yu P, Garrety KH. Complex adaptive systems as a model for evaluating organisational change caused by the introduction of health information systems. Paper presented at: Health Informatics Conference2009; Canberra, Australia. https://scholars.uow.edu.au/display/publication31058.
5. Fullmer S. PMP - Beyond Self Actualization: Leading Change - Part 1. *Interface: Technical training. Nothing but.* 2012; https://www.interfacett.com/blogs/pmp-beyond-self-actualization-leading-change-part-1/. Accessed August 18, 2021.
6. Health Information Technology Research Center (HITRC). Change Management in EHR Implementation. Version 1.0. 2013; https://www.healthit.gov/sites/default/files/tools/nlc_changemanagementprimer.pdf. Accessed August 18, 2021.
7. Hummel J, Evans P. EHR Implementation with Minimal Practice Disruption in Primary Care Settings: The Experience of the Washington & Idaho Regional Extension Center. *HealthIT.gov* 2012; https://www.healthit.gov/sites/default/files/ehr_implementation_white_paper.pdf. Accessed August 18, 2021.
8. Kotter JP, Schlesinger LA. Choosing Strategies for Change. *Harvard Business Review.* 2008(July-August 2008). https://hbr.org/2008/07/choosing-strategies-for-change.
9. Kruse CS, Goswamy R, Raval Y, Marawi S. Challenges and Opportunities of Big Data in Health Care: A Systematic Review. *JMIR Med Inform.* 2016;4(4):e38. https://www.ncbi.nlm.nih.gov/pubmed/27872036.
10. Kruse CS, Kothman K, Anerobi K, Abanaka L. Adoption Factors of the Electronic Health Record: A Systematic Review. *JMIR Med Inform.* 2016;4(2):e19. https://www.ncbi.nlm.nih.gov/pubmed/27251559.
11. Lorenzi NM, Riley RT. Managing change: an overview. *J Am Med Inform Assoc.* 2000;7(2):116-124. https://www.ncbi.nlm.nih.gov/pubmed/10730594.
12. Meyer C. The Convergence of Information, Biology, and Business: Creating an Adaptive Health Care System. *The Bridge: Linking Engineering and Society.* 2008;38(1):26-32. https://www.nae.edu/File.aspx?id=7417.
13. Phillips JL, Rolley JX, Davidson PM. Developing Targeted Health Service Interventions Using the PRECEDE-PROCEED Model: Two Australian Case Studies. *Nurs Res Pract.* 2012;2012:279431. https://www.ncbi.nlm.nih.gov/pubmed/22852076.

14. Rouse WB. Health Care as a Complex Adaptive System: Implications for Design and Management. *The Bridge: Linking Engineering and Society.* 2008;38(1):17-25. https://www.nae.edu/File.aspx?id=7417.
15. Rowe A, Hogarth A. Use of complex adaptive systems metaphor to achieve professional and organizational change. *J Adv Nurs.* 2005;51(4):396-405. https://www.ncbi.nlm.nih.gov/pubmed/16086808.
16. Torda P, Han ES, Scholle SH. Easing the adoption and use of electronic health records in small practices. *Health Aff (Millwood).* 2010;29(4):668-675. https://www.ncbi.nlm.nih.gov/pubmed/20368597.
17. Vannoy SA, Parshant P. The social influence model of technology adoption. *Communications of the ACM.* 2010;53(6):149-153. https://dl.acm.org/doi/10.1145/1743546.1743585.

Change Management (not free) (1)

1. Vogel LH. Management of Information in Healthcare Organizations. In: Shortliffe EH, Cimino JJ, eds. *Biomedical Informatics: Computer Applications in Health Care and Biomedicine.* 4th ed. London, UK: Springer-Verlag; 2014:473-474.

Complex Adaptive Systems (free resources) (4)

1. Diment K, Yu P, Garrety KH. Complex adaptive systems as a model for evaluating organisational change caused by the introduction of health information systems. Paper presented at: Health Informatics Conference2009; Canberra, Australia. https://scholars.uow.edu.au/display/publication31058.
2. Meyer C. The Convergence of Information, Biology, and Business: Creating an Adaptive Health Care System. *The Bridge: Linking Engineering and Society.* 2008;38(1):26-32. https://www.nae.edu/File.aspx?id=7417.
3. Rouse WB. Health Care as a Complex Adaptive System: Implications for Design and Management. *The Bridge: Linking Engineering and Society.* 2008;38(1):17-25. https://www.nae.edu/File.aspx?id=7417.
4. Rowe A, Hogarth A. Use of complex adaptive systems metaphor to achieve professional and organizational change. *J Adv Nurs.* 2005;51(4):396-405. https://www.ncbi.nlm.nih.gov/pubmed/16086808.

