INITIAL IDENTIFICATION OF PROCEDURAL ISSUES FOR THE FUTURE DEPLOYMENT OF TERMINAL AREA PRODUCTIVITY (TAP) TECHNOLOGIES

FINAL REPORT
OCTOBER 1998

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Report Number: MTI 98-940506-36-1

Prepared for:
NASA Ames Research Center
Moffett Field, CA 94035-1000
Contract Number NAS2-14113

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ACKNOWLEDGEMENTS

This work was performed jointly by Monterey Technologies, Inc. and the San Jose State Foundation at NASA Ames Research Center. Monterey Technologies, Inc performed this work under NASA Contract No. NAS2-14113, Deliver Order No. 35.

The authors are grateful for the direction and support of Dr. David Foyle of the Flight Management and Human Factors Division at NASA Ames Research Center. Captain Dan Renfroe (retired) of United Airlines did an excellent job as the moderator for the mini-focus groups convened for this study.

We acknowledge the contributions of:

- Barry Crane, Tom Prevot, Ev Palmer (FMS/CTAS)
- Trent Thrush, Greg Pisanich (AILS)
- Dick Hueschen (ROTO)

who provided background information on the component systems, gave demonstrations of the component functionality, and provided time and information for production of the training videotape.

Finally, we would like to thank the 16 airline pilots and 8 Air Traffic Controllers who participated in the mini-focus groups. Although they must remain unnamed, their enthusiastic participation made this study possible.

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LIST OF ACRONYMS

ADI	Attitude Direction Indicator
AILS	Airborne Information for Lateral Separation
AIM	Aeronautical Information Manual
ATC	Air Traffic Control
ATM	Air Traffic Management
CAT III	Category III
CDU	Control Display Unit
CRM	Crew Resource Management
CSPA	Closely Spaced Parallel Approaches
CTAS	Center TRACON Automation System
DA	Descent Advisor
EICAS	Engine Indicating and Crew Alerting System
EMM	Electronic Moving Map
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FAST	Final Approach Spacing Tool
FO	First Officer
FMS	Flight Management System
GA	General Aviation
GC	Ground Control
GCAW	Ground Collision and Warning System
HUD	Head Up Display
HGS	Head-Up Guidance System
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
LNAV	Lateral Navigation
LVLASO	Low Visability Landing and Surface Operations
ND	Navigation Display
NASA	National Aeronautics and Space Administration
PF	Pilot Flying
PNF	Pilot Not Flying
RA	Resolution Advisory
ROTO	Roll Out and Turn Off
RSO	Reduced Spacing Operations
SA	Situation Awareness
SOP	Standard Operating Procedures
TA	Traffic Advisory
TAP	Terminal Area Productivity
TCAS	Traffic Collision and Avoidance System
TMA	Traffic Management Advisor
T-NASA	Taxiway Navigation and Situation Awareness
TRACON	Terminal Radar Approach Control
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VSD	Vertical Situation Display

EXECUTIVE SUMMARY

The purpose of the present study was to identify potential procedural difficulties in the future deployment of four proposed Terminal Area Productivity (TAP) technologies. These technologies essentially provide increased information to the flight crew regarding aircraft position and other traffic during low visibility conditions, specifically for approach, landing, and taxi operations. This study was intended to provide an initial assessment of how the technologies might affect crew procedures as well as the relationship between the flight crew and Air Traffic Control (ATC). The intention was to identify issues that need resolution to enhance the probability that the safety and capacity benefits of the TAP technologies might be achieved. The findings of an investigation of the issues in the physical integration of TAP displays into commercial aircraft are published in a separate report, Issues in the Physical Integration of TAP Displays into Commercial Aircraft Cockpits (Cotton, et al., 1998).

Nine mini-focus groups were conducted, nominally with three participants in each. The 16 airline pilots who participated represented six different airlines. All had experience in glass cockpit aircraft. Eight experienced ATC personnel from the San Francisco bay area were included in discussion groups with the pilots. An introductory period of approximately one hour was allocated to introduce the four TAP technology components and to explain their features and functions. A training video enabled consistent and comprehensive coverage of these topics for each group. Following the introduction and training period, the moderator, a recently retired 747-400 Captain, led the group through discussions of how current cockpit procedures might differ when the TAP technologies are deployed.

As expected, a wide range of opinion was found. Nevertheless, certain themes found consensus, if not unanimity for each of the four TAP components:

(1) The pilots were positive about the potential benefits of the Center-TRACON Automation System (CTAS), but expressed concerns regarding potential future uses of datalink technology. Both pilots and controllers thought that a certain amount of situation awareness, currently obtained through monitoring radio traffic during the approach, might be lost with a datalink implementations. New procedures may be necessary to ensure that the flight crew interacts with ATC to confirm datalinked revisions to the approach pattern.

(2) The Airborne Information for Lateral Spacing (AILS) was perceived by the pilots to provide good information about the location and near-future track of nearby aircraft during closely spaced parallel approaches. Pilots were concerned that procedures will be needed to ensure that only speed-compatible aircraft, both equipped with AILS, should fly this type of approach, and then only in a staggered formation. The pilots and the controllers agreed that one controller, in communication with both aircraft, should be assigned to monitor such approaches. Also, there was concern about the use of AILS in HUD equipped aircraft.

(3) The Roll Out and Turn Off (ROTO) component discussions raised many important issues. The pilots felt that they did not need an advisory display suggesting when to turn off the runway. They suggested that no automated system could feel the runway conditions as well as the pilot. Further, they suggested that ROTO would contribute to difficulties in crew resource management (CRM) because only the Captain will see the ROTO display (in a HUD). The First Officer must be equipped to provide feedback or corroboration.

(4) The Taxiway Navigation and Situation Awareness (T-NASA) component was viewed by pilots as being very helpful in poor visibility. Nevertheless, several procedural questions were raised. The need for new phraseology was identified. The role of Ground Control was questioned relative to the synthetic augmented display provided by T-NASA. If T-NASA progresses to a full datalink implementation and Ground Control passes information via datalink without voice, will pilots not need to verbally acknowledge crossing an active runway? The controllers voiced concern about safety if positive control and voice acknowledgment is diminished by this new technology. Finally, concerns were voiced about taxiing via the T-NASA display and encountering non-equipped aircraft or other vehicles such as fuel trucks.

In summary, considerable thought needs to be given to the implementation of these technologies. The role of ATC and Ground Control must be confirmed, or redefined, along with the necessary communications and confirmations from the flight deck. Procedures within the cockpit also must be established carefully in the context of the new technologies.

INTRODUCTION

In the United States over 300,000 flights annually experience delays that exceed 15 minutes. More than 60 percent of these are a consequence of operating in low visibility or instrument meteorological conditions. The estimated impact of these delays on airline operations is approximately 3 billion dollars. In response, NASA, in conjunction with the FAA, has created the Terminal Area Productivity (TAP) program. The mission of the TAP program is to achieve the same level of airport capacity and safety associated with clear-weather operation during instrument meteorological conditions. TAP will increase capacity and reduce delays by reducing spacing requirements between aircraft approaching an airport and by expediting ground operations. Working with the US airline and aircraft industries, airport owners and operators, and the FAA, the TAP Program will increase non-visual operations for single runway throughput by 12-15 percent. It will also reduce lateral spacing below 3,400 feet for independent operations on parallel runways, demonstrate equivalent instrument /clear weather runway occupancy time, and reduce taxi times, while meeting the public's expectation for safe operations.

Four TAP technologies are being developed in order to meet these goals.

- Flight Management System/Center TRACON Automation System (FMS/CTAS)
- Airborne Information for Lateral Spacing (AILS)
- Roll Out and Turn Off Guidance (ROTO)
- Taxiway-Navigation and Situation Awareness (T-NASA)

The purpose of the present study is to identify potential procedural difficulties in the future deployment of the four Terminal Area Productivity (TAP) technologies. This study is intended to provide an initial assessment of how the technologies might affect crew procedures as well as the relationship between the flight crew and Air Traffic Control (ATC). The potential procedural changes or difficulties identified in this report may vary according to the individual airline, the size or type of aircraft, and other factors. The intention was to identify issues that need resolution to enhance the probability that the safety and capacity benefits of the TAP technologies might be achieved.

A substantial amount of effort has been expended developing each of the TAP displays. Looking ahead to the realization of the practical benefits of the TAP capabilities and displays it is also important to determine what will be required to actually fit the TAP displays to aircraft and how their use will affect current flight procedures. What are the technical, regulatory, and cost impediments to the migration of the TAP displays from the laboratory to every day use in flight operations? Identifying problems early allows adjustments in design and planning for an orderly introduction of the TAP displays into commercial aviation. To this end, Monterey Technologies, Inc. was asked to do a preliminary investigation of what would be required to integrate the TAP displays physically and procedurally into aircraft. Physical integration and procedural integration were investigated concurrently but independently. The findings are reported in two separate reports. The companion to this report is Issues in the Physical Integration of TAP Displays into Commercial Aircraft Cockpits (Cotton, et al., 1998).

DESCRIPTION OF THE TAP TECHNOLOGIES

A brief description of each of the four TAP technologies is presented below starting with FMS/CTAS, followed by AILS, ROTO, and T-NASA. Further descriptions of the flight deck displays and intended usage procedures can be found in Appendix B.

Flight Management System / Center TRACON Automation System (FMS/CTAS)

The integration of on-board Flight Management Systems (FMS) with the Center-TRACON Automation System (CTAS) is being conducted as part of the Air Traffic Management (ATM) sub-element of TAP. The (FMS/CTAS) Flight Management System/Center TRACON Automation System integration effort proposes coordination of ground-based automation tools (i.e., CTAS) with the aircraft FMS to increase safety, efficiency, and capacity in and around the terminal airspace. To accomplish these goals, ATC may use CTAS tools with scheduling algorithms to control arriving aircraft.

The controller CTAS tools (shown in Figure 1) include: Descent Advisor (DA) which provides conflict free, fuel efficient descent information, Traffic Management Advisor (TMA) which plans sequence and landing times, and a Final Approach Spacing Tool (FAST) used to advise on accurate spacing on final approach. Flight deck modifications will include adjustable FMS leg types that will support simple FMS route adjustments (e.g., downwind leg length) in the TRACON airspace. While it is presently undecided, future implementations may also include the addition of a datalink display and response buttons that will support automatic loading of, and heads-up assessment and response to, uplinked CTAS routes.

