Overview of the TNASA Modeling Task

Allen Goodman
Human Error Modeling Team
San Jose State University Foundation

NASA Ames Research Center
Human Error Modeling Workshop
October 18-19, 2001

TNASA Modelers

- **Team ACT-R**

  Alex Kirlik & Mike Byrne
- **Team SA**

  Chris Wickens & Jason McCarley
- **Team IMPRINT**

  Rick Archer & team Micro Analysis & Design
- **Team D-OMAR**

  Stephen Deutsch, Dick Pew, & David Diller
- **Team Air MIDAS**

  Brain Gore & Kevin Corker

Topics Covered

- Review HEM Project objectives
- Selection of TNASA sim data set
- Modeling task requirements
- Information provided to modelers
- Issues and questions to consider

Key HEM Objectives

Develop reliable and valid error predictive capability for researchers /designers of aviation systems:

- **Useful in conceptual stages of design**
- **Provides emergent output independent of modeler’s domain knowledge**
- **Permits “reasonably” quick analysis**
- **Can be integrated with other tools and frameworks**

Why TNASA Data Set ?

Advantages of TNASA

Provides modelers human error data derived from:

- **“Operationally real□□” -- high fidelity simulation**
- **Addresses critical safety issue**
- **Offers advantages of controlled experiment**
  - √ Well defined task, equipment, and **environment**
  - √ Specified exposure rates
  - √ Supplementary behavioral data (timing, communications)
- **Availability of local simulation experts**

Modeling Task Requirements

- Represent conditions and pilot behaviors from TNASA2 baseline trials
- Stipulate operational and procedural assumptions used in conducting analysis
- Provide technical/theoretical account for generated model output
- Demonstrate model's ability to predict error in augmented display conditions
- Present modeling results for assessment at HEM workshop

Information Provided to Modelers

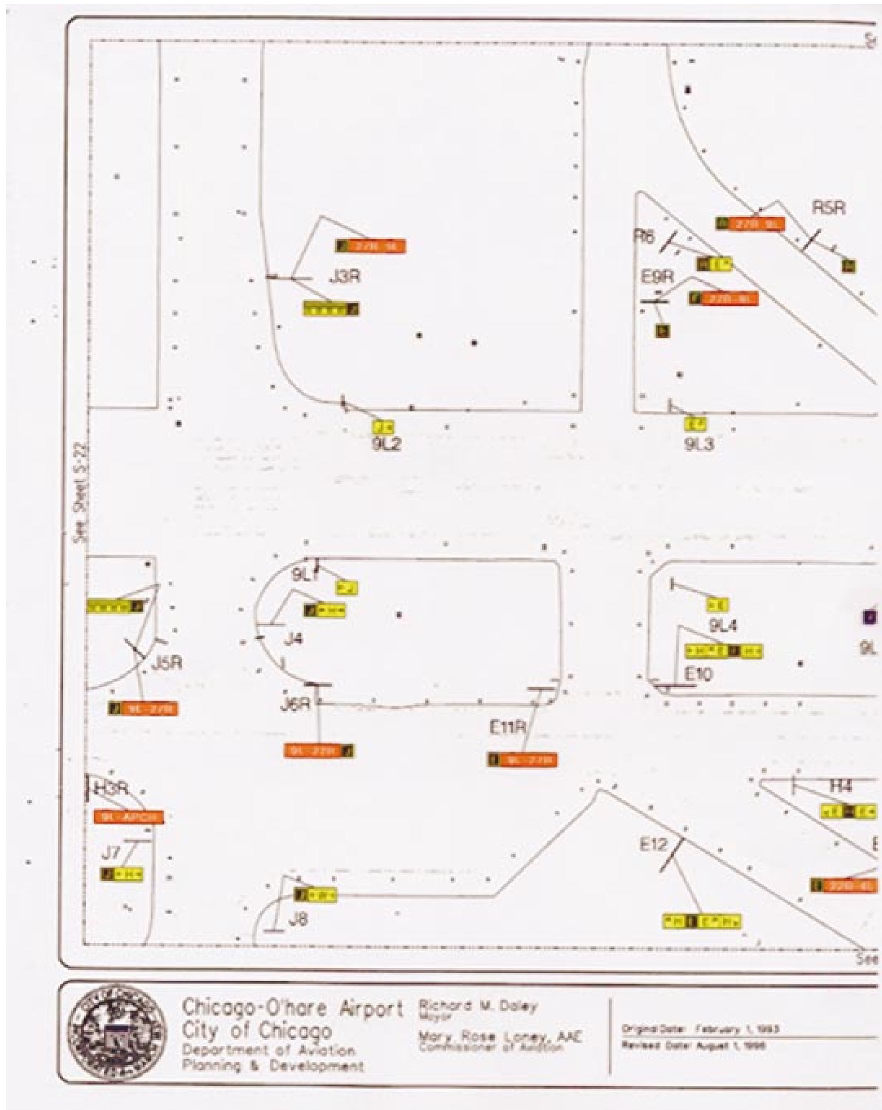
Descriptions, analyses, and summaries regarding:

