

## Measuring Change in Pilots' Conceptual Understandings of Autoflight

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## Goal

- How pilots' understanding of flight deck automation develops in early stages of operating experience.

## Participants

- 15 pilots transitioning to the Airbus A320
- Transitioning from DC-8, Fokker F-100, and Boeing 737.



## Data collection Points

- Initial: first few days of training (N=15)
- First line interview: first few months of line operations (N=14)
- Second line interview: about one year of experience on the line (N=13)
- Third line interview: about 18 months on the line (N=7)

## Data collection procedures

- Initial Interview: flying background, preconceptions (in person)
- Line interviews
  - In person or by phone
  - Recall last flight as PF
- Interview corpus size = 336,000 words
- Jumpseat observations – with about half of the interviews.

## Qualitative Analysis

(see Hutchins and Holder, 2001)

- A small set of simple conceptual models
- Embodied models
  - E.g., Pulling the thrust back
- Most conceptual problems are with managed descent modes
- When can they expect the automation to help them and how can they shape their operations to avoid surprises.

## DES Mode is

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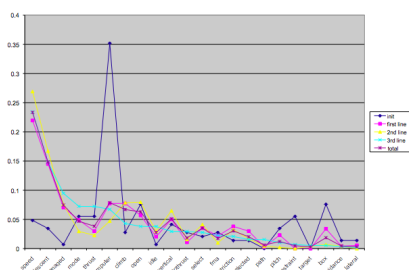
## Quantitative Measures

- Term frequency analysis
- Term co-occurrence analysis
- 22 terms related to autoflight
  - Technical terms
  - Operational terms
  - Pilot jargon

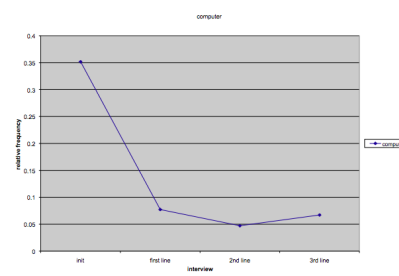
## Term Frequency Analysis

- Compute relative frequency of each term in each interview set (excluding words spoken by the interviewer)
- Assume relative frequency as a reflection of conceptual salience.

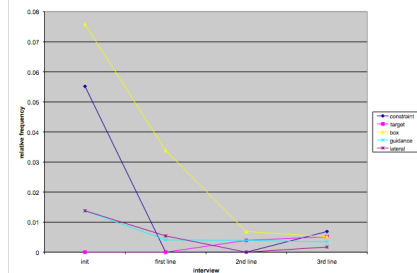
Relative Frequencies of all terms across all interviews



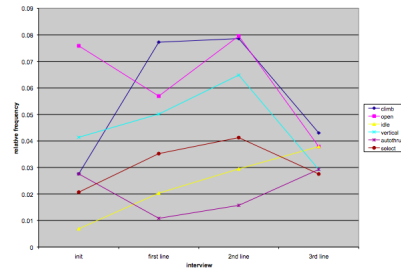
Relative Frequency of the term "computer" across the interviews



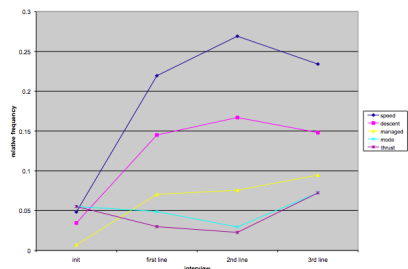
### Terms that peak in first line Interview



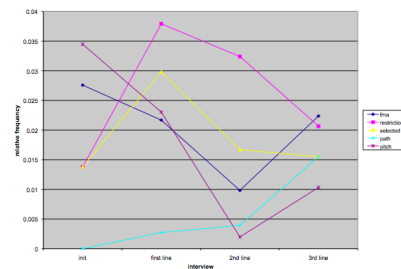
### Selected Modes



### Managed Modes



### Management Concepts



### Frequency data suggest

- With a year of experience the selected modes are more salient than the managed modes.
- With eighteen months experience, talk about selected modes still dominates but words associated with managed modes are increasing in salience.

