Needs Assessment

HUMAN-AUTOMATION INTEGRATION: PRINCIPLE & METHOD FOR DESIGN AND EVALUATION

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**Background**

- Space missions (ground and in-space) increasingly depend on effective human-system integration.
- How can we ensure developed systems do their job well?

**Objectives**

- **Long-term**: Develop, apply, and assess needs analysis method
- **Immediate Payoff**: Improve support for ADCO (Attitude Determination & Control) planning work
**General Method + Specific Case Study:**

How can we efficiently develop systems that support work-needs effectively? ADCO Planning Case

1. **Analyze Needs**
2. **Acquire (Re)design**
3. **Evaluate (Re)design**

- **Analyze Tasks & 
  **Products:** ADCO plan documents

- **Find & Modify:** prototype planning software

- ***Experimental Comparison:** New Prototype to Legacy Software

Move from Prototype to Operational Software
ISS Controller Group: ADCO
(Attitude Determination & Control Officer)

- Part of NASA Mission Control for ISS
- Works closely with Russian counterparts.
- Motion control, particularly orientation of ISS.

- Requires:
  - Execution & Planning
  - Our focus on planning:
    - forming and revising plans
Method & Results

• Identify the information & operations needed to build sound plans.

• Modify other NASA planning software to reflect ADCO needs.

• Compare performance on redesigned prototype to legacy system on key plan-revision tasks.

• Found redesign cuts time and errors on plan revision. ADCO secured funding for new software.

• Supports claim: (product-based) needs analysis improves design outcomes.
Interaction structure

Legacy Planning Software

NEW Planning Software

Activity representations circled

New prototype modified from HSI Ames
(McCurdy, Ludowise, Marquez, & Li 2009)

CHI2011: Billman, Arsintescu, Feary, Lee, Smith, & Tiwary
Redesign Matches Domain Needs Better:
(less grey in diagram)
New Prototype Makes Revision Tasks Easy

**Standard tasks:**
Reschedule an Action or Activity

Big performance benefit
where large increase
in match to plan structure.

**Unusual tasks:**
Reschedule collections of Actions
New prototype still provides benefit

Ave correct-response times (StErr) of **New & Legacy** software
for revision tasks, 2 Blocks on 2 Days, a week apart.
Conclusions-
Reducing Gap for HSI/HAI tools & methods

• Analyzing needs is critical to success. 
  *Product-document analysis* aids needs analysis 
  for work domains that are: 
  high stakes, technical, information-intensive, with heavily scheduled 
  domain experts.

• Given needs are understood, redesign may find&modify, not just build-
  from-scratch.

• (Re)design guided by aligning structure-of-interaction with structure-of-
  domain can have big payoff in improved performance.

• FUTURE RESEARCH: further develop needs analysis methods 
  for design (what should it do) & evaluation (does it do what it should).
Questions?
Analysis of domain structure:
Use information products to reveal information structure

1) Explicit recognition of middle level: activities
2) Temporal relations
3) Part-whole relations

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Ave % errors with **New & Legacy** software
for revision tasks, 2 Blocks on 2 Days, a week apart.
New Prototype Benefit Persists Longer-Term

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Performance by small number of **New (3) & Legacy(4) users** on initial 2 Days, a week apart, and **returning 7 weeks later**
Structure-Matching Illustration

Example: Hierarchy organizes structure

Domain structure

Interaction Structure (display & control)
When Interaction Structure aligns with Domain Structure, interaction should be transparent.
Is performance better in NEW vs Legacy?
Yes: faster across all revision tasks

Huge impact: required procedure change.

On the 4 Revision tasks:
Total time-half as long in NEW
51 vs 26 minutes

* p<.05