- **Simulation task**
- **Visual environment**
- **Routes & errors**
- **Communications behavior**
- **Pilot WL and SA**
- **Pilot demographics**

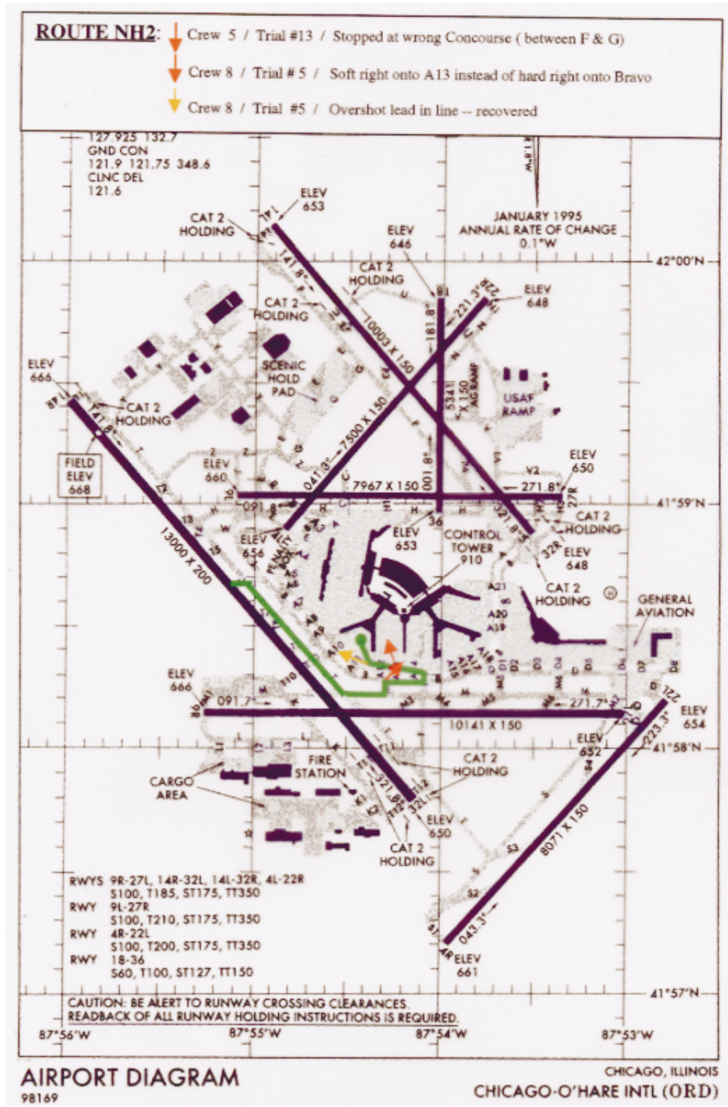
Nominal Task Sequence

Simulation Time	A/C Position	Event	Crew Member	Task / Sub-Task Actions	Task Type <input/output channels>	Interruptable
APPROACH SEGMENT (Median Duration = 4 min 33 sec)						
0	12 miles out	Simulation Initiated		**Monitor for Traffic and Ground**	**Intermittent**	Yes
			CA	- scans out-the-window view	<visual>	
			FO	- scans out-the-window view	<visual>	
				Monitor ATC Communications	**Continuous**	Yes
			CA	- listens to radio for directed comm & party-line chatter	<auditory>	
			FO	- listens to radio for directed comm & party-line chatter	<auditory>	
				Monitors Flight Displays	**Intermittent**	Yes
			CA	- checks displays for conformance/anamolies	<visual>	
			FO	- checks displays for conformance/anamolies	<visual>	
				Set Automation for Final Approach	**Discrete**	Not Readily
:3 (:01 - :06)			CA	- sets 180 kts. & engages speed mode & calls-out	<visual><verbal> <psychomotor>	
			CA	- engages center auto-pilot	<visual> <psychomotor>	
			CA	- engages approach mode	<visual> <psychomotor>	
:27 (:25 - :29)	11 miles out	ATC issues landing clearance		**Establish Landing Clearance**	**Discrete**	Yes
			FO	- acknowledges clearance to ATC	<verbal>	
		ATC suggests preferred exit	FO	- writes down preferred exit	<visual> <psychomotor>	

