Health Enterprise Computing and Patient Identification

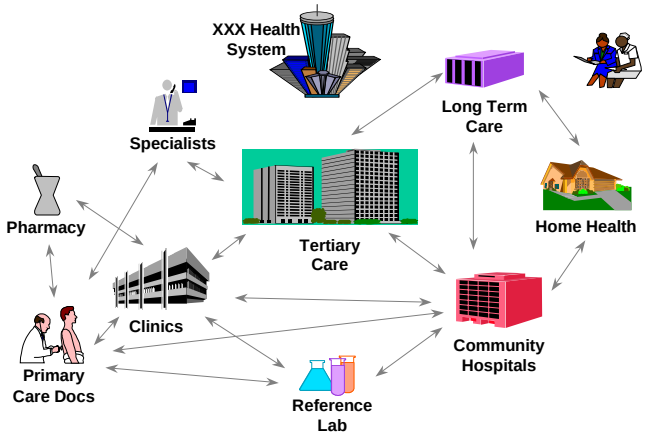
6.872/HST.950

February 13, 2003

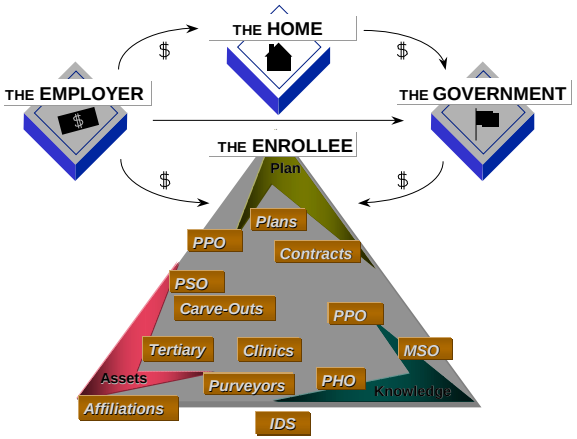
Peter Szolovits

(with first half content from David Margulies)

Integrated Delivery System...



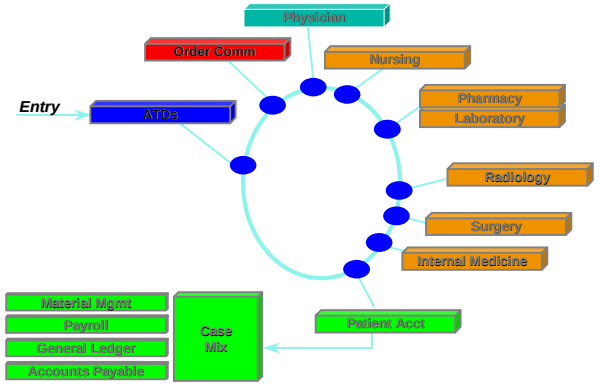
Complexity now within...



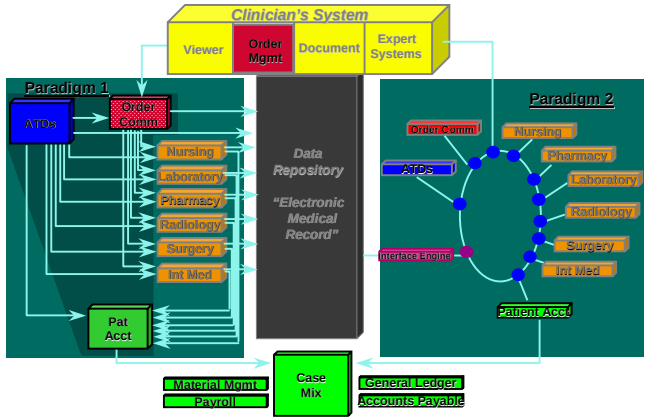
Context: Evolution of Clinical Computing...

- Focus evolved from automating AR process in hospitals, to LAN-based SI of departmental systems, to enterprise clinical computing, toward region- and system-level process automation
- Changing healthcare organizational models and economic models ---> changing clinical computing priorities and designs

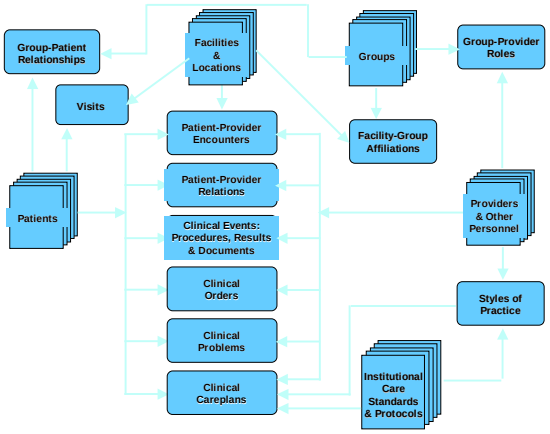
Phase 2: LAN-based SI -- Automate Data Distribution to MDs...



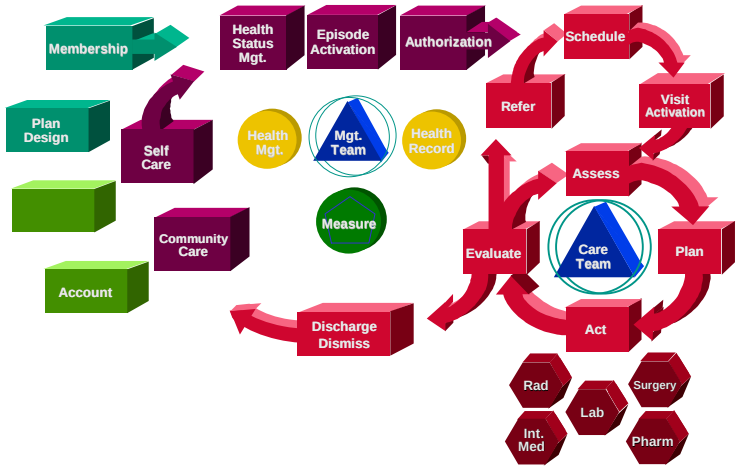
Phase 3: Data-based SI to Create an EMR...