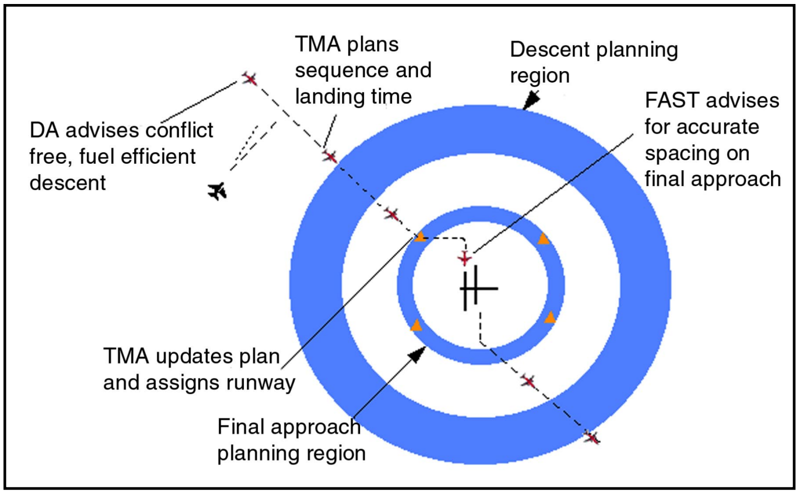

Figure 1. FMS/CTAS Integration

Airborne Information for Lateral Spacing (AILS)

Airborne Information for Lateral Spacing (AILS), a Reduced Spacing Operations (RSO) sub-element of the TAP program, will apply on-board precision navigation and communications technology in conjunction with onboard safety surveillance systems [i.e., Traffic Collision Avoidance System (TCAS)] to permit safer, reduced runway separation requirements for Closely Spaced Parallel Approaches (CSPAs). At airports with parallel runways spaced less than 3400 feet apart, CSPAs may only be conducted in Visual Meteorological Conditions (VMC), when both pilots can see the runway and the other aircraft. In IMC, airport capacity is significantly reduced - only one runway may be used, or the two runways may be used with aircraft spacing equivalent to the spacing used for a single runway. The purpose of the AILS system is to maintain aircraft separation during closely spaced parallel approaches of less than 3400 ft separation in IMC. Traffic advisories and resolution advisories (similar to TCAS) are provided to the flight crew to alert them of an encroaching aircraft.

Both pilots primary flight display (PFD) will be modified to display the following: a parallel traffic window which indicates the location (left or right) of the traffic; a slant range indicator, which shows the distance (in hundreds of ft) between the ownship and the traffic; and a horizontal motion arrow, which indicates that traffic is moving away from its centerline and toward the ownship. A traffic advisory accompanied by an aural alert is issued if parallel traffic executes a blunder that results in an intercept course. If the alerting system determines that a maneuver is necessary to maintain separation, a resolution advisory is issued and pitch & turn guidance cues and go-to bars appear on the PFD (see Figure 2, left).

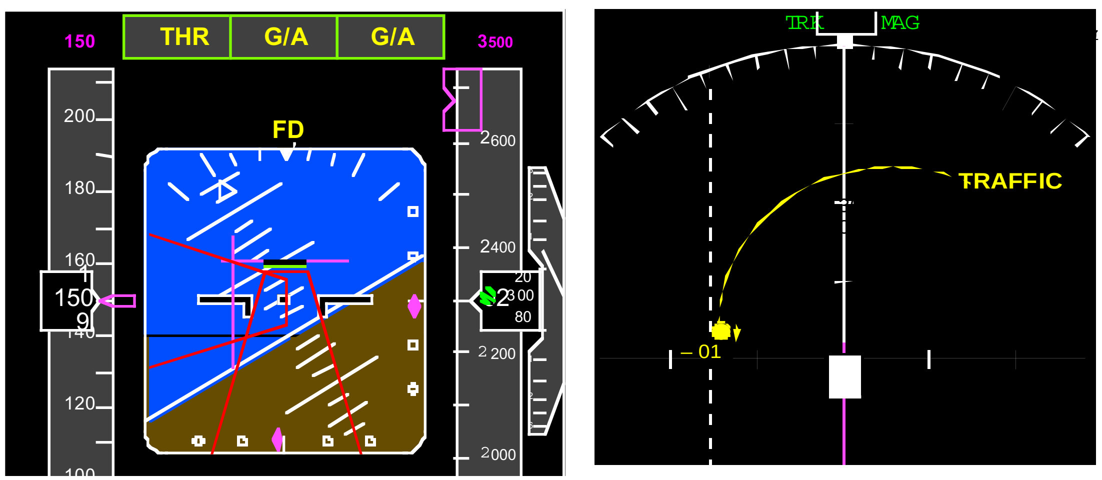

Figure 2. Primary Flight Display with AILS Resolution Advisory (left), and AILS Navigation Display enhancements (right)

AILS also includes modifications to both pilots navigation display (ND) including: a parallel runway and centerline cue, which indicates the location of the parallel runway and intended path for the other aircraft; and a traffic trend vector which indicates what direction the traffic is heading (see Figure 2, right).

Roll Out and Turn Off (ROTO)

Roll Out and Turn Off (ROTO) is a component of the Low Visibility Landing and Surface Operations (LVLASO) sub-element of the TAP program. ROTO is being developed to reduce the amount of time an aircraft needs to spend on the runway after landing. ROTO will assist the pilot to quickly and safely exit the runway by providing visual guidance, braking and turn advisories to the Captain via a head-up display (HUD).

While airborne the pilot can set ROTO to either automatic or manual exit selection. In the automatic mode, ROTO will select the first safe runway exit, while the manual mode allows pilots to manually select a desired runway exit. The selected exit appears in the upper right hand corner of the HUD (See Figure 3, left). At touch down, ROTO ground symbology appears (See Figure 3, right) which provides current and predicted speed information.

Figure 3. ROTO Airborne Symbology (left) and Ground Symbology (right).

A ground speed error bar (on the left wing of the aircraft symbol) indicates whether the deceleration rate is too high or too low for the selected turn off. As pilots approach the turn-off, guidance is provided to indicate when the pilot should begin the turn. Two 2-second trend vectors provide information to aid pilots in positioning the aircraft on the exit centerline during the turnoff from the runway. If while in automatic mode, the pilot cannot decelerate safely to make the selected exit, ROTO will automatically switch to the next turn off.

Taxiway — Navigation and Situation Awareness (T-NASA)

Also under the LVLASO sub-element, the Taxiway Navigation and Situation Awareness (T-NASA) system is being designed to improve the efficiency of taxiway operations in IMC and at night. The T-NASA system is comprised of a perspective, head-down display taxi map, a HUD with scene-linked symbology, and a Directional Audio Ground Collision and Warning System (GCAW). All components are designed to increase taxi speed, route navigation accuracy, and situation awareness in low visibility conditions. It is expected that near term implementation of T-NASA will augment, but not replace, current day Ground Control operations. However, future implementations are also being considered that may place a greater emphasis on datalink communications over voice communications.

The T-NASA Taxi Map can operate in two modes: perspective and overview. In the perspective mode, a view of the airport from above and behind the ownship (see Figure 4, left) is presented. The taxi map presents the cleared taxi route via a magenta path. Hold short instructions, ground speed, compass heading, and cardinal direction bars are also presented with four levels that show progressively greater levels of detail. In the overview mode, a fixed view of the entire airport surface, runway and concourse locations, is presented much like a paper taxi chart (see Figure 4, right). This may be best used for airborne preview, or on the ground to aid in planning a route before taxiing.

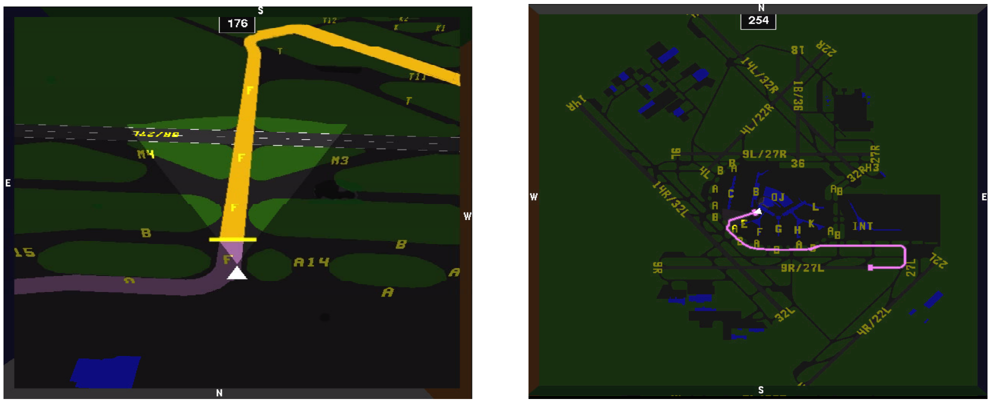

Figure 4. Taxi Map Perspective Mode (left) and Overview Mode (right).

The T-NASA Taxi HUD displays the cleared taxi route in the form of a series of virtual "cones" located along both edges of the cleared taxiway and a series of small squares that overlay the taxiway centerline (see Figure 5, left). The taxiway that the aircraft is currently on, as well as the taxiways that are coming up on the right and left, are presented in text form as is ground speed. The taxi HUD also provides turn angle and hold bar information.

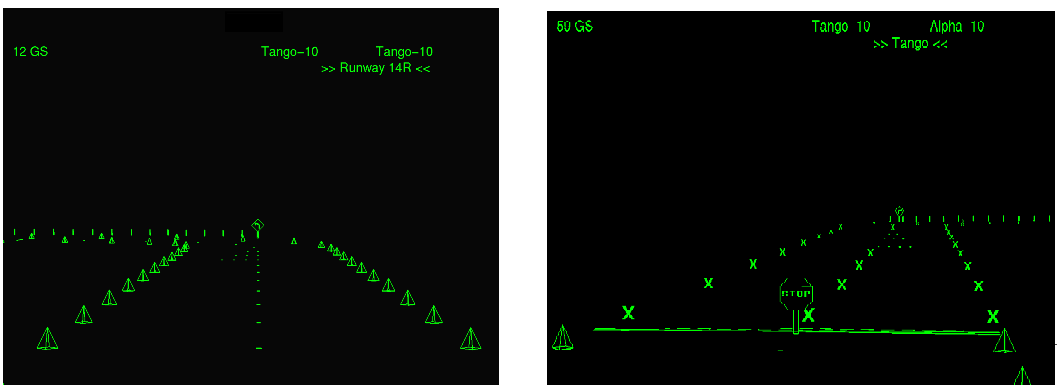

Figure 5. T-NASA Taxi HUD (left) and TNASA Taxi HUD Hold Short graphics (Right).

T-NASA directional audio GCAW sounds when the aircraft is in danger of collision with another aircraft or vehicle on the airport surface. If the collision is coming from the right, the auditory alert will be presented through the right earphone or speaker where as collisions from the left are alerted via the left earphone or speaker. This directional auditory alert system helps pilots identify the location of the problem faster.