Visual Environment



Route & Error Map

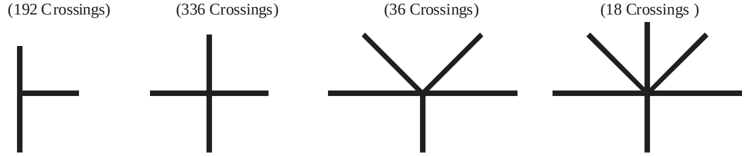


Intersection Geometry

Complexity Variable

(number of route options confronting crew at intersection - 4 levels)

2-way (192 Crossings)	3-way (336 Crossings)	4-way (36 Crossings)	5-way (18 Crossings)

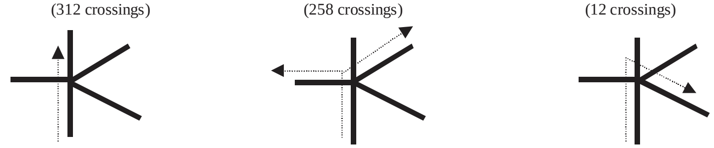


3 errors	7 errors	2 errors	0 errors

Turn Type Variable

(turn maneuver to be performed at intersection as required by clearance - 3 levels)

No turn required by clearance (312 crossings)	Soft/90ÞTurn required by clearance (258 crossings)	Hard Turn (> 90Þ) required by clearance (12 crossings)



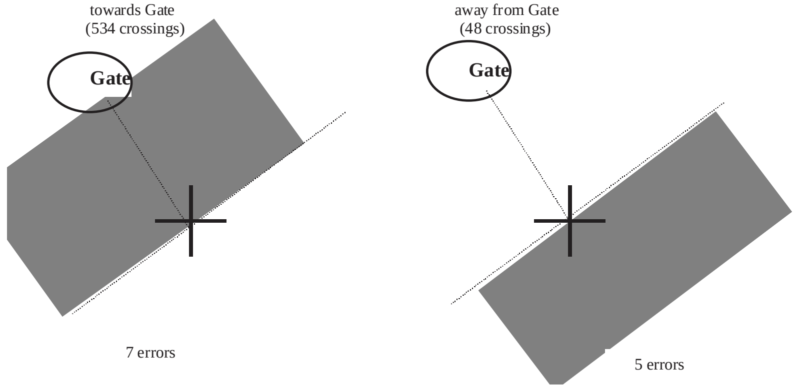
2 errors	9 errors	1 error

Directional Fit Variable

(heading of post-intersection cleared route segment relative to destination gate - 2 levels)

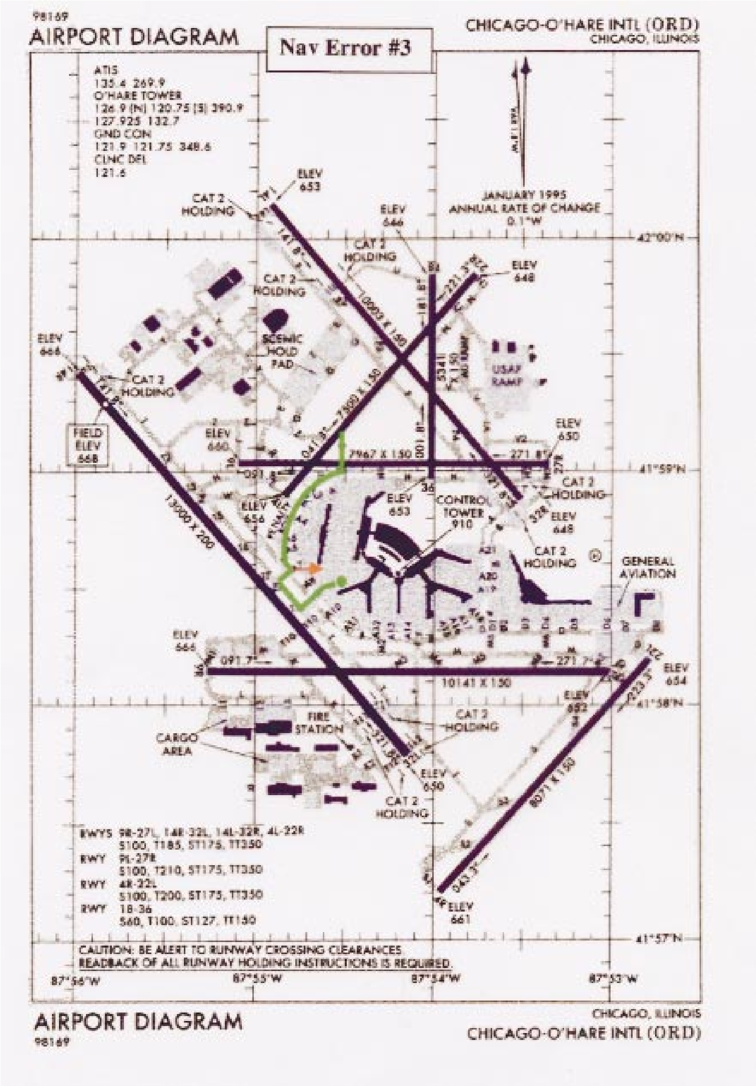
After intersection, route clearance directed pilots:

towards Gate (534 crossings)	away from Gate (48 crossings)



