Understanding and Visualizing Information Work Processes and Practices

25 October 2001

Walt Scacchi (wscacchi@uci.edu)

Institute for Software Research

University of California, Irvine

Backstory

- Major TelCo wants to develop broadband multi-media telecommunications system

- Anticipates $1B development, up to1500 system developers working 2-3 years

- Seeks industrial partners to provide supporting infrastructure to reduce risk

- IT partner wants to showcase new "process support technology" products as sales lead

- IT partner brings in academic research team to analyze and advise TelCo on "process issues"

Backstory

- Team, IT partner, and TelCo jointly elicit, capture, codify (*formalize*) and inter-relate TO-BE system development process.

- Team employs IT partner's products to present results of their "process analysis"

- Team view of their effort -- a major success for [publication](#) (and re-publication)

A complex organizational process:
a *decomposition-precedence* relationship view
(19 levels of decomposition, 400+ tasks)
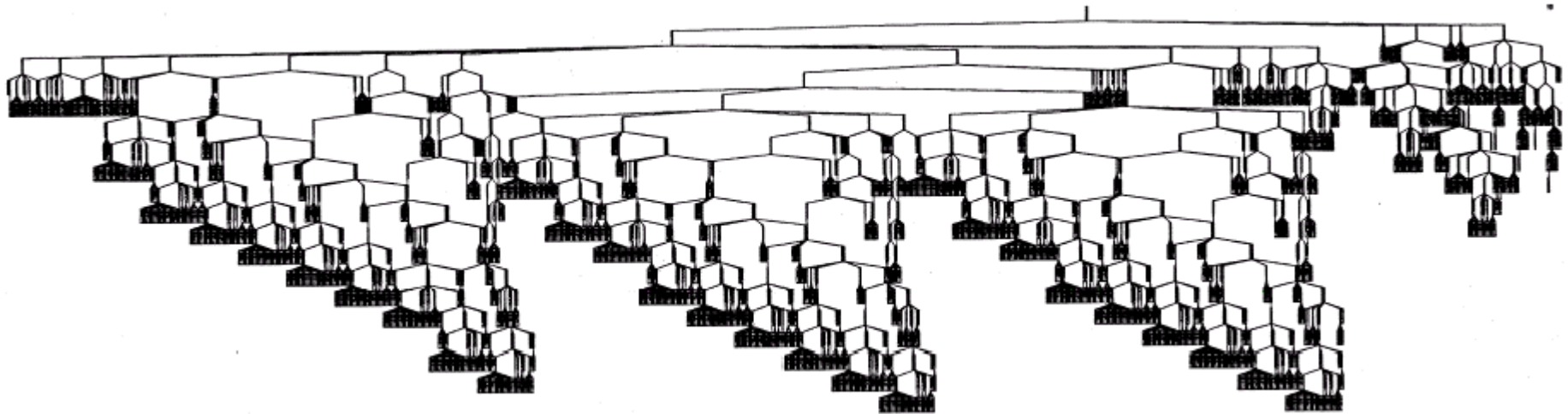
W. Scacchi, Experience with Software Process Simulation and Modeling, *J. Systems and Software*, 46(2/3):183-192,1999.

Backstory

- Team suggests overall process won't succeed -- too complex, too much delegation, problematic hand-offs ("throwing it over the wall")

- TelCo and IT partner dismisses team

- Less than one year later, IT vendor abandons process technology product

- Two years later, business press reports TelCo experiences major project failure and losses greater than $200M, and no system.

Overview

- Problems
  - Understanding, visualizing, (re)designing
- Related approaches
  - Soft systems, Actor Network Theory, etc.
- Current solution alternatives
  - Narrative, hypertext, computational visualization
- New avenues for exploration
  - Visual stories situated within synthetic settings
- Conclusions

Problem: *understanding*

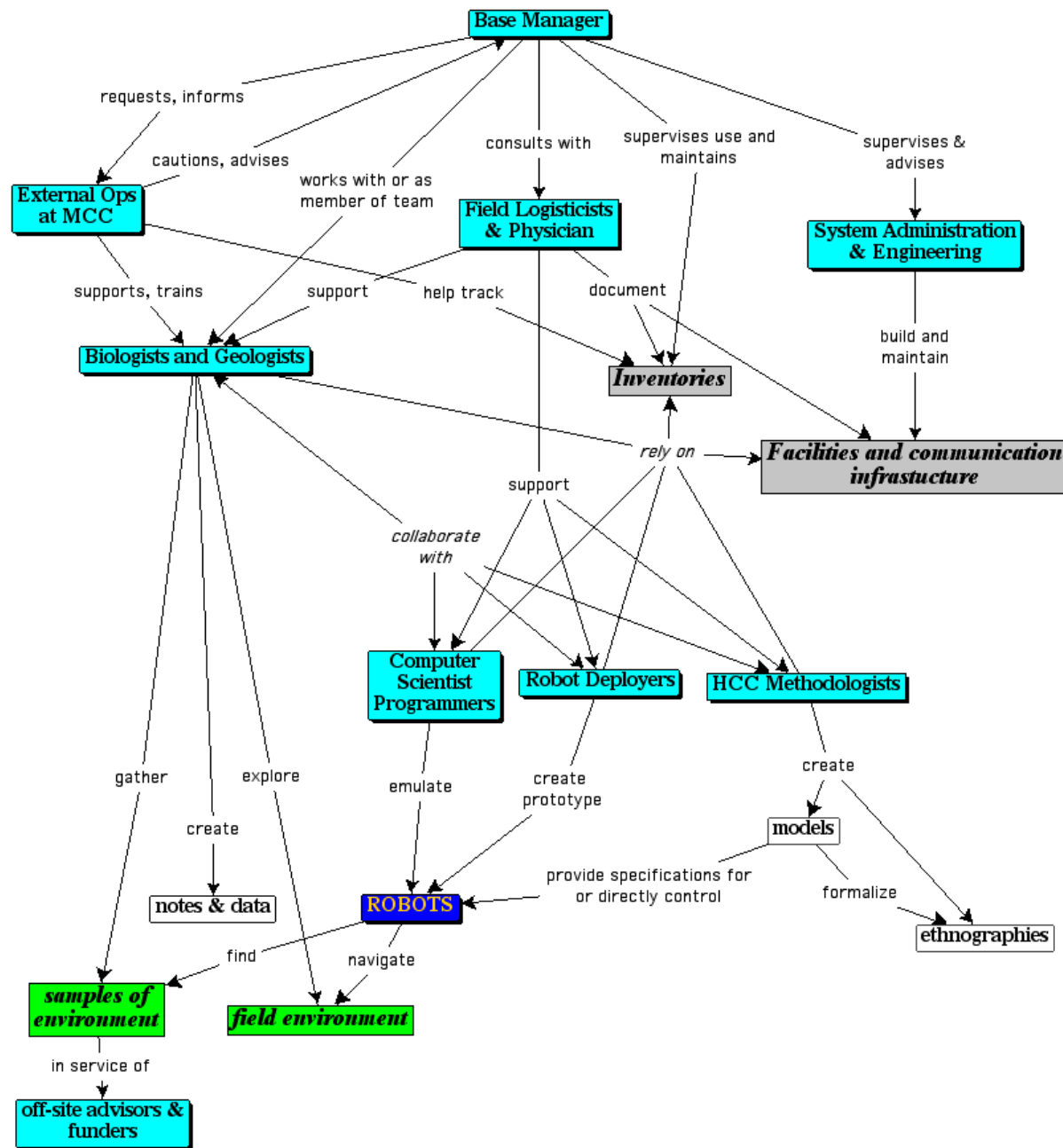- Field studies observing *information work*

Problem: *understanding*

- *Participant* observation
  - Elicitation of situated accounts and sense-making
  - Gathering and jointly creating artifacts
  - Coding and iterative participant validation
  - Representation
  - Analysis (inspection, walkthrough, simulation, statistics)
  - Re-representation (visualization, briefing, publication, etc.)

