Transcript of the

Workshop on Computer-Supported Cooperative Work

Co-sponsored by:
Digital Equipment Corporation
MIT Laboratory for Computer Science

August 13-15, 1984

Endicott House
Dedham, MA

Please direct your comments, corrections and additions to:

Dave Marca
Digital Equipment Corporation
77 Reed Road, HLO2-3/C10
Hudson, MA 01749

(617) 568-5770
ARPANET: Marca%what.DEC@DECWRL.ARPA
UUCP: decwrl!dec-rhea!dec-what!marca
DEC-NET: WHAT::Marca

CONTENTS

Topic 1

INTRODUCTIONS

rber, Gerry

- MIT AI Lab
- Building Description & Reasoning System
  - OMEGA (in LISP), a description language for the organizational environment
- Dissertation topic: How to apply OMEGA to help individuals manage organizational work
- OMEGA focuses on individuals
- INRIA -- Kayak project, France, under ESPRIT
- Focus changed from individuals to groups
  - Fulfulling org goals
  - Coordinate people
- MIT
  - Apiary Project
  - Thousands of processors
- Organization theory to help organize computer agents

Burton, Richard

- Xerox PARC
- Interactive Programming Environment
- Collaborative authoring (Annal)
- Demo of Interlisp environment

shman, Paul

- Got involved in this area in 1978 using Petri Nets to model management processes in a software project
- With Anatol Holt, built MONSTR, an early procedure understanding tool
- XPRESS project at DEC aimed at generalizing some of MONSTR's ideas
- Has questions:
  - Taxonomy of cooperative work & systems
  - Similarities between approaches
  - Consciousness of users

Cherubini, Ralph

- DEC AI tech
- Music Theory & Composition
- Computer music synthesis
- Realtime operating systems & applications
- Integrated approach to develop documentation
- Transfering expert system technology
  - How do you transfer knowledge?
  - Rely on electronic technology
- Generic system to develop ELECTRONIC-BASED documents
  - INFOBASE
  - System provides learning environment

Duncan, Dennis

- Software Engineering at DEC
- Human cooperation concerns
- Program support for VMS
- Focus on the individual --> current products
- Have a greater impact if teams are studies --> future products

Ellis, Clarence

- IBM Research, Bell Labs, MIT
- '76 -- Xerox PARC
- Math modeling
- Systems design
- Phenomenon of local optimization:
  - Leads to gobal disaster
- What people do in offices
- Models of different aspects of office sytems
- Office talk systems
- Modeling & dealing with social structures

Endres, Mack

- At ITT now
- Burroughs
  - Office systems & use interfaces
  - Multimedia workstation & high-bandwidth, LAN-based interconnect
- From program synthesis/SW reorg to electronic work environments
- How is orgware built?
- What kinds of structures can computers support?
- How can computers help people negotiate to change their work

Englebart, Doug

- Memex -- '44
- Augmenting human intellect
- AUGMENT at SRI
  - Symbols
  - Grasp
  - Structuring Activities
- Cultural inertia problems
- How will cultural changes be brought about?
- Open-end vocabulary
- No monolithic system
  - Must integrate into other systems
  - User interface to support integration
- NLS system (bought/rescued) by Tymshare
- User org has to be aware
- High performance of teams
  - Learning required
  - Interest just beginning in cooperative work & interpersonal computing
- "We are on the brink of a revolution."

Friedrich, Gerhard

- DEC
- Organizational design
- Social and information sciences
- How to manage change?
- Can't ignore new technology
    - First look at office automation
    - Look at AI
    - Bridge social org design & computer network design
    - "Orgware"
    - ORGS have to get smarter
    - How to help orgs think about 5th gen computing?
        - Cooperative work disciplines are central
        - Use computer mediated systems

Grief, Irene

- MIT
- Semantics of communicating systems
- Distributed system research
- Office automation
- Shared databases
- Communication in work situations
    - real-time
    - asychronous
- Network communication protocols -- calendar
- Questions
    - Roles
    - Evaluation

Hiltz, Roxanne

- At New Jersey Institute of Technology
- Social Scientist, trained at Columbia
- Social change
- Groups of people who use computers to communicate
    - Groupware
    - Strategic research sites
- Computer supported decision making
- GROUP processes are often ignored:
    - Motivation
    - Leadership
- Don't want to ruin the QUALITY of the decision
    - Don't jump to fast into a decision
- Large investment needed for evaluation
    - Need strategic sites for eval
    - Example: managerial finishing school
        - Let them try out tools
        - Get replications
- What things destroy group process?

"olt, Anatol

- ITT
- One track:
  - Study communication
  - Formalist
- Mathematics
- Descriptive Linguist
- Computers=commication machines
- What is at the heart of computing technology?
- Taming computers -- the wild ones
- Controlling our technology is in its infancy
- Products at ITT

Karr, Mike

- Software Options Inc.
- Representing Tom Cheatham
- Can orgs be put to any human good?
- Can people be put to any human good?

Kedzierski, Beverly

- Computer Science & Math
- Large software project management
- AI -- linguistics/natural language
- Automatic Programming
- Communication among software Designers
- Kerstrel Institute
  - CMS environment
    - Has model of what it means to build software
    - Rule based
- Managerial needs in software development
- Mix of AI & software Eng

Johansen, Bob

- Northwestern Univ.
- Automated Questionnaires
- Conferencing
- Inst of the Future -- IFTF
  - Conferencing for ARPA
    - FORUM
  - Computers help communicate
  - Media tradeoffs
    - Video
    - Audio
- "Teleconferencing & Beyond", McGraw-Hill, 1984
- Hybrid: electronic meeting with one machine & many people

vgen, John

- MCC
- Interactive Systems --> Operating Systems --> Software Engineering --> System Architecture --> Human Factors --> Computer-based Education:
    - Find systems that solve people's problems
- Simply interface problem among systems
- Gradual introductions to systems

Lowe, David

- Stanford Univ
- Collective Intelligence
- Decision Process
- Commputers take us out of paper mode
- Computers allow for concurrent contribution
- Explicitly representing decision process
    - Very basic?
    - WHY are we reaching a conclusion?
- Negotiation schemes help filter info

Malone, Tom

- Solve problems created by new technology
- Applied Math & Psychology -- Stanford
- Xerox PARC
- User-Interfaces
    - Educational software more interesting
    - How people organize their desks
- Forces are bigger than one person
    - Organizational coordination
    - Parallel between people & computer orgs
    - Apply cognitive psychology
    - Look at people groups
        - Get leverage to design groups of computer agent
    - Take organizational metaphors:
        - Bidding
- Formal models of orgs
- Filtering information project
    - Mail filter at Sloan School of Management
    - Avoid natural language processing

Marca, David

- Much experience modeling cooperative work while at SofTech, Inc.
- Graphic and executable specifications
- Applying specification technology to cooperative work problems
- What are good notations for representing cooperative work?

Peebles, Rick

- DEC office group
- Distributed data management
- Make business applications effective
- Solving team problems
- How are office precodures represented?
- Expert System technology can better represent office system workings
    - Rule-based specification
    - Individually specify procedural behavior
    - Experimental env where the PEOPLE define their procedures
- Two views
    - Organizational overstructing problems
    - Individual integration problems
- Debugging & maintaining office procedures by non-programmers

Pouzin, Louis

- Centre National des Etudes de Telecommunication (CNET)
- National Center (French Bell Labs)
- Industry/Research
- Networking
- Networks are social systems
- Involves social aspects
- Matching networks to people systems
    - Make them attractive
    - Make them simple
- Europe has no critical mass in computers
- Trying to get people to use computers & change their social life

Ramsey, Rudy

- Trained as a cognitive psychologist
- Now at ITT
- Human Factors
- Software tools
- Team productivity & coordinating individuals
    - Worked at Compass (Holt & Cashman) on understanding cooperative work
- Database approach failed (no coordination)
- TOOL to read in cooperation rules to guide programmers
- Coordinator SYSTEM
    - Executed protocals
    - Negotiated rules
    - Analysis of human orgs
    - Orgware
    - Networks of functions

Carin, Sunil

- Formally of MIT
- Semi-theoretical databases
- Multi-person work
- Real-time conferencing thesis, 1984
- Now at Computer Corporation of America (CCA)
    - Asynchronous communication
    - Managing bibliographies for coordinating researchers
        - Reviews
        - Abstracts
- What happens when these systems get huge?
    - Scale-up problems
    - Database solutions

Sathi, Arvind

- CMU Robotics Institute
- Combine info from various sources
- Decision making
- Project management of Large engineering projects
- CALLISTO
    - Planning
    - Scheduling
- Cooperative planning
- Distributed system approach

Schreiber, Ben

- VMS at DEC
- Notes -- VMS bulletin board (turning into product?)

Stroll, David

- Sales ---> research
- Executive work
- DEC office products
- Nature of executive work
- Make executives more effective
- Make organizations more effective

Trigg, Randy

- University of Maryland
- Now at Xerox PARC
- "Computer Lib" & "Dream Machines" were early influences
- TextNet -- get scientific community on-line
  -- collaborative writing
- "Notecards" on dandelion
- Multiple authors -- how people can help each other write
- Readers & Writers cooperating