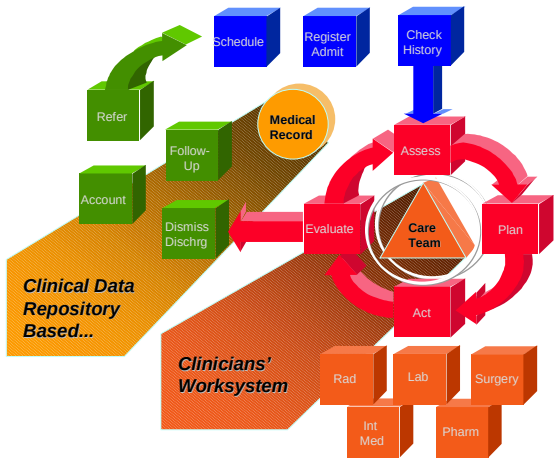
DATA REPOSITORY



Phase 4: Enterprise-level Clinical Process Automation...



Most Installations...



Mayo
Genesys
SOM
EMMC
HMW
…...
Samaritan

Different Imperatives, Different IT Strategies

Computer-Based Patient Record

- World-Wide
- Community-Wide
- Multiple Facilities

Care Team Support

- Critiqueing
- Scheduling
- Common Clinical Ordering

- Electronic Chart Viewer
- Clinical Data Repository
- MPI/ADT Synchronization
- Independent Departmental Systems

Evolutionary Stages

Stages	Characteristics	Examples
Departmental System	Access Directly Via Program	PathNet Laboratory Information System
Virtual Database	• highly structured • powerful Workstation Access Via Network ◆ distribution data ◆ disparate databases and user interface	HL7 Query Tools
Integrated Database	Copy Data into Central Depository ◆ relationships possible ◆ common user interface ◆ multimedia	ORACLE
Computer-Based Patient Record	Control Access and Encode ◆ nomenclature support ◆ security and audit control ◆ data succession ◆ date authenticity	Open Clinical Foundation Data Repository
Care Process Intrarelation	Diagnoses, Care Plans and Orders ◆ context for results ◆ expectations possible ◆ requirements for records	ProNet Orders CareNet Plans MRNet Operations
Pro-Active Management	Operations Data ◆ care management ◆ fiscal management ◆ EIS	Open Management Foundation Data Repository
Concurrent Event Critiquing	Normative Data and Rules ◆ extrapolations ◆ management by protocol	Discern Rules APACHE MEDIQUAL

Beyond the Enterprise: CHINs Valid needs, No Buyer...

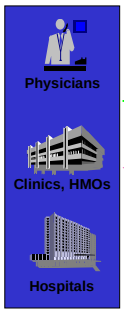
Network Applications
- ***E-Mail***

Database Application
- ***Membership***
- ***Eligibility***
- ***Health Record Access***
- ***Outcomes Measurement***

Transaction Applications
- ***Scheduling/Referrals***
- ***Electronic Signature***
- ***Claims Processing***

Clinical Systems
- ***Case Management***
- ***AHP Business Systems***

Providers



Utility

Community Health Information Services

Repository

External Organizations

Core Services
- ***E-Mail***

Database Systems
- ***Membership Server***
- ***Health Plan Server***
- ***Health Record Index***
- ***Outcomes Management***

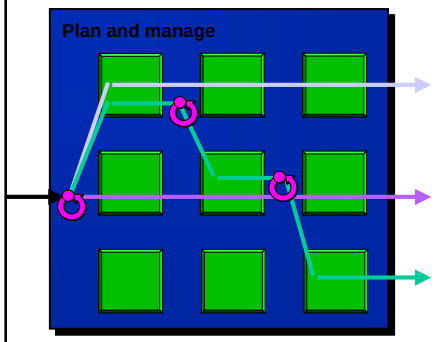
Transaction Systems
- ***Scheduling Services***
- ***Report Management***
- ***Claims Consolidation***
- ***Utilization Review***

Business Systems
- ***Client Billing***
- ***Financial Accounting***

Community Health Information Needs

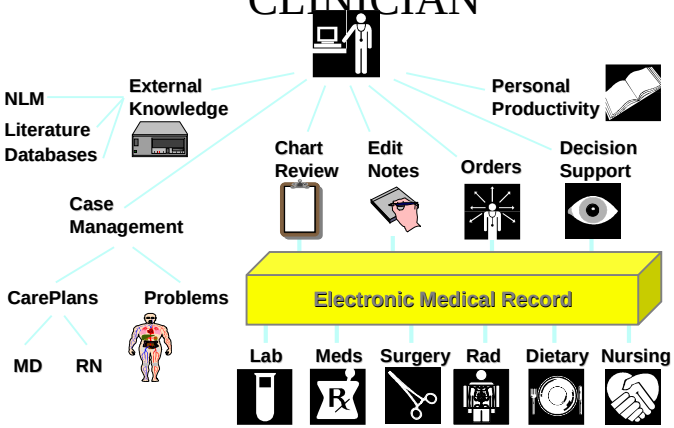
- Person Identification Server
- Membership Server
- Plan/Eligibility Server
- Health Record Server
- Resource Scheduling Server
- Care Protocol Server
- Commerce Server