Lean-Six Sigma (free resources) (2)

1. Agency for Healthcare Research and Quality. Figure 6. Sample Value Stream Map: Phlebotomy: A Toolkit for Redesign in Health Care: Final Report. Publication # 05-0108-EF 2005; https://archive.ahrq.gov/professionals/quality-patient-safety/patient-safety-resources/resources/toolkit/tkfig6.html. Accessed August 18, 2021.
2. Graban M. Lean Healthcare and Lean Design. *Slideshare: A Scribd Company* 2011; https://www.slideshare.net/mgraban/lean-healthcare-lean-design. Accessed August 24, 2021.

Logic Model (free resources)(1)

1. Milstein B, Chapel T. Chapter 2. Section 1. Developing a Logic Model or Theory of Change. In. *Community Tool Box*: The University of Kansas; 2021. https://ctb.ku.edu/en/table-of-contents/overview/models-for-community-health-and-development/logic-model-development/main.

PRECEDE-PROCEED (free resources) (2)

1. Chapter 2. Section 2. PRECEDE/PROCEED. In. *Community Tool Box*: The University of Kansas; 2021. https://ctb.ku.edu/en/table-contents/overview/other-models-promoting-community-health-and-development/preceder-proceder/main.
2. Phillips JL, Rolley JX, Davidson PM. Developing Targeted Health Service Interventions Using the PRECEDE-PROCEED Model: Two Australian Case Studies. *Nurs Res Pract.* 2012;2012:279431.

https://www.ncbi.nlm.nih.gov/pubmed/22852076.

Social Influence Model (free resources) (1)

1. Vannoy SA, Parshant P. The social influence model of technology adoption. *Communications of the ACM.* 2010;53(6):149-153. https://dl.acm.org/doi/10.1145/1743546.1743585.

Usability (free resources) (2)

1. Belli B. Study: Doctors give electronic health records an 'F'. *MedicalXpress* 2019; https://medicalxpress.com/news/2019-11-doctors-electronic-health.html. Accessed August 18, 2021.
2. Melnick ER, Dyrbye LN, Sinsky CA, Nedelec L, Tutty MA, Shanafelt T. The Association Between Perceived Electronic Health Record Usability and Professional Burnout Among US Physicians. *Mayo Clinic Proc.* 2019;95(3):P476-487. https://www.mayoclinicproceedings.org/article/S0025-6196(19)30836-5/fulltext.

Workflow Analysis (free resources) (11)

1. What is workflow? *AHRQ Digital Healthcare Research: Informing Improvement in Care Quality, Safety, and Efficiency* 2021; https://digital.ahrq.gov/health-it-tools-and-resources/evaluation-resources/workflow-assessment-health-it-toolkit/workflow. Accessed August 18, 2021.
2. Agency for Healthcare Research and Quality. Figure 6. Sample Value Stream Map: Phlebotomy: A Toolkit for Redesign in Health Care: Final Report. Publication # 05-0108-EF 2005; https://archive.ahrq.gov/professionals/quality-patient-safety/patient-safety-resources/resources/toolkit/tkfig6.html. Accessed August 18, 2021.
3. LA Net Community Health Resource Network. Module 5 Appendix: A Guide on Workflow Mapping. *Practice Facilitation Handbook* 2013; https://www.ahrq.gov/ncepcr/tools/pf-handbook/mod5-appendix.html. Accessed August 18, 2021.
4. Lopetegui M, Yen PY, Lai A, Jeffries J, Embi P, Payne P. Time motion studies in healthcare: what are we talking about? *J Biomed Inform.* 2014;49:292-299. https://www.ncbi.nlm.nih.gov/pubmed/24607863.
5. Sbaraini A, Carter SM, Evans RW, Blinkhorn A. How to do a grounded theory study: a worked example of a study of dental practices. *BMC Med Res Methodol.* 2011;11:128. https://www.ncbi.nlm.nih.gov/pubmed/21902844.
6. Sheehan B, Bakken S. Approaches to workflow analysis in healthcare settings. *NI 2012 (2012).* 2012;2012:371. https://www.ncbi.nlm.nih.gov/pubmed/24199123.
7. Stanley D. Raising a Well-Supported Workflow. 2016; https://www.youtube.com/watch?v=dAXXl4SHOrs. Accessed August 18, 2021.
8. Unertl KM, Novak LL, Johnson KB, Lorenzi NM. Traversing the many paths of workflow research: developing a conceptual framework of workflow terminology through a systematic literature review. *J Am Med Inform Assoc.* 2010;17(3):265-273. https://www.ncbi.nlm.nih.gov/pubmed/20442143.
9. Washington L. Analyzing Workflow for a Health IT Implementation: an Often Short-shrifted Step is Essential in Successful IT Deployments. *Journal Of AHIMA.* 2008;79(1):64-65. http://bok.ahima.org/doc?oid=77538#.YR2k0XySk2o.
10. Wilkerson-George J, Roark T, Turner R, Urby R, Kerr-Kanabec K. Tips on Workflow Analysis During a EHR Implementation. *HRSA Health Information Technology and Quality Webinar* 2011; https://www.hrsa.gov/sites/default/files/healthitBACKUPJan6-17/toolbox/webinars/pdfs/workflow.pdf. Accessed August 18, 2021.
11. Workflow Management Coalition. Workflow Management Coalition Terminology & Glossary, Document Number WFMC-TC-1011, Issue 3.0. 1999; http://www.workflowpatterns.com/documentation/documents/TC-1011_term_glossary_v3.pdf. Accessed August 18, 2021.