File ▽   View ▽   Edit ▽   Find ▽

```
; process defintion for order fullfillment

;Level Type Task            Predecessor              People            Input                 Output                Tool
;
0 TC manage_order           n/a                      n/a               n/a                   n/a                   n/a
1 A  price_and_delivery_quote n/a                    sales (1)         n/a                   system_quote          emacs
1 TC credit_approval        price_and_delivery_quote n/a               n/a                   n/a                   n/a
2 TC credit_request         n/a                      n/a               n/a                   n/a                   n/a
3 A  contact_credit_div     n/a                      field_sales (1)   n/a                   cust_info_received
digital_comm
3 A  record_cust_info       contact_credit_div       credit_clerk (1)  cust_info_received    cust_info_recorded    elect_comm
n/a  n/a n/a                n/a                      n/a               n/a                   n/a
digital_comm
2 TC credit_check           credit_request           n/a               n/a                   n/a                   n/a
3 A  assign_cr_request      n/a                      credit_mgr (1)    cust_info_recorded    cr_assignment         elect_comm
3 A  review_cr_request      assign_cr_request        credit_agent (1)  cr_assignment         reviewed_request1     elect_comm
n/a  n/a n/a                n/a                      n/a               n/a                   n/a
digital_comm
3 IB check_loop_begin       review_cr_request        credit_agent (1)  reviewed_request1     n/a                   n/a
3 A  review_cr_history      check_loop_begin         credit_agent (1)  n/a                   credit_history        cr_database
3 A  resolve_cr_probs       review_cr_history        credit_agent (1)  credit_history        n/a                   telephone
n/a  n/a  n/a               n/a                      credit_mgr (1)    n/a                   credit_dept_approval  telephone
3 IE check_loop_end         resolve_cr_probs         credit_agent (1)  n/a                   n/a                   n/a
n/a  n/a check_loop_begin   n/a                      n/a               n/a                   n/a                   n/a
3 A  prepare_cr_report      check_loop_end           credit_agent (1)  credit_dept_approval  credit_report         word_proc
3 A  record_credit_info     prepare_cr_report        credit_agent (1)  credit_report         cr_report_recorded    elect_comm
n/a  n/a n/a                n/a                      n/a               n/a                   n/a                   dss
2 TC terms_development      credit_request           n/a               n/a                   n/a                   n/a
3 A  write_std_clauses      n/a                      terms_agent (1)   cr_report_recorded    std_clauses
terms_database
n/a  n/a n/a                n/a                      n/a               n/a                   n/a
digital_comm
n/a  n/a n/a                n/a                      n/a               n/a                   n/a                   elect_comm
3 IB compile_loop_begin     write_std_clauses        terms_agent (1)   n/a                   n/a                   n/a
3 A  write_special_clauses  compile_loop_begin       terms_agent (1)   n/a                   special_clauses       n/a
3 A  ensure_acceptable1     write_special_clauses    terms_agent (1)   special_clauses       n/a                   telephone
n/a  n/a  n/a               n/a                      terms_mgr (1)     std_clauses           terms_dept_approval   telephone
3 IE compile_loop_end       ensure_acceptable1       terms_agent (1)   n/a                   n/a                   n/a
n/a  n/a compile_loop_begin n/a                      n/a               n/a                   n/a                   n/a
3 A  prepare_terms_doc      compile_loop_end         terms_agent (1)   terms_dept_approval   terms_document        word_proc
3 A  record_terms_info      prepare_terms_doc        terms_agent (1)   terms_document        terms_doc_recorded    elect_comm
n/a  n/a n/a                n/a                      n/a               n/a                   n/a
digital_comm
2 TC pricing                credit_request           n/a               n/a                   n/a                   n/a
```

9

B. Clancey and M. Sierhuis, Human-Centered Computing, Haughton-Mars Project, 1999.

10

Back Forward Reload Home Search Netscape Images Print Security Stop

Location: http://galahad.isi.edu:8000/LOOM/SHUTTLE.HTML What's Related

Theory: BUILT-IN-THEORY ▾ Show View... Hold Window Options... ◉ Browse only ○ Make Changes (Others blocked)

any ▾ [   ] Find ☐ **Exact Match** ☑ **UpCase**

Theory: **PROCESS-META-MODEL**   Package: PROCESS

📖 **Find Matching Instances**   📑 **Bookmark**
Definition

```
(defconcept PROCESS
   :IS-PRIMITIVE RESOURCE
   :ROLES ((RESOURCE-CONTROL )
           (STATUS )
           (ARTICULATING-STATUS )
           (PROCESS-HAS-SCHEDULE )
           (PROCESS-CONTROLLED-BY-AGENT-ROLE )
           (PROCESS-COMPONENT-OF )
           (PROCESS-HAS-PREDECESSOR )
           (PROCESS-HAS-SUCCESSOR )
           (PROCESS-TOP-PERFORMED-BY-AGENT-ROLE )
           (PROCESS-ASSIGNED-TO-AGENT-ROLE )
           (PROCESS-REQUIRE-TOOL-RESOURCE )
           (PROCESS-REQUIRE-RESOURCE )
           (PROCESS-PROVIDE-RESOURCE )
           (PROCESS-USING-RESOURCE )
           (PROCESS-BEING-PERFORMED-BY-COLLECTIVE-AGENT
           (PROCESS-AS-EXPERIENCE )
           (PROCESS-AS-SKILL )
           (TASK-TYPE )))
```

Child Concepts 1 2 3 4 5   PROCESS

ACTIVITY
    ACCOMMODATING
    AGENDAING
    ARTICULATING
    AUDITING/MONITORING
    BRANCH-BEGIN-ACTIVITY
    BRANCH-END-ACTIVITY
    CHECK-MAIL
    DOWN
    EVALUATING-TASK
    IDLE
    ITERATION-BEGIN-ACTIVITY

