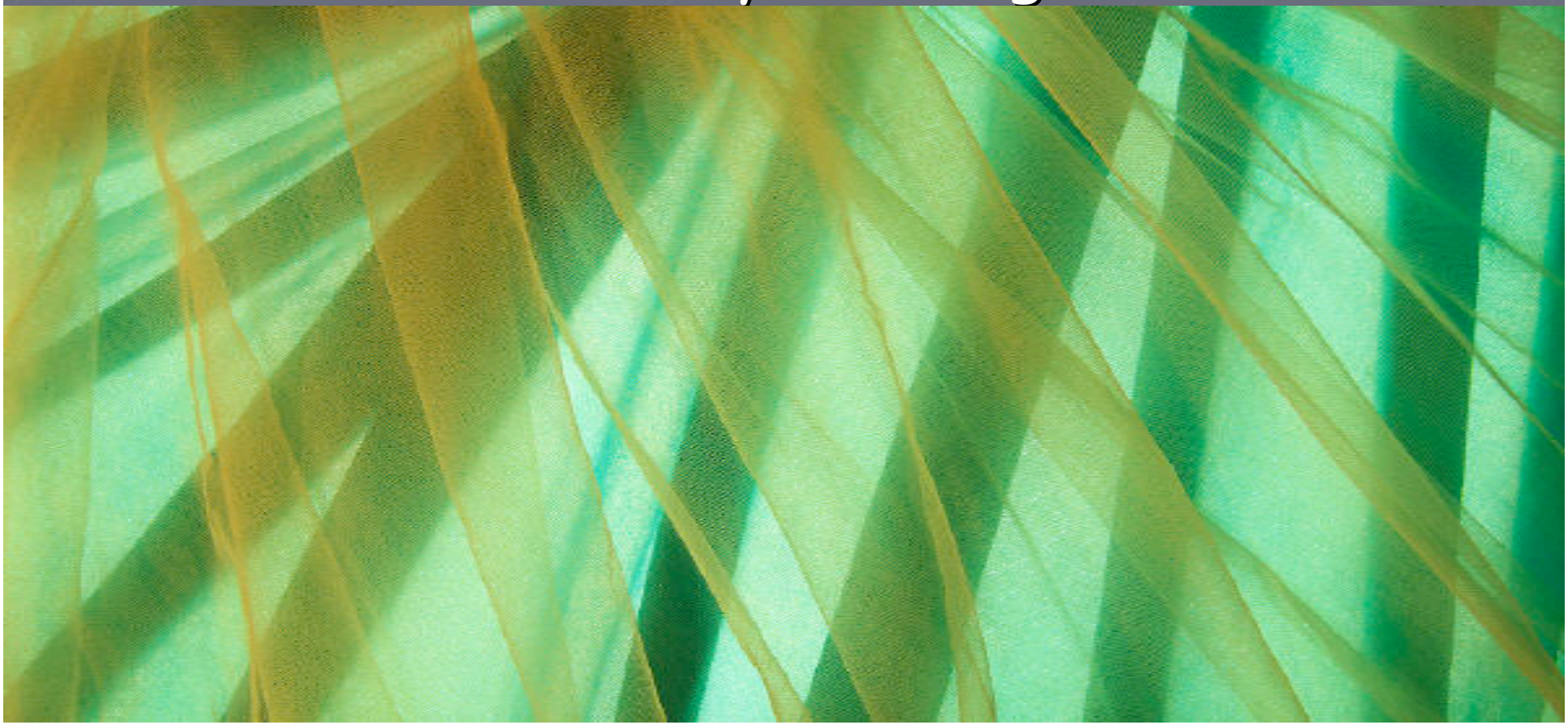
A Clinical View of Requirements Engineering

Stephen Fickas

University of Oregon

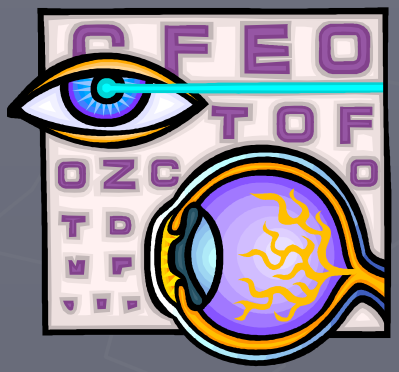


Talk Outline

- Working definition of a clinical process illustrated with Eye Clinic.
- Second example using rehabilitation field (extends the process).
- Description of four-year study using email as treatment (uses the process).
- Current status and future work.
- Conclusion.

The Clinical Process: a Working Definition

Starts With a Human-Centric Problem Domain



Initial Exam

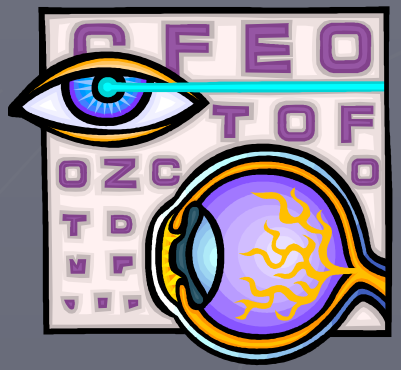
Treatment Package

Adapt

Monitor

Check-Ups

Sub-processes of Initial Exam

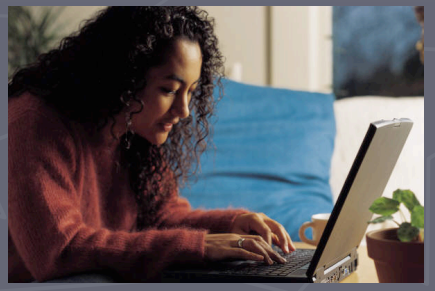


Initial Exam

Individual Assessment

Requirements Acquisition

Activities of daily living (ADLs) affecting vision



The Treatment Cycle

Initial Exam

Specification

Monitor

Check-Ups

Adapt

Key Points of Clinical Process

- Individual process: assumes (a) one-size-fits-all solution will fail, and (b) problem changes over time in individualized ways.
- Assessment implies a skills inventory. For optometry, a theory of vision under varying circumstances.
- Treatments imply a solution-theory that maps assessed skills (e.g., unaided eyesight), combined with requirements, to solutions.
- Process assumes that both humans and their environment can change over time. Hence, treatment comes in two sides of same coin: (a) what is delivered initially, and (b) what new/adapted solutions are delivered by monitoring over time.