Workflow Analysis Theories (free resources) (4)

1. Kaptelinin V. Chapter 16. Activity Theory. In. *The Encyclopedia of Human-Computer Interaction*. 2nd ed: Interaction Design Foundation; 2021. https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/activity-theory.
2. Korpela M, Mursu A, Soriyan HA. Information Systems Development as an Activity. *CSCW Journal, Special Issue: Activity Theory and Design.* 1999. https://www.ics.uci.edu/~redmiles/activity/revised-submissions/korpela.pdf.
3. Mursu A, Korpela M, Soriyan A. A Generic Framework For Analyzing the Sustainability of Information Systems. Paper presented at: AMCIS 2004 Proceedings; August 2004, 2004; New York, NY. https://core.ac.uk/download/pdf/301345209.pdf.
4. Zhang Z, Walji MF, Patel VL, Gimbel RW, Zhang J. Functional analysis of interfaces in U.S. military electronic health record system using UFuRT framework. *AMIA Annu Symp Proc.* 2009;2009:730-734. https://www.ncbi.nlm.nih.gov/pubmed/20351949.

Workflow Analysis Theories (not free) (2)

1. Patel V, Kaufman D. Cognitive Science and Biomedical Informatics. In: Shortliffe EH, Cimino JJ, eds. *Biomedical Informatics: Computer Applications in Health Care and Biomedicine.* 4th ed. London, UK: Springer-Verlag; 2014:109-148.
2. Vogel LH. Management of Information in Healthcare Organizations. In: Shortliffe EH, Cimino JJ, eds. *Biomedical Informatics: Computer Applications in Health Care and Biomedicine.* 4th ed. London, UK: Springer-Verlag; 2014:473-474.

Workflow Re-engineering (free resources) (4)

1. Agency for Healthcare Research and Quality. Tool D.5: Gap Analysis. *Agency for Healthcare Research and Quality* https://www.ahrq.gov/sites/default/files/wysiwyg/professionals/systems/hospital/qitoolkit/d5-gapanalysis.pdf. Accessed August 18, 2021.
2. Carayon P, Karsh B-T. Incorporating Health Information Technology into Workflow Redesign. AHRQ Pub. No. 10-0098-EF. 2010; https://digital.ahrq.gov/sites/default/files/docs/citation/workflowsummaryreport.pdf. Accessed August 18, 2021.
3. Hagg HW, Workman-Germann J, Flanagan M, et al. Implementation of Systems Redesign: Approaches to Spread and Sustain Adoption. In: Henriksen K, Battles JB, Keyes MA, Grady ML, eds. *Advances in Patient Safety: New Directions and Alternative Approaches (Vol. 2: Culture and Redesign).* Rockville (MD)2008. https://www.ncbi.nlm.nih.gov/pubmed/21249910.
4. Milstein B, Chapel T. Chapter 2. Section 1. Developing a Logic Model or Theory of Change. In. *Community Tool Box*: The University of Kansas; 2021. https://ctb.ku.edu/en/table-of-contents/overview/models-for-community-health-and-development/logic-model-development/main.