

**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

**Barbara G. Kanki
NASA Ames Research Center
MS 262-4, Moffett Field, CA 94035
bkanki@mail.arc.nasa.gov**



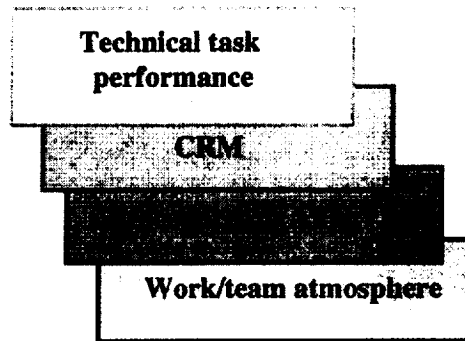
Agenda

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

Communication accomplishes. . .

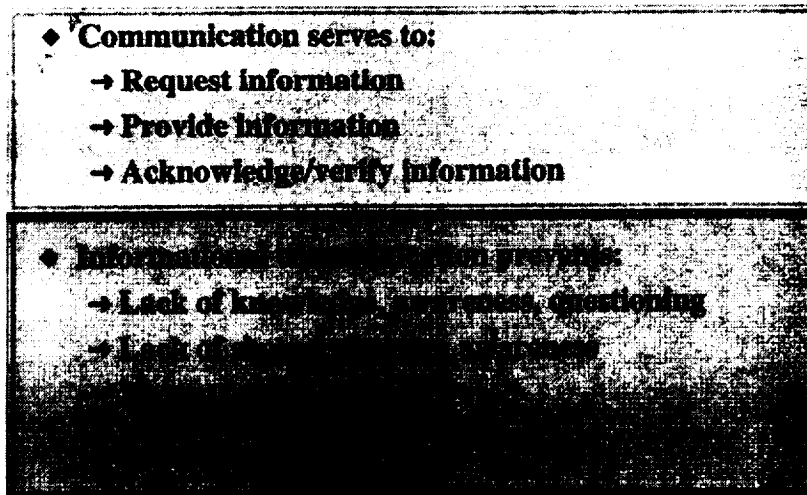
- ◆ Information transfer
- ◆ Team/task management
- ◆ Shared problem solving & decision making
- ◆ Establishment of the interpersonal climate

. . . which support outcomes



What does communication accomplish?

Information Transfer



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

- ◆ Team/task management prevents:
 - Nonstandard procedures, complacency
 - Lack of shared situation awareness
 - Inappropriate task assignments, task delegation
 - Unbalanced distribution of workload

What does communication accomplish?

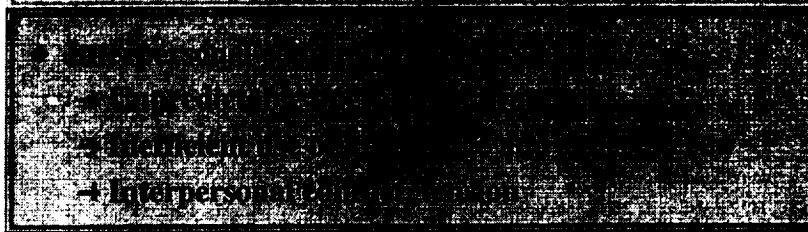
Problem Solving & Decision Making

- ◆ 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 shared situation awareness
 - Inadequate resolution of problems

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.

How are Communication Skills Used?

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

<p>Investigation</p> <ul style="list-style-type: none"> → Case study → Focus on causal and contributing factors → No scenario control → 100% validity 	<p>Research</p> <ul style="list-style-type: none"> → Experiment groups compared → Factors of interest designed into the scenario → Many factors controlled & manipulated / support staff → Operational realism limited
<p>Training</p> <ul style="list-style-type: none"> → 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

<p><i>Speech Act Indicators.....of crew performance; contributing factors</i></p>	
<p>Task-related speech acts</p> <ul style="list-style-type: none"> ✦ Emergency problem solving ✦ ATC, routine and non-routine 	<p>Response to the emergency, problem solving</p>
<p>Procedural speech acts</p> <ul style="list-style-type: none"> ✦ Adherence to regulations & company procedures 	<p>Adherence to procedures</p>
<p>Non-task related speech acts</p> <ul style="list-style-type: none"> ✦ Evidence of conflict, tension ✦ Attention to task, situation awareness 	<p>Cockpit atmosphere, interpersonal climate</p>

Investigation Example

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

CA, FO, ATC (Center, Approach)
CA on radio, FO pilot flying

<p>Task related speech acts</p> <ul style="list-style-type: none"> ● Indicator of cooperative crew coordination during routine flight ● Indicator of inadequate problem solving during 25 sec. to resolve emergency <p>Procedural speech</p> <ul style="list-style-type: none"> ● Indicator of general adherence to procedures and ATC protocol <p>Nontask-related speech</p> <ul style="list-style-type: none"> ● Indicator of normal cockpit atmosphere 	<ul style="list-style-type: none"> ● 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
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Evaluating Crew Communication in Research

<p><i>Speech Act Indicators.....of crew performance;</i></p> <p>Speech acts totals & ratio's</p> <p>Speech act sequences</p> <ul style="list-style-type: none"> ✦ question - answer ✦ command - acknowledgment <p>Dysfluencies</p> <ul style="list-style-type: none"> ✦ incomplete speech ✦ interrupted speech ✦ repetitions <p>Non-verbal acts</p>	<p><i>differences across experiment conditions</i></p> <p>Crew coordination strategies</p> <p>Workload and workload distribution</p> <p>Roles and procedures</p>
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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

<p>Speech acts totals, ratios and sequences (question-answer)</p> <ul style="list-style-type: none"> ● Indicator of information access and relevance to problem <p>Non-verbal acts (with visual access)</p> <ul style="list-style-type: none"> ● Indicator of changes in work roles, workload 	<ul style="list-style-type: none"> ● In the MD88 scenario <ul style="list-style-type: none"> → more total speech acts → more CA questions <ul style="list-style-type: none"> ✦ seek information (vs. verify) ✦ navigation & systems (vs. procedures) → more questions unanswered especially in the Abnormal phase ● In the MD88 scenario <ul style="list-style-type: none"> → CA = FO systems acts → CA > FO navigation acts <p style="text-align: center;">Traditionally, CA > FO systems acts FO > CA navigation acts</p>
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Evaluating Crew Communication in Training

<i>Speech Act Indicators.....of crew performance; individual evaluation</i>	
<p>Information transfer</p> <ul style="list-style-type: none"> ✦ Discuss flight conditions <p>Team/task management</p> <ul style="list-style-type: none"> ✦ Set priorities, state plans & intentions, distribute work <p>Shared problem solving & d-m</p> <ul style="list-style-type: none"> ✦ State decisions, course of action <p>Establish interpersonal climate</p> <ul style="list-style-type: none"> ✦ Solicit feedback & participation 	<p>Technical training objectives</p> <p>CRM training objectives</p> <p>Adherence to procedures</p>

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	Within Event Set 1,
<ul style="list-style-type: none">● Indicator of primary CRM element, <i>team management</i>● Indicator of quality of technical and CRM performance	<ul style="list-style-type: none">● 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
Description of additional relevant speech acts	
<ul style="list-style-type: none">● Indicator of secondary CRM elements	

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