Classified Instance
OBTAIN-WORK-ORDER-PREPAR

Theory: **PROCESS-META-MODEL**   Package: PROCESS

📖 **Find Similar instances**   📑 **Bookmark**

Types ❶   OBTAIN-WORK-ORDER-PREPARATION-INFO

Asserted: OBTAIN-ACCOUNTING-INFO, PROCESS
Direct: OBTAIN-ACCOUNTING-INFO,
            PROCESS-WITH-NO-AUTHOR ,
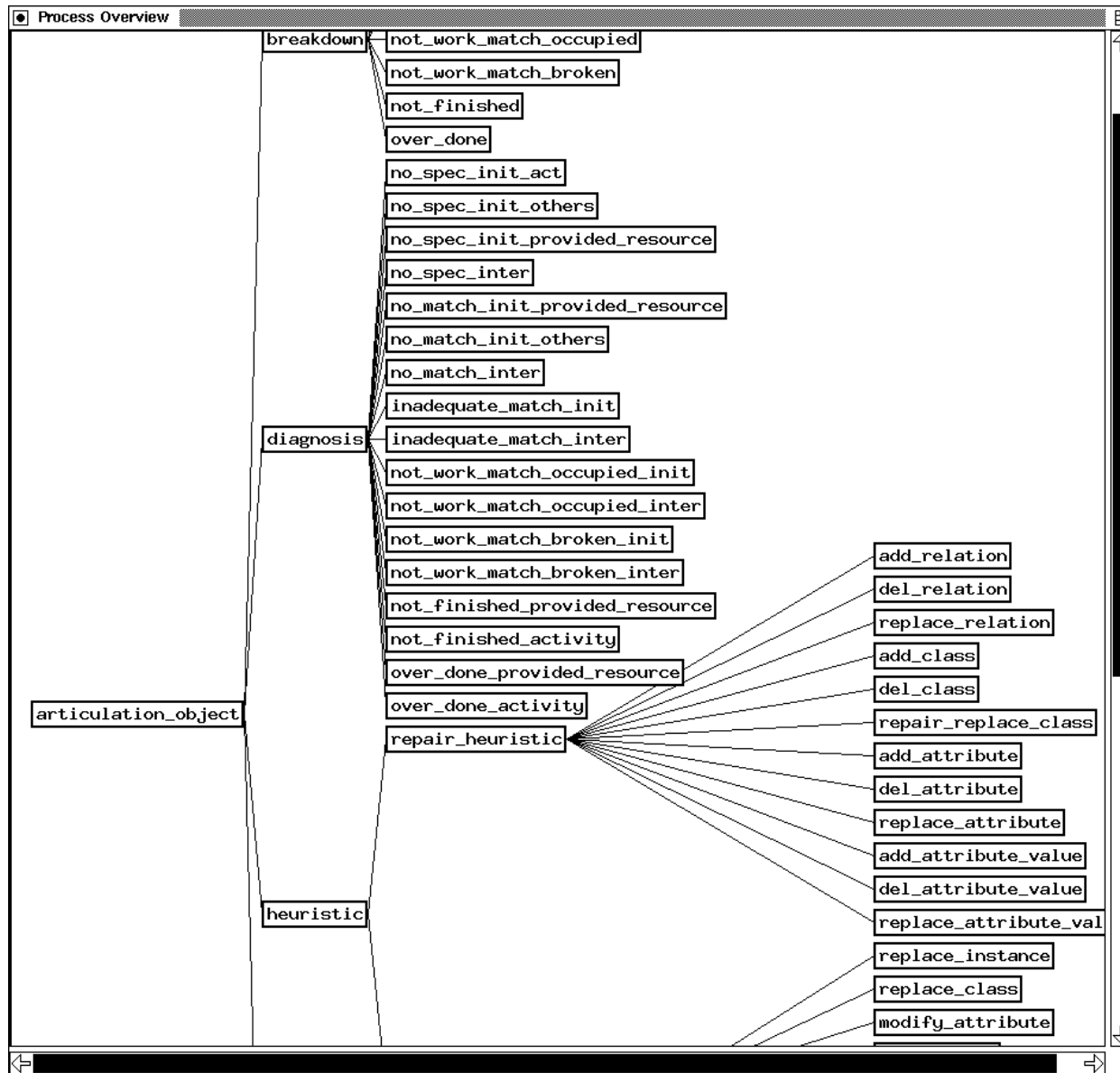   *PROCESS-WITH-NO-RESPONSIBLE* , *STARTING-POINT*

Role Fillers   OBTAIN-WORK-ORDER-PREPARATION-INFO

▤ PROCESS-ASSIGNED-TO-AGENT-ROLE COST-ACCOUNTING

📖 **Find Similar instances**   📑 **Bookmark**

Loom version 3.0, patch level 96 ; *Loom Ontosaurus v 1.5p0*
CL-HTTP/60.57 (Macintosh Common Lisp: 2.6.6)

Please send comments, bug reports and suggestions to Tom Russ.

A. Valente and W. Scacchi, Developing a Knowledge Web for Business Process Redesign, 14th. Knowledge Acquisition Workshop, Banff, Canada, October 1999.   11

P. Mi and W. Scacchi, Articulation: An Integrated Approach to the Diagnosis, Replanning, and Rescheduling of Software Process Failures , *Proc. 8th. Knowledge-Based Software Engineering Conference*, Chicago, IL, IEEE Computer Society, 77-85, September 1993

12

Problem: *visualizing and communicating*

- Briefings and (re)presentations
- Ethnographic narratives
- ([Not so]) Rich pictures
- Participatory simulation, walkthrough, scenario rehearsal, interactive prototyping, guided enactment
- Problematic many-to-many translations
  - Part vs. Whole (decomposition vs. composition)
  - Granularity vs. scalability
  - Generalization vs. specialization

Understanding Comics - Scott McCloud

ONE   A FEW   THOUSANDS   MILLIONS   (NEARLY) ALL

ANOTHER IS THE *UNIVERSALITY* OF CARTOON IMAGERY. THE MORE CARTOONY A FACE IS, FOR INSTANCE, THE MORE PEOPLE IT COULD BE SAID TO *DESCRIBE.*

Also see, W. Eisner, *Graphic Storytelling*, Poorhouse Press, 1996.

Problem: *(re)designing*

- ## What first: to-be goal vs. as-is mess?

  – *If you don't know where you are, any road will do* (proverb)

  – People at work cannot describe the processes they do with high fidelity (tacit knowledge)

  – Redesign necessitates as-is, to-be, *here-to-there*

- ## Workplace democratization

  – Intrinsic vs. extrinsic motivation

  – Empowerment, participation, incentivization (resource sovereignty), and recognition

W. Scacchi, Redesigning Contracted Service Procurement for Internet-based Electronic Commerce: A Case Study, *Journal of Information Technology and Management,* (to appear 2001).