Care Maps

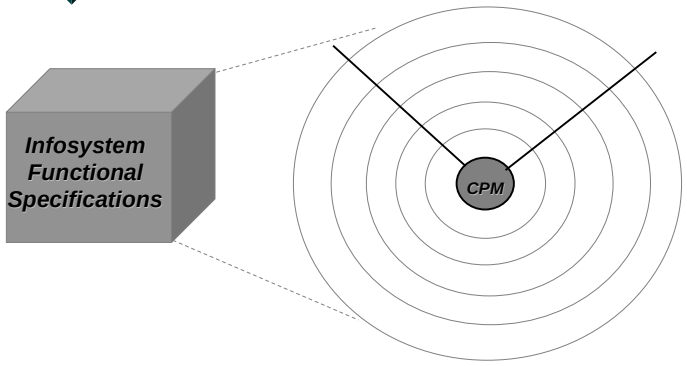


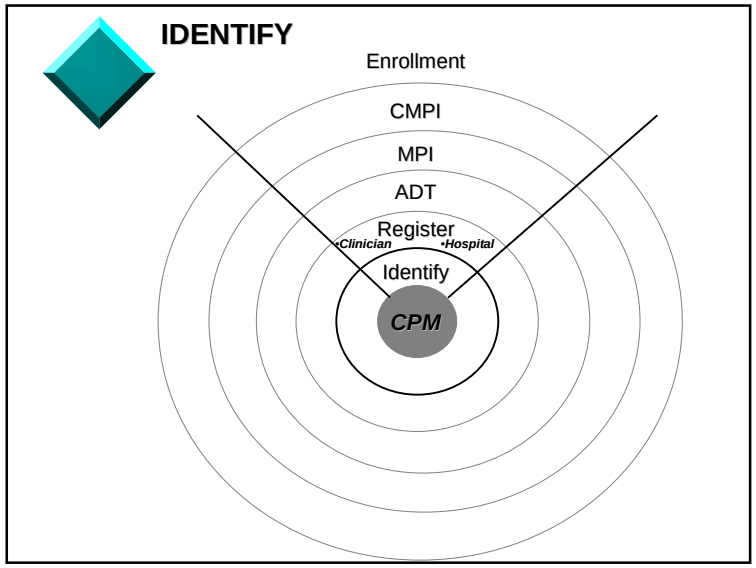
- Defined and tested clinical methods
- Specific paths through map individualized
- Multiple opportunities for triage and adaptation
  - by planned choice
  - by risk
  - by availability
  - by length of trajectory
  - by cost
  - by new information

THE EYE OF THE CLINICIAN



"EMERGING FROM THE COMMON PROCESS MODEL"

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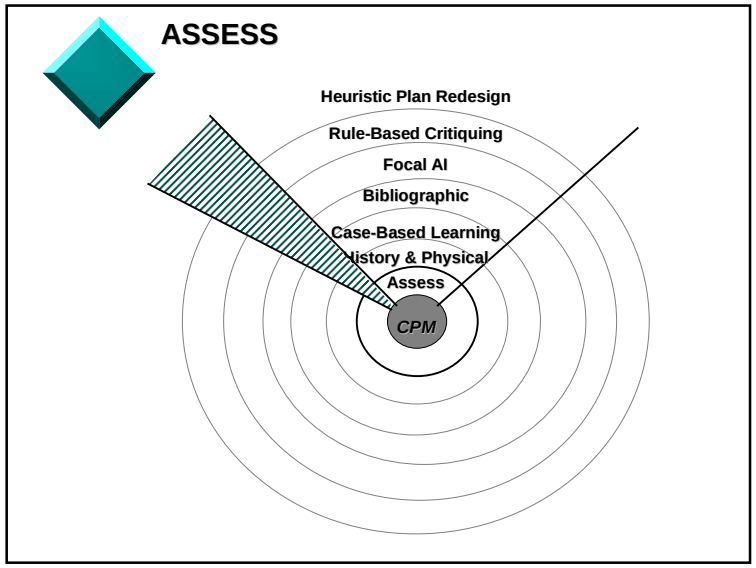
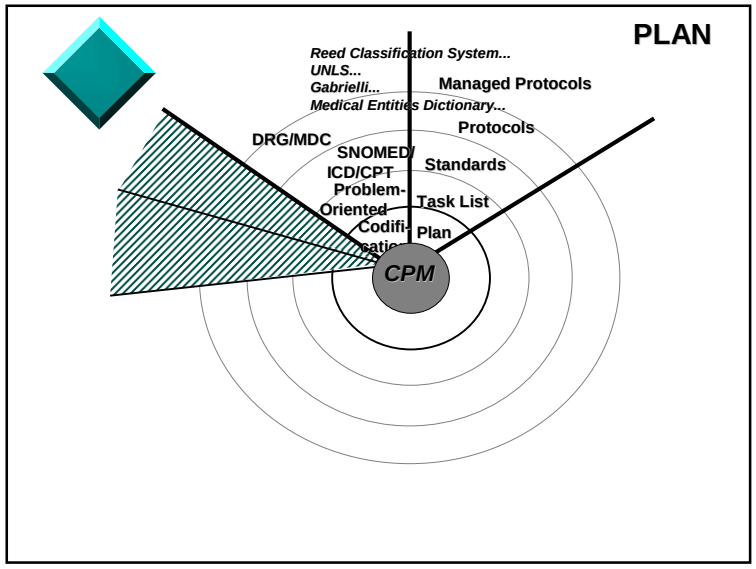
Enrollment
CMPI
MPI
ADT
Register
•Clinician
•Hospital
Identify
CPM


ASSESS
Heuristic Plan Redesign
Rule-Based Critiquing
Focal AI
Bibliographic
Case-Based Learning
History & Physical
Assess
CPM