Another Clinical Process: Rehabilitation

Starts With a Human-Centric Problem Domain

Initial Exam

Treatment Package

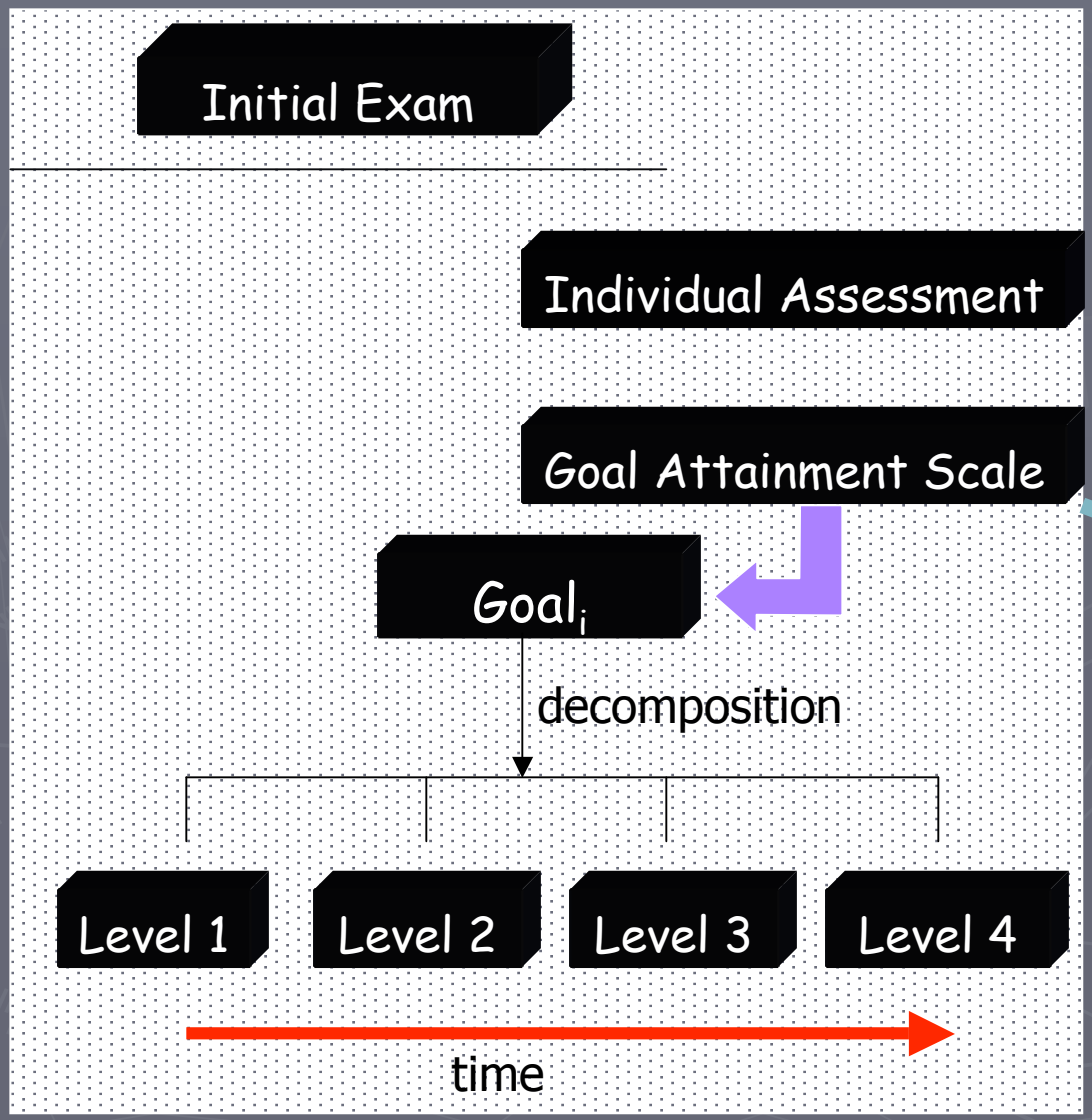
Monitor

Adapt

Deferred Goals

Check-Ups

Introduction of Goal-Attainment Scale



Some shared ADLs, some individualized

- ❖ self-care skills (dressing, eating, bathing, going to the bathroom)
- ❖ home-care skills (cooking, cleaning)
- ❖ work and leisure skills (using a phone, transportation)

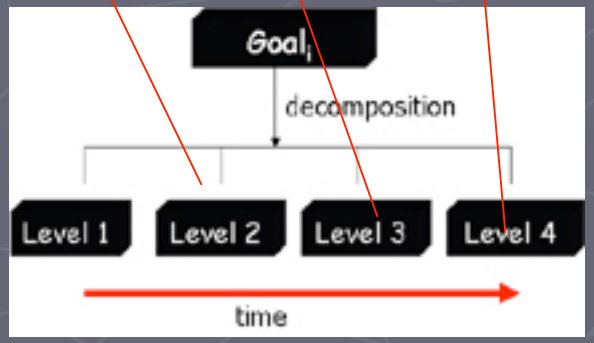
The Modified Treatment Cycle

Initial Exam

Specification

Adaptation is driven by attainment levels.

Adapt



Monitor

Key Points of Extended Process

- Goal-Attainment Scale (GAS) implies a decomposition of the domain into measurable sub-goals or levels of attainment.

- People are encouraged to set long-range goals. Goals/levels that are not immediately applicable are deferred.

- Deferred goals have some metric that allows them to be monitored for applicability.

- Monitoring is goal-based. The goals of an individual are used to prune the entire monitoring space.

Can Software Play a Role in Treatment?

- Staying in the Rehabilitation field, I will switch to Cognitive Rehabilitation.
- Within this field, I will focus on survivors of a Traumatic Brain Injury (TBI). Numbers are roughly 6-10 million in US.
- The Cognitive Rehabilitation field is not a software domain, per se. However, it follows a clinical process that includes a GAS component.
- The challenge handed to me was to work-in a software component to a treatment package, and working backwards into the entire clinical process

Brief Description of TBI impairments

Two general classes of problems:

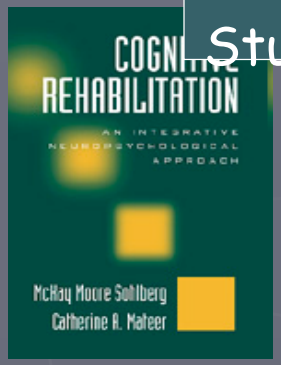
1. Memory
   - Short term memory (holding on to set)
   - Anterograde memory (memory for new learning)
2. Executive functions
   - Initiation
   - Organization
   - Planning
   - Self-monitoring
   - Inhibition

Impairment space is taken by expanding each issue on a severity scale, and then taking the cross-product of all issues+severity.

It is difficult to identify the *typical* brain injured individual from

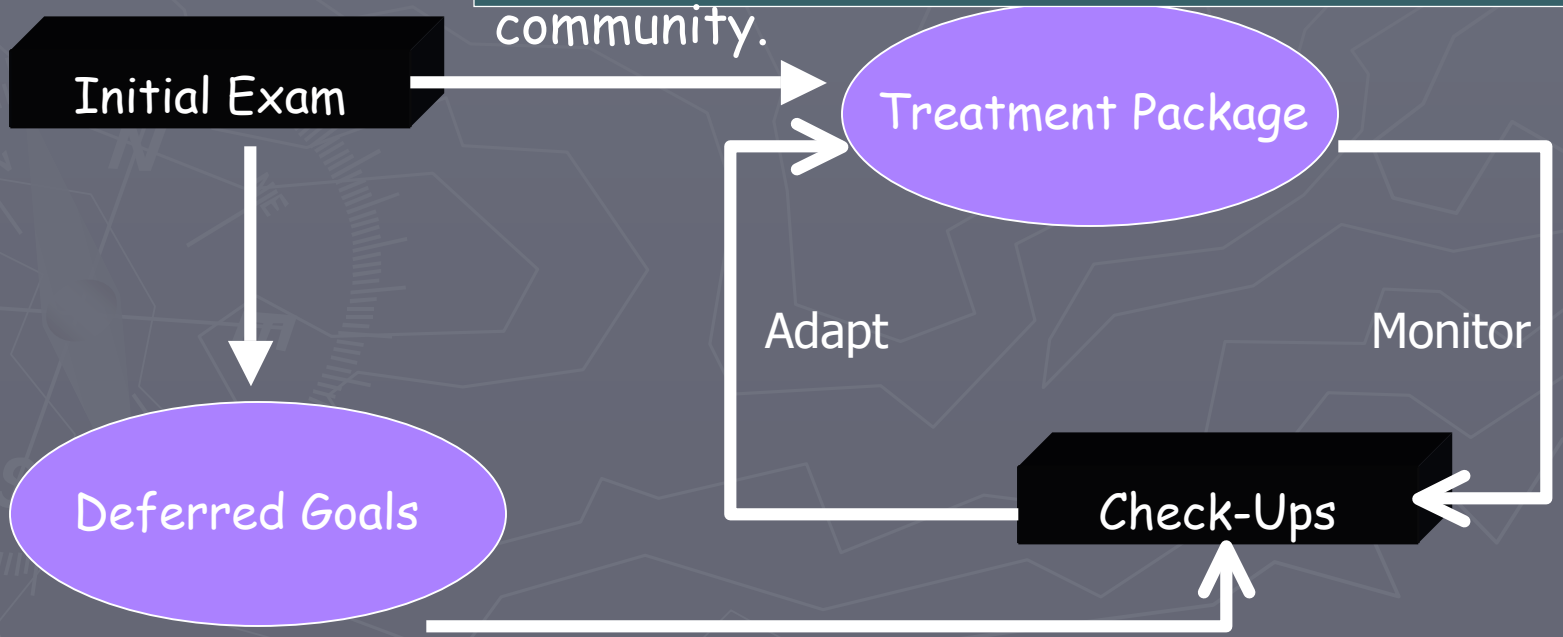
A Social-Reconnection Clinic for TBI Surv

❖ Clinic staff includes academics and practioners from the fields of Cognitive Rehabilitation, Training/Education, Qualitative Studies, Field Observation, Computer Science.

