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**
   - Analyze Tasks & Products: ADCO plan documents

2. **Acquire (Re)design**
   - Find & Modify: prototype planning software

3. **Evaluate (Re)design**
   - *Experimental Comparison: New Prototype to Legacy Software*

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**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

CHI2011: Billman, Arsintescu, Feary, Lee, Smith, Tiwary
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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