PLAN
Reed Classification System...
UNLS...
Gabrielli...
Medical Entities Dictionary...
Managed Protocols
Protocols
DRG/MDC
SNOMED/
ICD/CPT
Standards
Problem-
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Task List
Plan
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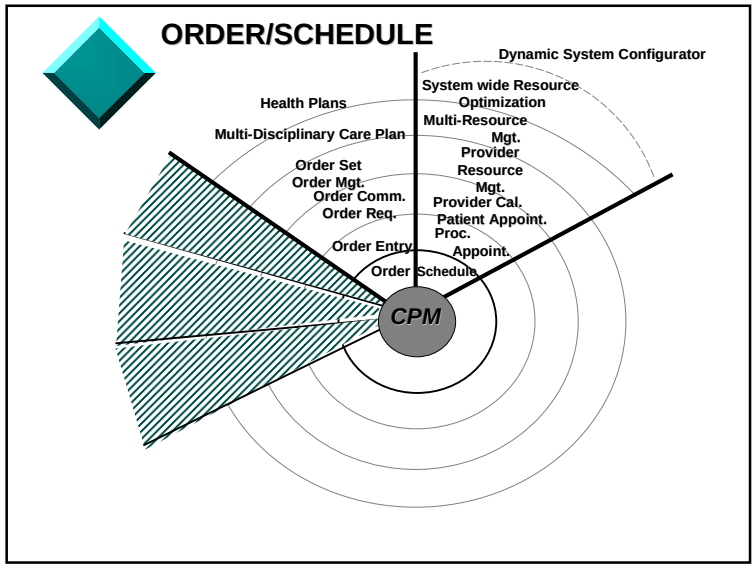
ORDER/SCHEDULE
Dynamic System Configurator
System wide Resource
Optimization
Health Plans
Multi-Resource
Mgt.
Multi-Disciplinary Care Plan
Provider
Resource
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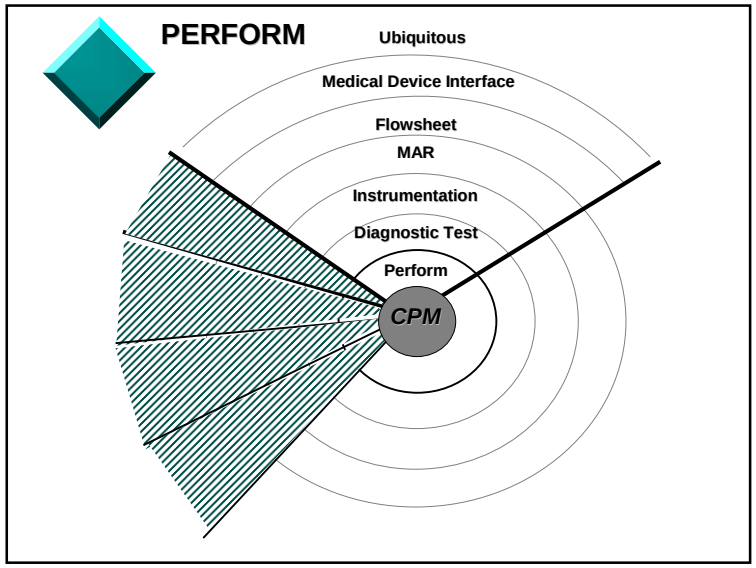
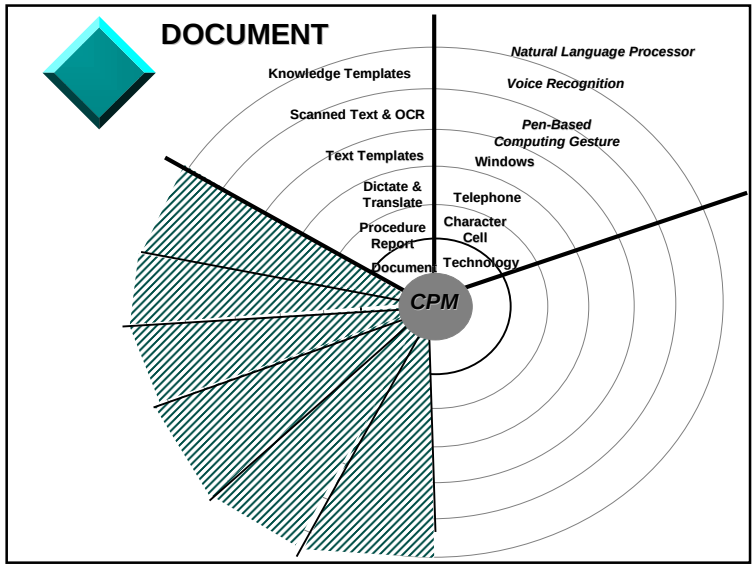
Order Set
Order Mgt.
Order Comm.
Order Req.
Provider Cal.
Patient Appoint.
Proc.
Order Entry
Appoint.
Order Schedule
CPM


PERFORM
Ubiquitous
Medical Device Interface
Flowsheet
MAR
Instrumentation
Diagnostic Test
Perform
CPM