7 errors	5 errors

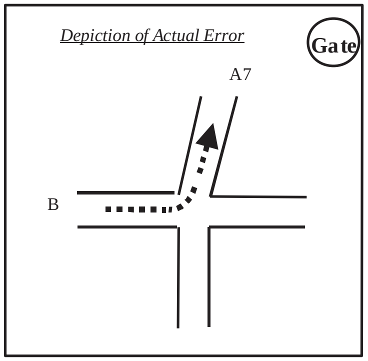
Error #3 Map

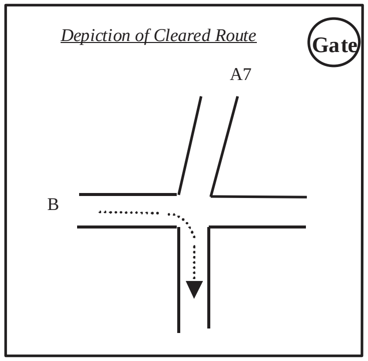


98169
AIRPORT DIAGRAM
Nav Error #3
CHICAGO-O'HARE INTL (ORD)
CHICAGO, ILLINOIS
ATIS
135.4 269.9
O'HARE TOWER
126.9 (N) 120.75 (S) 390.9
127.925 132.7
GND CON
121.9 121.75 348.6
CLNC DEL
121.6
JANUARY 1995
ANNUAL RATE OF CHANGE
0.1°W
CAT 2 HOLDING
SCENIC HOLD PAD
USAF RAMP
FIELD ELEV 668
CONTROL TOWER 910
GENERAL AVIATION
CARGO AREA
FIRE STATION
RWYS 9R-27L, 14R-32L, 14L-32R, 4L-22R
S100, T185, ST175, TT350
RWY 9L-27R
S100, T210, ST175, TT350
RWY 4R-22L
S100, T200, ST175, TT350
RWY 18-36
S60, T100, ST127, TT150
CAUTION: BE ALERT TO RUNWAY CROSSING CLEARANCES.
READBACK OF ALL RUNWAY HOLDING INSTRUCTIONS IS REQUIRED.
AIRPORT DIAGRAM
98169
CHICAGO, ILLINOIS
CHICAGO-O'HARE INTL (ORD)

Error #3 Description

Off-Route Navigation Error #3
Crew 3 -- Route N3 -- Trial 1
Left on A7 instead of right





Cognitive Classification: Planning Error

Planning	Did the crew correctly receive and understand the taxi route?	No	Crew correctly received route. Later, the crew erroneously modified route (decided to turn left at A7 and omit Tango from their clearance) *The crew verbalized that Tango didn't seem to make sense because it was a turn away from the concourse.*
Decision	Did the crew make the correct navigation decision?	N/A	
Execution	Did the crew correctly carry out the maneuver as discussed?	N/A	

Geometric Classification:

Intersection Type

Intersection Complexity = 3-way
Turn Type Require by Clearance = Soft turn/90Þ
Directional Fit of Cleared Route = Away from gate

Total Crossings of This Type of Intersection = 24 of 582

Errors Committed at this Type Intersection = 4 (Nav Error #1, #3, #5, #8)

Information Provided to Modelers . . .

- Communications behavior
  - √ **Frequency and type comm acts (TNASA1)**
  - √ **Full transcriptions of cockpit dialogue (TNASA1)**
- Pilot WL and SA
  - √ **Observer ratings of error vs non-error trials:**
    - **Work load**
    - **SA**
    - **Efficiency**
    - **Planning**
- Pilot demographics
  - √ **Position, age, gender, familiarity with O'Hare, etc.**

Information Not Provided to Modelers

Primary source or raw data such as:

- Videos of actual trials
- Model of vehicle dynamics
- Database of physical environment
- Communications transcripts of actual trials
- Tracks of vehicle ground movement
- Time-stamped records of pilot control inputs
- Eye tracking data

Issues and Questions to Consider

- Are some models especially well suited to predict some types of error rather than others?
- Which of the assumptions or implementation details, given by models presented, are most critical to developing accounts of errors?
- What are the data requirements for error modeling?
- How close is the modeling community to being able to predict errors rather than just explain them?
- What are the crucial human error types we should be trying to model?