METHOD

Review of Current Airline and ATC Procedures

Current Standard Operating Procedures (SOPs) from four commercial airlines (Alaska Airlines, 1997; FedEx, 1998; Southwest Airlines, 1993; United Airlines, 1994), the Federal Aviation Regulations (FAR) / Aeronautical Information Manual (AIM) (U.S. Department of Transportation, 1997), the ATC Procedures Manual (U.S. Department of Transportation, 1996), as well as Boeing s aircraft-specific guidelines (Boeing, 1994) were reviewed in order to understand potential procedural changes and additions necessitated by the integration of TAP technologies. Collectively, these manuals describe how the aircrew should operate and interact with air traffic controllers by outlining intended crewmember responsibilities and communications.

Focus Groups

The focus group was chosen as the method to identify potential procedural problems associated with the integration of the TAP technologies. This exploratory process relies on group interactions within the group to raise issues for further consideration and investigation.

Moderator Selection and Training

A recently retired B747-400 Captain from a major airline was chosen as moderator of the focus groups. That the moderator was recently retired, and no longer associated with an airline, eliminated concerns of airline competitiveness and secrecy. The moderator underwent training that included how and when to ask specific questions of members, and how to change topics or subtly guide the conversation back on target. The moderator was provided with a list of topics or questions that were to be used only as a reminder of upcoming questions or to foster conversation if necessary. Part of the moderator's job was to encourage active participation by all the members of the group. Also, the moderator was trained to avoid biasing the participants, and avoid volunteering his own point of view.

Participants

Nine focus groups were conducted with two to four participants in each group. The first five focus groups consisted only of pilots and the remaining four focus groups combined pilots with air traffic controllers. In total, 16 pilots (7 captains and 9 first officers) from 6 different airlines (2 major, 2 regional, and 2 commuter carriers) participated in the focus group discussions. The pilots reported experience with a variety of glass-equipped aircraft including SAAB 340, CL-65, B737 (200, 300, 500, 700), B747-400, B757/67, and B777. The mean number of hours logged on glass equipped aircraft was 2869 (ranging from 40 to 5000). Four pilots reported experience with HUD-equipped aircraft. Eight air traffic controllers also participated in the sessions along with the pilots. While most controllers reported working a variety of controller positions in the past, four work currently as TRACON controllers, and four as tower/ground controllers. The controllers reported a mean of approximately 17 years of ATC experience (ranging from 12 to 22 years).

Procedure

Each session began with the moderator introducing the purpose of the interview and providing a general overview of the session objectives. It was emphasized that the purpose of the focus groups was to identify potential procedural issues associated with integrating the TAP technologies into the flight deck. It was also emphasized that the purpose of the sessions was NOT to discuss design issues of each particular display, as the displays presented were still undergoing design and development research, and not necessarily final products ready for flight deck integration. All focus group participants completed a Participant Consent Form and a Participant Information Questionnaire (see Appendix A). Participants were told that all comments would remain confidential and anonymous, and that their names and airlines would not be associated with their opinions.

Participant Training. Focus group participants received an hour long training session which began with a specially prepared 35 minute training video. The TAP video introduced the purpose and flight deck enhancements associated with each technology and then dynamically displayed them in part-task simulators. This training video enabled a consistent and comprehensive introduction for each focus group session. Subsequently, participants reviewed written TAP Technology summaries (See Appendix B), which described the purpose of the displays, flight deck display enhancements as well as anticipated uses and procedures. In addition, basic procedural assumptions were also presented for each TAP technology.

Following is a list of assumptions that pilots were asked to consider throughout the focus group discussions:

FMS/CTAS:

Three potential FMS/CTAS implementations, each with increasing reliance on datalink technology, are under consideration:

- Controllers use CTAS tools to determine the length of the downwind leg. At the appropriate time, the controllers will provide vectors (via radio) to the aircraft to begin the base turn.
- The aircraft will be cleared for a FMS descent route which will include a downwind leg and a default base turn. Using CTAS scheduling and planning tools, ATC may extend the downwind leg via radio communications. Pilots acknowledge the downwind extension by voice and make the necessary modification using the CDU.
- Instead of extending the downwind leg via radio (as above) datalink may be used. The modified FMS descent route automatically loads into the modified route buffer of the FMS. The crew confirms and assesses the loaded route on their Navigation Displays. They execute the route (if acceptable) in the CDU, and respond to ATC by pressing an ACCEPT button located on the glareshield.

AILS:

The following set of ATC/Pilot responsibilities are under consideration:

- The final controller is responsible for aircraft separation until AILS approach clearance is given to the aircraft. The final controller will notify both aircraft of the parallel traffic prior to turning final - and will apply standard separation between aircraft during turn on to final approach.
- Both aircraft will confirm that they have their traffic in sight (under electronic surveillance) and assume separation responsibility prior to losing standard separation. After receiving AILS approach clearance, the aircraft are solely responsible for separation.
- In the event of a blunder or intrusion incident, the flight crew maintains separation responsibility. ATC will not assume separation responsibility until the initial conflict has been resolved by the flight deck crews.
- Once the initial conflict has been resolved and safe separation achieved, ATC will assume responsibility for separating the two aircraft involved in the incident from all traffic, and to vector the aircraft back into the approach sequence.

ROTO:

- Currently, it is expected that most aircraft will be equipped with one head-up display centered over the left seat, therefore only the Captain will have access to ROTO information. Additional displays for the first officer are under consideration, however the form they may take is still to be determined.
- It is expected that pilots will always 'own the runway' and maintain the right to choose their runway exit. Current implementations of ROTO do not include ATC involvement in the runway exit selection.

T-NASA:

Two operational implementations of T-NASA, each with different emphasis on voice and datalink communication, of T-NASA are under consideration:

- Communications between ground control and pilots will remain as they are today and will be redundantly presented via datalink in the cockpit. Pilots will acknowledge taxi routes and amendments both by voice and datalink response buttons on the glare shield.

- All communications between pilot and ATC will be performed via datalink. Routes and amendments will be automatically up-linked to T-NASA. Pilots will acknowledge the route using datalink response buttons on the glare shield.

Focus Group Discussions. Upon completion of the training segment, the moderator began the focus group discussion by defining a scenario to provide a context for the discussion. Participants were asked to imagine they were flying an approach into an unfamiliar and complex airport in low visibility conditions. They were told to consider their tasks, roles, and typical communications for each of the following time periods: Top of Descent to Final Approach, Final Approach to Landing, Landing and Roll Out, and Taxi to the gate. While this provided the basis for the discussion, it was emphasized that the discussion need not be limited to this scenario. For example, pertinent issues associated with clear visibility, familiar airports, and departure scenarios were also encouraged.

The first segment of the discussion began by participants considering procedures from the top of descent to final approach. Participants were asked to outline the procedures currently implemented by their airline, and review the tasks and communications within the cockpit during this phase of flight. This served primarily to put participants in the context of the phase of flight being discussed, and was also helpful in identifying procedural differences among airlines. Subsequently, the first TAP technology (FMS/CTAS) was introduced and participants were asked to identify ways in which CTAS would affect current procedures during this phase of flight. This process was repeated to determine how AILS would affect final approach procedures, how ROTO would affect landing and roll out procedures, and how T-NASA would affect taxi procedures. Throughout the discussions, a list of probe questions was used by the moderator to foster discussion and when necessary, the moderator reminded participants to consider the assumptions outlined during the training session. Where more than one operational implementation option was proposed (i.e. the use of datalink for CTAS and T-NASA), each option was discussed in turn. Prior to the conclusion of the session, the participants were asked to summarize their views and express their main procedural concern associated with the TAP technologies. Each session lasted approximately 5 hours (including training and a lunch break).

Data Logging and Synthesis. Data capture was accomplished through data logging and audio cassette recording. A minimum of two data loggers were present at each session in order to record the participants comments. The data loggers did not participate in the discussion, but were given opportunities at the end of each segment to ask participants to expand or clarify their issues. An audio recording captured the session in the event that specific comments needed to be reviewed for the purpose of clarification and also as a back-up recording device. After careful transcription to ensure a complete and comprehensive collection of notes, subsequent analyses began by sorting the content into meaningful categories.

Survey

The focus groups raised a large number of issues, but due to the nature of the focus groups there was no systematic way to determine if an issue raised in one group, was agreed upon by members of other focus group sessions. In order to achieve a better understanding of the consensus of the issues, a summary of focus group comments was compiled and distributed to participants in the form of a mail-back survey (see Appendix C). Participants were asked to rate their level of agreement with each quote on a five point scale (from strongly disagree to strongly agree) as well as the degree of criticality of each statement on a three point scale (not critical, somewhat critical, and very critical). Survey response rate was 88% for air traffic controllers (7 of 8 responded) and 56% for pilots (9 of 16 responded).

RESULTS: FOCUS GROUP FINDINGS

Below is a summary of the issues raised in the focus group for each of the four technologies. They are sorted into the following categories:

- Areas of procedural concerns
- New flight deck procedures needed
- Role conflicts or changes on the flight deck
- Role conflicts or changes with ATC
- Issues in operational deployment

Where relevant, direct quotes are provided preceded by the author s role (pilot or ATC). As pilots were familiar with both Captain and First Officer roles, and all ATC controllers were experienced with more than one ATC station, these were not delineated further. Where survey data was obtained, the comment that was rated is provided followed by the survey data in table format. The data table provides the percent of pilots and air traffic controllers that agreed with the statement (rated it a 4 or 5 on the five point agreement scale), and felt that the statement represented a critical issue (rated the statement a 2 or 3 on the 3 point criticality scale).

Due to the large number of comments and issues raised in the focus groups, it was not practical to obtain survey responses for all issues. In cases where survey data was not obtained, particularly if the comment reflected problems or changes required beyond the scope of the TAP technologies, the comments are presented without data tables. These comments and opinions are important and may be valid although consensus data are not available.

Flight Management System / Center TRACON Automation System (FMS/CTAS)

FMS/CTAS: Areas of Procedural Concerns

- ***Failure to Comply with ATC Directives and Clearances***

Both pilots and controllers acknowledged the relatively high frequency that ATC directives are either misunderstood, or simply not followed. This will be especially dangerous in the FMS/CTAS environment, where traffic congestion is high and spacing between aircraft is minimal.

Please rate the comment below for your level of agreement and criticality:
CTAS will be great when it all works, but hiccups in the terminal air space could mess up the entire system. When something goes wrong (i.e. a missed approach, or an aircraft does not make an assigned altitude crossing) things will be bad. There is no room for error with CTAS.

	AGREE	CRITICAL
Pilots	44%	89%
ATC	57%	100%

FMS/CTAS: New Flight Deck Procedures Needed

- ***Verify FMS/CTAS Operations with Manual Computations***

Pilots should be required to manually compute the descent path and verify with FMS/CTAS system. Pilots expressed a concern of over-reliance on automation, especially in inclement weather and poor visibility conditions.