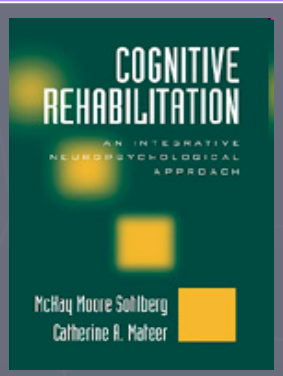


In spr

Working with clinic staff, I came up with two potential treatments: (1) email as a way to reconnect with friends and family (and to make new friends), and (2) navigation aids to support trips that provide reconnection with the physical community.



A Social-Reconnection Clinic for TBI Survivors



We started here

Initial Exam

Treatment Package

Adapt

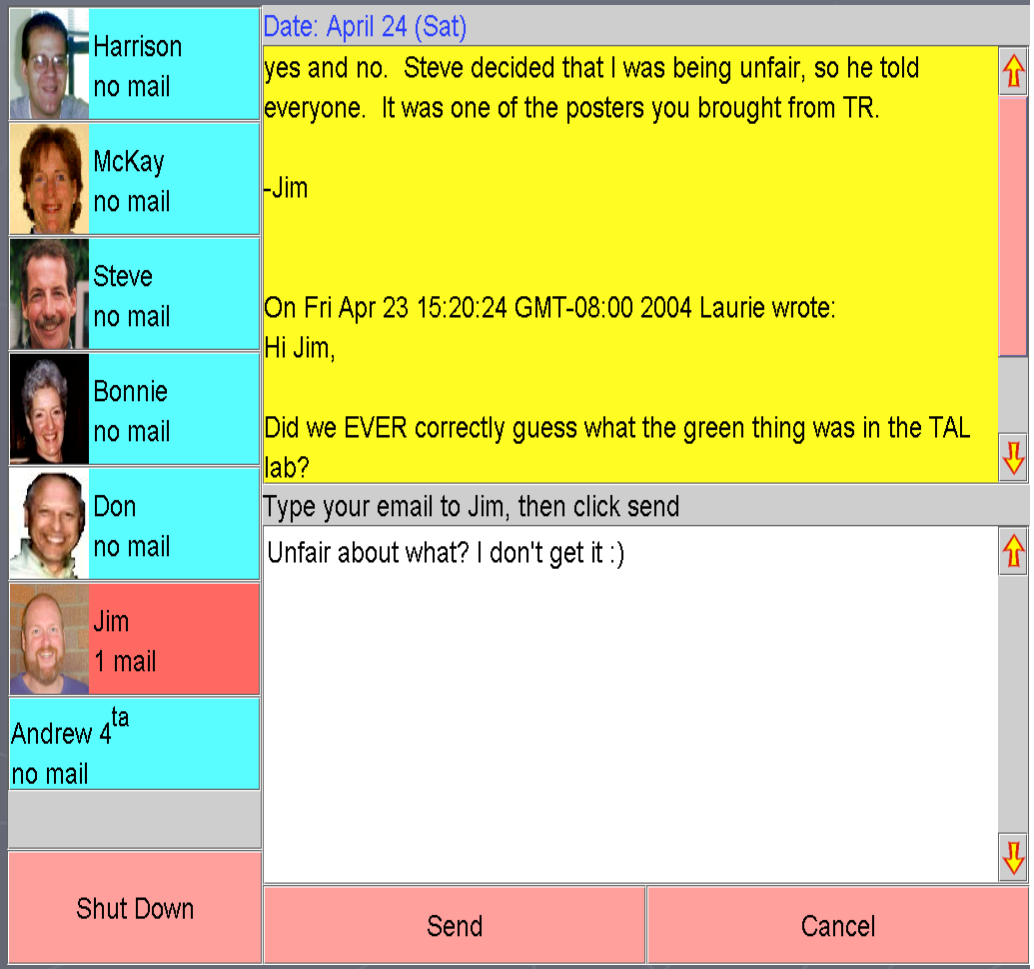
Monitor

Deferred Goals

Check-Ups

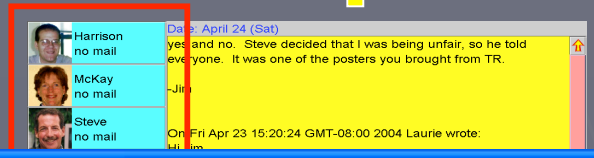
The Email Client

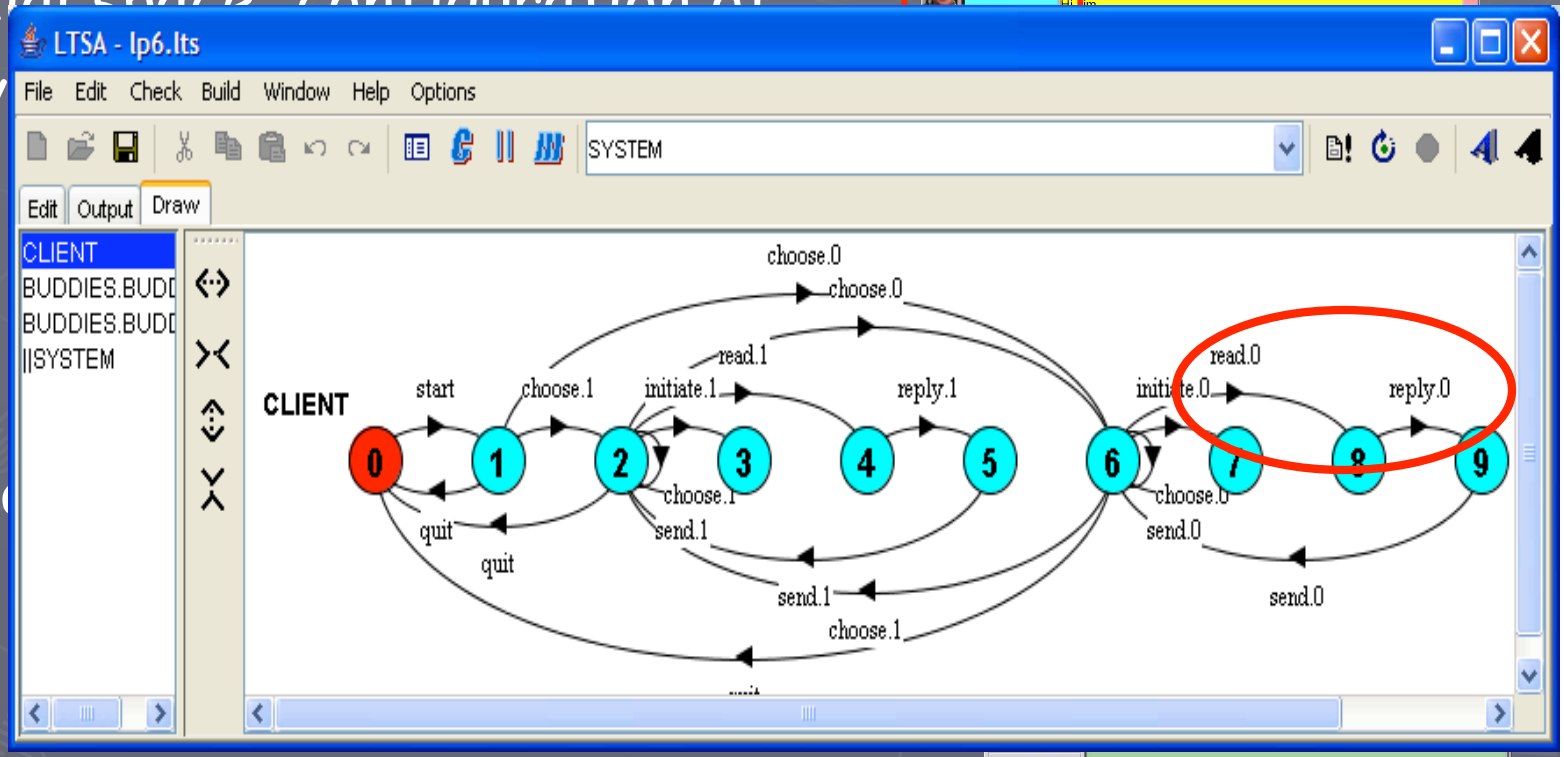
- In the summer of 2001, we ran a pilot study to determine the range of email clients (and features) that
  - Closed buddy list.
  - Fixed windows.
  - Minimize access to OS interface.
  - Control of process different individuals.
  - Control of composition
- This led to our construction of a