DOCUMENT
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Knowledge Templates
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Pen-Based Computing Gesture
Text Templates
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Dictate & Translate
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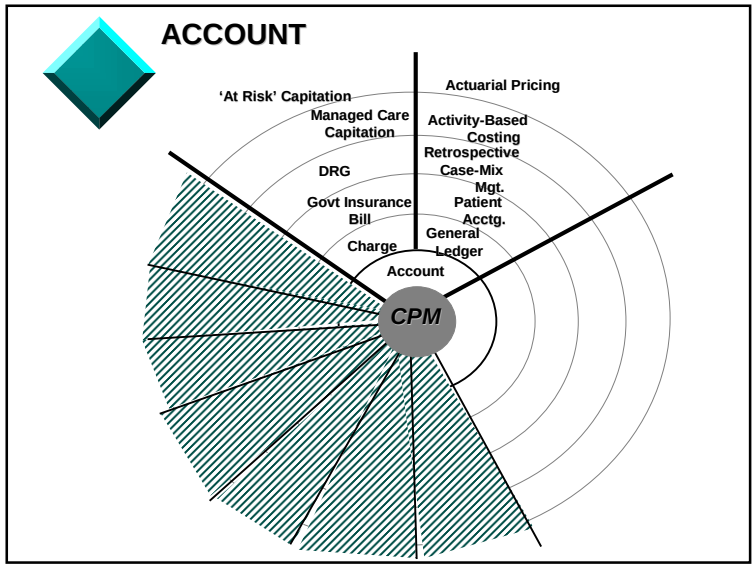
Procedure Report
Character Cell
Technology
CPM