Please rate the comment below for your level of agreement and criticality:
My airline s Standard Operating Procedures should include a requirement that the crew must calculate the vertical profile, and double check/verify that CTAS is correct.

	AGREE	CRITICAL
Pilots	78%	66%
ATC	N/A	N/A

- ***Modify LNAV Procedures***

Pilots may be required to stay on LNAV for longer duration and in closer proximity to the ground. This will be a change for some airlines.

Please rate the comment below for your level of agreement and criticality:
In our current operating procedures, we turn LNAV off when we are below 3000 feet. With CTAS we d have to stay on LNAV longer.

	AGREE	CRITICAL
Pilots	44%	50%
ATC	N/A	N/A

- ***Modify FMS Procedures***

Pilots may be required to remain coupled to the FMS for longer duration and in closer proximity to the ground. This will be a change for some airlines.

Please rate the comment below for your level of agreement and criticality:
Remaining coupled to the FMS longer is a procedural change, but it should not pose a problem.

	AGREE	CRITICAL
Pilots	44%	44%
ATC	N/A	N/A

- ***Develop Procedures to Allow Pilots to Reject a CTAS ATC Directive***

Develop procedures that permit the pilot to reject a CTAS route directive without the penalty of increased workload. A route may be rejected accidentally or because of terrain, weather, or other aircraft performance constraints.

Please rate the comments below for your level of agreement and criticality:
If a pilot accidentally hit Reject when he meant to accept the datalinked route change, it could be more workload to get the information back. Errors like this would increase our workload over present day levels.

	AGREE	CRITICAL
Pilots	78%	100%
ATC	100%	100%

Please rate the comments below for your level of agreement and criticality:
There is no room for quick modifications. If a pilot knowingly rejects a route because it is not acceptable (i.e. due to weather or terrain) it could create more workload to call ATC to explain why the route was rejected and get an amendment.

	AGREE	CRITICAL
Pilots	89%	100%
ATC	N/A	N/A

- ***Datalink Response Time Limits***

A pilot should be required to have a time limit to respond to datalink messages. The terminal area is a closely controlled situation and ATC does not have time to wait for a pilot to respond to a datalink message.

Please rate the comment below for your level of agreement and criticality:
In the terminal area, ATC doesn t have time to issue clearances by datalink and wait for a response.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	71%	100%

FMS/CTAS: Role Conflict or Changes on Flight Deck

- ***Loss of Situational Awareness (SA) Due to Datalink***

Procedures or new technologies (i.e. Cockpit Display of Traffic Information) may be required to compensate for the loss of the party-line communications. The "party-line" effect (hearing conversations between ATC and near by aircraft) allows the pilot to build a situation awareness or mental model of the location of other traffic. With a full or even partial implementation of datalink, this may be lost.

Please rate the comment below for your level of agreement and criticality:
With CTAS speed, altitude, and route changes arriving by datalink, pilots would lose their situational awareness. We won t have as clear a picture of the aircraft around us because we can t hear them.

	AGREE	CRITICAL
Pilots	56%	78%
ATC	N/A	N/A

Please rate the comment below for your level of agreement and criticality:
Mixed fleets will not work. If you have one or two aircraft using datalink, and the rest using voice, the datalinked aircraft will not be included in other pilots situation awareness.

	AGREE	CRITICAL
Pilots	67%	66%
ATC	N/A	N/A

- ***Increased Automation and Complacency***

Pilots may become complacent with CTAS amendments automatically entered into the FMS because workload is too low. In order to minimize automation-induced pilot complacency, procedures would be required to keep pilots in the automation loop.

Please rate the comment below for your level of agreement and criticality:
With speed altitude and route changes arriving by datalink, or automatically being loaded into the FMS, a pilot could become complacent and not pay attention to what the aircraft is doing.

	AGREE	CRITICAL
Pilots	56%	78%
ATC	N/A	N/A

- ***Increased Heads-Down / Eyes in Time***

Develop procedures that require a crew member to maintain "eyes-out" while route changes are being processed by other crew member(s). Whether entering modifications via the CDU, or reviewing an amendment uplinked to the FMS, many CTAS route changes could require the pilot to spend more time "heads down" and "eyes-in" to process the information.

Please rate the comment below for your level of agreement and criticality:
Datalink will interfere with current cockpit procedures by forcing pilots to change from the primary task to address datalink messages.

	AGREE	CRITICAL
Pilots	33%	67%
ATC	N/A	N/A

FMS/CTAS: Role Conflict or Changes with ATC

- ***Maintain Pilot-ATC Communications***

Periodic confirmation of route changes through radio communications between the pilot and ATC should be required. This will reassure the aircrew that ATC is still actively controlling air traffic and that ATC is receiving all necessary messages. For example, some pilots expressed a need for a verbal confirmation from ATC in order to perform a base leg turn that is based on FMS/CTAS system inputs.

Please rate the comment below for your level of agreement and criticality:
We will lose the interpersonal dialogue between the controller and the pilot. A controller may ask a pilot to try to make a certain altitude and the pilot will try to make it work —or negotiate another option. This interaction will be lost with datalink.

	AGREE	CRITICAL
Pilots	67%	78%
ATC	100%	86%

- ***Provide ATC Flexibility to Easily Change a Routing Without Affecting Other Aircraft***

Plan for contingencies when a pilot rejects an ATC CTAS amendment due to weather or terrain. The controller may be required to change routes for several other aircraft as well. This may create a "domino effect", effecting the CTAS clearances for all aircraft in the terminal area.

Please rate the comments below for your level of agreement and criticality:
The number of interactions and communications between ATC and the flight deck to make the necessary CTAS speed, altitude, and route adjustments will mean extra workload for the controllers / pilot not flying.

	AGREE	CRITICAL
Pilots	55%	67%
ATC	100%	100%

Please rate the comments below for your level of agreement and criticality:
I d let CTAS assign routes and I would watch the patterns. When I see that it isn t going to work, then I d step in. However this could be problematic. If a controller changes a routing, it may have a negative impact on other CTAS routes.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	86%	100%

- ***Defining ATC's Role with CTAS***

FMS/CTAS system may require ATC to shift roles from controlling aircraft to monitoring and approving computer-generated decisions. Controllers expressed concerns of lower situation awareness and higher complacency.

Please rate the comments below for your level of agreement and criticality:
CTAS will radically change the nature of our job. We will no longer be separating aircraft, just monitoring them.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	71%	100%

Please rate the comments below for your level of agreement and criticality:
With CTAS determining all speed, altitude and route changes, a controller could lose awareness of the big picture of traffic flow patterns .

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	71%	86%

Please rate the comments below for your level of agreement and criticality:
With CTAS determining all speed, altitude and route changes, a controller could become complacent and not pay attention to what the aircraft traffic is doing.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	57%	71%

FMS/CTAS: Issues in Operational Deployment

- ***Mixed Fleets***

Implement procedures required to manage non-FMS/CTAS equipped aircraft. Non-equipped aircraft may not be able to maintain an accurate approach route (i.e., inability to accurately maintain time and speed relative to FMS/CTAS-equipped aircraft).

Please rate the comment below for your level of agreement and criticality:
Mixed fleets (some aircraft equipped for CTAS and some not equipped) will increase workload for controllers.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	100%	100%

- ***High Traffic Airports***

For busier airports, the FMS/CTAS system may be limited by excess traffic conditions. This may require procedures dictating that FMS/CTAS can only be used to set-up traffic patterns 100-200 miles from the terminal area.

Please rate the comment below for your level of agreement and criticality:
CTAS will not work in the terminal area. There are too many variables (i.e. airspace, terrain, weather, wake turbulence) and things change to quickly.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	57%	86%

- ***General Aviation (GA) Aircraft***

Develop ATC procedures to protect approaching GA aircraft with airspace buffers to prevent any larger aircraft (e.g., commercial airliners) from passing the GA aircraft enroute to the airport.

- ***Environmental Issues***

Pilots expressed a need for the pilot to be informed of terrain conditions when accepting a new route. In addition, the route changes must take into account terrain, weather, high jet streams/winds, and wake turbulence.

- ***CTAS and HUD-Equipped Aircraft***

Determine HUD operation requirements during the CTAS phase of flight for HUD-equipped aircraft. Determine if there is a need to present CTAS information directly on the HUD.

Airborne Information for Lateral Spacing (AILS)

AILS: Areas of Procedural Concerns

- ***AILS and HUD-Equipped Aircraft***

There is a need to assess the impact of AILS information on procedures when operating the HUD-equipped aircraft. Without AILS information on the HUD, the First Officer (FO) will be required to monitor the AILS display and communicate the information to the Captain, possibly resulting in errors and increased workload. On the other hand, presenting AILS information on the HUD may add too much display clutter.

Please rate the comment below for your level of agreement and criticality:
In the HUD equipped aircraft, the Captain gets all necessary flight information from the HUD so has no reason to check the primary flight display or navigation display. It is a serious safety concern that AILS information is not displayed in the HUD.

	AGREE	CRITICAL
Pilots	67%	89%
ATC	N/A	N/A

AILS: New Flight Deck Procedures Needed

- ***Missed Approach Procedures for HUD-Equipped Aircraft with AILS***

Procedures for conducting a missed approach for HUD equipped aircraft must be determined. As the First Officer would be the only crew member monitoring the AILS displays and heads-down instruments, one focus group decided that the first officer should conduct the missed approach if necessary. However survey data show that this is far from unanimous.

Please rate the comment below for your level of agreement and criticality:
If a missed approach was necessary in a HUD equipped aircraft, the first officer should initiate the procedure. The Captain should initiate the missed approach procedure.

	AGREE	CRITICAL
Pilots	22%	89%
ATC	N/A	N/A

- ***Missed Approach Procedures to Ensure Vertical and Horizontal Separation***

Missed approach procedures must be developed that ensure vertical and horizontal separation of aircraft making a Closely Spaced Parallel Approach (CSPA). This includes accounting for traffic, wake turbulence, weather, and terrain. Procedural requirements are as follows:

- Mandatory missed approach when aircraft is encroached upon by 'X' number of feet
- Specific missed approach paths to include heading and altitude
- Specific calls to be made by the PNF regarding proper spacing during the approach
- Specific roles for Captain and First Officer during the missed approach.

Please rate the comments below for your level of agreement and criticality:
The closely spaced parallel approach in IMC conditions would be considered a different procedure. A separate briefing card should be developed for each AILS approach.

	AGREE	CRITICAL
Pilots	78%	89%
ATC	N/A	N/A

Please rate the comment below for your level of agreement and criticality:
AILS resolution advisories need to be coordinated to ensure both lateral and vertical separation.

