Tools for Designing, Evaluating, and Certifying NextGen Technologies and Procedures: Automation Roles and Responsibilities

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Agenda

- Introduction
- Changes in Roles and Responsibilities
    - Focus on Collaborative Work
    - Focus on New Technologies
    - Focus on Roles and Responsibilities
- Collaborative Systems Assessment (CSA)
    - Developing a Baseline Interaction Matrix
    - Developing a Framework for CSA
    - Future Directions

Introduction

Program: NextGen Flight Deck Human Factors

– Division: Human Interaction with NextGen Technologies

– Topic Area: Automation/Roles & Responsibilities

– Project Focus: Pilot/ATC/Flight Operations Center Communication & Coordination

Research Team – NASA Ames Research Center

– Barbara G. Kanki, Ph.D., NASA

– Thomas L. Seamster, Ph.D., Cognitive & Human Factors

– Eric Chevalley, Ph.D., San Jose State Univ. Fndn

– Subject Matter Experts: pilots/air traffic controllers/dispatchers

Changing Roles and Responsibilities

Changes in the roles and responsibilities of pilot, ATC, FOC and automation are anticipated in future NextGen collaborative systems

– In order to implement the most effective distribution of roles and responsibilities there needs to be a way to assess various collaborative arrangements that:

- takes into account Human Factors considerations,
- identifies benefits and risks at a general level,
- addresses performance tradeoffs at a procedural level.

Focus on Collaborative Work

AIR TRAFFIC CONTROL

Tower Team
Flight data
Tower supervisor
Ground control
Cab coordinator
Local control

TRACON Team
Arrival/Departure data
Arrival Control
Departure Control
Satellite Control
Traffic Management Unit

**EN ROUTE
SECTOR TEAM**
Radar flight data
Radar coordination
Radar associate
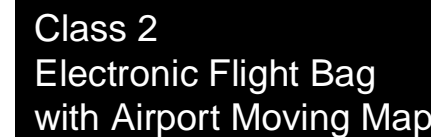Traffic Management Unit

TRAFFIC MANAGEMENT

FLIGHTDECK
Captain - First Officer
Pilot Flying – Pilot Monitoring

FLIGHT
OPERATIONS
CENTER (FOC)

Dispatchers who plan and release flights
Dispatches who coordinate with ATC

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Focus on New Technologies

AGD ADS-B Guidance Display

Class 3 EFB (Electronic Flight Bag)

CDTI Cockpit Display of Traffic information

Class 2 Electronic Flight Bag with Airport Moving Map

Focus on Roles and Responsibilities

- In the current system:
    - Are responsibilities shared within/across teams?
    - Who does what and with what level of authority?
    - How are responsibilities governed?
    - How do roles communicate and coordinate; by what means?

- When roles change:
    - Will responsibilities shift or be shared across teams?
    - Will there be changes in workload, where will they occur?
    - What are the information requirements; will there be changes in situational awareness?
    - What are the overall benefits and risks?

Collaborative Systems Assessment (CSA)

Assumptions for developing a CSA framework:

1. Framework for assessment is generic (e.g., technology and procedure neutral).

2. Framework incorporates basic operational concepts (e.g., phase of flight, nominal vs. off-nominal conditions, time-sensitive vs. time-critical).

3. Currently, there is substantial interaction between groups but little "collaboration".

4. Current interactions involve limited automation but as advanced automation is implemented, "automation" is considered the 4th "collaborator.

Developing a Baseline Interaction Matrix

1. Detail current roles and responsibilities of pilots, controllers and dispatchers by phase of flight

    – on the basis of task analyses for each role,

    – using operator manuals, FAA guidance documents,

    – interviews and surveys with subject matter experts.

2. Identify generic points of interaction for normal and key off-normal operations (pilot-ATC, pilot-FOC, ATC-FOC)

    – describing the current function of the interaction,

    – providing the current means of interaction or communication.