ACCOUNT
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Actuarial Pricing
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Govt Insurance Bill
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General Ledger
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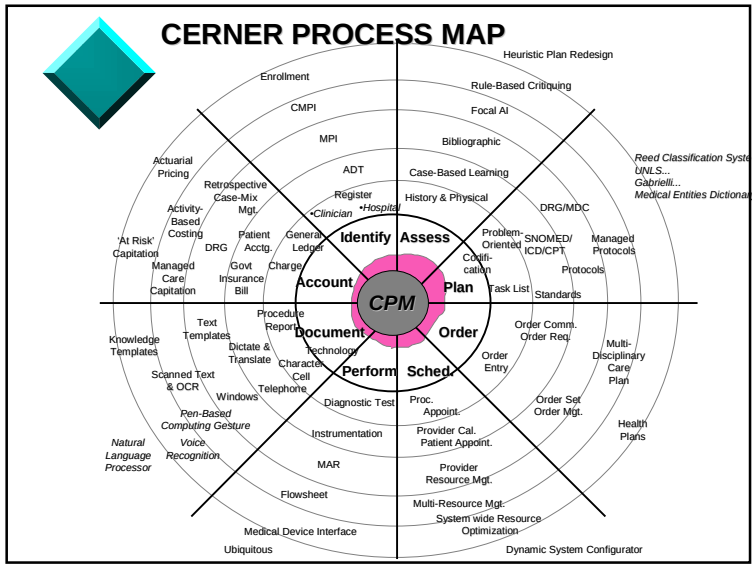
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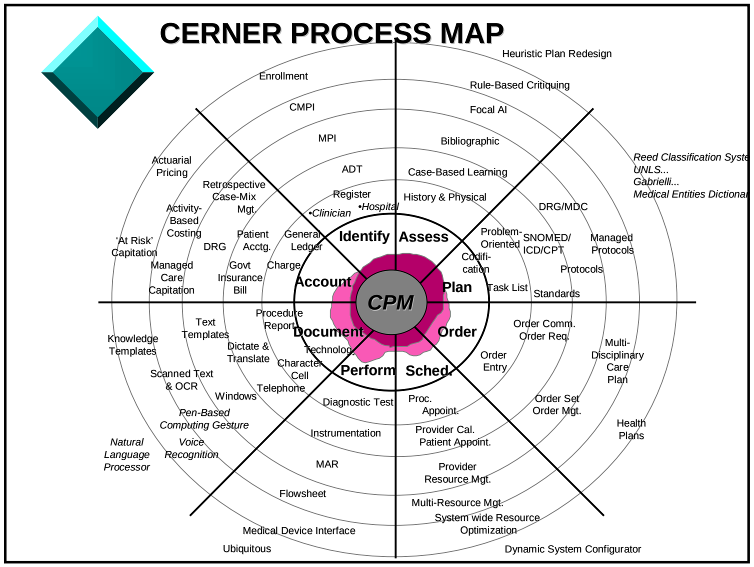
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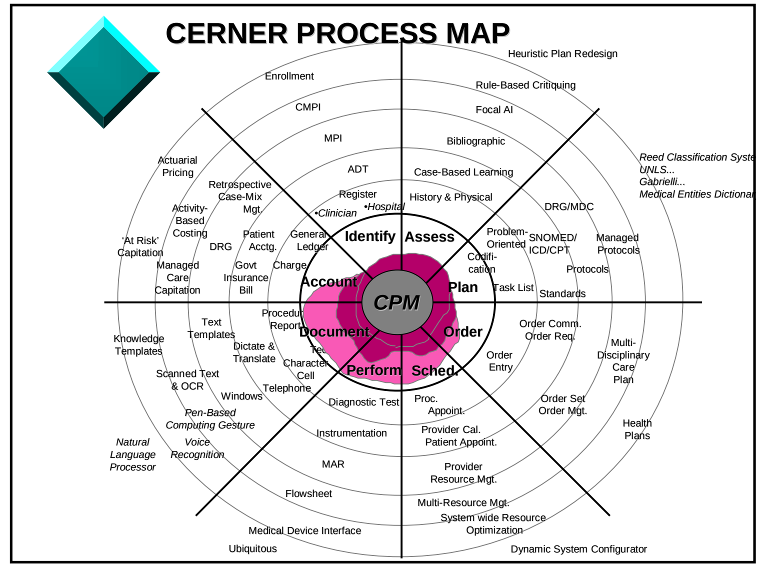
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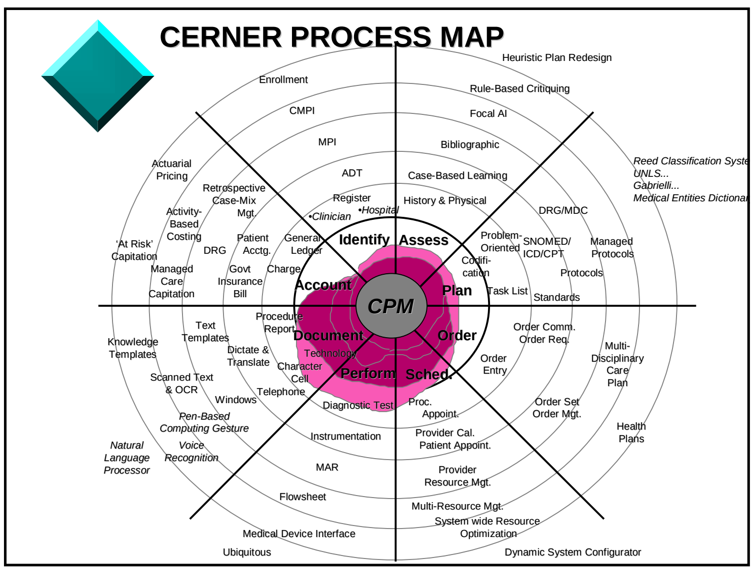
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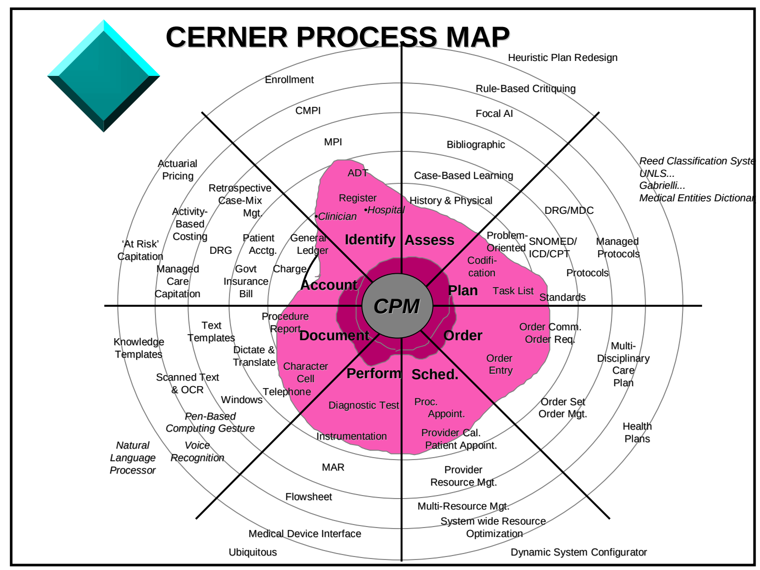
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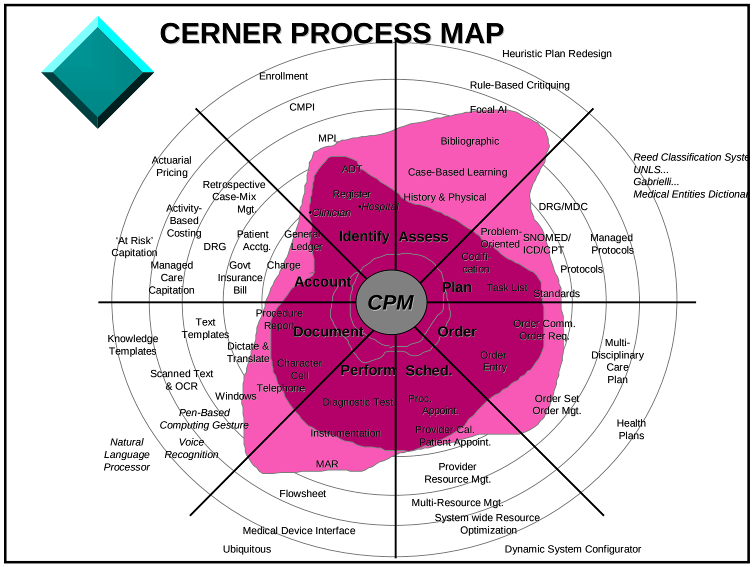
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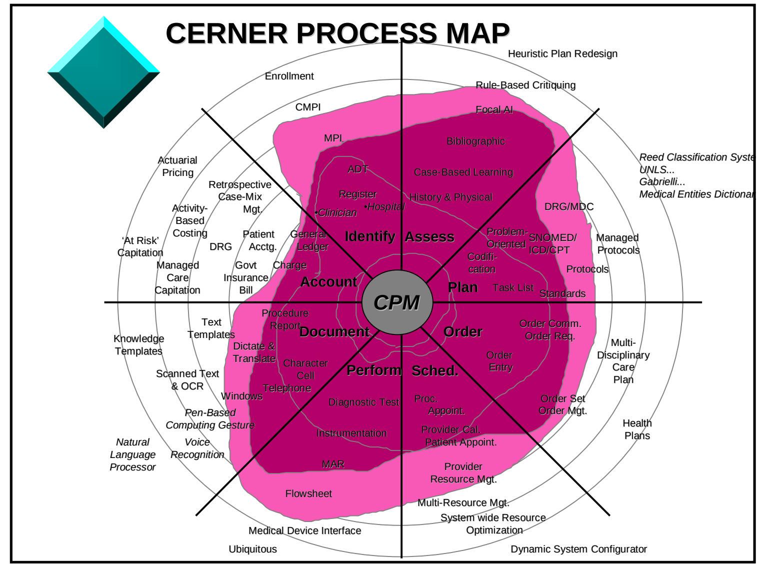
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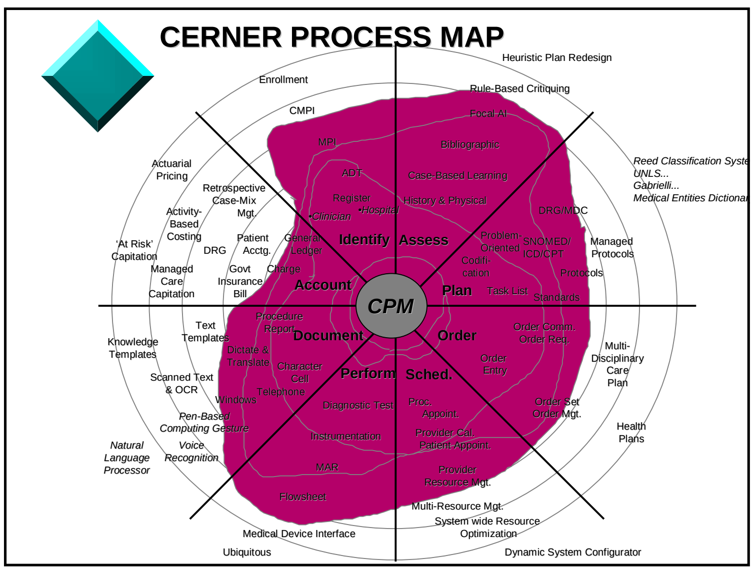
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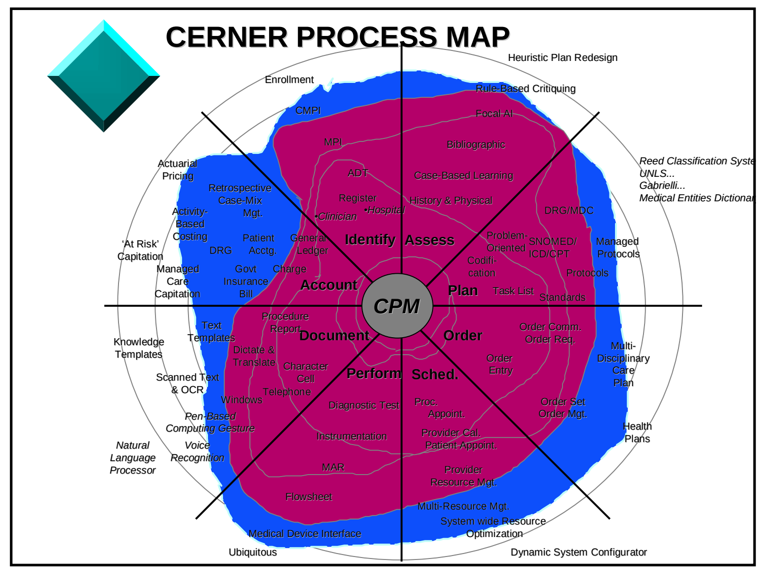