	AGREE	CRITICAL
Pilots	89%	89%
ATC	71%	86%

AILS: Role Conflict or Changes on Flight Deck

- ***Determining Crew Roles***

Determine each crew members responsibility for display monitoring and missed approaches. Currently, for VFR parallel approaches, the PNF monitors the other aircraft out the window. In IMC, the PNF will have to spend more time "eyes-in" monitoring traffic on the AILS display. The aircrew will have to include the AILS displays in their visual scan pattern. There was no support for the idea that the first officer should be in control of the aircraft while following the resolution advisory.

Please rate the comments below for your level of agreement and criticality:
If the First Officer was flying the approach and received and AILS alert, the First Officer should clear the conflict. Once clear the Captain should take over the missed approach.

	AGREE	CRITICAL
Pilots	0%	77%
ATC	N/A	N/A

- ***Pilots' Role in Conflict Resolution.***

Several pilot conflict resolutions actions were raised during the focus groups. Survey results suggest pilots should follow AILS resolution commands, and contact ATC only once clear of conflict. Another option considered was that pilots contact ATC immediately as soon as they see the aircraft encroaching. Some suggested they would like to be able to contact the other aircraft directly, although this was not highly agreed upon by all participants.

Please rate the comments below for your level of agreement and criticality:
If a pilot receives an AILS traffic advisory, the pilot should monitor the traffic advisory, follow the AILS resolution advisory, and contact ATC once clear of conflict.

	AGREE	CRITICAL
Pilots	89%	89%
ATC	100%	100%

Please rate the comments below for your level of agreement and criticality:
If a pilot receives an AILS traffic advisory, the pilot should contact ATC immediately.

	AGREE	CRITICAL
Pilots	67%	100%
ATC	57%	71%

Please rate the comments below for your level of agreement and criticality:
If a pilot receives an AILS traffic advisory, the pilot should contact the other aircraft immediately.

	AGREE	CRITICAL
Pilots	22%	89%
ATC	14%	86%

AILS: Role Conflict or Changes with ATC

- ***ATC Role in Conflict Resolution***

Four possible ATC conflict resolution actions were discussed among the focus groups. Survey results suggest that the controller should monitor the parallel approach closely and step in by calling the encroaching aircraft before pilots receive a traffic advisory. Other, less popular, suggestions were that controllers receive an aural alert *after* pilots receive the resolution advisory and step in to resolve the conflict at that time, or ATC call the aircraft only after clear of conflict to provide heading and vector information.

Please rate the comment below for your level of agreement and criticality:
Controllers should monitor the parallel approach, and step in before either plane receives a traffic advisory.

	AGREE	CRITICAL
Pilots	75%	88%
ATC	86%	100%

Please rate the comment below for your level of agreement and criticality:
ATC should call the encroaching aircraft and tell him to correct his flight path as soon as he sees the problem.

	AGREE	CRITICAL
Pilots	75%	88%
ATC	100%	100%

Please rate the comment below for your level of agreement and criticality:
Controllers should receive a red alert accompanied by an aural alarm AFTER pilots receive their red alert and resolution advisory. ATC should step in and resolve the conflict at this time.

	AGREE	CRITICAL
Pilots	38%	100%
ATC	29%	100%

Please rate the comment below for your level of agreement and criticality:
ATC should contact the aircraft only after they are clear of conflict and provide heading and altitude vectors.

	AGREE	CRITICAL
Pilots	38%	76%
ATC	29%	100%

- ***Tower Frequency***

Most participants agreed that a separate monitor position would need to be established in the tower or TRACON to monitor the final approach course. It was also suggested that both aircraft on a closely spaced parallel approach be on the same tower frequency.

Please rate the comment below for your level of agreement and criticality:
Both aircraft need to be on the same tower frequency and an air traffic controller should be dedicated to monitor the approaching aircraft. This dedicated controller should be able to override the tower controller.

	AGREE	CRITICAL
Pilots	100%	100%
ATC	86%	85%

- ***Separation Responsibility***

All focus groups debated who should be responsible for separation of aircraft on a closely spaced parallel approach: Pilots or ATC. Moderately high support for ATC was observed in the survey data.

Please rate the comment below for your level of agreement and criticality:
Separation between aircraft during closely spaced parallel approaches in IMC should be ATC s responsibility.

	AGREE	CRITICAL
Pilots	67%	88%
ATC	71%	100%

- ***ATC Information and Alert Requirements***

Irrespective of legal separation responsibility, controllers expressed a desire for advanced displays to depict necessary AILS information. Several ATC information and alert requirements are listed below:

Please rate the comment below for your level of agreement and criticality:
It would be necessary to have a no transgression zone marked on the controllers current radar display.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	85%	86%

Please rate the comment below for your level of agreement and criticality:
I probably wouldn t use an AILS display in the tower. My eyes are much more sensitive.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	0%	85%

Please rate the comment below for your level of agreement and criticality:
Controllers should receive an AILS chime and visual warning to notify them when an aircraft is diverging into another aircraft s path on a CSPA.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	100%	100%

Please rate the comment below for your level of agreement and criticality:
The aircraft should be datalinked to ATC, so that ATC knows the aircraft received the alert and is carrying out the Resolution Advisory.

	AGREE	CRITICAL
Pilots	89%	89%
ATC	57%	100%

AILS: Issues In Operational Deployment

- ***Pilots / Airlines May Refuse Closely Spaced Parallel Approaches***

Parallel approach procedures vary between airlines - some airlines prohibit conducting parallel approaches even in VFR. This will make it difficult for controllers attempting to pair aircraft for CSPA.

Please rate the comment below for your level of agreement and criticality:
ATC: It will be difficult enough for controllers to pair aircraft for a CSPA on final given wake turbulence, not to mention additional problems if one aircraft refuses a parallel.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	71%	86%

- ***Determining CSPA Restrictions***

Aircraft should be permitted to conduct a closely spaced parallel approach in IMC only if these conditions are met:

- The aircraft is AILS equipped
- The aircraft is on a coupled approach (not manually flying)
- Crosswinds do not exceed a pre-determined maximum

Please rate the comment below for your level of agreement and criticality:
Both aircraft need to be equipped with AILS. It should be a requirement.

	AGREE	CRITICAL
Pilots	89%	89%
ATC	86%	100%

Please rate the comment below for your level of agreement and criticality:
Closely Spaced Parallel Approaches should not be performed with manual lands. The aircraft must be auto-coupled.

	AGREE	CRITICAL
Pilots	44%	66%
ATC	43%	100%

- ***Vectoring Aircraft to Final***

ATC must ensure that the two aircraft coming from different base legs have a gentle angle to intercept the final approach. In poor visibility conditions, sharp turns into final must be avoided, due to potential crosswinds, etc. that may lead to traffic conflicts.

- ***Staggered Approaches***

Several comments suggested that pilots are would not be comfortable with the AILS concept, unless only staggered approaches were implemented. Wingtip to wingtip approaches would be too dangerous.

- ***Impact of Missed Approaches on Traffic Patterns***

If a resolution advisory (RA) occurs, and a missed approach is initiated, procedures need to be developed that account for other aircraft landing on the parallel runways, or other departing aircraft.

ATC: "Note that there is a domino effect when a pilot executes a TCAS RA in a busy terminal area. Ditto for AILS."

- ***Automatic Escape Maneuver***

The escape maneuver required to conduct the missed approach should not be performed manually. It would be safer to program the missed approach into the autopilot.

- ***Loss of Party Line Communication***

Procedures need to be implemented that allow the pilot to listen to communications between parallel approaching traffic and ATC. A move to a datalink in the terminal environment may jeopardize this necessary form of communication.

- ***Trust in the AILS technology***

Trust in the system will develop over time if pilots are first given opportunities to use AILS for closely spaced parallel approaches in VFR conditions.

Roll Out and Turn off Guidance (ROTO)

ROTO: Areas of Procedural Concerns

- ***Defining the Role of ROTO***

The runway exit depends on many dynamic factors. ROTO should provide guidance (i.e., display all runway exits and clearly mark closed exits), but should not make the exit decision for the aircrew. One pilot expressed I feel that any information a pilot can receive is a benefit. But I just don t feel comfortable using ROTO. There are so many dynamic variables upon landing i.e. wind, wet-slippery runways that preclude the use of ROTO in its present form.

Please rate the comment below for your level of agreement and criticality:
I don t want ROTO making turn-off decisions for me — just show me all exits so I know what my options are.

	AGREE	CRITICAL
Pilots	56%	66%
ATC	N/A	N/A

- ***Manual Mode Issues***

ROTO s manual mode could adversely increase crew workload during roll out, an already busy and high workload period. Crew procedures, communications and display technologies should be developed to lessen this workload.

Please rate the comments below for your level of agreement and criticality:
ROTO (particularly in the manual mode) may add to communication demands at an already busy time. The crew is too busy on the runway to communicate and adjust the manual ROTO selection.

	AGREE	CRITICAL
Pilots	56%	78%
ATC	N/A	N/A

ROTO: New Flight Deck Procedures Needed

- ***Runway Exit Plan and Approach Briefing***

Many, but not all, airlines include the runway exit plan in their approach briefing at approximately 10,000 ft. This would require a simple procedural change in which all aircraft would need ROTO to be activated at a minimum of 10,000 ft to accommodate the runway exit plan. However, some pilots noted often they would not be able to make a runway exit decision at the time.

Please rate the comments below for your level of agreement and criticality:
Currently we do not conduct an approach briefing. With ROTO, we d have to add the runway exit to our approach briefing .

	AGREE	CRITICAL
Pilots	63%	43%
ATC	N/A	N/A

Please rate the comments below for your level of agreement and criticality:
There is no way that I would be prepared to select an exit at the time of my approach.

	AGREE	CRITICAL
Pilots	33%	56%
ATC	N/A	N/A

- ***Standardized Aircrew Phraseology***

It is important that a standardized form of communications between members of the aircrew is developed to maintain safe operations.

Please rate the comment below for your level of agreement and criticality:
My airline should implement standard phraseology such as A5 is to the left, I ll take it and Can t make A5, I ll take the next one.

	AGREE	CRITICAL
Pilots	67%	78%
ATC	N/A	N/A

- ***Standardized Phraseology for Manual Mode Operations***

Pre-determined communications between the Captain and FO would be required for operations in ROTO s manual mode. The Captain would have to command an exit or exit change, and the FO would make the change.

ROTO: Role Conflict or Changes on Flight Deck

- ***Increased heads-down / eyes-in time.***

Adjusting the manual mode could require the pilot to spend more time "heads down" and "eyes-in" to perform the procedure. In addition, manual mode selection may adversely increase crew workload in the cockpit.

Please rate the comment below for your level of agreement and criticality:
In the manual mode, being head-down to select the runway exit is a problem. It will add to the workload and crew communications during an already busy time.