### Term co-occurrence analysis

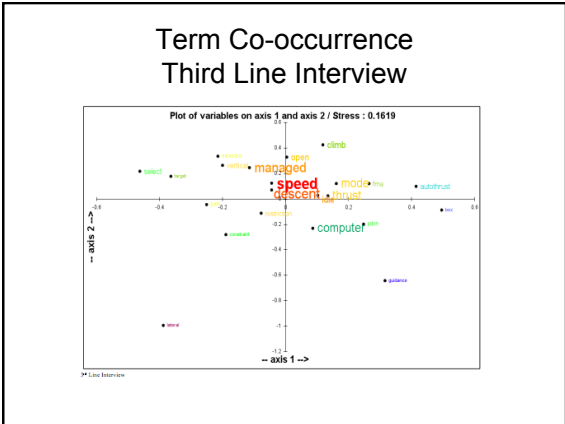
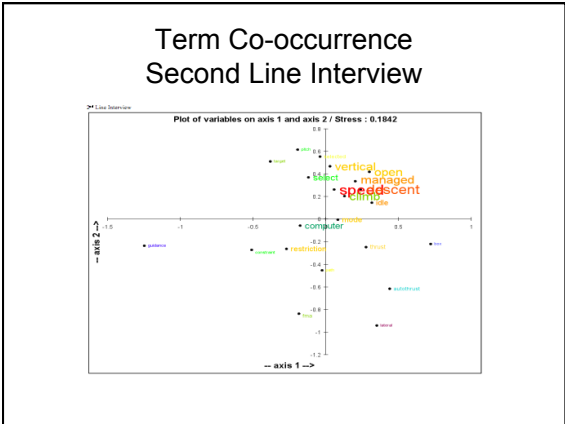
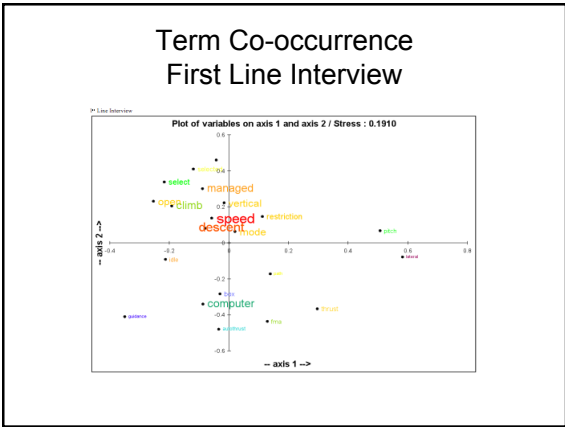
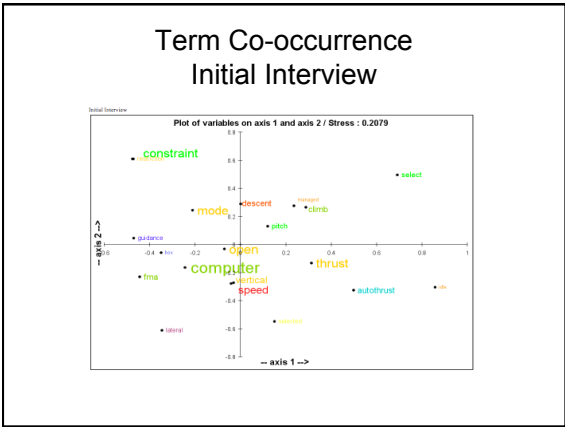
- For each interview corpus
  - For every word in the corpus
    - Compute raw co-occurrence scores with all other words: ► a huge symmetric matrix
  - For every autoflight-related term
    - Compute cosine between the vector for that term and every other autoflight-related term. (gem, jewel)
  - Sum of cosine scores for a term is a measure of the term's centrality.
  - Use MDS to plot terms in 2-dimensional space

### Term relatedness plots

- Relative Frequency:
  - Font size
- Centrality (in third line interview):
  - Color, warm for central, cool for peripheral
- Relatedness:
  - Distance between terms

### DES Mode Schema

A **managed descent mode** based on a vertical **path** defined by **constraints** and computed such that when flown at **idle thrust** the desired **speed** schedule will result.



## Discussion

- Clear evidence of conceptual reorganization
- Selected modes are mastered first
- DES mode still not fully conceptualized after 18 months.