Turoff, Murray

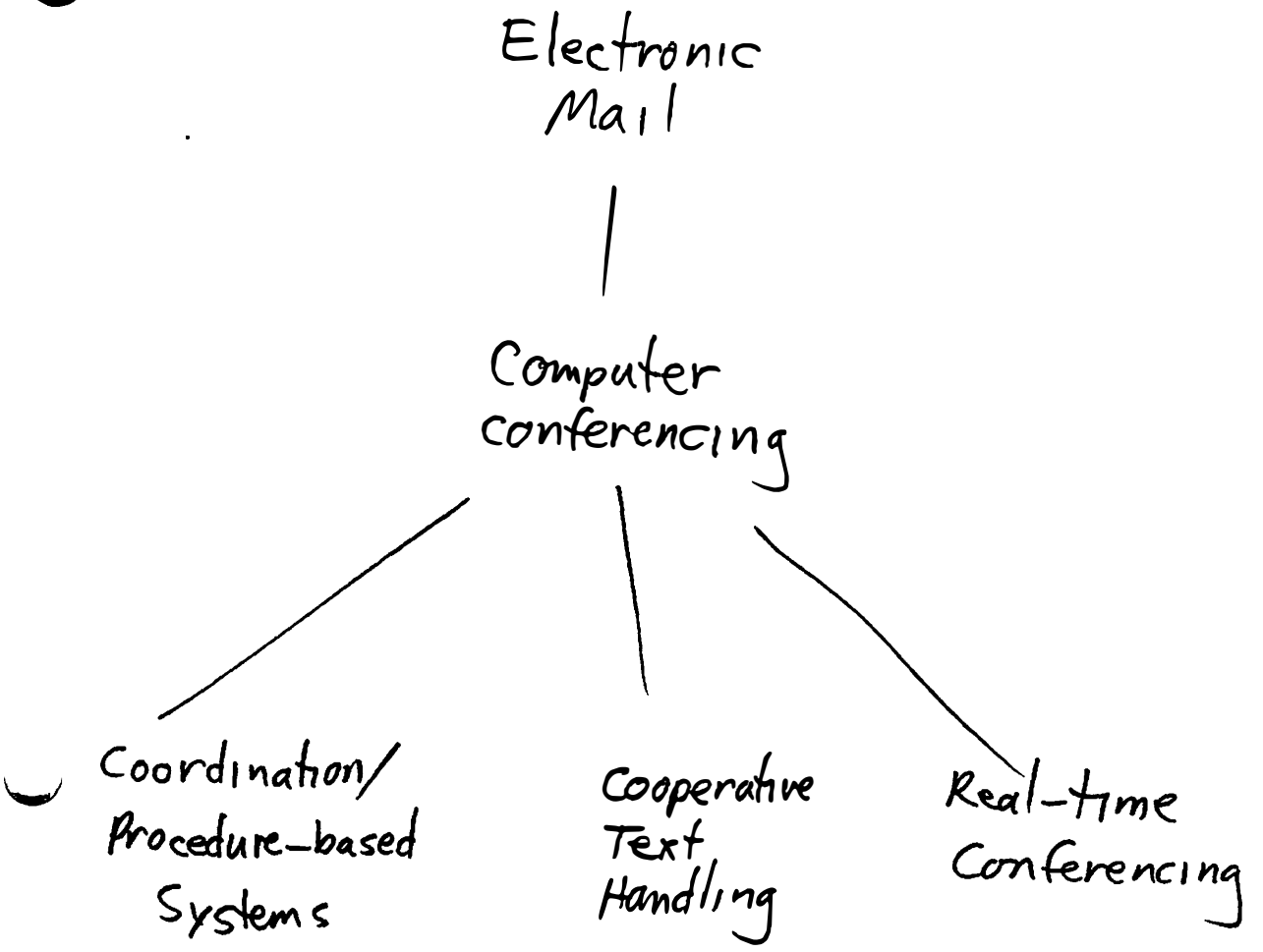
- Physicist & Computer Science
- Gaming -- active players
- Delphi exercises -- organizational issues
- Paper & pencil Delphi studies
- Office of Emergency Preparedness
    - Crisis management
    - Policy Delphi system -- '71
- NJ Inst of Technology
    - Elec Info Exchange System (EIES)
    - Comm Structures
    - Computer based social systems
        - group interations
    - CONSCIOUSLY design what we want

Topic 2

Taxonomies

Cashman:

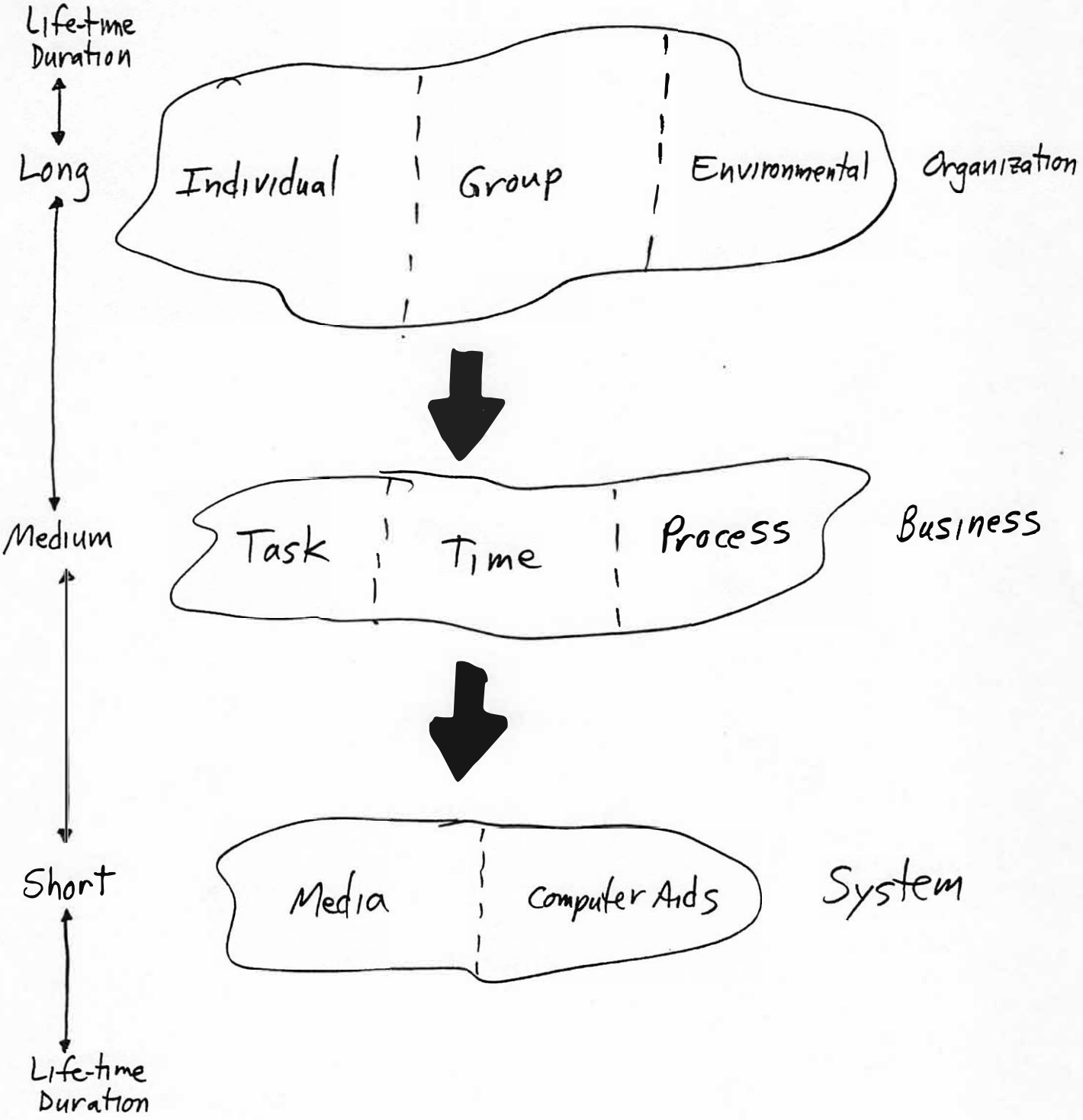
- Electronic Mail
  - one-to-one
  - one-to-many
  - Asynchronous
  - Text
  - Little message collection support
- Computer Conferencing
  - Many-to-many
  - Organized collections (conferences)
  - Controls on joining conferences
  - Asynchronous
- Coordination/Procedure-based Systems
  - Many-to-many
  - Concept of organization's structure
  - Language for specifying coordination
  - Asynchronous OR synchronous
  - Knowledge bases
- Cooperative text handling
  - Like computer conferencing
- Real-time Conferencing
  - Synchronous
  - Shared screen
  - Viewing and editing shared OBJECTS
- Discussion:
  - What's the same about all?
  - What's different about all?
  - Where does each break down?



Cashman's Taxonomy

Johansen:

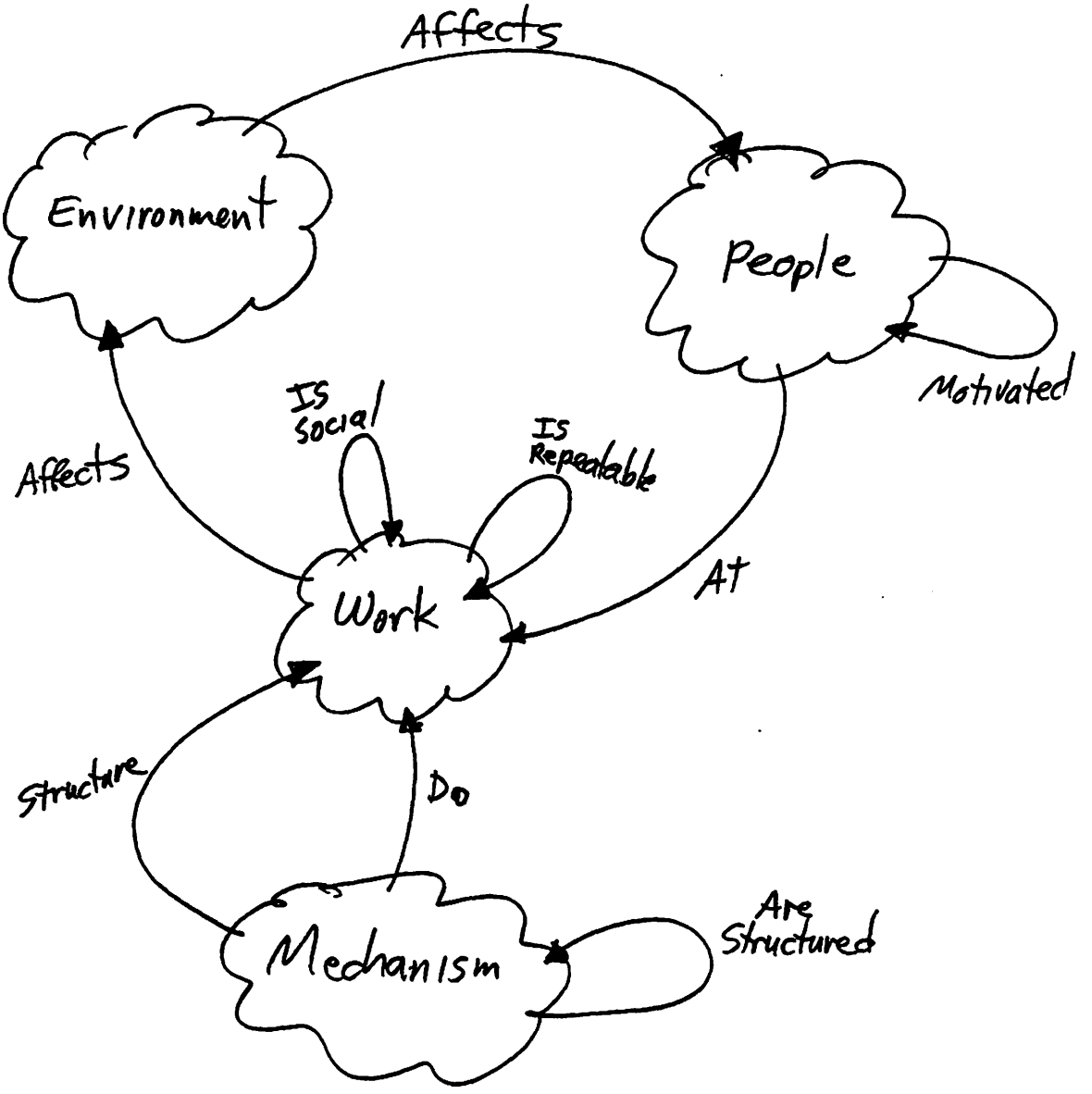
- Three levels of variables which determine success of computer-based systems
- Organization Level
  - Individual -- motivation
  - Group -- roles
  - Environment -- unexamined assumptions
- Business Level
  - Task -- what group is about
  - Time -- schedule
  - Process -- leadership
- System Level
  - Media
  - Computer aids
- Discussion:
  - Are these levels or orthogonal dimensions?
  - There's time, but where's space?
  - Success is motivated by strong task and time constraints