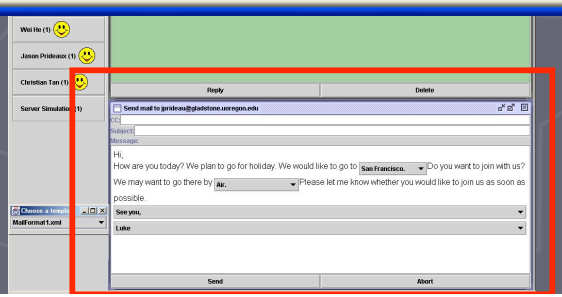


Configuration Space

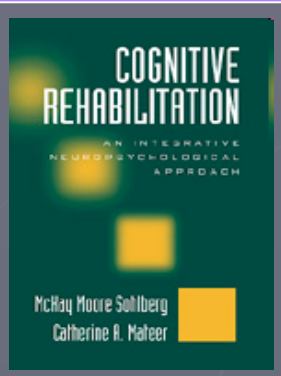
- 1. The social space: configuration of the buddy
- 2. The em control vs
- Roughly composition space configurations.



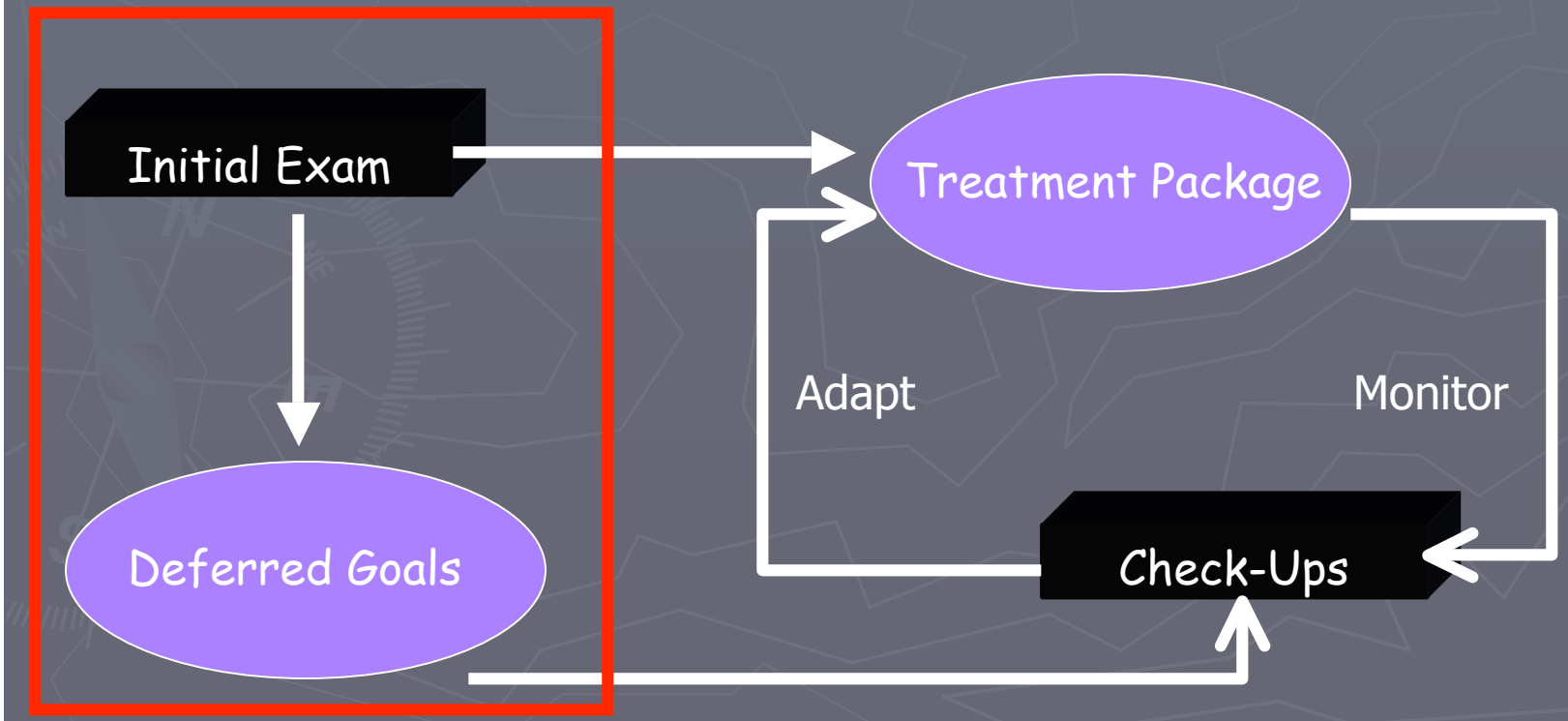




A Social-Reconnection Clinic for TBI Survivors



We next looked here

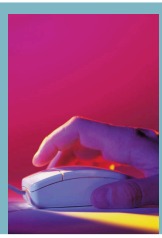


A Skills-Study of Emailing

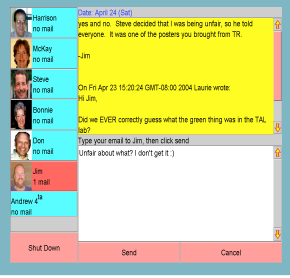
- Initial Exam
- Individual Assessment
- Goal Attainment Scale