Keeping a systems perspective…
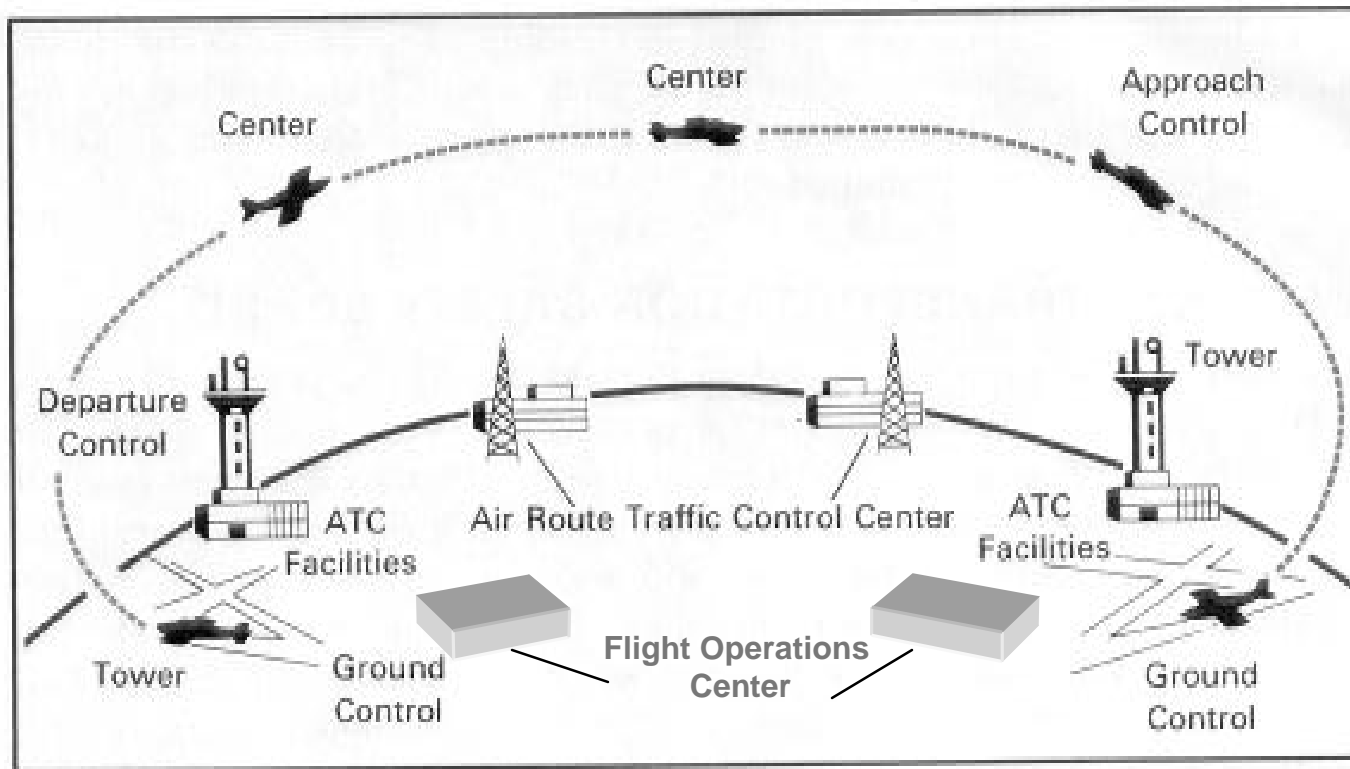
… focusing on collaborative functions

Developing a Framework for CSA:
5 Key Elements

1. Collaborators: Flightdeck, ATC, FOC, Automation

2. Collaborator Responsibilities for each

3. Functions and Procedures

   – Function Allocation

   – Collaborative Procedures

   – Tasks

4. Human Factors Considerations

   – Scenarios including Nominal and Off-nominal Operations

   – Measures and Metrics

5. Required Technologies

   – System requirements and technologies

Developing a Framework for CSA Inputs

CSA Input Elements for pilot/ATC/FOC/Automation

- When only General inputs are available
  - Phase of Flight of interest
  - Time Criticality: (e.g., critical, sensitive, planning)
  - Collaborator Responsibilities (e.g., collaborative trajectory mgmt)
  - Collaborator Functions (e.g., merging, spacing, separation mgmt)
  - Level of Automation (e.g., none, partial, full)

- When Detailed Procedural inputs are available
  - Assumed Systems/Technologies (e.g., ADS-B, Data Comm, RNAV, RNP, ERAM available, System Wide Information Management (SWIM),NextGen Network Enabled Weather (NNEW) is available, CDTI, Collaborative Trajectory Planning)

Developing a Framework for CSA Output

CSA Output

- When only General inputs are available,
  - General Benefits, e.g. efficiency, flexibility, enhanced situational awareness, decreased workload,
  - General Risks, e.g., work overload, not maintaining shared situational awareness, level of automation required not available.

- When Detailed Procedural inputs can be assumed, trade studies may be performed for particular collaborations
  - Metrics for each collaborator (e.g., Flightdeck, ATC, Automation) may include: Communication frequency, efficiency, flexibility, shared situational awareness, workload.

Future Directions

- The CSA framework (currently in the form of checklists) allows the user to assess collaborative systems at a General and/or Detailed, procedural level

- The framework can be further developed into a stand-alone tool, supported by links to research literature as well as operational and guidance documents

- Intended users are ConOps developers and other NextGen researchers