Johansen's Taxonomy

Holt:

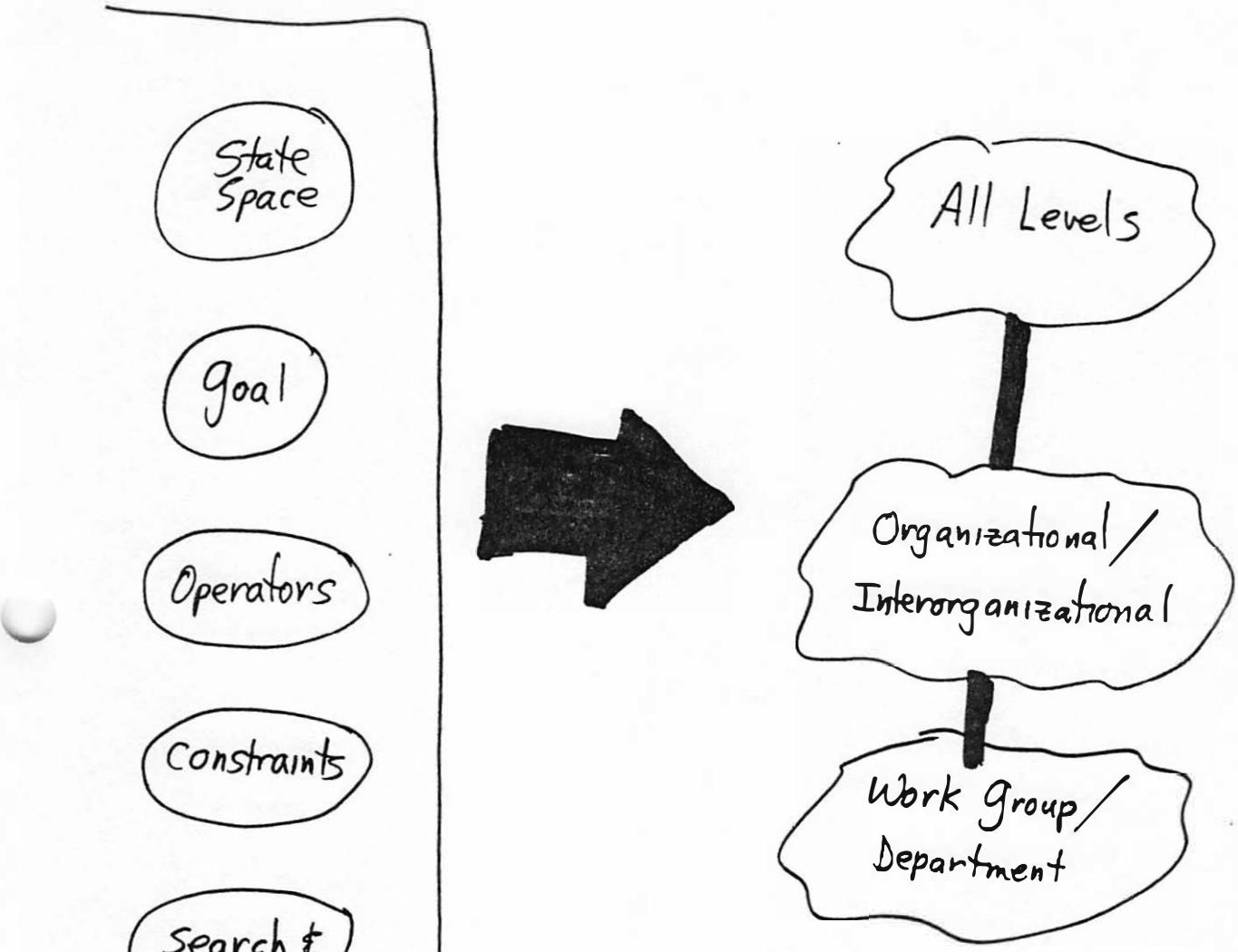
- People at work
- Motivation
- Repeatable aspects of work
- Work affects the environment
- Work is social
- "Repeatable" is social
- Affected environment affects one or more people
- Mechanisms = work structures
  = structured work environments
  = machines
  = structured workers
- What is outside the domain?
- Are systems like payroll part of the cooperative work domain?



Holt's Taxonomy talk

Malone:

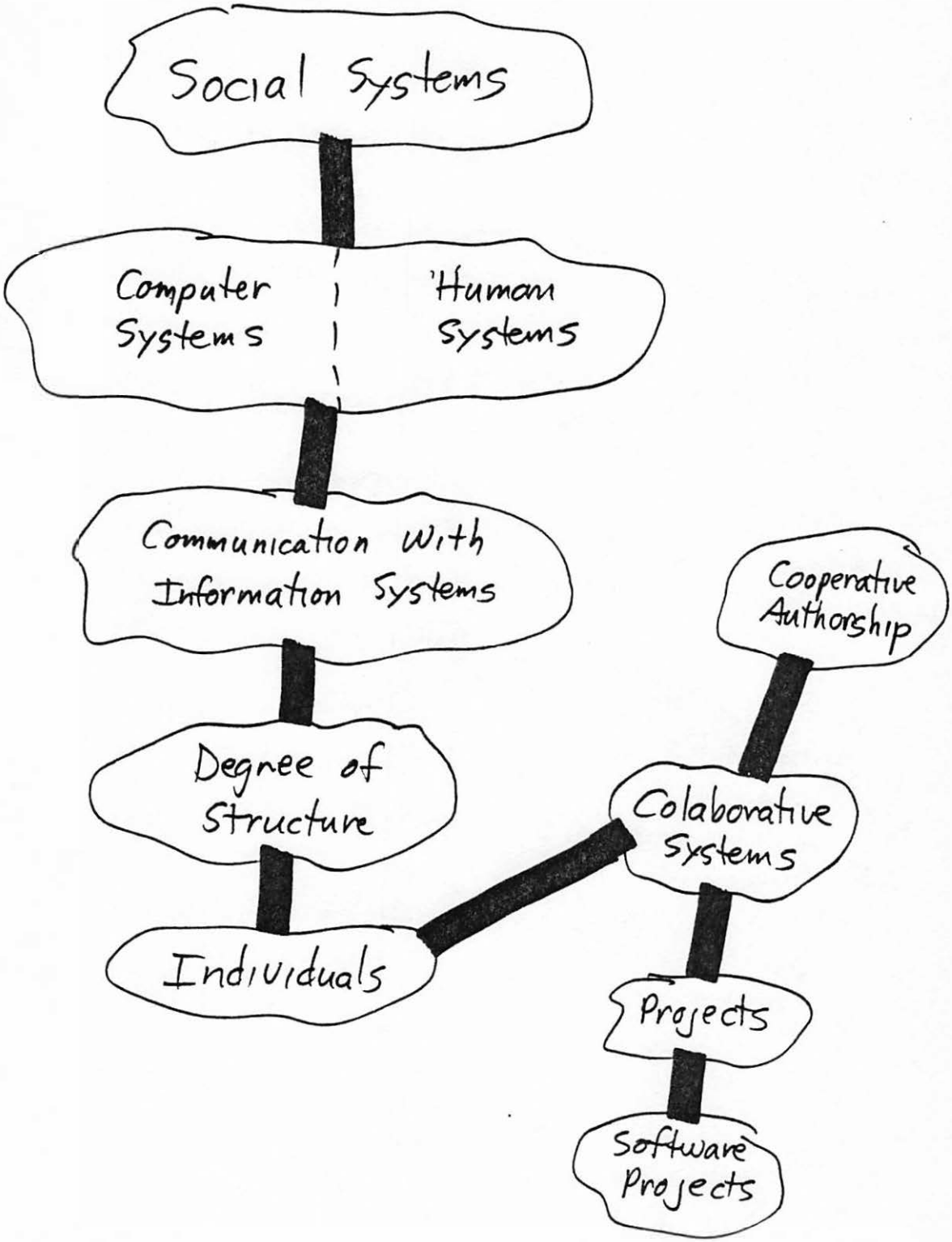
- Problem solving theory
  - State space
  - Goal
  - Operations for searching
  - Constraints on search
  - Search control & knowledge
- Attack problems
  - Using problem solving technology
  - Development of "organizational types" may help
  - See "Building Expert Systems" by Stefik et al
- Taxonomy of systems based on what level of organization is supported by the computer system
  - All levels of the organization
    - Electronic mail
    - Computer conferencing
    - Electronic BBD
  - Organizational/Inter-organizational
    - Computer-based markets
    - Inter-organizational network
- Comments:
  - Does an organization have a goal?
  - Do we really know how to solve problems?



Malone's Taxonomy

Turoff:

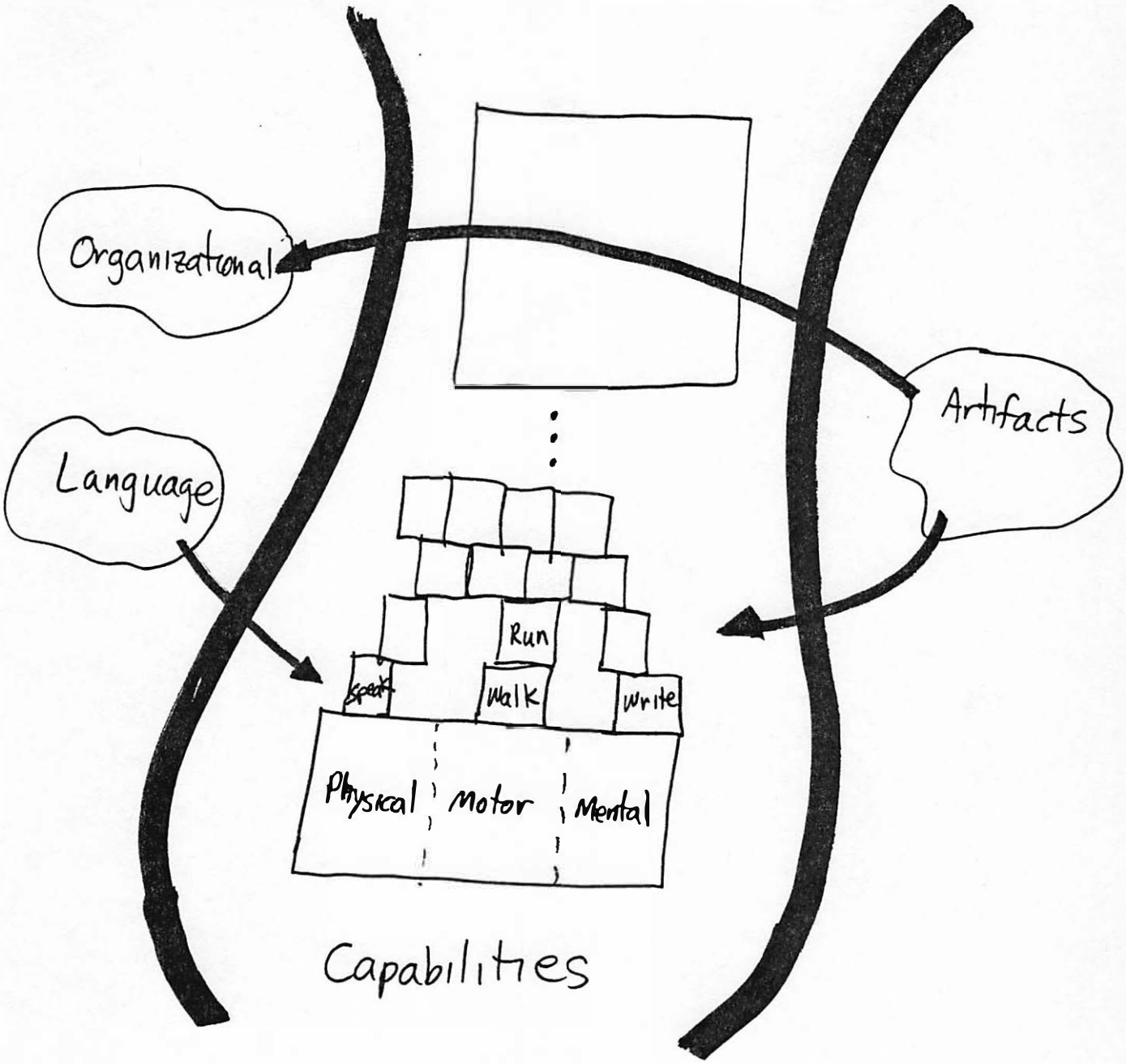
- What's been talked about so far ...
  - It's wrong to think we understand:
    - how individuals think
    - how groups collaborate
    - how organizations work
  - and then program it!!
  - It's wrong to think we can learn from specialized systems
- Levels
  - Social systems
    - Computer systems
    - Human systems
  - Communication with information systems
  - Degree of structure
    - Roles are key
    - Equality
  - Individuals
    - Group interaction
    - Electronic mail
  - Collaborative system (versus Exchange systems)
    - Project
      - Software project
    - Cooperative authorship
- The process (applied to all levels)
  - Meta-description -- design primitives
    - What primitives are central?
      - Question and answer?
  - Philosophical -- validity of the process
  - Measurement -- on an operative system
    - Integrated into design
  - Evaluation



Turoff's Taxonomy

Engelbart:

- How can we augment humans with computers?
- Organizational Dimension:
  - Organizations
  - Methods
  - Procedures
  - Processes
  - We grew up with these
  - These will have to change
- Language Dimension:
  - Concepts
    - Cold, hot, ...
  - Written & spoken language
  - Big growth coming here
- Capabilities Dimension:
  - Are hierarchical
  - Lowest level = physical, motor, mental
  - Next level = walk, speak, write, read
  - Continue adding upon building blocks of capabilities
- Artifacts Dimension
  - Toolkit
  - Axe --> paper & pencil --> telephone --> computers
  - New artifact affects many things
    - Computers affect the LOWEST level of capability
    - They haven't greatly impacted higher capabilities
- Discussion:
  - Higher level impacts to come much later
  - Co-evolution of ALL dimensions
  - Measure valued added
    - Paul Streisman's work on economic analysis of organizational management productivity:
    - If good productivity first, then good productivity after office automation



Engelbart's Taxonomy

Topic 3

APPLICATIONS

Fox: (Manufacturing)

- Example 1:
  - Westinghouse turbine blades, expert system approach to scheduling parts mfg
  - There aren't expert schedulers, so don't look to people for knowledge
  - 10-20% scheduling, 80-90% talking
  - Cooperative activity that produced the schedule
  - Constraint-directed reasoning -- tried talking to people, human scedulers learned about constraints which fed into the scheduling process
  - 3rd version of ISIS (knowledge-based scheduler) will go into plant
- Example 2:
  - DEC engineering
  - CORRECT design critical
  - Engineers cooperate with and constrain each other
  - Similar to the Jupiter project
  - Reviews of designs
    - Slow
    - Loss of windows for component replacement
    - Interrupts current work
  - Another design goal
    - Check the interfaces
    - Make integration work
- Discussion:
  - What is it that is managed?
  - What knowledge is going around
  - CALLISTO
    - Semantic primitives
      - Time, authority, tasks, activities
      - Objects, components
      - Revisions, variations, changes
    - Object modeling
    - Scheduling
  - Knowledge representation stumbling block to manage cooperative work
  - Each group/person needs a "mini-CALLISTO"
  - How can CALLISTO bae distributed?
    - Hide certain information
    - Negotiating task changes
    - Incompleteness & uncertainty of knowledge base
    - How does one incorporate new concepts into own CALLISTO
  - Project management portion is in use now

Hiltz: (Virtual Classroom)

- Learning is a cooperative structure
- Virtual Classroom
- Build structures of interaction to facilitate learning
- Working towards seminar-like, action, cooperative learning
- Structures (9 or 10)
    - Questions
        - Teacher of the moment
        - Essay-like question
        - Students answer
        - Then they see other answers
        - Independent thinking, independent evaluation & formulation
    - Pen names
        - Students assume roles
        - Play games
        - Simulate real life
        - Computer hides identities
- Anonymity vs Pen names
    - Options given:
        - Face to face, pen-names, role play
    - Pen names
        - Only here elicited negative comments
        - Hard to reach consensus
- Anonymity doesn't let you respond or argue to points raised
    - Originally in Delphi
    - Taken out of most organizations
    - Elicits too many radical changes

Hiltz: (Evaluation)

- Good eval requires MANY methods
- Multi-method approaches are best
- Groups mature, so you must observe over long time
- Separate evaluator vs observer
    - "How do I figure out WHAT to test?"
- Understand incentives, then determine test criteria
- Easiest things to measure are LEAST important
- Filter out irrelevant data
- Can't measure org effectiveness directly, so use proxies
- Stay humble, don't believe the numbers
- Dimensions that determine success are VERY different than those that determine failure

Johanson: (Evaluation)

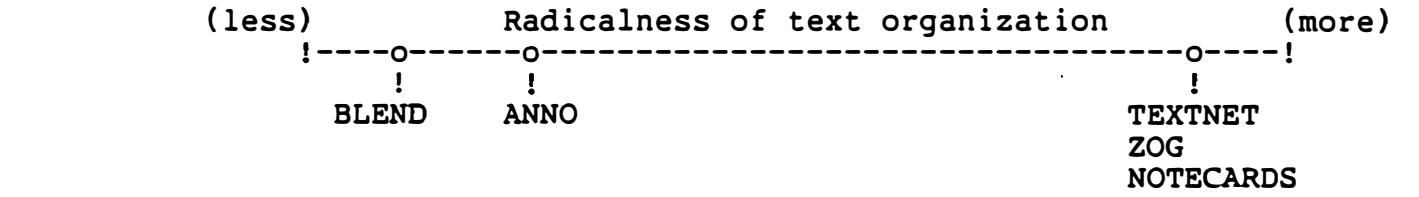
- Think about --
    - What we can do/what we get (by evaluation) vs doing nothing
- Methods
    - In field settings
    - Can't measure things directly
    - Do proxies -- -
        - Pretest
        - System monitors
- What kinds have been done?

Kedzierski: (Software Development)

- Automatic programming
- Help one programmer
- Adding knowledge about the group
- Evolutionary system
- Collected data on interactions
- Classification of info (by speech-act theory)
    - Intention behind the statement
- Planning
    - Talking out loud
    - Sketching
- System had to be convenient to use
- Programmers told system WHAT they wanted to do
- Make taxonomy of activity
- Interrelated Acts
    - Requests
    - Questions
    - Plans
    - Gripes
    - Changes
- CMS Capabilities
    - Help/Doc
    - Critique
    - Project Management
    - Gripe
- Simplified form of "V" specification language
    - Used to enter info like gripes
    - Prolog-like
- Rule base
    - Contained rules of the software process
    - 50 rules
    - Some rules form the core of software development
    - Dependency info was only user supplied
    - No version control
    - Rule must be modifiable
        - Rules tailorable to every situation
- ODL: Organization Design Language
    - Knowledge sources define roles
    - Organization has defined goals
        - No organization has a centralized collection of information that governs its operation
    - Blackboard made some information public
        - Does blackboard oversynchronize?
        - Hearsay II blackboard has levels

Randy Trigg: (Text)

- BLEND system, developed in England
- TextNet -- readers can restructure, hierarchy organizes FINAL doc
- Notecards
- Collaborative authoring
- Two questions --
  - How radical is the text structure?
  - How much freedom do users have to build text?
- Collaborative authoring line:



- BLEND -- fixed integration of comments into pre-written documents
- ANNO -- margin notes, divided documents not permitted, annotations are not bounded (just a char)
- ZOG -- maps to find your way in the maze are required

- Links
  - People probably use FEW link types because they undestand the implications of the link types
  - But what about in the multiple authoring situation?
  - Should link types be restricted?
  - What is the relation of a NEW link?
    - New type?
    - Fixed type?
    - New relation?
  - Want system to understand shape of evolving text
- Writing
  - How do people write?
  - Is two people writing effective?
  - Is there a way to merge diverse multiple styles?
- We're not talking about TEXT; we're talking about IDEAS.
  - Chunk size will vary
  - Links will vary
- Who has rights to change whose chunks?
  - And in what roles?
  - Access control can vary over time

Topic 4

AI TECHNOLOGY

Fox:

. Early work in automated reasoning
. Areas:

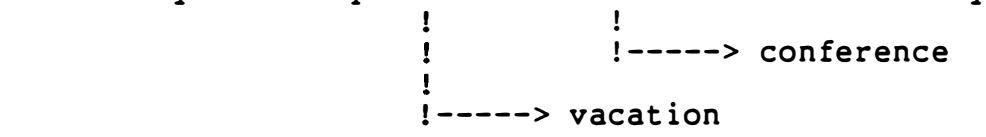
BASIC	APPLIED	TOOLS
. Knowledge Representation	. Vision	. Languages:
. Problem Solving	. Speech	. Lisp
. Natural Language	. Medicine	. IPL-V
. Learning	. Eng & Mfg	. Environments
	. Games	

. Reasoning:

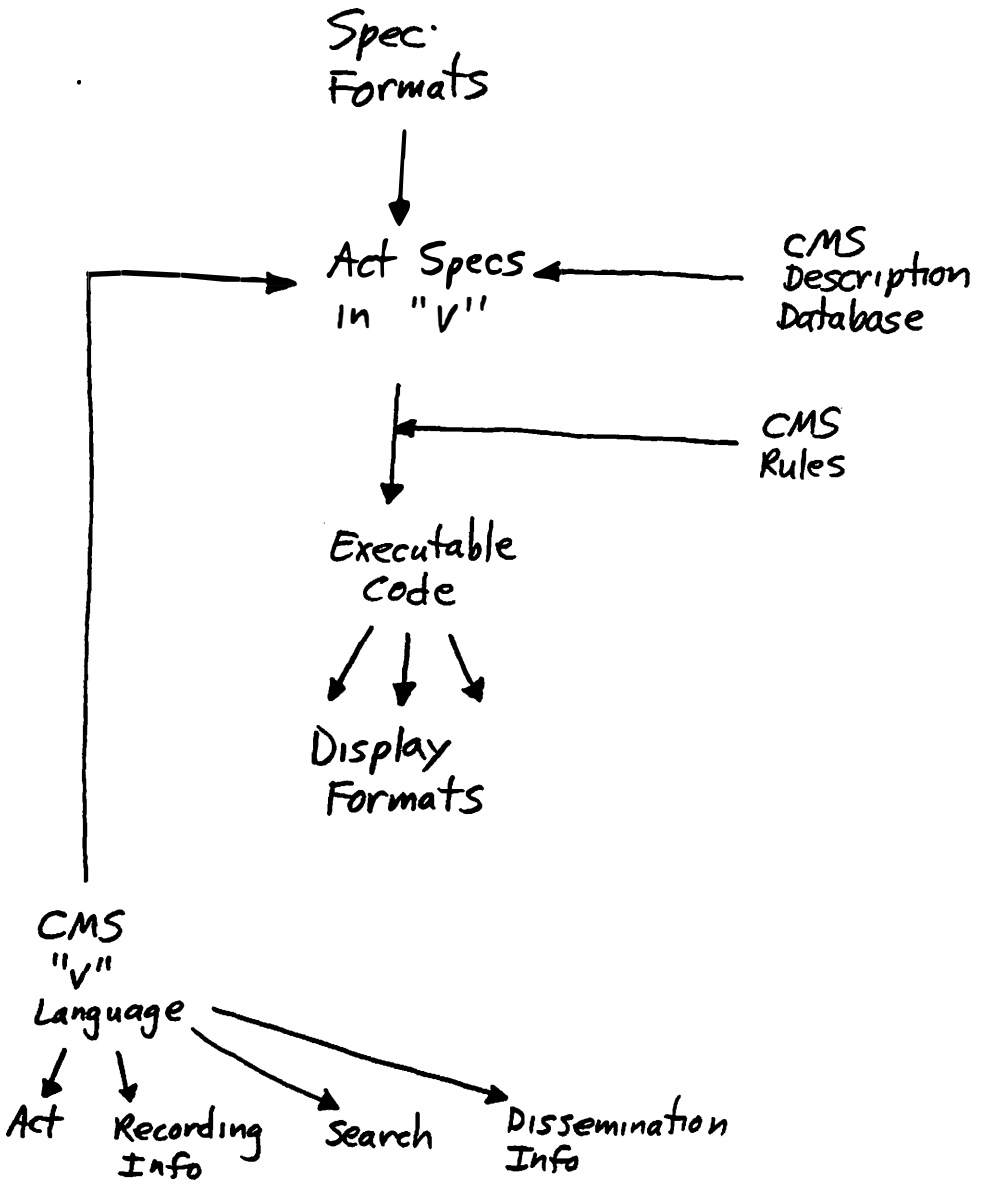
	Single Person	Multiperson
Knowl Rep	understand semantic/structure of natural language (Shank's work) object representation	- goals, orgs (ODL)(Hearsay II) - belief models; multi-agent reasoning (SRI, Toronto); related to natural language
Prob Solv	search paradigms, state space, init/final states, operators, constraint satisfaction, hierarcial/opportunistic search, balance knowledge with search --> rule base system (thousands of operators limit search; huge left hand sides=specific situations) RETE networks makes rule-based systems more efficient	- MESSAGE SENDING: Actor formalism in APIARY - BEINGS cooperating - HYPOTHESIZE & TEST (Hearsay II -- U.Mass Lesser,CMU); shared blackboard of hypotheses & verifications (Hearsay III -- SRI) Opportunistic fashion= greatest certainty used to attack next part of the problem - CONTRACTS (R Smith, R Davis, Malone); task decomposition, formulation, delegation, integration - SCIENTIFIC COMMUNITY (Hewitt) --- multiple solution of same goals; debate; negotiation (dealing with incomplete knowledge)

Fedzeirski:

- Combine frames of reference to reduce propagation of large semantic nets
- Building a knowledge-based software system
  - Tools & framework
  - Life-cycle
  - Policy
  - Knowledge Representation
- Acts
  - Seek Info
    - Request
    - Question
  - Give Info
    - Gripe
    - Inform
    - Plan
- To-act structure
  - Name
  - Subacts
  - Rules
- A-Change structure
  - Name
  - Agent
  - Component
  - Date
  - Description
- CHI Program Synthesis Environment
  - Capability
  - Synthesis
  - Rule compiling
  - Inference
- Knowledge = instances of templates with filled in properties
- Time hierarchy knowledge:
  - Time --> year --> quarter --> month --> week --> day



- Architecture (see next page)
- Users had to understand the Acts Hierarchy



Kedzierski's Architecture

Sathi:

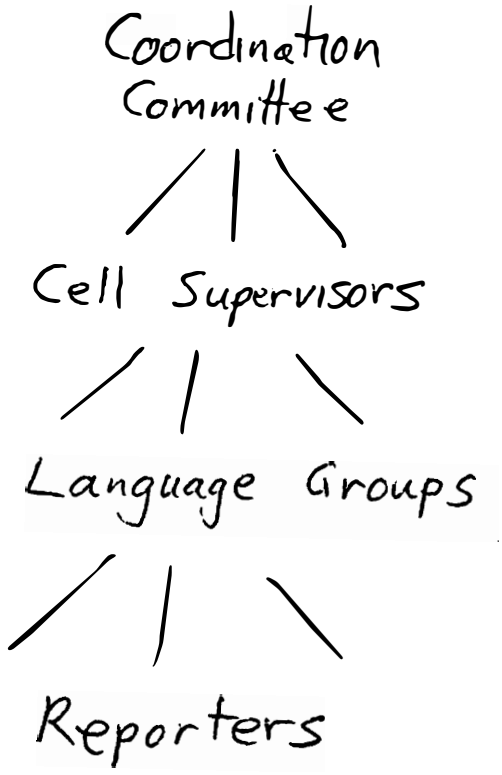
- Example: before (A,B) & before (B,C) --> before (A,C)
- Four levels of knowledge representation:
  - Information Layer
    - frames/schemata
    - relations
    - inheritance
  - Epistemological Layer
    - the way info is structured
    - classification relations --> kinds
    - aggregation relations --> collections
    - refinement/elaboration relations --> more knowledge for more detail
    - individualization relations (instantiation)
  - World Layer -- primitives for:
    - time
    - causality
    - activity + state
    - ownership
    - possession
    - roles
    - authority
    - goals
    - beliefs
    - space -- Pat Hayes "Nature Physics Manefesto Pt II"
  - Domain Layer (for a specific application):
    - revisions
    - variations
    - operators
    - change-order
- Discussion:
  - Levels recognize the different kinds of knowledge
  - '79 Brachman's layering in "Epistomology of Knowledge Representation", Associated Networks (ed) Findler, Academic Press

Topic 5

Theory

Barber:

- Organizations have goals
- Increase the effectiveness of accomplishing goals
- Organizations are problem solving mechanisms
- Organization structure is a reflection of the problems it is solving
    - Functional hierarchy ---> subgoals
    - Product hierarchy ---> parts
- Methodological approach to viewing organizations
- Field study
    - INRIA, France
    - Structure of organization (see next page)
    - Coordination committee
        - Rule interpretation
        - Rule formulation
        - Model sharing
        - Consensus
        - Negotiation
        - Evolutionary adjustment
    - Exception handling
        - Resolve with peers
        - Move up in the hierarchy
    - This organization had lots of structure
    - What's the relation between the organization's structure and the structure of the information it uses?



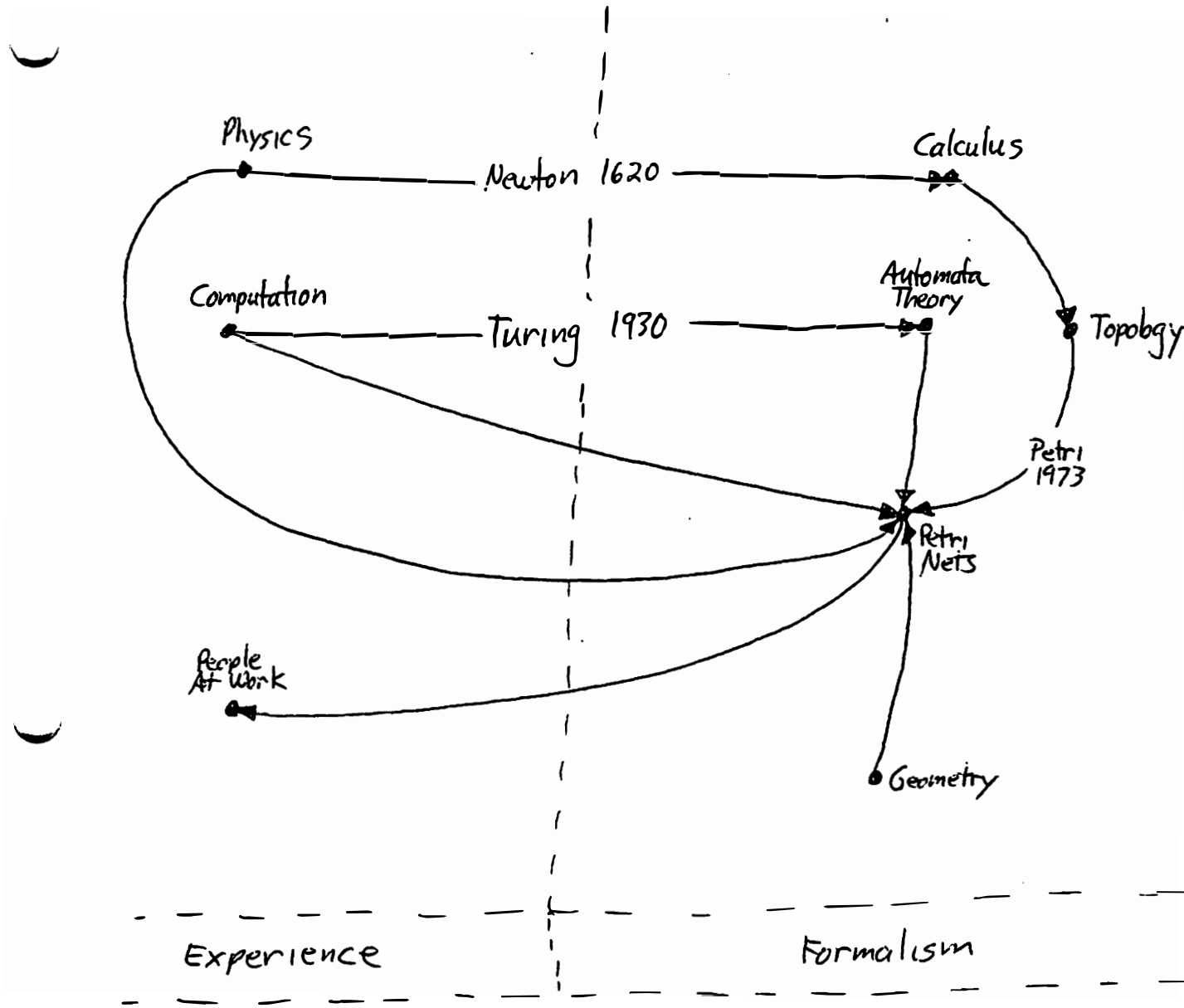
Barber's Cell Organization

Ellis:

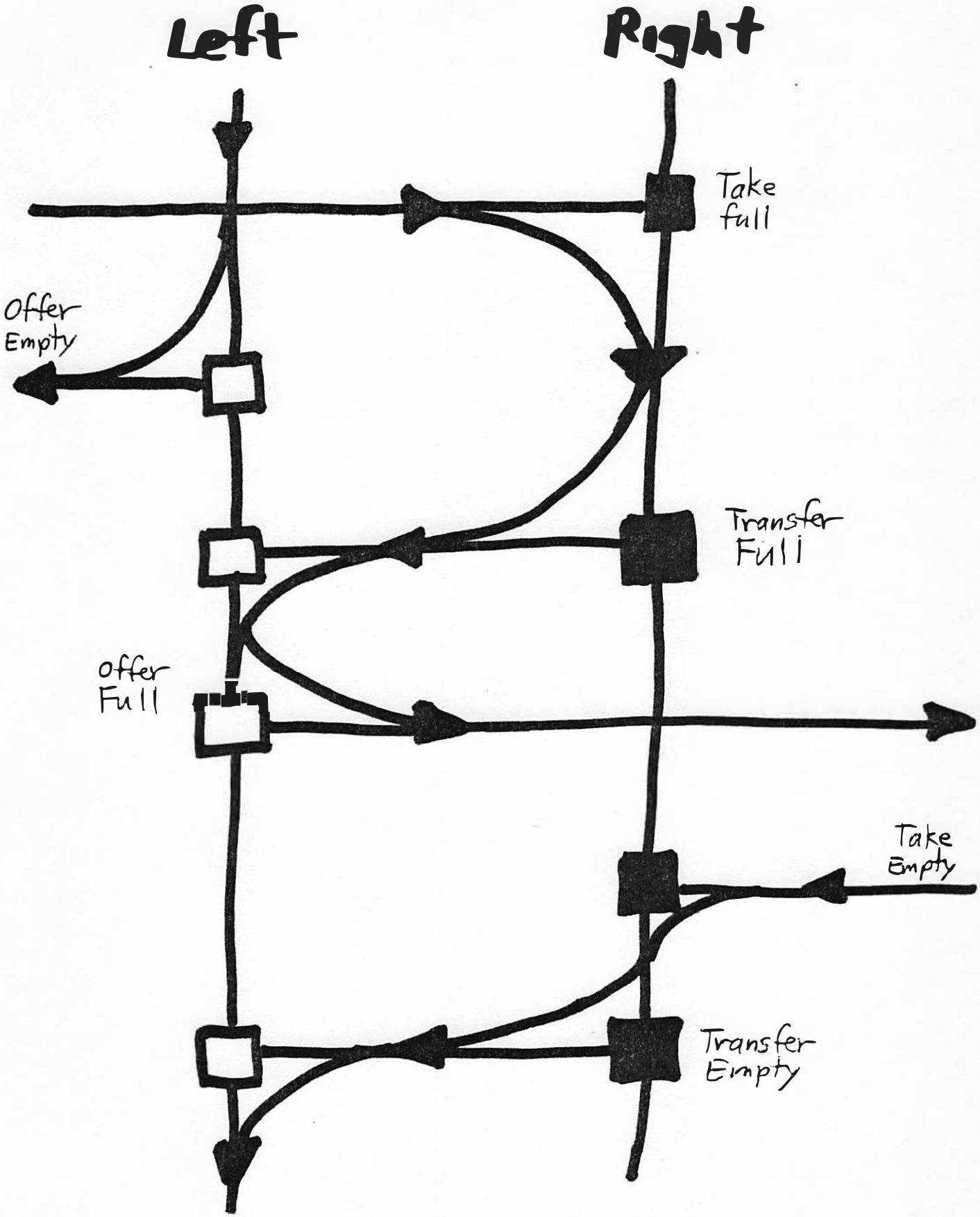
- Types of work
  - Structured vs unstructured
    - Often, no distinction is made between them.
  - clerical vs knowledge workers
    - But exception handling occurs in BOTH types
- Old categorizations are bad
- Loosen our definition of work!!
  - So people can enjoy cognitive activity
  - Work is not a place
  - Work is not a level of intricacy
- No one model fulfills all of organization theory
  - Be open minded to pick the right model
  - Models are informal or formal
    - Often, people use informal mental models
  - User's model must match
    - The organization
    - The implementation
      - Implementers don't know what's relevant
- Think of implementation and organization models TOGETHER
  - A system should be built from several models
  - There are tradeoffs
    - Build around the user's model
    - Build around a DEFINED model

Holt (Theory):

- History (see next page)
- People at work
  - Operations
  - Work is repeatable
  - Communication mechanics
- Constraints
  - Relations governing the change of things
  - Inescapable laws of governing organizations
    - One key concept: the role
    - Role is
      - A body of material
      - An interest (responsible, etc)
      - Actors (those who can play)
      - Neighbors
      - Activities
    - Roles don't move
  - Computers are parts of role bodies
  - Laws of people contact
  - Need: categories of nets



Holt's History Talk



Holt's Pass Bucket Role

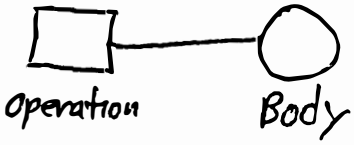
Holt (Entities & Activities):

- System = people at work (see next two pages)
- Body, operation, connection
- Connection = is involved in
  - Some involvements: Produced/consumed, Houses
- Operations happen within the context of the body
- Frame of operation = the totality of the bodies
  = theater of operation
- Frame of body = the totality of the activities
  = life of the body
- Operations
  - Take time
  - What happens
  - When
  - Are points of junction among entities
- Bodies
  - Take space
  - Where
  - What is
  - No idle bodies
  - Entire life of body is framed
  - Are points of junction among activities
- Atomics:
  - Bodies are atomic to an operation if its whole is involved in the operation
  - Operations are atomic to a body if the body is involved in the whole operation
  - If [A] is atomic,
    then: o----[A]----o
    hence: bodies are adjacent, values are preserved
- Just a body or just an operation never exists
  - Bi-poles are required
  - Axiom: These networks are bi-partitioned graphs
  - No isolated verticies
- Subnets
  - Can have a border of all operations = entity
  - Can have a border of all bodies = activity
  - Else ... don't care
- Entity
  - Is spatially closed
  - Is temporally open
  - Overlap in time
  - Share an operation (co-operate)
- Activity
  - Is temporally closed
  - Is spatially open
  - Overlap in theater
  - Interfere with each other
- Foldings
  - Is decomposition
  - Circles map to circles
  - Boxes map to boxes
- Systems are entities

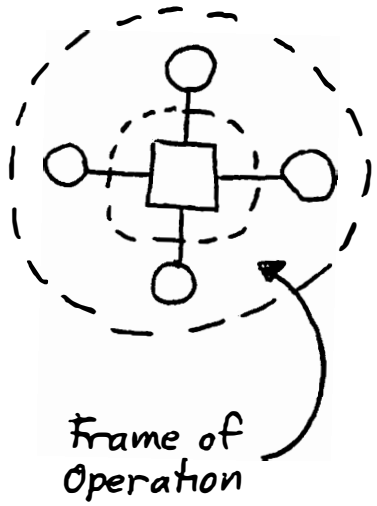
O Body

□ Operation

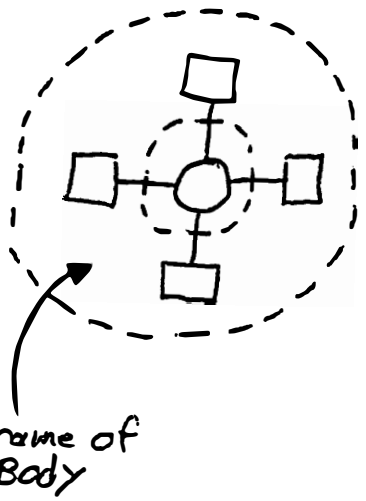
— Connection (is involved in)



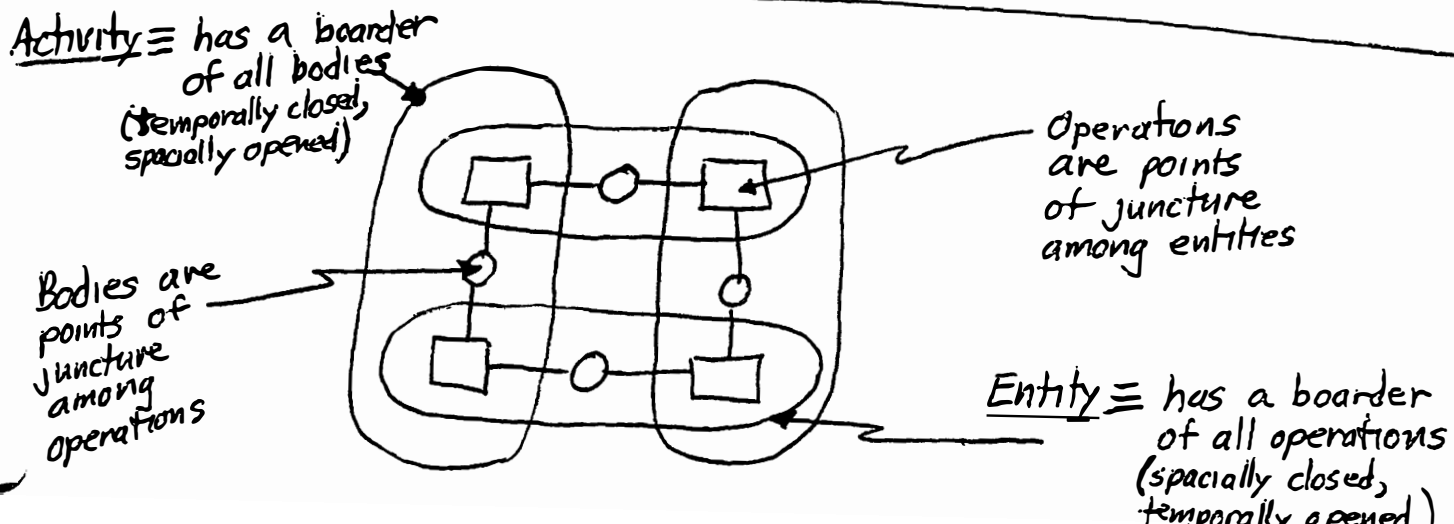
≡ Operation happens within the context of the body