Letter keys,
Special characters,
Arrow keys

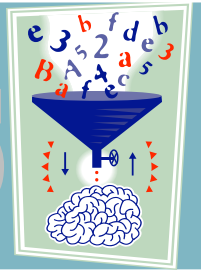
Mouse movement,
Clicking



Interface navigation

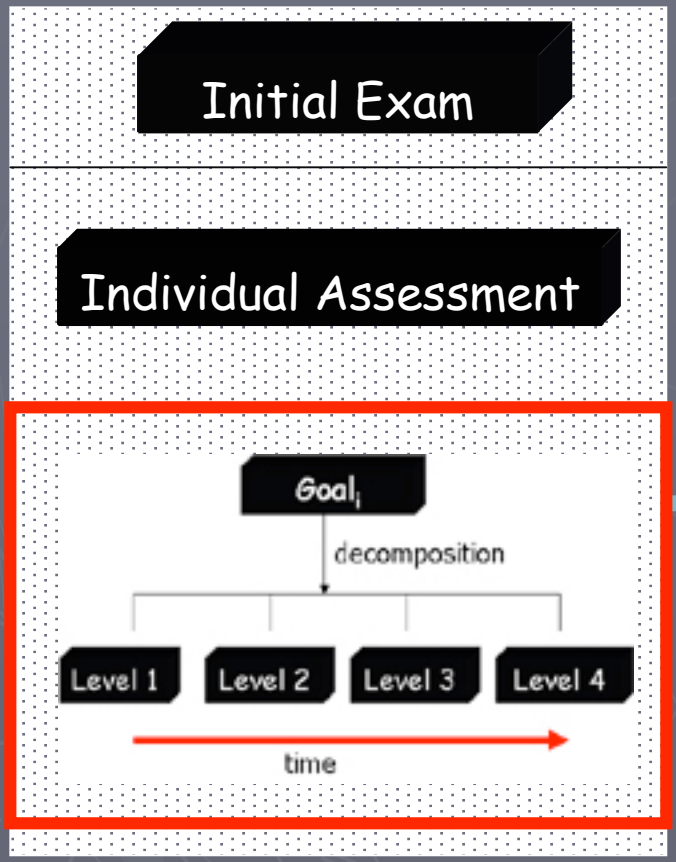


Memory
Executive Function



Six month project produced roughly 50 skills

Email GAS



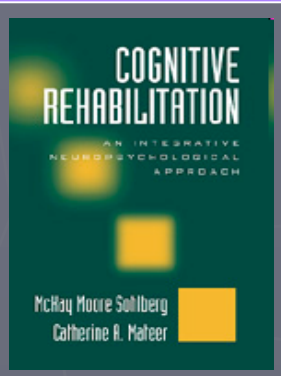
General Goal Patterns

- Reconnect with friends and family
- Learn something new
- Advocate (e.g., congressman, SIG)

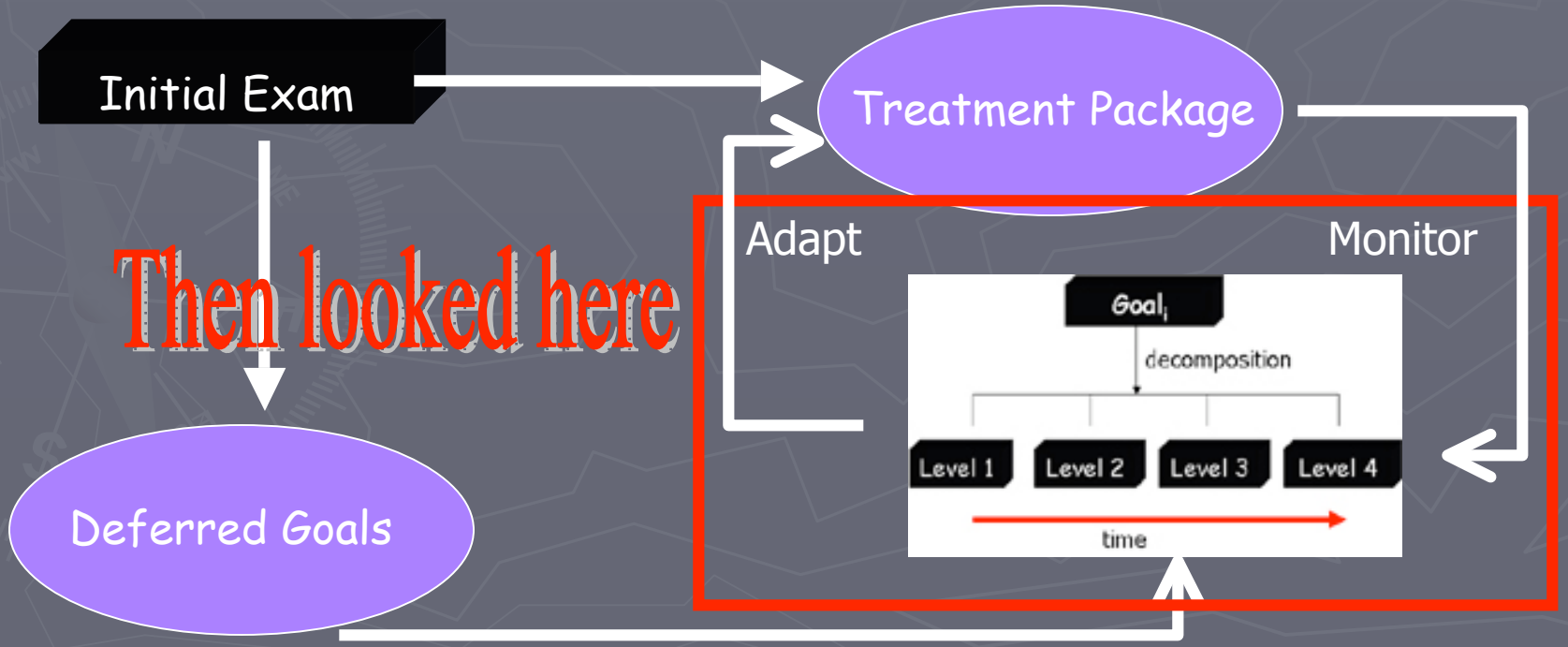
Idiosyncratic Goals

- Work on getting inheritance cleared up
- Distribute poetry

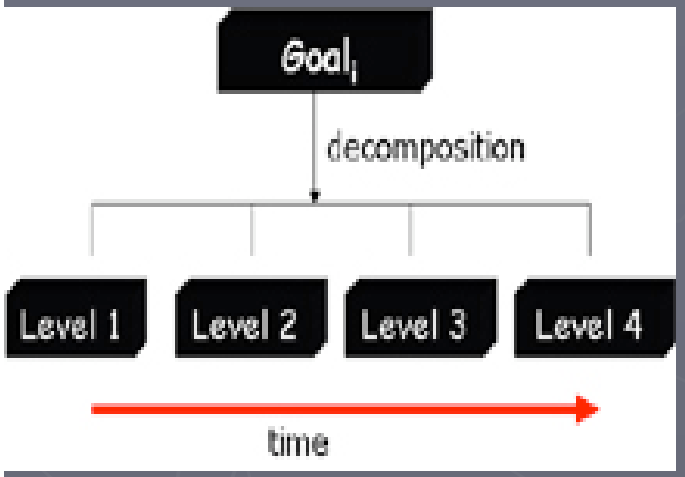
A Social-Reconnection Clinic for TBI Survivors



Note: assistive-technology (AT) abandonment is well-known for this population. Saw this play out in our clinic in terms of the treatment cycle.

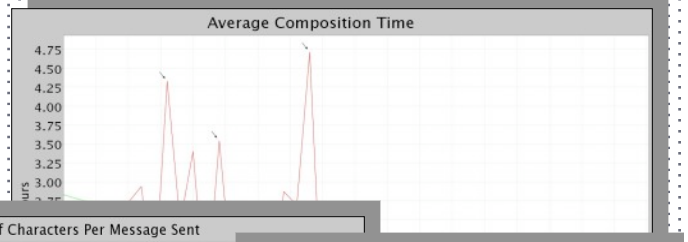


Weekly Evaluation



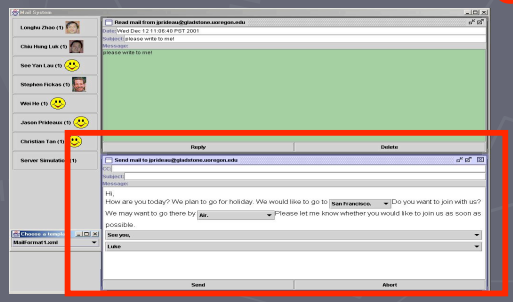
Deferred goal becomes active goal.