16
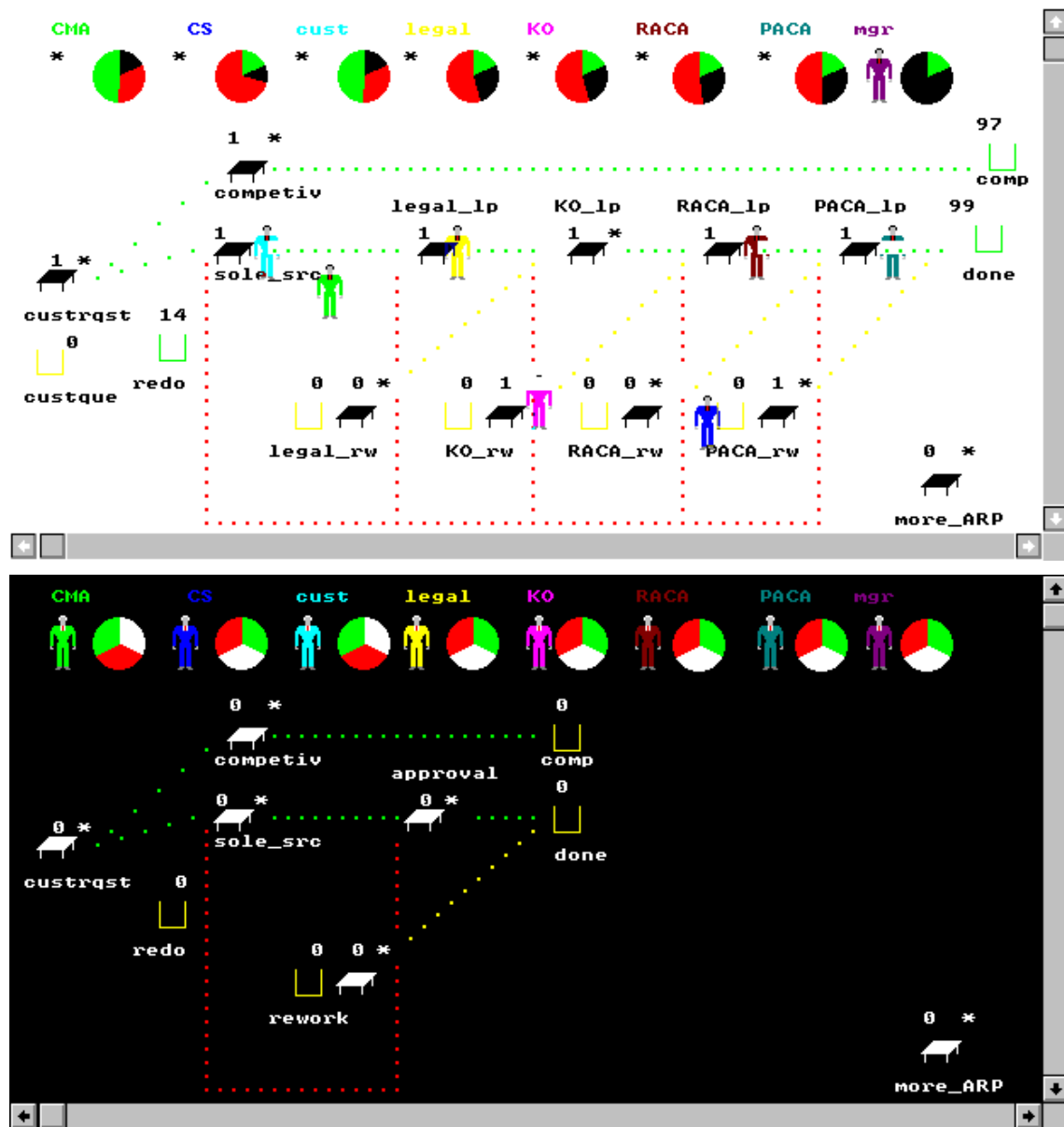
Research grant justification and approval process at Office of Naval Research (c. 1995)
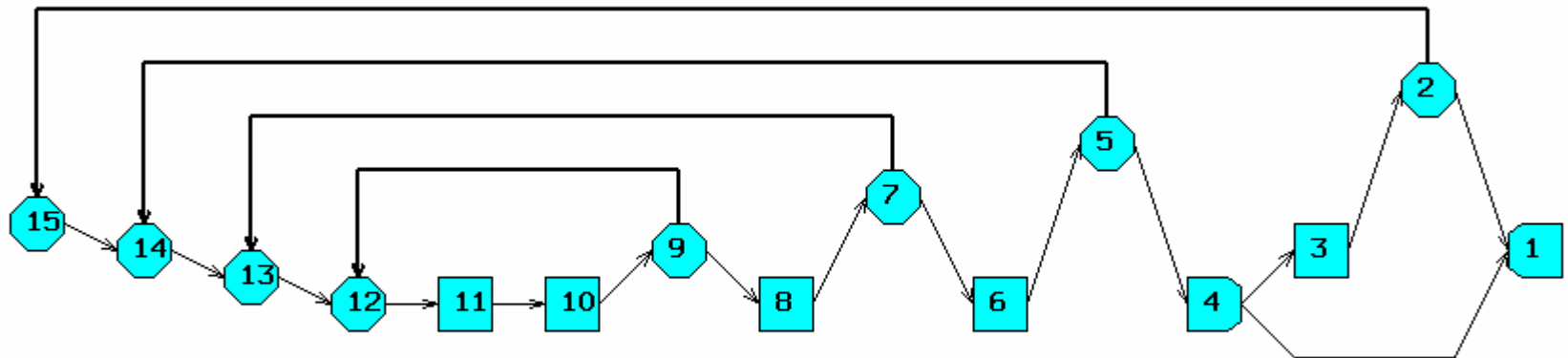
Related approaches

- Social informatics
  - Kling and Scacchi 1982, Kling, *et al.*, 2000
- Actor-network theory (ANT)
  - Callon, Latour, Law 1992, Bowker, Star
- Technomethodology
  - Suchman, Goguen, Dourish and Button 1998
- Computational ethnography
  - Clancey, *et al.,* 1998
- Organizational process engineering
  - Scacchi and Mi 1997

Current solutions

- Narrative descriptions

- Hypertext descriptions/representations

- Computational representations

Current solution forms

- Narrative
  - Linear (traditional)
    - Dominant approach
    - Reinforced by academic traditions, institutional politics, and industrial practices
    - Visual narrative (cinema, comics) is uncommon
  - Non-linear/interactive
    - Contending/repressed approach
    - Experiential (different, plastic, dis-orienting)
    - Multiple storylines
    - Multiple interlinked media (text, audio, video, images, software, etc.) requiring new skills and infrastructures

Current solution forms

- Hypertext/media (Web)
  - Globally accessible texts, cross-links (relations), and media/artifacts (passive or interactive) configured into multiple overlapping contexts
  - A hypertext/media web represents a *context* (the configured, interconnected network) of text objects (iconic nodes), relations types (as colored/black links), and geographically distributed actants and resources.

J. Noll and W. Scacchi, Supporting Software Development in Virtual Enterprises, Journal of Digital Information, 1(4), February 1999.

Current solution forms

- Computational
  - Codified representations or hypertexts with enactable interpretations and (mutable) mobile ontologies
  - We have developed *resource-based* ontologies (aka, process meta-models) that associate
    - 10-800 entity, attribute, or concept types
    - 5-2000 relation types
    - 50-1500 pattern recognizers and transformers

P. Mi and W. Scacchi, A Meta-Model for Formulating Knowledge-Based Models of Software Development *Decision Support Systems*, 17(4):313-330, 1996.

KNOWLEDGE CRAFT

Current context: $ROOT-CONTEXT

Palm Network Editor

Viewport

tions

```
{{ TASK-FORCE
        IS-A: SIMPLE-RESOURCE
        IS-A+INV: ACTIVITY TASK-CHAIN PRODUCTION-LATTICE
        CONTROL: NONSHARED
        STATUS: ALLOCATED
        ARTICULATING-STATUS: NON-AGENDAED
        TASK-FORCE-HAS-SCHEDULE:
        TASK-FORCE-CONTROLLED-BY-AGENT-ROLE:
        TASK-FORCE-COMPONENT-OF:
        TASK-FORCE-HAS-PREDECESSOR:
        TASK-FORCE-HAS-SUCCESSOR:
        TASK-FORCE-TOP-PERFORMED-BY-AGENT-ROLE:
        TASK-FORCE-ASSIGNED-TO-AGENT-ROLE:
        TASK-FORCE-REQUIRE-TOOL-RESOURCE:
        TASK-FORCE-REQUIRE-RESOURCE:
        TASK-FORCE-PROVIDE-RESOURCE:
        TASK-FORCE-USING-RESOURCE:
        TASK-FORCE-BEING-PERFORMED-BY-COLLECTIVE-AGENT:
        TASK-FORCE-AS-EXPERIENCE:
        TASK-FORCE-AS-SKILL:
        TASK-TYPE:
        EARLIEST-START-TIME: -1
        LATEST-START-TIME: -1
        SLACK:-1
        OPTIMISTIC-DURATION: 0
        MOST-LIKELY-DURATION: 0
        PESSIMISTIC-DURATION: 0
        AVERAGE-DURATION: 1
        REMAINING-DURATION: 0
        DUE-TIME: 0
        ACTUAL-START-TIME: 0
        ACTUAL-FINISH-TIME: 0
        TASK-FORCE-COLLECTIVELY-AGENDAED:
        ITERATION-NEST-LEVEL: 0

}}
```

Type any character to continue

*AGENT 1
         1
                          *NON-INTELLIGENT-AGENT

                          *INTELLIGENT-AGENT

*RESOURCE 1

*SIMPLE-RESOURCE

Relation Keys:
(1) IS-A

Create Schema

Delete Schema

Create Link

Delete Link

Network

Create Relation

Status

Exit

M: Initial scroll position, R: Item command menu.

