From Crew Communication to Co-ordination: A Fundamental Means to an End

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Agenda

- What does Communication Accomplish?
- How are Communication Skills Used?
- Evaluating Crew Communication
  - in investigation
  - in research
  - in training
- Lessons Learned & Unresolved Issues
Communication accomplishes...  

- Information transfer  
- Team/task management  
- Shared problem solving & decision making  
- Establishment of the interpersonal climate

... which support outcomes

- Technical task performance
- CRM
- Work/team atmosphere

What does communication accomplish?

Information Transfer

- Communication serves to:  
  - Request information  
  - Provide information  
  - Acknowledge/verify information  

- Ineffective communication results in:  
  - Lack of information  
  - Inaccurate information  
  - Questioning  
  - Confusion

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What does communication accomplish?

Team/task Management

- Teams/tasks are managed through communication:
  - Standard operating procedures
  - Planning, briefing, monitoring
  - Maintaining situation awareness, task attention
  - Setting task priorities, distribution of workload

- Problems:
  - Nonstandard planning
  - Lack of situational awareness
  - Inappropriate distribution of workload
  - Unbalanced distribution of workload

Problem Solving & Decision Making

- Communication facilitates shared problem solving
  - Problem recognition
  - Problem identification
  - Decision making
  - Critique & resolution

- Problem solving communication prevents:
  - Lack of planning & preparation
  - Lack of joint problem solving
  - Lack of situational awareness
  - Inadequate situation awareness
What does communication accomplish?

Interpersonal "Climate"

- Communication establishes:
  - Predictability, resource availability
  - Work preferences, attitudes
  - Competencies/skill level
  - Work atmosphere, "setting the tone"

How are Communication Skills Used?

- Communication is a multipurpose tool which supports team performance
  - Technical task
  - CRM
  - Procedures & ATC
  - Work/team atmosphere

- Specific speech acts must be interpreted within the contexts in which they occur
  - Physical Context
  - Social & Organizational Context
  - Task & Operational Context
  - Speech & Linguistic Context
How are Communication Skills Used?

Physical Context

- Aircraft states
  - On the ground vs. inflight
  - Automation mode
  - Normal vs. abnormal

- Environment states
  - Weather, noise, light, day/night
  - Airspace location, traffic, terminal area

- Communication network
  - Remote, face-to-face, media availability

Speech acts are interpreted within a physical context.

When speaking face-to-face, speech is often abbreviated because the communicators share the same situation. Similarly, daylight and good visibility conditions may require less explicit referencing.

Social & Organizational Context

- Communicators
  - Within Cockpit
  - Pilot - ATC
  - Pilot - Dispatch/Mx
  - Cockpit - Cabin

- Crew composition
  - Experience, skill
  - Familiarity, diversity

- Roles and authority
  - Captain - First Officer
  - ATC, cabin, others

Speech acts are interpreted within a social/org. context

Some speech patterns are strongly linked to the CA-FO authority structure (e.g., command-acknowledgement). Deviations may indicate imbalance in crew composition or simply a required deviation from normal operations.
How are Communication Skills Used?

Task & Operational Context

- Phase of flight & procedural context
  - Taxi, Takeoff, Cruise
  - Approach, Landing

- Normal vs. non-normal operations
  - Routine adjustments
  - Inflight problems

Speech acts are interpreted within a task/operational context

Under non-normal conditions, communications which deviate from SOP's may be required for re-adjusting priorities and workload. Under normal conditions, the same deviations may indicate non standard practices.

Speech & Linguistic Context

- Individual styles
  - Formality
  - Communication rate

- Grammatical patterns
  - Completed statements
  - Non-standard English

- Speech Act patterns
  - Question - Answer
  - Command - Acknowledgement
  - Statement - Verification
  - Instruction - Readback
  - Readback - Hearback

Speech acts are interpreted within a speech/linguistic context

Deviations from expected sequences may indicate:
- non-response, inattention, pre-occupation
- incomplete or interrupted communication
Evaluating Crew Communication

Investigation
- Case study
- Focus on causal and contributing factors
- No scenario control
- 100% validity

Research
- Experiment groups compared
- Factors of interest designed into the scenario
- Many factors controlled & manipulated / support staff
- Operational realism limited

Training
- Training crew members, evaluating individuals
- Performance requirements embedded into scenario
- A few factors controlled & manipulated / limited staff
- Operational realism limited

Evaluating Crew Communication in Investigation

Speech Act Indicators............of crew performance; contributing factors

Task-related speech acts
+ Emergency problem solving
+ ATC, routine and non-routine

Procedural speech acts
+ Adherence to regulations & company procedures

Non-task related speech acts
+ Evidence of conflict, tension
+ Attention to task, situation awareness

