TECHNOLOGICAL ADVANCES FOR
STUDYING HUMAN BEHAVIOR

Renate J. Roske-Hofstrand
NASA Ames Research Center
Requirement/Justification

**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**
- **Part-Task Simulation**  
- **Iterative Design/Testing**
- **Comparative System Test/Design**
- **Field Study Cockpit Observation**
- **Basic Laboratory Research**

**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
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)

- Integrated Data Collection
  - Time-Stamped Event Protocol Files
  - Screen - Configuration
  - Summary Files (Action Breakdown)

- Integrated Data Analysis
  - Statistical Software Packages

- Design Documentation and Training Module
  - Concept Communication
  - Criterion Practice and Testing

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):

\[
S = \frac{1}{PC} \quad \text{A rate measure that expresses percentage of the task completed per unit of time - the higher the score, the better, the more efficient the performance}
\]

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 HDG 160

OK ??? "..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!