24

New avenues

- ## Organizational mandalas
  - *Conceptual* visualization of stories
    - Multiple overlapping actors (actants), relationships, and network configurations
    - Rich pictures (with links to external descriptions)
    - Mandala stories are contemplated and revealed via navigational traversal in a quest for enlightenment
      - Outside-in spiraling traversals (encounters)
      - Situated encounters with actants help instigate revelation
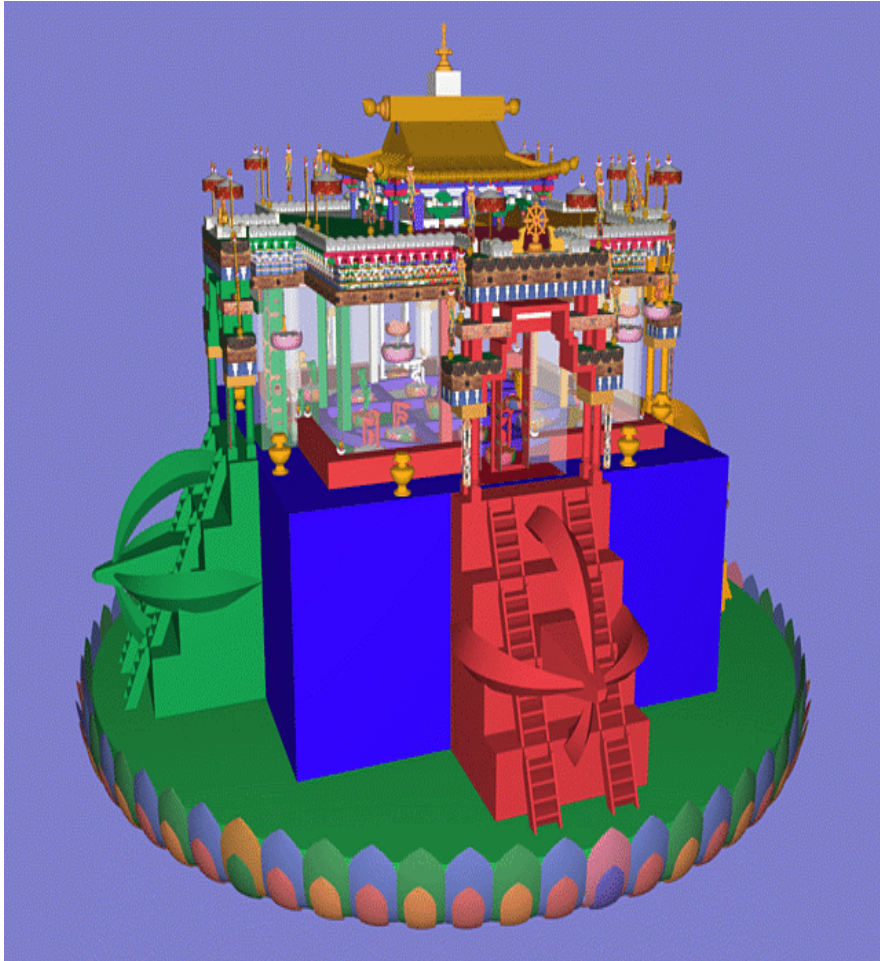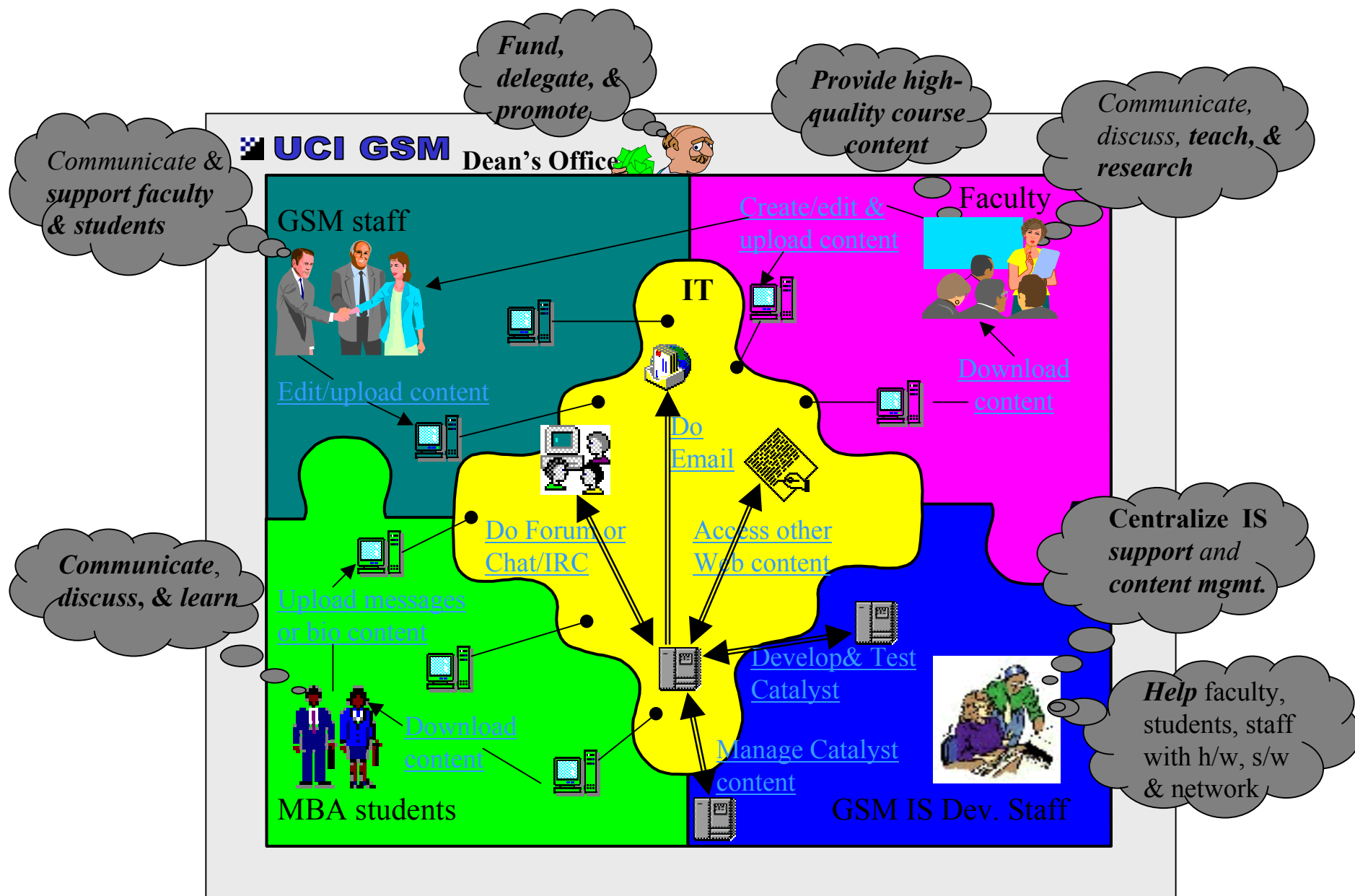
A *socio-technical enterprise mandala* for the UCI GSM Catalyst System:

a corporate infrastructure for information sharing

28

- Early Tibetan Mandalas: The Rossi Collection
- Robert A. F. Thurman and Denise Patry Leidy *Mandala: The Architecture of Enlightment*, Asia Society Galleries, Tibet House, 1997.

New avenues

- Process Webs
  - *Logical* visualization of configured/networked stories articulated through navigational traversal
    - *Techno*logical
    - *Socio*logical
    - *Anthropo*logical
    - *Sociotechno*logical
    - *Technosocio*logical
    - etc.

J. Noll and W. Scacchi, Specifying Process-Oriented Hypertext for Organizational Computing, *J. Network and Computer Applications,* 24(1):39-61, 2001

File Edit View Go Communicator Help

Back   Forward   Reload   Home   Search   Netscape   Print   Security   Stop

Bookmarks   Location: http://www.ics.uci.edu/~wscacchi/DAU-Demo/ACQ-Process-D   BullsEye   What's Related

Software Acquisition Web MANager (SAWMAN) Process Enactment demonstration.