Response to the emergency, problem solving
Adherence to procedures
Cockpit atmosphere, interpersonal climate
Investigation Example

<table>
<thead>
<tr>
<th>Task related speech acts</th>
<th>Procedural speech</th>
<th>Nontask-related speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Indicator of cooperative crew coordination during routine flight</td>
<td>● Indicator of general adherence to procedures and ATC protocol</td>
<td>● Indicator of normal cockpit atmosphere</td>
</tr>
<tr>
<td>● Indicator of inadequate problem solving during 25 sec. to resolve emergency</td>
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</tbody>
</table>

- Request for ATC/ATIS information followed by imm. response
  - FO-> CA 5 instances
  - CA-> FO 1 instance
- Joint recognition of problem, but no identification of problem or stated plan within 25 seconds
- Adherence to SOP (checklists & ATC)
- Appropriate social conversation/responsiveness, return to task speech when appropriate

Evaluating Crew Communication in Research

**Speech Act Indicators**

- Speech acts totals & ratio's
  - differences across experiment conditions
- Speech act sequences
  - question - answer
  - command - acknowledgment
- Crew coordination strategies
- Dysfluencies
  - incomplete speech
  - interrupted speech
  - repetitions
- Workload and workload distribution
- Non-verbal acts
  - Roles and procedures
Research Example

Full mission simulation
12 DC-9 crews, 10 MD88 crews

Low vs. High level of automation
Normal and abnormal flight conditions
CA = pilot flying
FO = pilot not flying

Speech acts totals, ratios and sequences
(question-answer)

- Indicator of information access and relevance to problem

Non-verbal acts
(with visual access)

- Indicator of changes in work roles, workload

- In the MD88 scenario
  - more total speech acts
  - more CA questions
    - seek information (vs. verify)
    - navigation & systems (vs. procedures)
  - more questions unanswered
    - especially in the Abnormal phase

- In the MD88 scenario
  - CA = FO systems acts
  - CA > FO navigation acts
  - Traditionally, CA > FO systems acts
  - FO > CA navigation acts

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Evaluating Crew Communication in Training

Speech Act Indicators..........of crew performance; individual evaluation

Information transfer
  - Discuss flight conditions

Team/task management
  - Set priorities, state plans & intentions, distribute work

Shared problem solving & d-m
  - State decisions, course of action

Establish interpersonal climate
  - Solicit feedback & participation

Technical training objectives
CRM training objectives
Adherence to procedures
Training Example

LOE Event Set
Pre-departure through beginning of takeoff IAD ATIS 134.85
Event trigger = consideration of summer operations, low visibility, abnormal engine start, possible windshear
Conditions: Aborted engine start. Congested ramps and taxiways in low visibility on taxi out

Ratings of pre-defined observable speech acts
- Indicator of primary CRM element, team management
- Indicator of quality of technical and CRM performance

Description of additional relevant speech acts
- Indicator of secondary CRM elements

Within Event Set 1,
- Crew discussion of complex departure partially observed
- ABOVE AVERAGE crew discussion of summer ops SOP
- CA completed STANDARD pre-flight briefing
- PF analyzed takeoff WX and requested takeoff alternate
- PNF verified PF intentions prior to taxi start

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Designing Scenario Event Sets
Interpretation and evaluation of communication is aided by designing and controlling the speech contexts

- Physical
  → Consistent, realistic A/C and environment conditions and consequences
  → Realistic communication media

- Social & Organizational
  → Consistent roles and responsibilities
  → Incorporation of communication network as needed

- Task & Operational
  → Appropriate flight phases and procedures
  → Realistic normal & non-normal conditions surrounding “event triggers” “distracters” and supporting events

- Speech & Linguistic
  → Appropriate interactive context for communicators
Lessons Learned

- Communication serves many functions
  - Concrete operational definitions of communication will simplify the evaluation process

- Numerous ways to characterize speech: counts, ratio's, content, sequences, completeness
  - But they must be interpreted in the context in which they occur

- Speech context determines interpretation
  - Control the scenario/speech context so that speech acts can be consistently interpreted and evaluated

- "Words" alone do not constitute communication
  - Consider the significance of interactive sequences, non-verbal actions, and the shared situation

Unresolved Issues

- DEFINITIONS & EVALUATOR RELIABILITY: Because communication is a tool which cross-cuts numerous CRM skills, it is difficult to agree on standard definitions of communication skills across instructor/evaluators.

- SCENARIO DESIGN: More systematic methods of scenario design and validation are needed so that behavioral options are controlled without degrading realism.

- TRAINING IMPLEMENTATION: Inconsistent implementation of simulation training (e.g., scenario events, instructor interventions) degrade the reliability of performance evaluations