CERNER PROCESS MAP

Summary...

- Diverse organizational models
- Healthcare IT emphasis moving from enterprise to health system focus
- Increased emphasis on patient's role and MD risk
- An open, net-based commerce model fits in all organizational models

Definition...

- ***Definition:***
  - ***"Net-based clinical commerce***" is the ability for patients, physicians, and other buyers of healthcare products and services to arrange, track, and pay for services, purchase healthcare commodity products from an electronic exchange, and manage health records on the Internet.

Context: Evolution of Commerce on the Internet...

- Commerce-enabled Web
  - banking
  - retail
- Extensive use in healthcare
  - research
  - communication
- Toward Clinical Commerce!!

Healthcare Commerce Entry Barriers

- Consumers purchase health *processes*
- Processes are ongoing with multiple points of contact with the provider
- Payment is by assignment of entitlement
- Payer exerts significant control over choice
- Payer exerts significant control over care
- Some goods and services require license

Patient Identification

Patient Identification

- Example: Partners Health Care EMPI (Enterprise Master Patient Index)
  - Lisa Adragna, J AHIMA 1998 Oct;69(9):46-8, 50, 52
- Probabilistic Models for Matching

Partners EMPI Goals

- (Context) Partners Healthcare is affiliation of Brigham and Women's, Mass. General, North-Shore Medical Center, Dana-Farber Cancer Institute, Spaulding Rehab, McLean, Partners Community Healthcare, …, formed in 1994.
- Eliminate need to renumber existing systems by creating Partners-wide unique ID
- Foundation for Clinical Data Repository
- Minimally invasive to current operations
- Rapid installation

Partners EMPI Scope

- Medical record "crosswalk" across Partners
  - Local medical record numbers linked to Partners-wide ID
- Back-end, real-time, one-way interface
  - No modifications to existing systems
- Automated tools for identifying and resolving duplicates
  - No human intervention at "run time"

Partners EMPI Matching

- Three methods of lookup:
  - Last and First names
  - First name, Date of Birth and Gender
  - Social Security Number
- If no matches, create new EMPI number
- If exact match on all known features (above), then link to existing EMPI entry
- If multiple possible matches, create new entry and flag as potential duplicate; *manual intervention*

Partners EMPI Experience (1997)

- 1M records entered from BWH & MGH
- 170,000 pair of records identified as potential duplicates
- 80% of new registrations match a unique EMPI entry; ~1800/day
- Sites made 3308 “within-entity” merges
- EMPI Admin staff (3 FTE) resolved over 200,000 potential duplicates.

