Royal Aeronautical Society Human Factors Group
Communication & Co-ordination: How Good is the Team?
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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... which support outcomes

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

What does communication accomplish?

Information Transfer

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

- Impediments:
  - Lack of knowledge or understanding
  - Misunderstanding
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

**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
  - Ineffective communication
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.

How are Communication Skills Used?

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

<table>
<thead>
<tr>
<th>Investigation</th>
<th>Research</th>
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</thead>
<tbody>
<tr>
<td>→ Case study</td>
<td>→ Experiment groups compared</td>
</tr>
<tr>
<td>→ Focus on causal and contributing factors</td>
<td>→ Factors of interest designed into the scenario</td>
</tr>
<tr>
<td>→ No scenario control</td>
<td>→ Many factors controlled &amp; manipulated / support staff</td>
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<tr>
<td>→ 100% validity</td>
<td>→ Operational realism limited</td>
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</table>

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

NTSB-CVR transcript
30.5 min. routine flight, 25 sec. emergency

Task related speech acts
- Indicator of cooperative crew coordination during routine flight
- Indicator of inadequate problem solving during 25 sec. to resolve emergency

Procedural speech
- Indicator of general adherence to procedures and ATC protocol

Nontask-related speech
- Indicator of normal cockpit atmosphere

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 of crew performance;
differences across experiment conditions
Speech acts totals & ratio's
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

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

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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

<table>
<thead>
<tr>
<th>Ratings of pre-defined observable speech acts</th>
<th>Within Event Set 1,</th>
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<tr>
<td>• Indicator of primary CRM element, team management</td>
<td></td>
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<tr>
<td>• Indicator of quality of technical and CRM performance</td>
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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

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

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

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

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

- Communication serves many functions
  - Concrete operational definitions of communication will simplify the evaluation process
- Speech context determines interpretation
  - Control the scenario/speech context so that speech acts can be consistently interpreted and evaluated
- Numerous ways to characterize speech: counts, ratio's, content, sequences, completeness
  - But they must be interpreted in the context in which they occur
- “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