- the totality of the bodies
- theater of operation

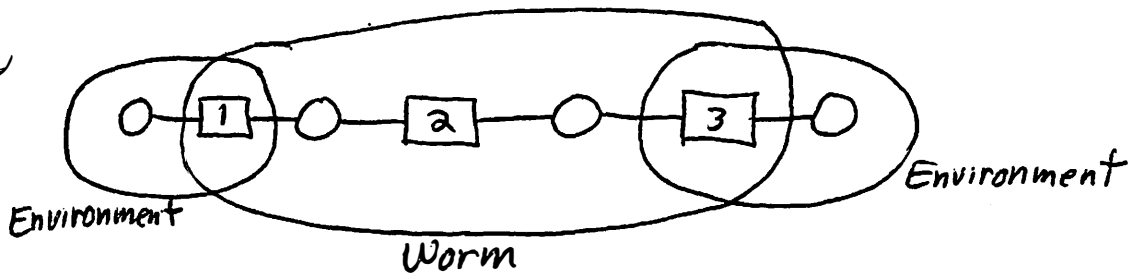


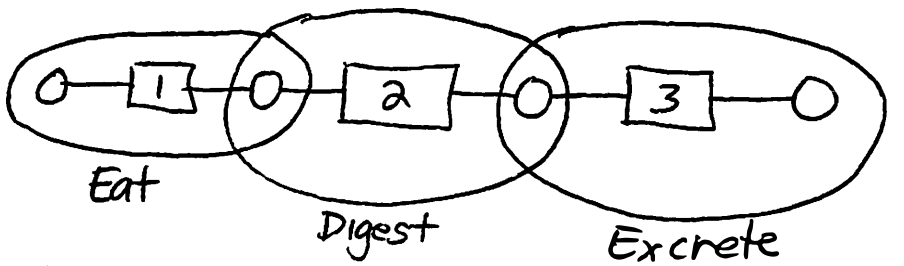
- the totality of the operations
- life of the body

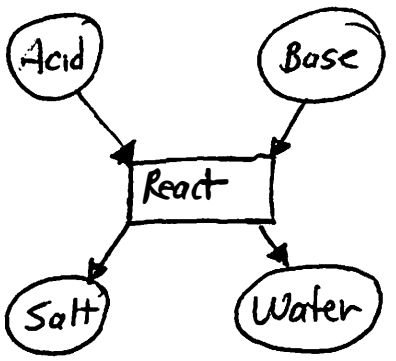


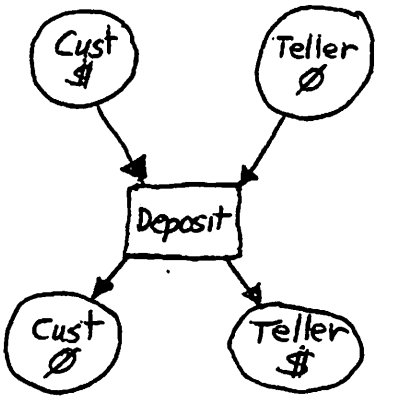
Holt's Entities & Activities

Worm:

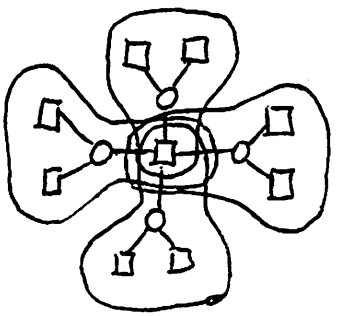






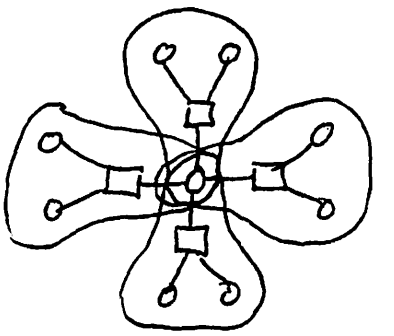


Entities



- overlap in time
- share an operation (co-operate)

Activities



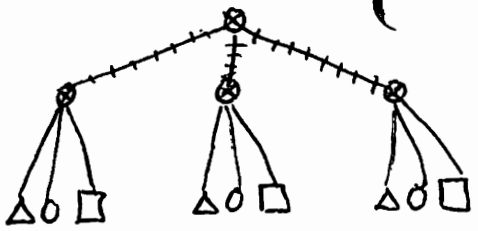
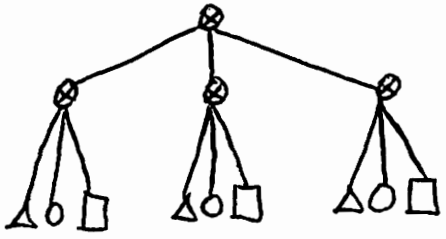
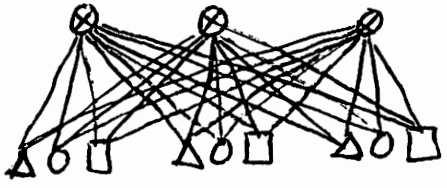
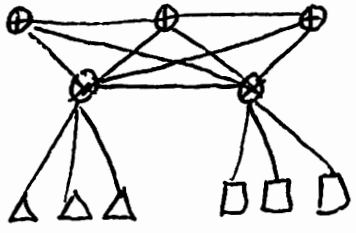
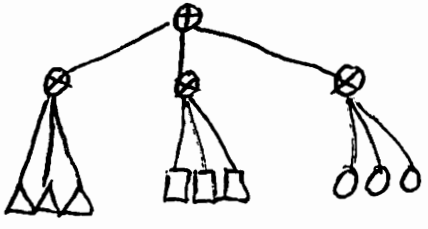
- overlap in their theater
- interface with eachother

Holt's Entities & Activities

Malone:

- Parallels among human and computer organizations (see next page)
- There exists an organizational science that applies to both
- Designing multi-agent systems that cooperate
- Two most-important agents that are not present in single agent problem solving:
  - Task assignment
    - Do organizations have goals
  - Interagent communication
- Task assignment problem (see also next page)
  - Goal supervisors (crossed circles)
  - Goal achievers (empty circle, triangle, square)
  - Goal achievers are processors
  - Questions:
    - Will processors be shared?
    - Centralized/decentralized decision making?
    - Large/small scale processors?
- Example of the theory in use:
  - 1850 -- Decentralized markets
  - 1900 -- Functional hierarchies
  - 1950 -- Product hierarchies
  - 2000 -- Centralized markets (increase production)
    -- Decentralized markets (reduce vulnerability)

Aspect	Product Costs	Coordination Costs	Vulnerability
Product Hierarchy	H	L	M
Central Market/ Functional Hierarchy	M	M	M
Central Market/ Functional Hierarchy (large scale)	L	M	H
Decentralized Market	M	H	L

Shared Processor	Centralized Decisions	Structure	Name	Task Assign Protocol	Computer Analog
N	N		Product Hierarchy	Send The Task	Separate Personal Computers
N	Y		Product Hierarchy	Send The Task	
Y	N		Decentralized Market	Receive Bids Take Lowest (No Pre-emption)	
Y	Y		Centralized Market	Executive polls brokers Brokers poll processors	
Y	Y		Functional Hierarchy	Executive sends to dept Dept sends to best processor	Main Frames

Malone's Theory

Stroll:

- Customer's view
- What do we know about organizations and work?
    - Organizations are hierarchies
    - Organizations have levels
    - Elliot Jaques
        - Levels differ according to timespan
        - Timespan = how long one is responsible for the work
            - 0-3 months
            - 12 months
            - 24 months
            - 5 years
            - 10 years
            - 25 years
        - Pay structure is closely related to timespan
        - Timespan is shortening because MIS systems are giving managers more information
        - There are only 4 cognitive modes
            - Used in every timespan
- What don't we know about organizations and work?
    - Why only 4 cognitive modes?
    - Do different levels of work require different levels of information systems?
    - What is the nature of work at the senior executive level?
        - What makes the senior level different?
            - They're constructing a world that they are trying to bring about
- Global business is starting to influence the forming of mega-corporations

Topic 6

Primitives

Trigg (Summary):

- Ownership & privileges
  - Read access --> copying rights
- Signatures of last changer
- Notification:
  - Retain ownership of a message
  - Sender notified when message was read
  - News dispersal:
    - Get headline about a conference
  - Humans:
    - They fill others through: summaries, headlines, outlines, etc
- Anonymous vs pen names
  - Multiple pen names most appropriate
  - Pass around ROLES not pen names
- Text
  - Sharable pointers inside text
    - Jump indirectly through a collaboratively kept collection of pointers
  - Shared label (like shared pointers)
- Collaborative writing
  - How can personal style differences be handled?
- Decision support systems
  - Quality of answers related to strength of leadership
    - Experiment showed DSS might be harmful
    - Minority views were de-emphisized
  - People use their own tools with sensitivity:
    - Methodologies to deal with on-going records
    - David Evans (Stanford)
- Structures
  - Which are most appropriate?
  - Outline structures are a KEY PRIMITIVE to browsing
  - Linked lists
  - Cross-file links
  - Automatic pointer building
- Social systems

Sarin:

- Communication
  - Interaction between spaces
  - Ensemble (multi-party session)
  - Kinds
    - One-way
    - Two-way alternating sync
    - Two-way simultaneous sync
    - Non-interruptable
  - Atomic level
    - Atomic async
    - Non-atomic synch
    - Non-interruptable
  - Broadcasts
    - Consumable
    - Non-consumable
  - Dialogues
    - Turn take
    - Have floor
    - Question-answer
    - Explain (see Kedzierski's work)

Turoff:

- privileges
  - Add only (no read)
  - Use only (data used by certain procedures)
    - Aren't these capability systems?
  - Establish vs edit
    - Fast access to processors and I/O channels?
  - Focus privileges down to individual objects
  - Ticketing (privelege passing)
  - Dynamic status of privileges (detect current priv actions)
  - [person vs role privileges]
  - [role privileges could be collections of person privileges]
- Data structures
  - Attach privelege to component
  - Built-in dating & ownership
  - [content: bits, fields, pointers, expressions, procedures]
  - [containment: network, hierarchical, directed graph]
  - [link: directed, weighed, named, types, ...]
    - Link is an object, points to nothing
  - Fixed vs dynamic attributes
  - System-understood object
  - Fixed vs dyanamic system definitions
  - Fixed vs dynamic freedoms
- Cooperative work means shared data. Does this mean database?

