TECHNOLOGICAL ADVANCES FOR STUDYING HUMAN BEHAVIOR

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GOAL: To conduct principled human-systems interaction research:

- Develop Significant Design Principles
- Develop Timely Design Alternatives
- Develop Appropriate Design Tools
- Develop Meaningful Evaluation Instruments

JUSTIFICATION: Performance-Aiding Systems are proliferating without a fundamental understanding of how they should interact with the humans who must control them.

HUMAN-CENTERED AUTOMATION INVOLVES INTERACTION IN ALL THREE DOMAINS
THE EVOLUTIONARY RESEARCH PROCESS (adapted from W. Rouse, 1989)

- What you know you can do
- What you are willing to promise you can do
- What you would like to do

Two Views of Automation Research

**HARDWARE VIEW:**
- Focus on Hardware Capability
- Focus on Hardware Performance
- Focus on Hardware Testing
- Focus on Sensing Criteria & Logic

**HUMAN-CENTERED VIEW:**
- Focus on the User
- Focus on User Performance
- Focus on Human Performance Testing
- Focus on Matching Information to user need and current context

PERFORMANCE-AIDING SYSTEMS (just as any technological systems) WILL SUCCEED IN THEIR PURPOSE TO THE EXTENT THAT THEY EFFECTIVELY DELIVER THEIR CAPABILITIES TO THEIR USERS!!!
VITAL ELEMENTS FOR HUMAN-CENTERED RESEARCH

- **DOMAIN MODEL**
  - Event-Driven Task and Performance Constraints
  - Scenario Specification

- **BEHAVIORAL MODEL**
  - User goal / intent structure
  - User Understanding
  - Performance Predictions

- **PERFORMANCE TRACE**
  - Measurement Technology
  - Testing Environment
  - Analysis Technology

A Continuum of the Research Process

- Full Simulation Environment
- Basic Laboratory Research
- Comparative System Test/Design
- Iterative Design/Testing
- Part-Task Simulation
- Field Study Cockpit Observation
- Questionnaires Subjective Rating Scales

Dimensions:
- Complexity - Simplicity
- Control - Realism
- "Principled" - Trial & Error
- Applied - Basic (theoretical)
- System Specific - System Generic
Available Technologies

- Personal Computer Work Stations
- Local Area Network (LAN) connection
- Interactive Digital Video
- Sophisticated Hyper-Type Software
- Integrated Input/Output devices: keyboards, mice, track-balls, joy sticks, microphones, touch-screens, speakers, printers, telephones, video tape recorders/players, cameras, scanners, sound digitizers etc.

NEW TECHNOLOGIES FOR PERSISTENT PROBLEMS

PROBLEMS:
- Access to Expert subjects (potential users)
- Limited time frame
- Cost & scheduling of Full Simulation
- Data translation / lack of comprehensive analysis

SOLUTIONS:
- Portability
- Rapid Dynamic Prototyping
- Coarse-Grain Simulation
- Integrated Measurement

Example: PASS = Portable Air traffic control Simulation System
THE "PASS" SYSTEM

Sample Research Infrastructure

- Scenario Specification
  - Dynamic Scenario Generator
  - Simulation Event Editor
  - Scenario Bank

- Rapid Dynamic Prototyping
  - Easy to Use Object Behavior Specification
  - Reusable & Copyable Code
  - Quick to Adjust/Change Feature Specification
  - Alternative Design Concepts Specification

- Simulation in the Field
  - Quick set-up
  - More subjects
  - Automatic collection of data
  - On-line Evaluation
Sample Research Infrastructure (continued)

<table>
<thead>
<tr>
<th>Integrated Data Collection</th>
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<tbody>
<tr>
<td>- Time-Stamped Event Protocol Files</td>
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<tr>
<td>- Screen - Configuration</td>
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<tr>
<td>- Summary Files (Action Breakdown)</td>
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<table>
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<th>Integrated Data Analysis</th>
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<tr>
<td>- Statistical Software Packages</td>
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<tr>
<th>Design Documentation and Training Module</th>
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<tr>
<td>- Concept Communication</td>
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<td>- Criterion Practice and Testing</td>
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Popular Statements based on Misconceptions about Human Factors and Interface Design

"The system will use a mouse and icons and will have multiple windows - therefore it will be easy to use."

"The new interface, using color coding, command echoing, text editing, and a variety of input modes, has resulted in a substantial improvement in operation over the old system."
"AVIATION-SAFETY GENERAL'S WARNING:

USING THIS TECHNOLOGY CAUSES OPERATIONAL ERRORS, PANIC, INCREASED WORKLOAD, AND MAY COMPLICATE YOUR JOB"

NEED FOR METRICS

- What constitutes safe and efficient performance?
- How can and should we measure the impact of new devices?
- How can we translate system capacity improvement goals into standards for acceptable human performance?

Example metric for Performance Analysis with new Interfaces (after Whiteside, Wixon, and Jones, 1988):

$$S = \frac{1}{PC} \frac{T}{T}$$

A rate measure that expresses percentage of the task completed per unit of time - the higher the score, the better, the more efficient the performance

S = Performance Score
T = Time spend in task
P = Percentage of task completed
C = A constant (example 5 minutes)
FACT: SYSTEM TYPE MAKES LITTLE DIFFERENCE IN USABILITY!

New problems are found in the "new and improved" systems which renders them ineffective.

TYPICAL Predictable Problems:

- Lack of feedback....what is the system doing?
- Unanticipated Interdependencies....why is it not accepting this?
- Lack of "impedance matching"....why does it take 3 steps when I think of it as just one step?
- Lack of consistency of input forms (and labelling)....which do I use "cancel" or "delete"?
- Lack of proper information management.....where is the information?

Examples for Data-Link Technology

"THE FEEDBACK PROBLEM"

A CONFIRMATION MESSAGE IS NEEDED ESPECIALLY WHEN SENDING INFORMATION FROM ONE STATION TO THE NEXT!
Examples for Data-Link Technology (continued)

"THE LABELLING PROBLEM"

A. CLEAR CANCEL DELETE

? clear the current display, message, paragraph, line, word ?
? cancel the current selection, this message, the last request ?
? delete WHAT FROM WHERE ?

B. 

ALT FL330

OK

HDG 160

???

"...turn LEFT/RIGHT ..."

FACT: "MATURE" SYSTEMS ARE BETTER

A HUMAN-CENTERED APPROACH MEANS CRAFTSMANSHIP AND ATTENTION TO DETAILS!

- stress clear system and performance goals
- involve users at all phases of design
- conduct empirical tests

DESIGNERS MUST BE PREPARED TO REEVALUATE THEIR ASSUMPTIONS>>>WE NEED A FLEXIBLE AND HOLISTIC APPROACH TO USABILITY OF NEW AUTOMATION!