Reference Materials:

- DD21 Program Acquisition: A candidate Program for SAWMAN experimentation and evaluation?
- Software Program Management Best Practices
- Acquisition Review Quarterly
- ARQ article by Walt Scacchi and Barry Boehm on Virtual System Acquisition
- Information on Federal Acquisition Regulations and Acquisition Reform
- Information about the Defense Acquisition University, sponsor of this research project.

Guidance and data for SAWMAN tasks appear in this window.

Please select Begin to start the SAWMAN process execution demo.

Next Task

Document: Done

32

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Stop

Bookmarks Location: http://www.ics.uci.edu/~wscacchi/DAU-Demo/ACQ-Process-D BullsEye What's Related

Result

submit_proposal
- baa = N00244-00-X-BAA1
- CBD-source = http://web.nps.navy.mil/~menissen/earp/FY00/FYOOBAA.doc
- title = Exploring Software Product Line Architectures for Software Acquisition Research
- institution = Institute Software Research, University of California, Irvine
- PI = Richard N. Taylor
- PIemail = taylor@ics.uci.edu
- contact = Walt Scacchi, Co-PI
- contactEmail = wscacchi@ics.uci.edu
- file = http://www.ics.uci.edu/~wscacchi/DAU-Demo/ACQ-Process-Demo/proposal/proposal.html

Next Task

Exec: executing root
Exec: executing proposal_submit
Exec: executing submit_proposal
submitForm: submitting submit_proposal

Document: Done

34
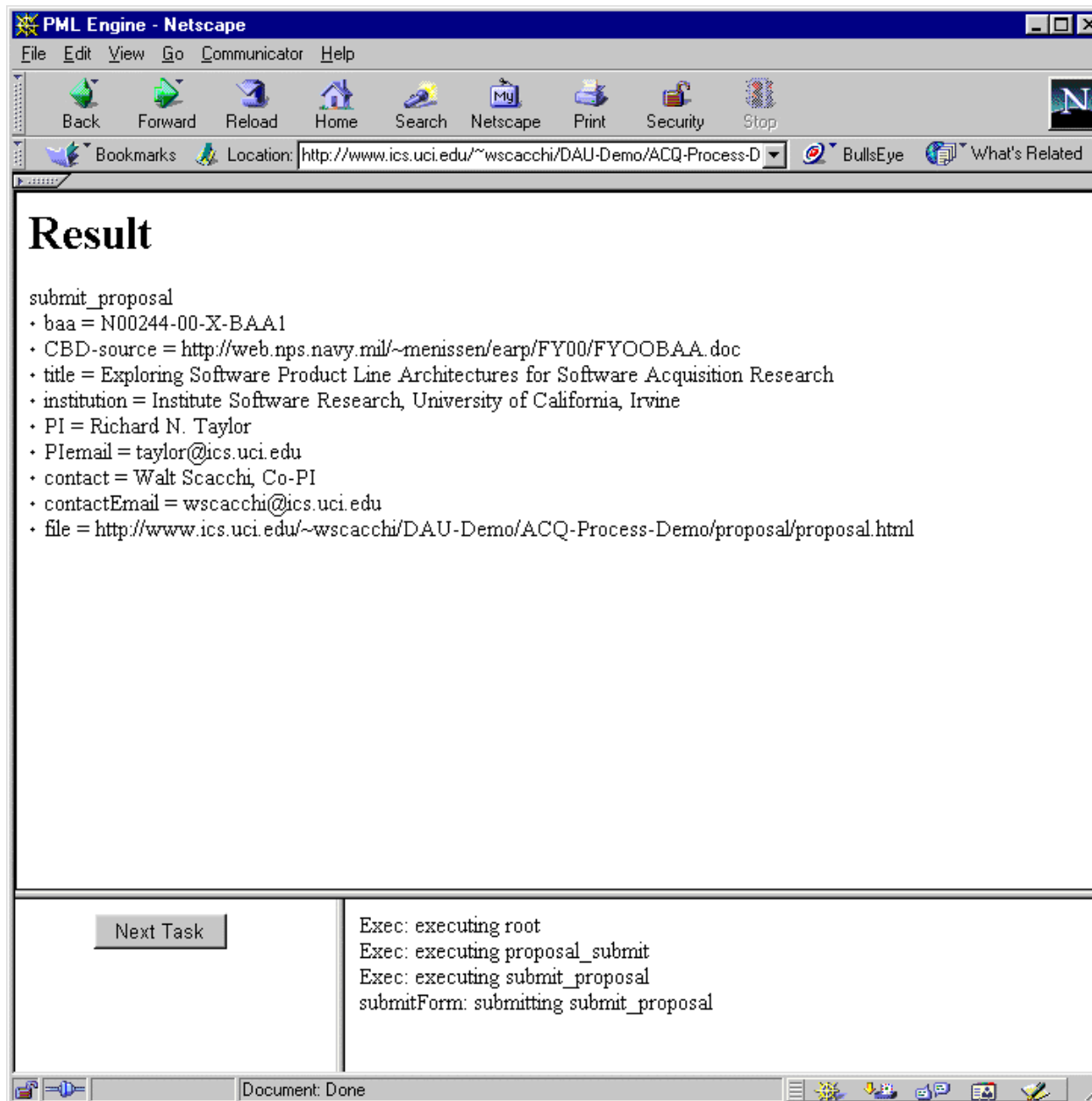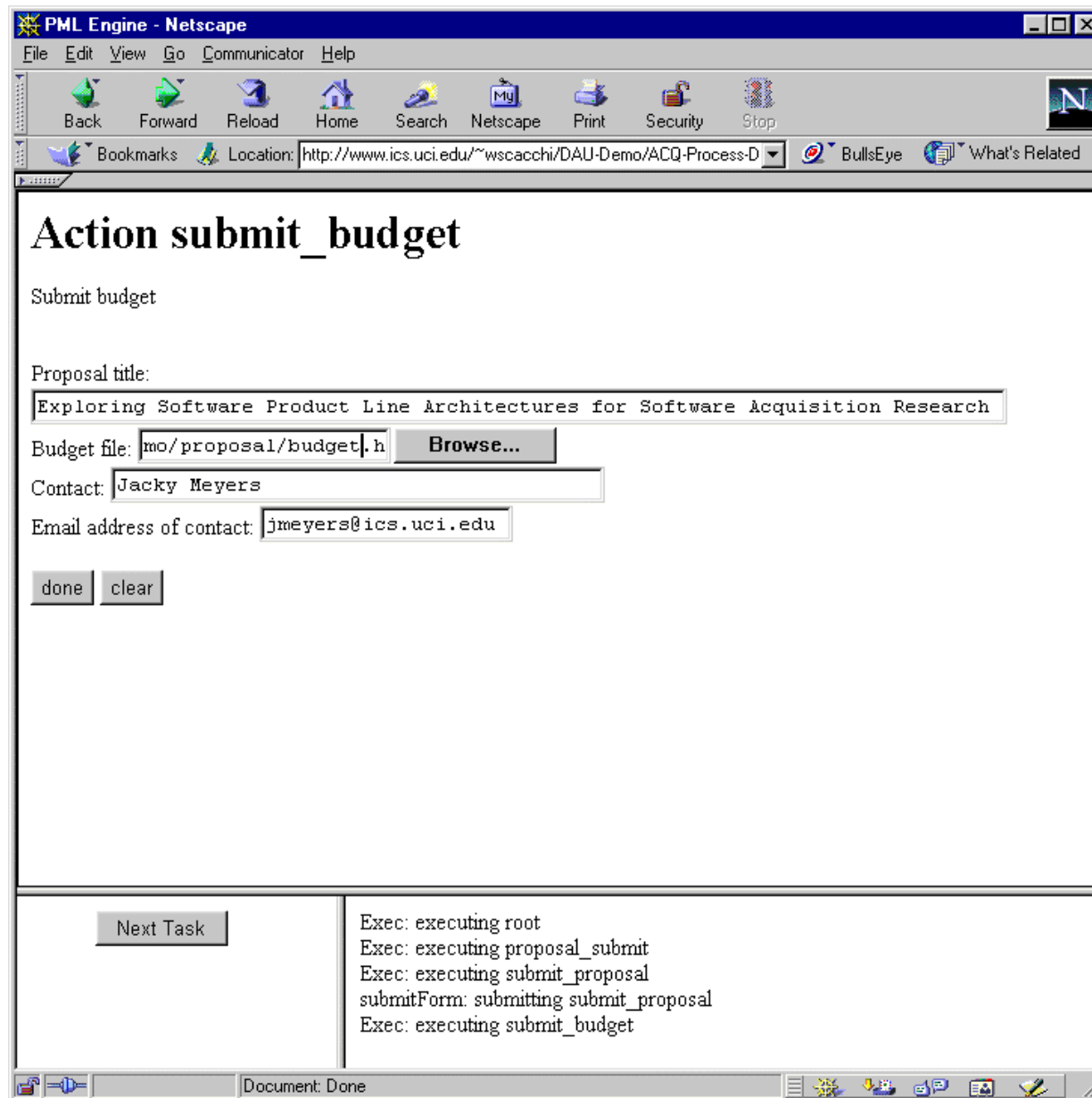
New avenues