	AGREE	CRITICAL
Pilots	56%	78%
ATC	N/A	N/A

Please rate the comment below for your level of agreement and criticality:
I d rather the first officer be looking for center line lights so I know if I am off centerline.

	AGREE	CRITICAL
Pilots	56%	89%
ATC	N/A	N/A

- ***Crew Resource Management (CRM) principles violated***

The current ROTO system presents information to the Captain only via a HUD. Displays should be developed to allow the First Officer to receive ROTO information as well.

Please rate the comments below for your level of agreement and criticality:
It would be better if the First Officer had a ROTO display. Redundancy and backups are always important.

	AGREE	CRITICAL
Pilots	78%	78%
ATC	N/A	N/A

Please rate the comment below for your level of agreement and criticality:
Keep the ROTO display a Captain only function. If the co-pilot has the ROTO display also, it might promote too much eyes-in time.

	AGREE	CRITICAL
Pilots	22%	100%
ATC	N/A	N/A

ROTO: Role Conflict or Changes with ATC

- ***Defining the Role of ATC (Ground Control /Tower)***

Several focus groups debated whether Tower/Ground Control should play a role in runway exit selection. It was generally acknowledged that though it may increase throughput, it would neither be safe nor possible for pilots to be obligated to take any specific runway exit.

Please rate the comments below for your level of agreement and criticality:
The tower controller should tell pilots which exit to take, if one (or more) exits is blocked.

	AGREE	CRITICAL
Pilots	56%	89%
ATC	76%	86%

Please rate the comments below for your level of agreement and criticality:
I think it would be ok for the tower/ground controller to always suggest a preferred exit that would increase airport traffic flow and shorten taxi time to the gate — even though pilots wouldn t be obligated to take it.

	AGREE	CRITICAL
Pilots	56%	44%
ATC	29%	43%

Please rate the comments below for your level of agreement and criticality:
As a tower/ground controller, I don t want to have to suggest a runway turn-off to each aircraft. I am too busy to do that.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	43%	43%

- ***ATC s (Ground Control / Tower) Information Requirements.***

There was moderate interest by Ground Controllers in receiving a datalinked message to indicate the intended exit for each aircraft. However, this may become problematic if the pilot does not make the intended turn-off.

Please rate the comment below for your level of agreement and criticality:
As a tower/ground controller, I would find it helpful to know what runway exit the Captain was planning so that I could try to keep that exit clear and keep other traffic flowing better.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	71%	43%

Please rate the comment below for your level of agreement and criticality:
If tower/ground controllers were notified of an aircraft s intended turn-off, and the Captain could not make that turn-off, it would mean more work for controllers.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	29%	43%

ROTO: Issues in Operational Deployment

- ***ROTO and Gate Coordination***

Coordination between the company/gate and ROTO would be useful so that ROTO can receive and distribute information about the most optimal exit and runway exit side.

- ***ROTO Display Distance to Turn Information***

If ROTO provided distance to turn information, then the first officer could call out distances to Captain. While this is a ROTO design issue, it also impacts crew roles and procedures.

- ***Pilot-Determined Runway Exit Speeds***

Implement ROTO so that the pilot has the option to set his own runway exit speeds. Pilots disapproved of ROTO providing guidance to encourage high speed exits in low visibility conditions.

- ***Autobrake Selection***

Autobrake selection could impact which runway exit is possible to take, therefore requiring procedures that take into account autobrake needs when ROTO is used.

Taxiway Navigation and Situation Awareness (T-NASA)

T-NASA: Areas Of Procedural Concerns

- ***ATC Authority***

Develop procedures that outline pilot-controllers authority in taxiway operations. Several controllers acknowledged that it is always a problem for ATC when pilots don t do what ATC says. With T-NASA, pilots may question some ground control communications because they have more or better information.

T-NASA: New Flight Deck Procedures Needed

- ***Standardized Aircrew Phraseology***

Add standard phraseology to ensure communication between Captain and First Officer. Examples of these communications include:

Captain to First Officer: I ve got the stop sign [in my HUD]
First Officer to Captain: Traffic to the left
First Officer to Captain: Next left, 30 degrees.

Please rate the comment below for your level of agreement and criticality:
My airline should include a Standard Operating Procedure which states that the first officer should call out ALL taxi turns i.e. 90 degree right turn next .. or.. 45 degree left turn now.

	AGREE	CRITICAL
Pilots	44%	78%
ATC	N/A	N/A

- ***Verify New Routes and Route Amendments***

Additions to standard operating procedures may be required to accept new routes and route changes using T-NASA.

Please rate the comments below for your level of agreement and criticality:
Upon receiving a route change, the first officer should verify that the route is correct, zoom to the biggest scale to make sure the route goes to the right gate, and tell the Captain: Route looks good.

	AGREE	CRITICAL
Pilots	100%	89%
ATC	N/A	N/A

Please rate the comments below for your level of agreement and criticality:
The first officer should cross-check their taxi map display with the clearance provided by the ground controller (via radio).

	AGREE	CRITICAL
Pilots	78%	89%
ATC	N/A	N/A

Please rate the comments below for your level of agreement and criticality:
The first officer should continually cross-check their taxi map display with the Captain s HUD using a defined verbal protocol

	AGREE	CRITICAL
Pilots	67%	88%
ATC	N/A	N/A

- ***Procedure for Crossing Runways***

Procedures need to be developed for the flight deck crew to ensure safe runway crossings.

Please rate the comment below for your level of agreement and criticality:
Before crossing an active runway, the first officer should zoom his taxi map to the biggest scale to ensure that the runway is clear and communicate this to the Captain.

	AGREE	CRITICAL
Pilots	78%	89%
ATC	N/A	N/A

T-NASA: Role Conflict or Changes on Flight Deck

- ***Maintain Voice Commands***

Pilots stated that they still want to check in with a real controller (human voice). Pilots will be reluctant to cross an active runway on the basis of T-NASA -- without a voice command. A controller is needed as an active participant in the system."

Please rate the comments below for your level of agreement and criticality:
PILOT: I d be nervous just following the magenta line with no voice control.

	AGREE	CRITICAL
Pilots	78%	100%
ATC	N/A	N/A

Please rate the comments below for your level of agreement and criticality:
ATC: I d be nervous just sending clearances via datalink without receiving a verbal acknowledgement from the pilot [note: ATC would receive a datalinked acknowledgement].

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	43%	100%

Please rate the comment below for your level of agreement and criticality:
Busy airports are so dynamic and crossing active runways is difficult. I don t think it would be feasible to update routes and issue holds via datalink.

	AGREE	CRITICAL
Pilots	33%	100%
ATC	86%	86%

T-NASA: Role Conflict or Changes with ATC

- ***Defining the Role of Ground Control***

There is a need for T-NASA automation at the controller station, however the exact nature of the level of automation needs to be investigated. It is clear that controllers feel the need to be in charge of the dynamic environment. They feel that T-NASA should be used to help the controller, but the controller should make the decisions regarding routes, holds, runway crossings etc..

Please rate the comments below for your level of agreement and criticality:
T-NASA should provide ground controllers with guidance and alerts for potential conflicts and if an aircraft is off route, but the controller should retain control over the actual assignment of routes and hold commands.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	86%	100%

Please rate the comments below for your level of agreement and criticality:
The computer should generate routes, but the controller would be responsible for stopping (holding) aircraft if necessary to avoid collisions

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	57%	86%

Please rate the comments below for your level of agreement and criticality:
The controller should be responsible for stopping aircraft. If a controller fails to issue a hold command which may lead to a collision then T-NASA should step-in and issue the hold command.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	86%	100%

- ***Controller Workload***

Controllers expressed concern that the near-term implementation (data link + voice) will be too task intensive and time consuming.

Please rate the comment below for your level of agreement and criticality:
At least initially, controllers will send a taxi route via datalink as well as verbally. This may be too task intensive (time consuming) for controllers.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	86%	100%

- ***Defining ATC Information and Alerts***

Procedures need to be developed that clearly define the role of T-NASA in providing information to ATC. The impact of heavy ground traffic on alerts to ATC requires further investigation.

ATC: "Which aircraft should get the right of way - how will right of way rules be determined?"

ATC: "T-NASA could be helpful to controllers during extreme low visibility condition. However, during VFR operations when a ground controller handles over 100 aircraft in an hour, T-NASA would be transmitting non-stop alerts."

T-NASA: Issues in Operational Deployment

- ***Datalink Security***

PILOT: "There has to be a way to verify that this is my route, it is intended for me, and it is still correct."

- ***GA Aircraft and Other Ground Vehicles***

All aircraft (and ground vehicles) will have to be equipped with transponders and necessary equipment to be displayed on the T-NASA taxi map.

- ***Company, Gate, and Ground Control***

PILOT: "The system needs to link company, gate, and ground control to be most efficient."

- ***Mixed Fleets***

PILOT: "Aircraft equipped with T-NASA may be able to go much faster then planes without. This could be a danger - or at least a frustration."

PILOT: "The chain is only as strong as its weakest link. If 10% of the aircraft don't have it, will the system be safe? Will we realize any productivity gains from it?"

- ***Airborne Route Information***

Please rate the comment below for your level of agreement and criticality:
The T-NASA taxi map should not show the taxi route while airborne. The exit and route may have to change due to conditions on the ground.

	AGREE	CRITICAL
Pilots	N/A	N/A
ATC	86%	100%

DISCUSSION

The exploratory focus group process raised a number of procedural issues associated with the TAP technologies. The comments collected in the group discussions are opinions obtained from a small sample of pilots and controllers and therefore can be used only to identify, not resolve, potential issues concerning the impact of TAP technology on current procedures. We hope that these findings can serve as the basis for subsequent analysis of potential procedural issues using more systematic methods such as surveys, simulation, and flight tests.

TAP Technologies: Specific Issues

CTAS. Three potential implementations of CTAS were discussed and all three produced widely different opinions and concerns. The use of CTAS as a controller aid was highly favored, as long as ATC voice control is maintained. The possible implementation requiring pilots to receive amendments via radio and enter changes manually on the CDU was cautiously accepted. In this case, pilots expressed concerns that CTAS amendments would increase workload and heads-down time. The final implementation, in which CTAS amendments are automatically uplinked to the FMS and verbal communications replaced with datalink communications, was a source of concern. Currently, pilots use "party line" communications between other aircraft and ATC as a means of monitoring and maintaining situational awareness of traffic. The loss of this awareness and the loss of voice communications as a means of verifying ATC instructions were considered potentially problematic. New procedures and technologies will be needed to resolve these communications and datalink issues.