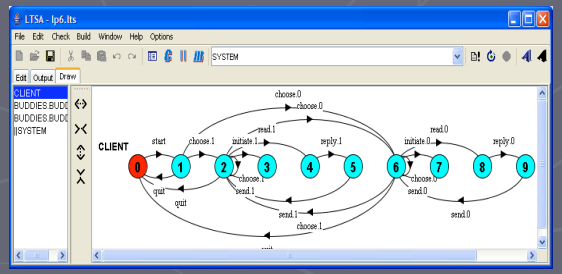
Log Data

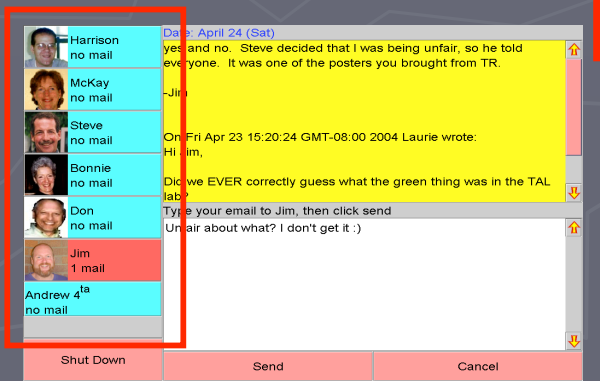


Field Notes

Configuration changes







Case Study: Yolanda

- Yolanda is a 37-year old, Native American female with cognitive disabilities due to a traumatic brain injury from a motor vehicle accident 17 years

- She

for new

planning

- She i

- Staf

and in n

counsel

- She is independent using the bus to visit familiar locations around town.

Yolanda's Impairments

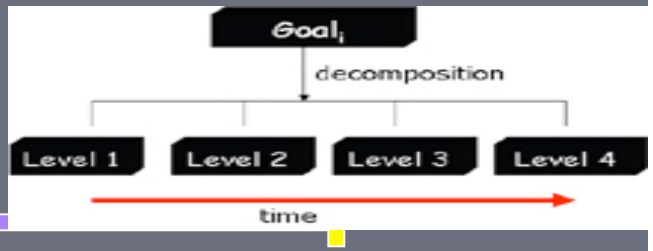
1. Memory

Short term memory	**(moderate)**
Anterograde memory	**(mild)**

2. Executive functions

Initiation	
Organization	**(mild)**
Planning	**(moderate)**
Self-monitoring	**(severe)**
Inhibition	**(severe)**

One of Yolanda's Goals



Goal: contribute to an online newsletter

Level 1 : can do simple email correspondence.

Level 2: will be able to write letter-style email (size, topic).

Level 3: will have one letter printed in the newsletter.

Level 4: will have regular letters printed in the newsletter.

Level 5 (fully attained): will be asked to write a guest letter.

Yolanda's Timeline of Adaptation

Initial system:

- Controlled composition (size limit)
- Restricted process (reply required)
- Short buddy list (two relatives)

First letter published!

Toda =20M

0-3	3-6	6-9	9-12	12-15	15-18	18-21

Adaptation within process space:

Change to: saved drafts

Linked-goal: letter-style content

Triggered-by: retain set across sessions

Adaptation within composition space:

Change to: freeform composition

Linked-goal: letter-style content

Triggered-by: meeting size constraints

Adaptation within social space:

Change to: added editor to buddy list

Linked-goal: submit to newsletter

Triggered-by: consistent performance

My Notes On Adaptation Experience

Adaptation management is a critical problem:

1. Missed adaptations.

   A modification was needed and either (a) monitoring did not pick it up or (b) staff evaluation of monitored data did not pick it up.

2. Superfluous adaptations.

   Typically, project staff inferred the need for an adaptation that was either (a) not supported by monitoring data, or (b) did not match with a user's goals.

Example of the former: ADLs that are hard to monitor, e.g., changing meds.

Examples of the latter: lots ☹. But it got better as we built up higher level concepts from raw monitoring data. And were better able to know individual behavior patterns.

Example of the former: attempts to use time as a measure, e.g., after 6 months, most should be ready for a less-intrusive system.

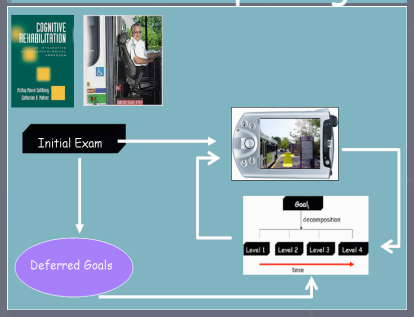
Examples of the latter: our good, but misguided intentions, e.g., changes to social space when not goal-directed.

Summary to Date

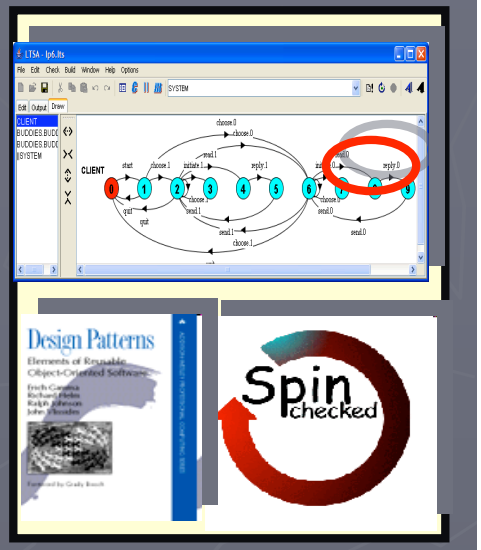
- Ten participants in study: 4 have been emailing a year or longer, 4 have been emailing at least 6 months, and 2 have just entered the study.
- They range in living environments: 3 live in their own homes, 4 live in a minimal-care facility, and 3 live in a full-care facility.
- All reported an inability to use a computer when entering the study.
- None were able to use a COTS email client during the initial exam. Same result at 6-month re-exams: none have been able to use COTS email without FTF staff support.
- The good news: all participants continue to use email successfully. All have reached at least minimal attainment of

Current and Future Work

Adding 2nd treatment package

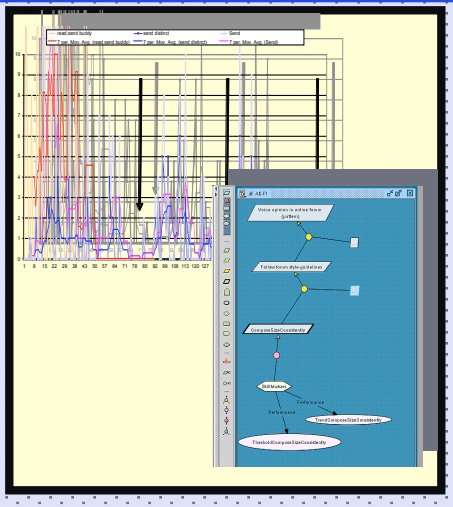


Use of Formal Modeling in Adaptable Systems



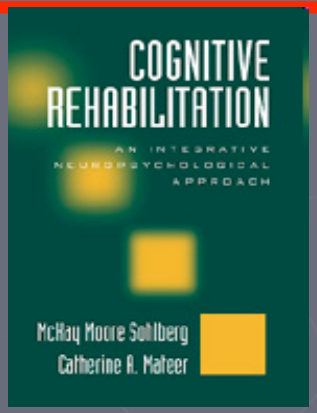
Pondering a mainstream clinic, e.g., Digital Imaging Clinic.

Scale and automation issues

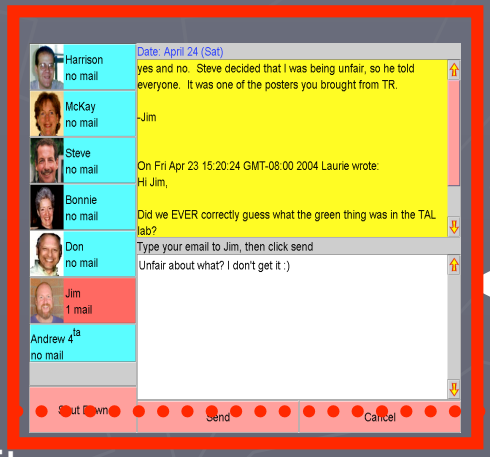


Applications ↔ Infrastructure

Scale Issues, One By One



Labor-intensive process now.
Some automation is needed.