Models of Patient Matching

- *Ad hoc* methods are weak, and difficult to improve
- Motivational observation:
  - *Two records that share the last name Kowalczyk are more likely to refer to the same individual than two that share the name Smith.*

Computing posterior odds of a match

- $O(match|obs)=O(match)L(obs|match)$
- $O(match)=1/N$
- $L(obs|match)=P(obs|match)/P(obs|\sim match)$
- P(Smith,Smith|*match*) = P(Smith)
- P(Smith,Smith|~*match*) = P(Smith)^2
- L(Smith,Smith)=.01006/.01006^2=99.4
- L(Kowalczyk,K…)=1/.00001=100,000

Multiple evidence accumulates

- Smith has same Soundex code as Smyth
- L partially matches Liz
- Same street address number, street name
- Ave. vs. Blvd.
- Different phone numbers
- …
- Assume conditional independence

Soundex

- Developed in 1800's to represent phonetic similarity of names
  - E.g., Smith ➔S-530; Smyth ➔S-530
- Rules:
  - 1 B, F, P, V
  - 2 C, G, J, K, Q, S, X, Z
  - 3 D, T
  - 4 L
  - 5 M, N
  - 6 R
  - Disregard the letters A, E, I, O, U, H, W, and Y.
  - Special rules for doubled consonants, prefixes, …

Soundex examples

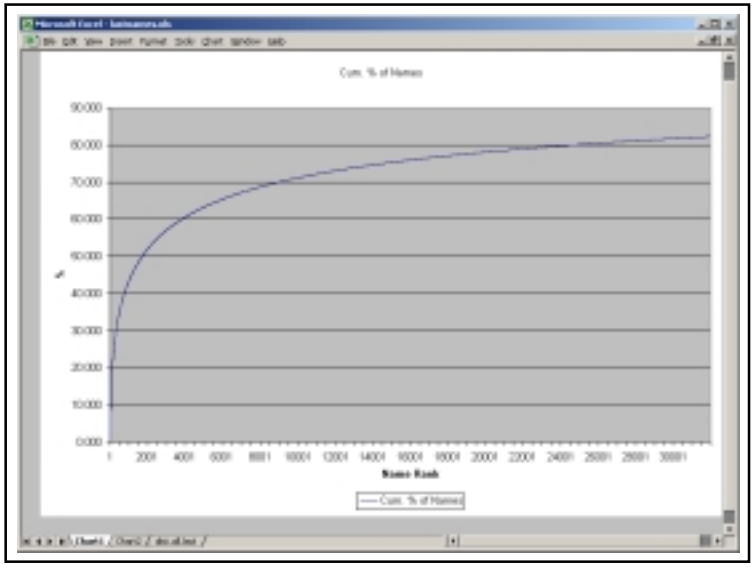
Szolovits	S-413
Beethoven	B-315
Smyth	S-530
Kowalczyk	K-422

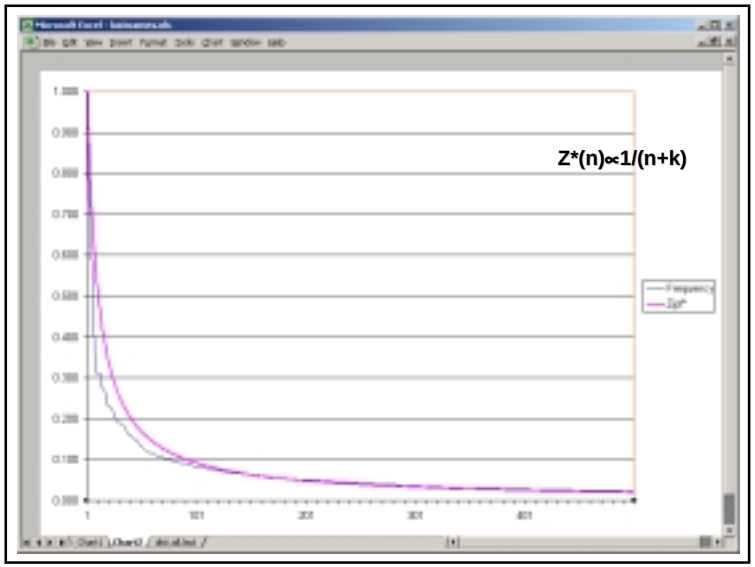
Typing/Transcription Error Model

- Consider probabilities of
  - Insertion
  - Deletion
  - Transposition
  - (Mutation) – varies with key layout
- Compute "distance" between mismatched features
- *Same idea in **BLAST***

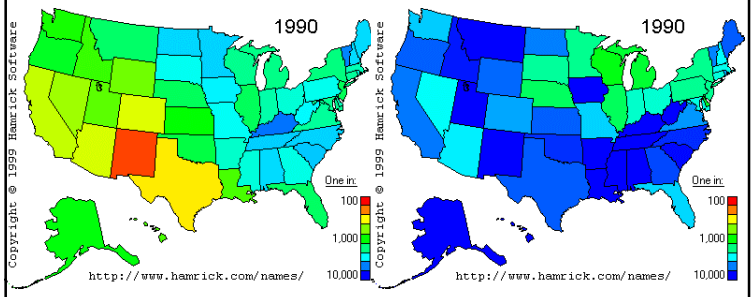
Frequency of U.S. Last Names

--U.S. Census Bureau





Geographical Distribution of "Gonzales" vs. "Lewandowski"



A Theory for Record Linkage

- Fellegi IP, Sunter AB. *J. Am. Stat. Assn.* **64**(328):1183-1210. 1969
- Estimate L(*obs*|*match*) for all possible observations
  - Normally must make independence assumption to factor contributions of different aspects of *obs*
- Define *decision policy*
  - P(A+|*obs*), P(A?|*obs*), P(A-|*obs*), sum=1
  - Based on thresholds on L's
- Yields errors
  - P(A+|~*match*) or P(A-|*match*), minimize P(A?)

Blocking Sets

- Pair-by-pair comparison is expensive
  - E.g., 1M records at Partners → 10^12 comparisons
- Therefore, compare only smaller subgroups
  - E.g., assume first letter of name is never misspelled, as Soundex does
  - E.g., assume Soundex pronunciation code is correct, even if spelling is not
- Increased chance of missing matches, much faster