Topic 7

Multi-Media

Pouzin (summary):

- What is it?
  - Media
    - Page = paper, fax, ...
    - Text = free running text
    - Graphics
    - Audio
    - Still video
    - Motion Video
  - Space
    - Desks
    - Rooms
    - Multi-point
    - Point-to-point
  - Time
    - Synchonous, asynchronous

MEETING PHASE	DOCUMENT HANDLING MEDIUM
. Set date	. Phone
. Book facilities	. Message
. Meet	. Video
. Report	. Mail

- Why not text, graphics, audio together now?
  - Technology is there
  - People don't know the best ways to combine them
  - People like their favorite media
  - Lesson: try not to close out media possibilities
- Signal/Noise Ratio
  - "Richness"?
  - "Bandwidth"?
  - Fit means
    - most appropriate
    - not always richest
  - Signal-to-noise despends on subject & correspondents
- Selection criteria
  - Task
  - Backround of correspondents
  - Visibility
    - Person-person -----> large public audience
  - Constraints
    - Media available
    - Costs

Topic 8

Future Directions

Cashman:

- Workshop Accomplishments
  - Formed a group from previously unrepresented & fragmented people
  - Provided a forum for a mix of interests
  - Collected together previously uncollected, relevant work
  - Emphasized cross-connections between:
    - Organization theory & design
    - Software engineering
    - Artificial Intelligence
    - Mathematical modeling
    - Sociology
    - Communication mechanics
    - Linguistics
    - Augmentation theory
- Issues
  - What dimensions help us categorize work in general?
  - Any difference between 1 person and >1 person cooperation?
  - Is there a distinction between work and communication?
  - What dimensions help us categorize exising CWSS's?
    - Areas approached
    - How successful/unsuccessful
    - What was learned?
    - Underlying theories, assumptions, engineering principles, architectural principles
    - What measurements were/should/could have been done
    - Project history
  - What is the mix/relation between "theory producers" and "theory consumers"?
  - Challenges to social scientists:
    - Formulate criteria for, or for studying, organization effectiveness
    - Builders can use this criteria to evaluate their human/machine systems
    - Recommend "the one" book or article on organization theory
  - Challenges to computer scientists:
    - The above points made to social scientists apply
- Next steps:
  - Who else is interested?
  - How do we form a community?
  - Identify what we don't know
    - Use computer technology:
      - USENET interest group
      - ARPANET AI Digest
      - Human-nets (Doug)
      - Professional organizations
  - Start forming a community
  - How can we avoid forming separate, non-communicating camps of application builders?
  - What are we calling this field anyway?

- Concrete activities:
  - Build an annotated on-line bibliography
  - How can we continue our discussions?
    - Use of PARTICIPATE (computer conferencing)
  - Next conference:
    - Possibly March/April after SIGCHI?
  - When we meet in small groups:
    - Keep and disseminate notes
- Goal
  - Make this an empirical discipline
    - More emphasis on evaluation, theory formulation, and testing

Greif:

- Sense of the workshop:
  - Majority -- shared data view
    -- single applications
    -- no integrated substrate
  - Interdisciplinary
    - Social science practitioners
    - Consciousness raising
    - No clear sense of "a discipline"
    - Methodologies
  - Too much theory <--> no theory
- Where we've been: barking and sniffing
- Next steps:
  - More communication
  - Define areas of interest
  - Other participants
    - Proctor & Gamble (social science practioners)
  - Meet again
    - Maybe 6 months
    - Definitely less than 1 year
  - Continue publishing in related conferences:
    - SIGOA
    - SIGSOC
    - SIGCHI

Malone:

- Workshop summary:
  - Concentrated on the area of coordinated work
  - Discussed models and notations
- Issues:
  - Paradigm of intervention -- What will be the desired effect?
  - What IS coordinated work?
  - What is implied by AN action?
  - Values to apply during design:
    - Who shapes values during design?
    - Controllable design
      - How do you build a CONTROLLABLE system?
  - What are good design theories
    - Link values to implementation?
  - Group identified "privacy" to be "boundaries of effect"
- Next Steps:
  - Hold another workshop
  - Establish ARPANET communication among us
    - Annotated bibliography
    - Questions & running dialog

Appendix

Addresses, Phone Numbers, Network Mailboxes

Barber, Jerry
MIT AI Lab
Room 809
545 Technology Square
Cambridge, MA 02139
(617) 253-5871 (-5873)
ARPANET: JerryB@MIT-MC

Burton, Richard
Xerox PARC
3333 Coyote Hill Road
Palo Alto, CA 94304
(415) 494-4356
ARPANET: Burton@Xerox

Cashman, Paul
Digital Equipment Corp.
77 Reed Road, HLO2-3/C10
Hudson, MA 01749
(617) 568-5947
DEC E-net: WHAT::CASHMAN
ARPANET: Cashman%What.DEC@DECWRL.ARPA
UUCP: decwrl!dec-rhea!dec-what!cashman

Cherubini, Ralph
Digital Equipment Corp.
77 Reed Road, HLO2-3/N10
Hudson, MA 01749
(617) 568-6570
DEC E-net: CRLF::CHERUBINI
ARPANET: Cherubini%CRLF.DEC@DECWRL.ARPA
UUCP: decwrl!dec-rhea!dec-crlf!cherubini

Duncan, Dennis
Digital Equipment Corp.
110 Spitbrook Road, ZKO2-3/N30
Nashua, NH 03062
(603) 881-2054
DEC E-net: BABEL::DUNCAN
ARPANET: Duncan%Babel.DEC@DECWRL.ARPA
UUCP: decwrl!dec-rhea!dec-babel!duncan

Ellis, Clarence (Skip)
Xerox PARC
3333 Coyote Hill Road
Palo Alto, CA 94304
(415) 494-5841
ARPANET: ELLIS@XEROX

Engelbart, Doug
Tymshare, Inc.
20705 Valley Green Drive
Cupertino, CA 95014
(408) 446-6320
ARPANET: DCE.TYM@OFFICE-2.ARPA

Endres, D. Mack
ITT Advanced Technology Center
One Research Drive
Shelton, CT 06484
(203) 929-7341
UUCP: ucbvax!decvax!ittvax!wxlvax!endres

Fox, Mark
Robotics Institute
Carnegie-Mellon Univ.
Pittsburg, PA 15213
(412) 578-3832
ARPANET: Mark.Fox@CMU-10A

Friedrich, Gerhard
Digital Equipment Corp.
77 Reed Road, HLO2-3/N10
Hudson, MA 01749
(617) 568-6570
DEC E-net: CDR::Friedrich
ARPANET: Friedrich%CDR.DEC@DECWRL.ARPA
UUCP: decwrl!dec-rhea!dec-cdr!friedrich

Greif, Irene
MIT Lab for Computer Science
545 Technology Square
Cambridge, MA 02139
(617) 253-5987
ARPANET: Greif@MIT-XX

Hewitt, Carl
MIT AI Lab
Room 813
545 Technology Square
Cambridge, MA 02139
(617) 253-5873
ARPANET: Hewitt@MIT-MC

Hiltz, Starr Roxanne
CCCC
New Jersey Institute of Technology
Newark, NJ 07102
(201) 232-7829

Holt, Anatol
ITT Advanced Technology Center
One Research Drive
Shelton, CT 06484
UUCP: ucbvax!decvax!ittvax!wxlvax!holt

Johansen, Bob
Institute for the Future
2740 Sand Hill Road
Menlo Park, CA 94025
(415) 854-6322

Karr, Michael
Software Options, Inc.
22 Hilliard Street
Cambridge, MA 02138
(617) 497-5054

Kedzierski, Beverly I.
Kestrel Institute
1801 Page Mill Road
Palo Alto, CA 94304
Home: (415) 494-7231
Work: (415) 494-2233 x-2132
493-6871
ARPANET: Kedzierski@Kestrel
Kedzierski@ECLC
bik@SU-AI

Lovgren, John
MCC
9430 Research Blvd.
Bldg 1, Suite 200
Austin, TX 78759
(512) 343-0860
CSNET: lovgren@mcc

Lowe, David
Computer Science Dept.
Stanford Univ.
Stanford, CA 94305
ARPANET: DLO@SU-AI

Malone, Thomas
MIT
Sloan School of Management
Cambridge, MA 02139
(617) 253-6843
ARPANET: MALONE@MIT-XX

Marca, Dave
Digital Equipment Corp.
77 Reed Road, HLO2-3/C10
Hudson, MA 01749
(617) 568-5770
DEC E-net: WHAT::Marca
ARPANET: Marca%what.dec@DECWRL.ARPA
UUCP: decwrl!dec-rhea!dec-what!marca

Peebles, Rick
Digital Equipement Corp.
MKO1-2/G9
Merrimack, NH
(603) 884-5256
DEC E-net: XANADU::PEEBLES
ARPANET: Peebles%Xanadu.DEC@DECWRL.ARPA
UUCP: decwrl!dec-rhea!dec-xanadu!peebles

Pouzin, Louis
CNET-PAA
40 Rue General Leclere
92131 Issy Les Moulineaux
France
(331) 632-4850
ARPANET: Pouzin@MIT-Multics.Arpa
ucbvax!Pouzin%MIT-Multics.arpa

Ramsey, H. Rudy
ITT Advanced Technology Center
One Research Drive
Shelton, CT 06484
(203) 929-7341
UUCP: ucbvax!decvax!ittvax!wxlvax!ramsey

Sarin, Sunil
Computer Corporation of America
4 Cambridge Center
Cambridge, MA 02142
(617) 492-8860
ARPANET: SARIN@CCA-UNIX

Sathi, Arvind
Robotics Institute
Carnegie Mellon Univ.
Pittsburgh, PA 15213
(412) 578-8825
ARPANET: sathi@cmu-ri-isl.arpa

Schreiber, Benn
Digital Equipment Corp.
110 Spitbrook Road, ZKO1-1/C42
Nashua, NH 03062
DEC E-net: STAR::SCHREIBER
ARPANET: Schreiber%Star.DEC@DECWRL.ARPA
UUCP: decwrl!dec-rhea!dec-star!schreiber

Stroll, David
Digital Equipment Corp.
77 Reed Road, HLO2-3/M07
Hudson, MA 01749
(617) 568-5876
DEC E-net: RDVAX::STROLL
ARPANET: Stroll%rdvax.DEC@DECWRL.ARPA
UUCP: decwrl!dec-rhea!dec-rdvax!stroll

Trigg, Randy
Xerox PARC
3333 Coyote Hill Road
Palo Alto, CA 94304
(415) 494-4852
ARPANET: trigg@xerox

Turoff, Murray
CCCC
New Jersey Institute of Technology
Newark, NJ 07102
(201) 232-7829