Initial Exam

Monitor

Adapt

Deferred Goals

Check-Ups

Two Important Scale Questions

1. Can we automate portions of the monitor-adapt cycle?

   [and by backchaining]

2. Can we formalize the assessment and goal-attainment processes?

A First Cut at Formalizing GAS

The KAOS Tool as a Means to Formalize GAS

1. A means to refine a goal into levels.

Yes. Rich language of goal refinement.

2. A means of attaching skill prerequisites to goals.

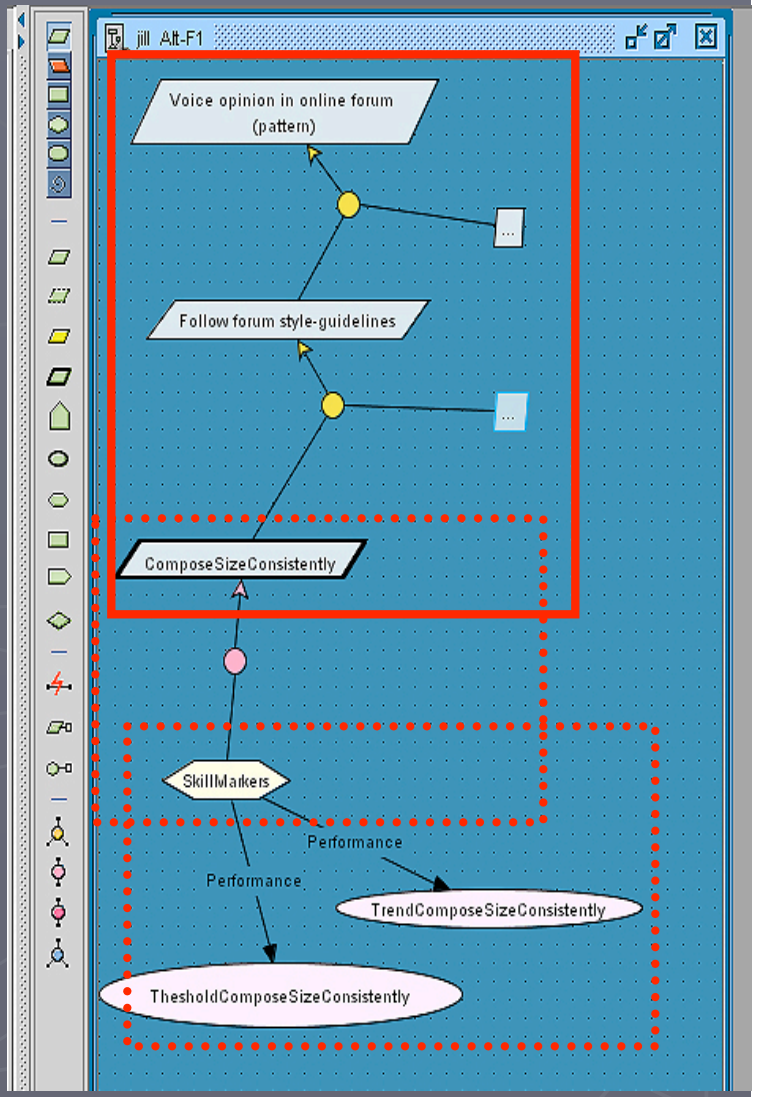
We are extending the language to include this.

3. A means of linking prerequisities to performance.

We are extending the language to include this.

4. A means of reasoning about events in past, present and future.

Yes. Use of LTL-style logic to reason temporally



ReqMon: Linking KAOS Goals to Monitoring (credit to Bill Robinson)

A means of attaching skill prerequisites to goals.

A means of reasoning about events in past, present and future.

A means of linking goal activation to performance.

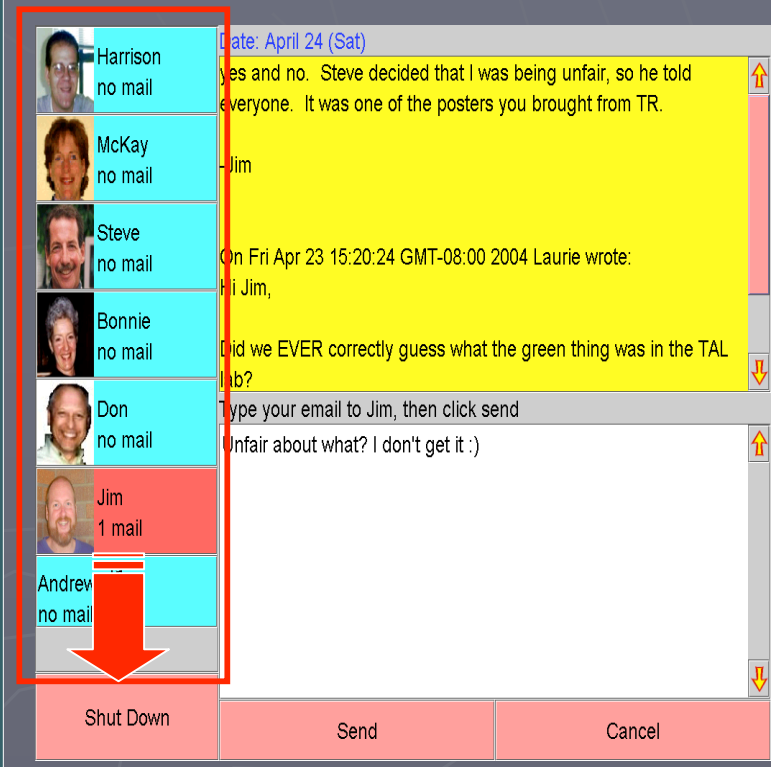
```
(GOAL ReplyInTimelyFashion
   (BaseSkills: ReadSkill ReplySkill …)
   (MonitoredSkills: ThesholdReadAndReply …)
 …)

(MONITOR ThesholdReadAndReply
   (Count: read:event
         (m1:EmailMessage, u1,u2:User
           EmailRead(m1,u2,u1))
   (Count: reply:event
         (m1:EmailMessage, u1,u2:User
           (EmailRead(m1,u2,u1) ->
              <> EmailReply(m1,u1,u2)))
   (Trigger: (reply/read > .75) over 14d)
…)
```

A Small Case Study: Ron's Buddy List

Data Mining

- *Test:* rational-reconstruction of adaptations seen on project.
- *Goal monitored:* Ron wanted to eventually have lots of buddies.
- *Data collected:* Ron's daily activity in correspondence.
- *Adaptation looking for:* add new buddy to Ron's list.



Ron's email client

Read/reply within a session.

Number of *different* buddies sent to in a session.