- Synthetic environments (computer game worlds) for situated visual storytelling
  - Situated *physical* visualization of storyline trajectories interpreted via navigational traversal
  - N.B., Computer game industry is moving toward offering end-user authoring extension facilities with consumer games.
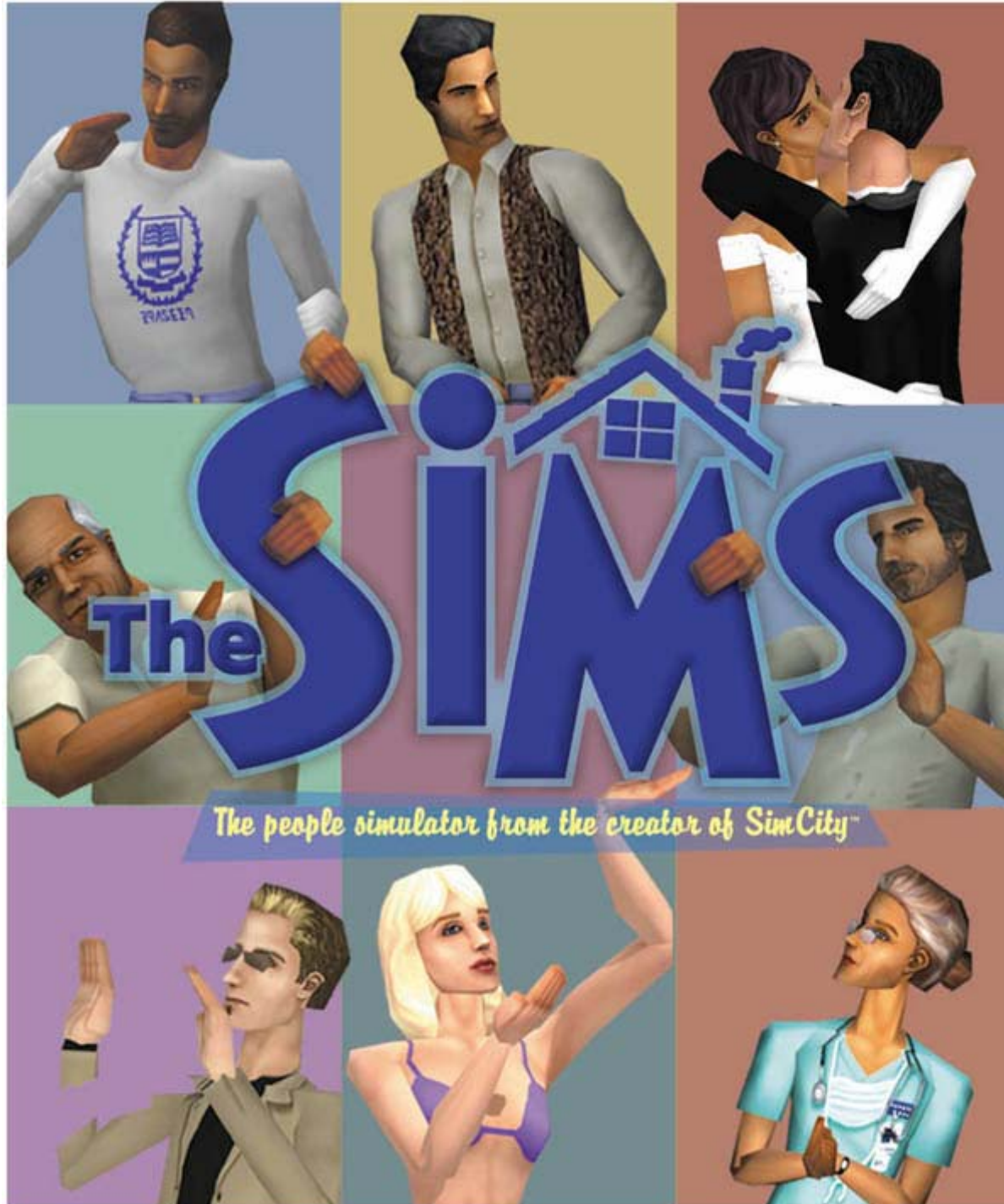
The people simulator from the creator of SimCity™

"Starbucks Sucks"
(a contributed story)

(20) ——————— Tool Builders

(150) ——————— Content Artists

(300) ——————— Webmasters

(10,000) ——————— Storytellers

(500,000) ——————— Collectors

(3,000,000) ——————— Players

1% of 1M - Enable vrs. Leverage Success

Work practice simulators?

Current field study

- Understanding open source software practices and processes in different domains
  - Academic research vs. Commercial development
  - Where is the workplace?
  - Emergent systems engineering as social order?
- Moving toward *open research* methodology
- To produce and compare narrative, hypertext, and computational renderings.

Conclusions

- Understanding, communicating and redesigning complex processes *consumes* and *produces* multiple renderings in multiple forms.

- Methods of inquiry becoming more *open*, and accommodating of *mutually bi-directional* cause and consequence.

Conclusions

- Conceptual, *logical, and physical visualizations of organizational processes (stories) are complementary, in conflict, thus desirable.

- Interactive, multi-player computer game worlds will emerge as *a new visual information media*
  - Cultural form, research, work practice, education.

◀ Create/edit & upload content

- Faculty (authors) create (insert) new content or edit (update) existing course content
- Faculty can transmit the content they create to Administrative staff for edit&upload into Catalyst, else Faculty upload their content into Catalyst
- Faculty/staff can only upload one type of course content at a time into Catalyst
  - (Exception) Catalyst will allow existing content to be copied from one course to another without upload.
- Faculty can only edit (update) content they have individually created
  - (Exception) Faculty may copy and paste content created by other Faculty from one part of Catalyst ("Faculty Lounge") into their course content.
- *User constraint*: Catalyst cannot verify if content uploaded is correct in any sense. User is responsible for correctness of content
- *System constraint*: Catalyst will not allow content edit/upload if the Catalyst DBMS is not available

Download content

- Users (Faculty and Students) can search and download course content:
  - for courses Faculty have created; or
  - for messages or biography info. entered by Students in a course; or
  - (Exception) from course content designated for sharing by all Faculty (course syllabi and linked materials)
- *User constraint*: Catalyst will not allow access to content except as allowed by GSM Dean's policy
- *System constraint*: Catalyst will not allow search or download of Catalyst content if Catalyst DBMS is unavailable.
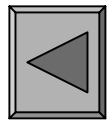
◀ Edit/upload content

- Faculty can transmit the content they create to Administrative staff (publishers) for edit&upload into Catalyst

- Administrative staff can only upload one type of course content at a time into Catalyst

  – (Exception) Catalyst will allow existing content to be copied from one course to another without upload.