AILS. The main issues concerning the impact of AILS on current procedures are two-fold: adapting AILS to the HUD-equipped aircraft and developing CSPA approach procedures for both flight crews and ATC. AILS does not provide separation information on the HUD, requiring the Captain to scan the head-down displays for information. Pilots stated that this is not possible while manually flying a CAT III approach, which currently occurs on HUD-equipped aircraft. A combination of developing communication procedures and adding AILS information should be considered. Both ATC and pilots stated that the two aircraft need to be on the same frequency and monitored by a dedicated controller. Also, CSPA procedures would need to be developed to clarify pilot-ATC authority issues (i.e., who has authority when to do what?). Some of these authority issues include who has responsibility: 1) To maintain separation between aircraft, 2) to provide traffic incursion alerts, and 3) for missed approach guidance.

ROTO. User acceptance of ROTO technology is a focal point. A number of pilots expressed serious concerns about the ROTO concept. Their main concern is that they may be asked to take a potentially dangerous high speed turn off in low visibility in order to increase terminal area productivity. During roll-out and turn-off, current procedure dictates that the pilot 'owns the runway' and can choose any available exit. Pilots state they often don't make this decision until they are on the ground and after factoring in aircraft speed and runway conditions. A general impression across sessions was that pilots would prefer that ROTO display turn-off information, but not make the turn-off recommendation. This would require only minor modifications to current procedures. The manual mode also posed a potential problem in that pilots felt they would not be able to select a turn-off until on the ground, at which time, it would be too late to be "eyes-in" and make the required manual control inputs to the ROTO system.

T-NASA. Pilots generally liked the concept of improved situation awareness of taxiways and other traffic as provided by the T-NASA displays. Controllers expressed a concern that maintaining current voice communications in addition to sending datalink messages to aircraft could detrimentally increase workload. Furthermore, replacing voice communications with datalink messages was cause for concern for both pilots and tower/ground controllers. Eliminating voice control in favor of datalinked taxi clearances appears to be a concept that would require further research to address issues such as the feasibility of issuing route changes, hold clearances, and clearances to cross active runways by datalink.

Global Issues

A review of airline and ATC procedures manuals and the focus group findings revealed that before TAP can be fully implemented, most airlines will need to modify existing procedures and develop new procedures to address: 1) head-up displays, 2) datalink communications, and 3) mixed-equipped fleets.

Head-Up Displays. ROTO and T-NASA require that a head-up display (HUD) be integrated into the flight deck. Whether the HUD is used for surface operations only, or for approach and landing as well, new procedures will be required to determine crew responsibilities and communications. Procedure manuals for airlines that have already adopted the HUD, Southwest Airlines and Alaska Airlines, suggest that the HUD has a profound effect on existing aircrew communications and procedures for approach, landing, and roll out. For example, Southwest Airline's manual (1993) includes an entire set of procedures specific for Head-Up Guidance System (HGS) Approaches. In general, greater emphasis is placed upon the First Officer remaining heads down, scanning the instruments, and informing the Captain about any indications of system faults. Alaska Airlines (1997) also has added similar SOPs to accommodate the use of HGS. Their manual states that because of the amount of attention focused on the HUD by the Captain, it is imperative that First Officers retain overall cockpit situational awareness with particular attention to any critical anomalies not apparent in the Captain's head-up scan. Further the SOPs suggest that the approach briefing should include a reminder that the Captain will be head-up throughout the approach, thus requiring the First Officer to remain head-down to monitor all phases of the approach.

Datalink and Communication. Most airlines' procedural manuals clearly define in-cockpit communication procedures while ATC manuals define communication among controllers and between controllers and pilots. However, these manuals do not address the use of datalink in the terminal area, as is proposed by both CTAS and T-NASA. For example, procedures do not currently exist to determine crew roles associated with receiving datalink messages, to check data-link message for errors, and to address the timeliness of datalink communications between flight deck and ATC in this closely controlled environment. Further, it is likely that if datalink is incorporated into terminal area operations, AILS and ROTO will also be impacted, even though these technologies do not intend to utilize datalink. For example, one can imagine that losing party line situational awareness of an aircraft on a CSPA may negatively impact the safety of AILS. In general, the pilots' and controllers' responses to the TAP technologies varied widely depending on ones' assumptions about datalink in the terminal area (whether or not datalink is merely redundant to a voice system or becomes the sole communication source), and the procedures and interfaces involving how datalink information gets input by the controller and reviewed and accepted/rejected by the pilots. The implementation of datalink in the terminal area is a research area that needs to be examined further, as it impacts the procedural integration of all TAP technologies.

Mixed-Equipped Fleets. It is likely that TAP technologies will be slowly integrated and retrofitted into current fleets. Therefore, at least initially, mixed-equipped fleets will exist, where some aircraft are TAP-equipped and some are not. This may create procedural difficulties for airlines, pilots, and controllers. Airlines will be faced with difficult issues regarding training and whether to allow pilots to fly both equipped and non-equipped aircraft. For pilots, mixed-equipped fleets may mean losing awareness of the location of some surrounding aircraft (those datalinked) but not all, or being unsure of the information availability of near-by aircraft. For controllers, mixed-equipped fleets may mean increased workload, either to determine which aircraft are equipped and which are not, or to send ATC directives redundantly via both voice and datalink. Communications, procedures, and technologies are required to better address mixed-equipped fleet issues.

Summary

The main areas of concern across all TAP technologies are: 1) determination of pilot/ATC roles, 2) integration of TAP head-down displays in the HUD-equipped aircraft, 3) the impact of TAP technology on communications procedures (specifically datalink), and 4) mixed-equipped fleet operations. The absence of procedures to address these issues could compromise the overall safety of the air traffic system and interfere with any productivity gains.

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APPENDIX A: PARTICIPANT MATERIALS

Pilot Information Questionnaire

Gender: Female_____ Male _____ **Age:** ___________________

FLIGHT EXPERIENCE: CURRENT

1. Current Crew Position (Please check one): Captain ____ First Officer ____
2. Current Airline: _________________________ Years with airline: ______
3. Current Aircraft Operated (make and model, e.g. B747-400): _______________________
4. How many hours have you logged at your current position in your current aircraft?

___hrs

5. Is your current aircraft EFIS (glass) equipped? Yes ______ No ______
6. Is your current aircraft equipped with a HUD? Yes ______ No ______
7. Is your current aircraft equipped with FMS? Yes ______ No ______
8. Is your current aircraft equipped with a CDU? Yes ______ No ______
9. Is your current aircraft equipped for autolands, Yes ______ No ______

If yes, what percentage of time do you perform autolands? ____________

FLIGHT EXPERIENCE: TOTAL

10. Across your entire career in commercial aviation, approximately how many hours have you logged with: Traditional cockpits _______hrs

    Glass cockpits _______hrs

    HUDs _______hrs

11 Across your entire career in commercial aviation, for what percent of the flights were you in control of the aircraft (Pilot Flying) during:

Take-off _____%
Approach _____%
Landing _____%
Rollout and Runway Turnoff _____%
Taxi _____%

12 Across your entire career in commercial aviation, what percent of all flights you have completed (either as Pilot Flying or Pilot Not Flying) involved:

Parallel Approaches _______%
Taxiing in low visibility conditions — RVR 700 or less? _________%

ATC Information Questionnaire

Gender: Female_____ Male _____

Age: __________________

ATC EXPERIENCE: CURRENT

1. Current ATC Position/Location (i.e. Bay TRACON): ___________________

2. Years at current ATC Position: ____________

3. Please list the equipment you use currently to do your job:

____

____

____

____

4. If you could change anything about the equipment you use today, what would you change?

____

____

____

____

____

ATC EXPERIENCE: TOTAL

5. How many years have you worked as an ATC controller of any kind? ________?

6. Please list all ATC positions (including military etc..) that you have worked:

____

____

____

____

____

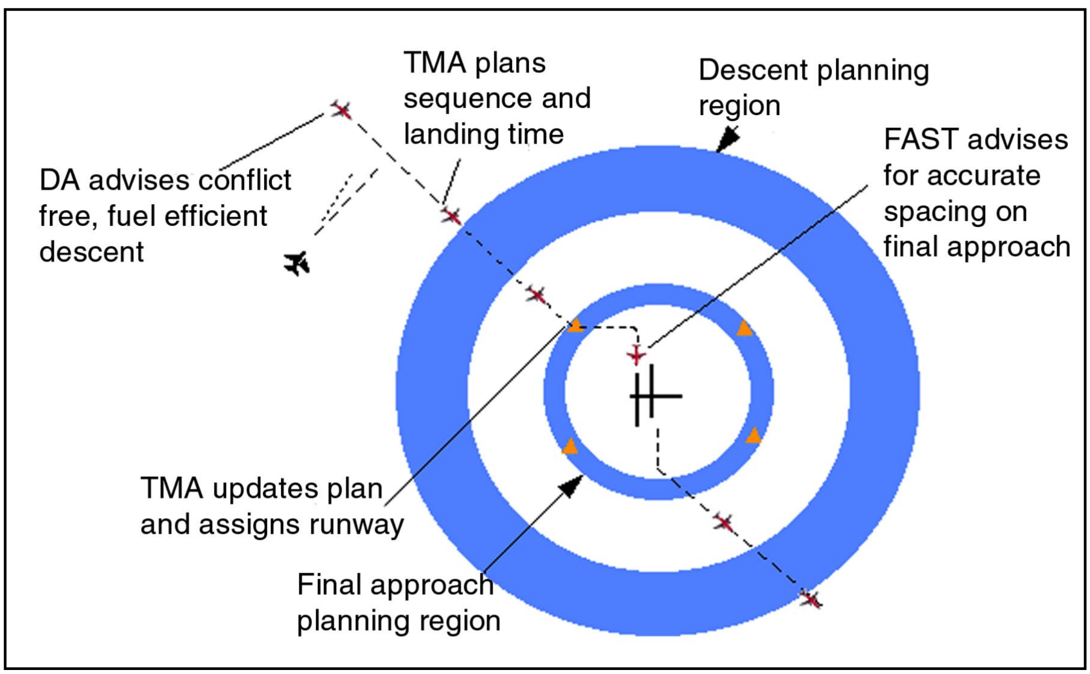
APPENDIX B: TAP TRAINING MATERIALS

Center TRACON Automation System / Flight Management System (CTAS/FMS)

Purpose

The Center TRACON Automation System/ Flight Management System (CTAS/FMS) integration effort proposes coordination of ground-based automation tools (i.e., CTAS) with the aircraft FMS to increase safety, efficiency, and capacity in and around the terminal airspace. In order to increase safety, efficiency, and throughput in the terminal area, ATC may use CTAS tools with scheduling algorithms to control arriving aircraft. First, ATC will issue a FMS arrival and descent clearance with cruise and descent speeds. Then, if necessary, ATC may issue route modifications to adjust the meter fix arrival time, or speed amendments to adjust threshold arrival times. Also, if necessary, ATC may issue downwind extensions to adjust threshold arrival times.