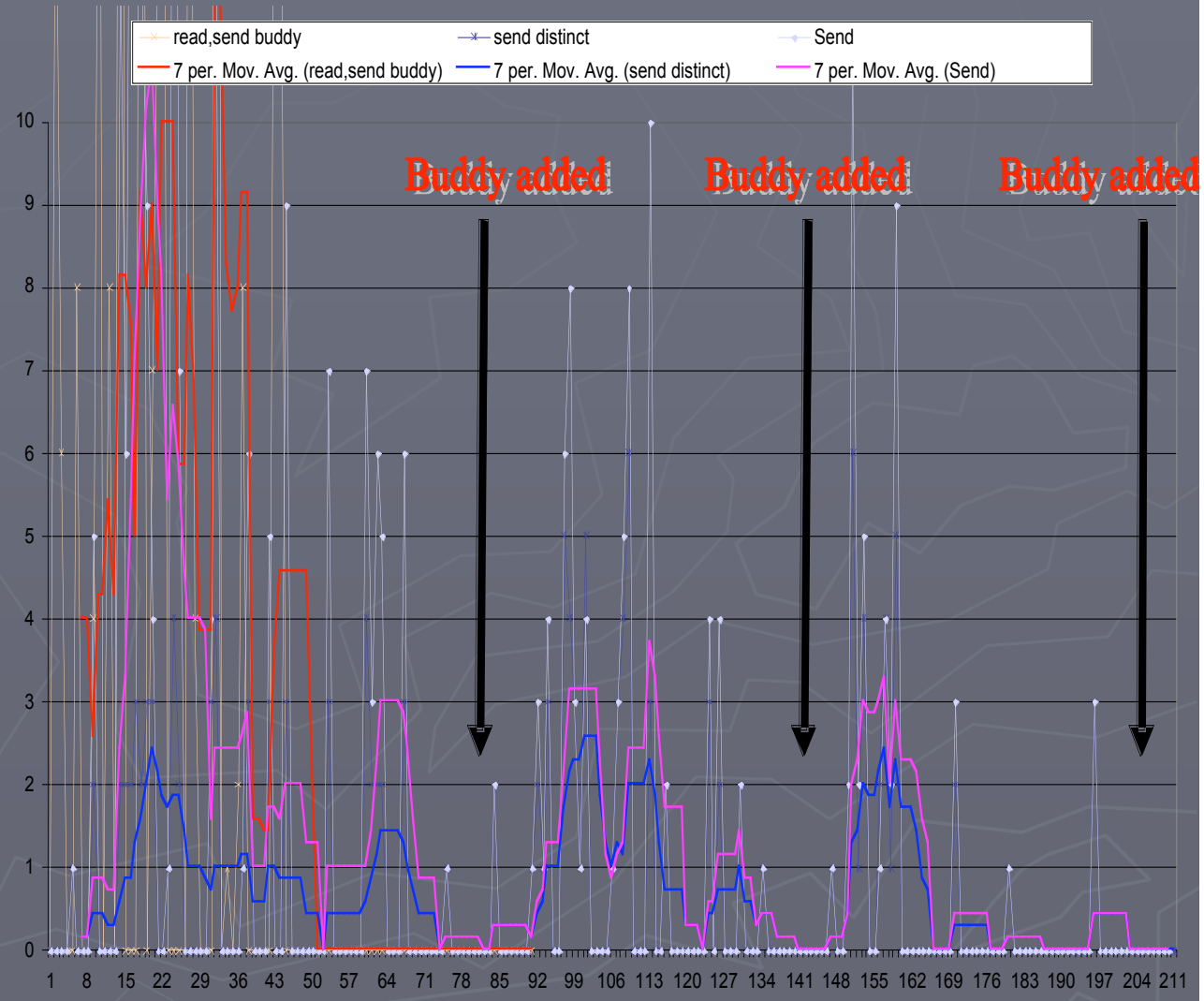
Total number of sends in a session (could be all to same buddy).

Results

- ✓ Placed monitored data in Excel.
- ✓ Plotted using various curve fitting and running average techniques.
- ✓ Potential correlation between down-trend in activity and adding buddy.

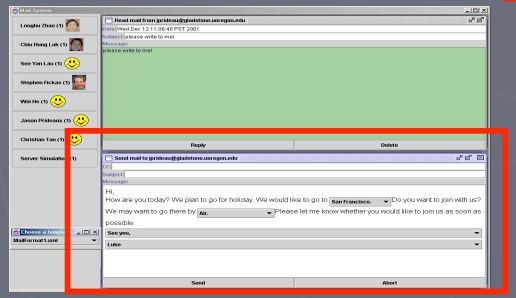
Future

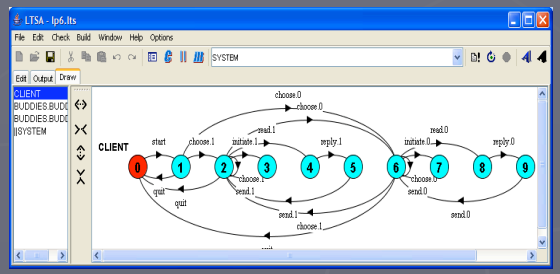
- ➢ Use ReqMon data-miner to analyze, rather than Excel
- ➢ Use regression, neural net, & statistical correlation techniques

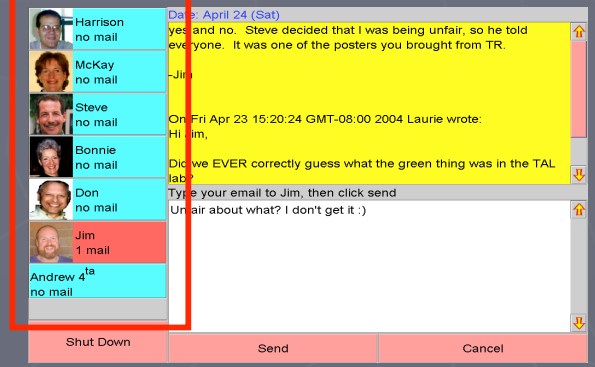


Reasoning About Adaptation

Configuration changes







Ties to adaptive systems in HCI.

Related to look-and-feel adaptations (see GITK).

Ties to adaptive business-rules.

Just starting to look here.

Ties to the social-space of email.

Growing body of work on ~~MoSoSos~~.

Conclusions I Feel Safe Making

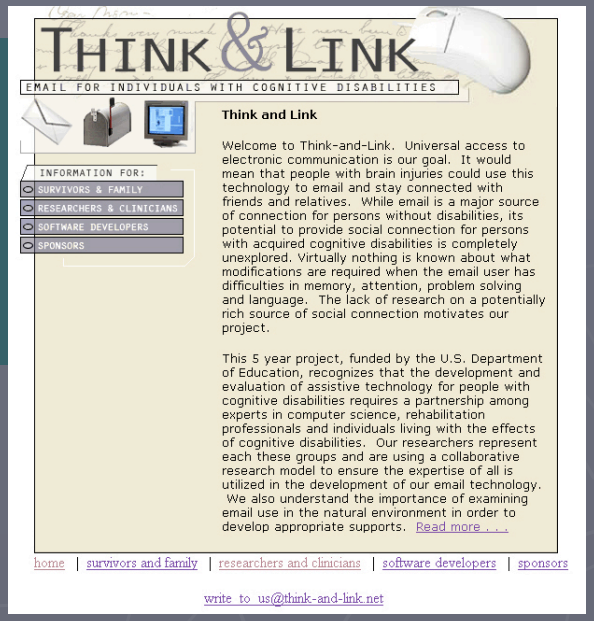
- Clinical fields take a personal view of treatment, and often employ the GAS approach to structure treatment.
- Cognitive Rehabilitation Clinics are a logical place to start to provide computer-based tools to a marginalized population.
- It is possible to work a Personal RE process into these clinics and have success in tool delivery and sustainability.
- Scale issues are challenging (but interesting ☺).

Sponsors Acknowledgement

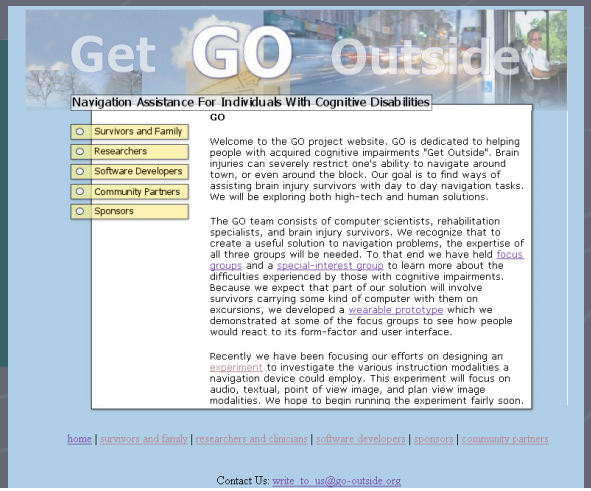
National Institute on Disability and Rehabilitation Research

Web Sites

http://www.think-and-link.org



http://www.go-outside.org



Talk Bibliography

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Thank You