- *User constraint*: Catalyst cannot verify if content uploaded is correct in any sense. User is responsible for correctness of content

- *System constraint*: Catalyst will not allow content edit/upload if the Catalyst DBMS is not available

Upload messages/bio. content

- Students can download, update, then upload personal biography information for sharing with other users.

- Students (end-users) can upload messages for sharing with other students in their course at any time.

  – (Exception): Students can send&receive email from other students via Catalyst, without uploading these messages into Catalyst

- *User constraint*: Catalyst cannot verify if content uploaded is correct in any sense. User is responsible for correctness of content

- *System constraint*: Catalyst will not allow content edit/upload if the Catalyst DBMS is not available

◀Do Forum or Chat

- Faculty can request students in their courses to download or upload messages via a Discussion Forum or Chat

- Faculty or Students can download/upload messages for sharing with other students in their course at any time.
  - (Exception) Faculty can remove messages from their Discussion Forums

- User constraint: Messages that are deleted from a Discussion Forum cannot be retrieved

- *User constraint*: Chat message content is not saved by Catalyst

- *System constraint*: Discussion Forum message content may be lost if Catalyst Database is not backed-up.
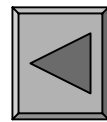
Do Email

- Any user can access internal or external email systems via Catalyst to create, upload, download, update then upload messages for other users at any time.

- Catalyst does not manage email messages or message services
  - (Exception): Users can create, upload, download, update then upload email messages via Catalyst, without uploading these messages into Catalyst.

- *User constraint*: Users cannot use Catalyst to manage or keep track of personal/private email messages or message content

- *System constraint*: An email server may fail to send or receive email messages with/without notifying email users
 - (Exception) Email servers will notify users if sent mail cannot be delivered
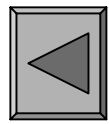
Manage Catalyst content

- Developers create the representations, relations, and system components that provide users access to content managed by Catalyst.

- Catalyst is used to organize, store, query, retrieve or update content that is managed by Catalyst

- Catalyst uses a (relational) database management system to organize, query, retrieve or update content that is stored in its database

  – (Exception) Catalyst stores data that identifies content, and controls access to content, stored as files in a networked file server, or as Web-based content accessed via the Web.

- *User constraint*: Catalyst cannot be used to store arbitrary files for end-users.

- *System constraint*: Catalyst cannot control updates to external content accessed via the Web.
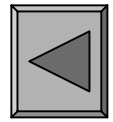
Develop & Test Catalyst

- Developers create the representations that other users utilize to create, insert, update or delete their content.

- Developers create, insert, update and delete content stored in Catalyst representations to test its proper operations

  – (Exception) Developers cannot guarantee that all functions supported by Catalyst have been tested.

  – (Exception) Developers cannot guarantee that all functions supported by Catalyst are re-tested every time any Catalyst function or operation is modified (updated).

- *User constraint*: Developers expect that users will notify them if the users encounter anomalies in Catalyst usage.

- *System constraint*: Catalyst system components may fail to operate correctly even though they have been tested.
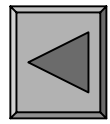
◀ Access other Web content

- Faculty can create content that contains Web hyperlinks
- Users can select hyperlinked items
  - A selected item is downloaded into the User's client if the Web server can retrieve the item.
  - (Exception) Users that select hyperlinked content will be disconnected from Catalyst after a certain elapsed time, unless they return to Catalyst
- *User constraint*: Catalyst will not allow access to its content directly from the Web
- *System constraint*: Catalyst may unexpectedly terminate a user session if a user accesses Web items that attempt to upload information into Catalyst, or launch applications unknown to Catalyst.
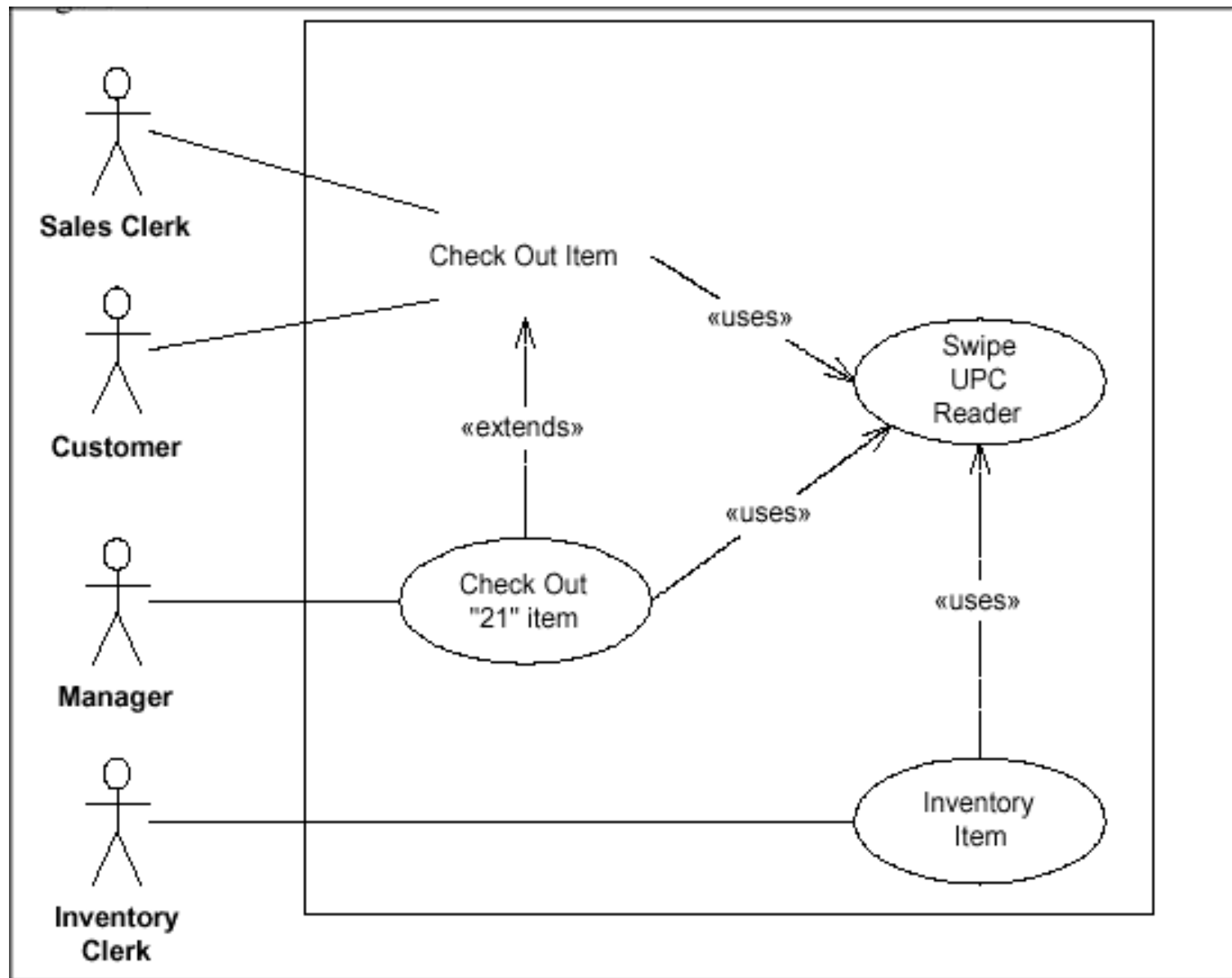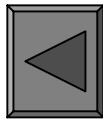
A "use case" requirements diagram for representation in the standard *Unified Modeling Language* 61