The controller CTAS tools include a: Descent Advisor (DA), Traffic Management Advisor (TMA), and Fast Approach Spacing Tool (FAST). Flight deck modifications include adjustable FMS leg types, a vertical situation display, and a datalink display and response buttons.



CTAS Concept

Air Traffic Controller Tools

Descent Advisor (DA)

- Designed to support ground-based air traffic control.
- Generates clearance advisories that help sequence aircraft in Center’s airspace.
- Used for metering arrivals into the TRACON to ensure fuel-efficient and conflict-free descents with highly accurate arrival times--on the order of 10-20 seconds.
- Conflict Probes generate detailed predictions of conflicts for all traffic.
- Conflict Resolution functionality s range from manual what-if input and feedback to fully automatic generation of resolution advisories.

Traffic Management Advisor (TMA)

- TMA assists, but does not replace, the Center TMCs and air traffic controllers in the following ways:
  - Increases situational awareness through graphical displays and alerts.
  - Generates statistics and reports about the traffic flow.
  - Computes the undelayed estimated time of arrival (ETA) to the outer meter arc, meter fix, final approach fix and runway threshold for each aircraft.
  - Computes the sequences and scheduled times of arrival (STAs) to the outer meter arc, meter fix, final approach fix, and runway threshold for each aircraft to meet the sequencing and scheduling constraints entered by the TMC.
  - Assigns each aircraft to a runway to optimize the STAs.
  - Continually updates its results at a speed comparable to the live radar update rate in response to changing events and controller inputs.

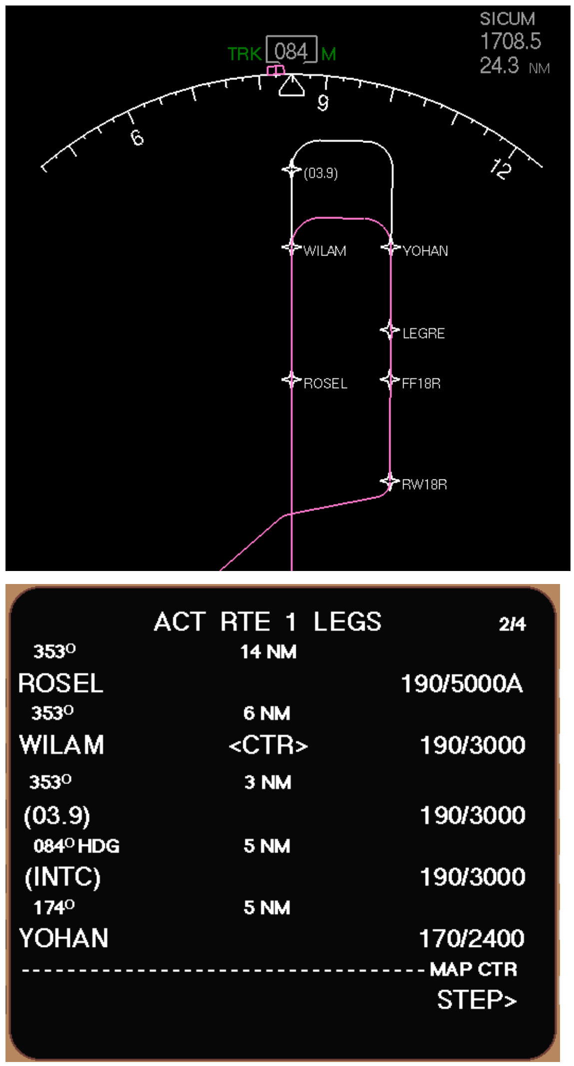
Final Approach Spacing Tool (FAST)

- FAST is a CTAS decision support tool for the terminal area (TRACON) air traffic controllers.
- Provides landing sequences and landing runway assignments, as well as speed, and heading advisories that help controllers manage arrival traffic and achieve an accurately spaced flow of traffic on final approach.
- FAST uses accurate arrival times for sequencing and scheduling aircraft to the runway threshold.
- FAST computes routes for each aircraft entering the TRACON airspace. The controller can generate and display a route for each aircraft on his or her radar display and communicate it to the aircraft as a route modification clearance.

FLIGHT DECK DISPLAYS

Adjustable FMS Leg Types

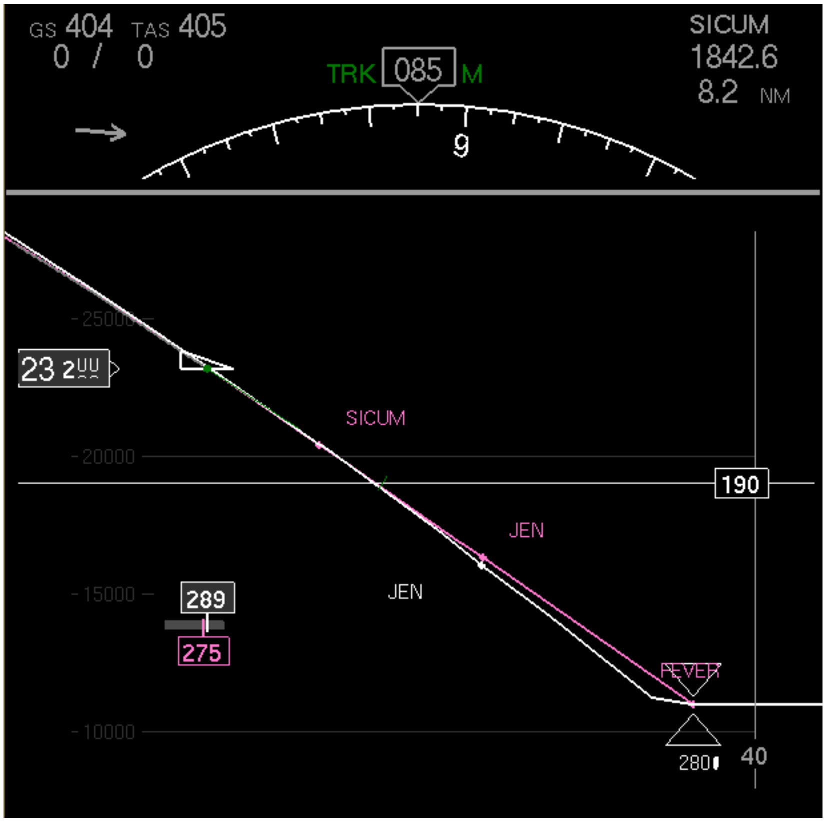
Adjustable FMS leg types will support simple FMS route adjustments (e.g., downwind leg length) in the TRACON airspace. This modified FMS function information is displayed on both pilots Navigation Display. In the graphic below, the base turn routing (shown in magenta) is modified by extending the downwind leg by 3.9 nm. The new base turn routing (shown in white) is pending until loaded, executed, and accepted by the flight crew.



Downwind leg extension provided by CTAS/FMS

Vertical Situation Display (VSD)

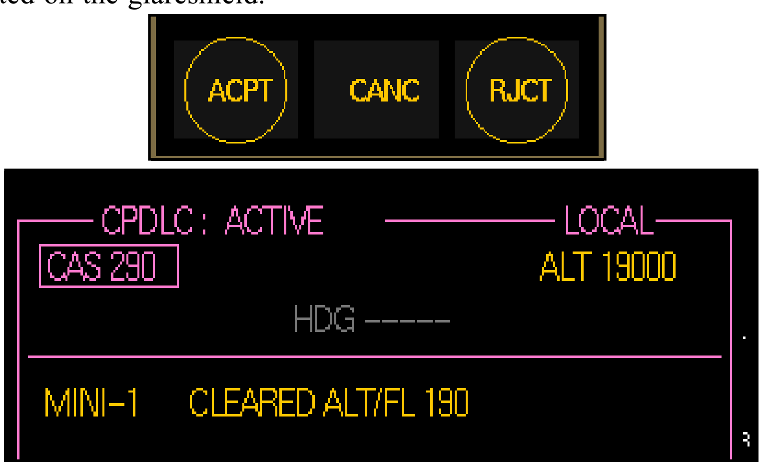
The Vertical Situation Display is intended to aid pilots with vertical management and control of the aircraft during the descent phase of flight. The VSD provides a side view of the FMS computed vertical profile and the position of the aircraft relative to the profile. It also provides trend, crossing restriction, and mode information. Speed and altitude crossing restrictions are depicted at flight plan waypoints with programmed restrictions. Mode information is provided graphically to indicate current and future aircraft behavior. The VSD shares display space with the current Navigation Display and is selectable in three configurations: 1) it can be concealed, 2) displayed in an 80 percent split-view, or displayed in a 20 percent split-view.



Vertical Situation Display

Advanced Datalink Interface

It is envisioned that in the future the advanced datalink interface will support automatic loading of, and heads-up assessment and response to, uplinked CTAS routes. The data-link display will be located on the central EICAS, and two sets of response buttons, one for each pilot, will be located on the glareshield.



Advanced Datalink Interface

ATC-Pilot Interaction Using CTAS/FMS

When using the modified FMS function, the crew must be on a FMS descent procedure that specifies a default downwind (and final approach) distance as measured from a reference waypoint on the route. Prior to reaching this point, ATC will issue a downwind length extension to adjust spacing or arrival time at the threshold.

In the near term, CTAS/FMS will be implemented as follows:

- The FMS procedure will terminate on the downwind leg. Pilots will continue on the downwind leg until they receive a base turn vector from ATC.
- Controllers will be provided with tools that allow them to determine the length of the downwind leg and when the aircraft should begin the base turn. At the appropriate time, the controllers will provide vectors to the aircraft to begin the base turn.
- After the downwind leg, all ATC clearances will be delivered by voice.

In the far term, it is envisioned that CTAS/FMS may be implemented as follows:

- Feeder control will clear the aircraft for a FMS descent route which will include a downwind leg and a default base turn — the default will always allow for the shortest downwind leg possible.
- If necessary, and as advised by CTAS scheduling and planning tools, ATC may extend the downwind leg. Depending on technology availability, this could occur in one of two ways:
    1. ATC advises the pilot of a downwind extension by voice. Pilots acknowledge the downwind extension by voice, make the necessary modification using the CDU, and continue to fly the FMS route.
       or
    2. ATC datalinks the modified FMS descent route to the flight deck and it automatically loads into the modified route buffer of the FMS. The text of the route clearance appears on the center EICAS. The crew reads the message text on the EICAS screen, and confirms and assesses the loaded route on their Navigation Displays. They execute the route (if acceptable) in the CDU, and respond to ATC by pressing an ACCEPT button located on the glareshield. The crew then continues descent coupled to the FMS while flying the CTAS modified routing.

Airborne Information for Lateral Spacing (AILS)

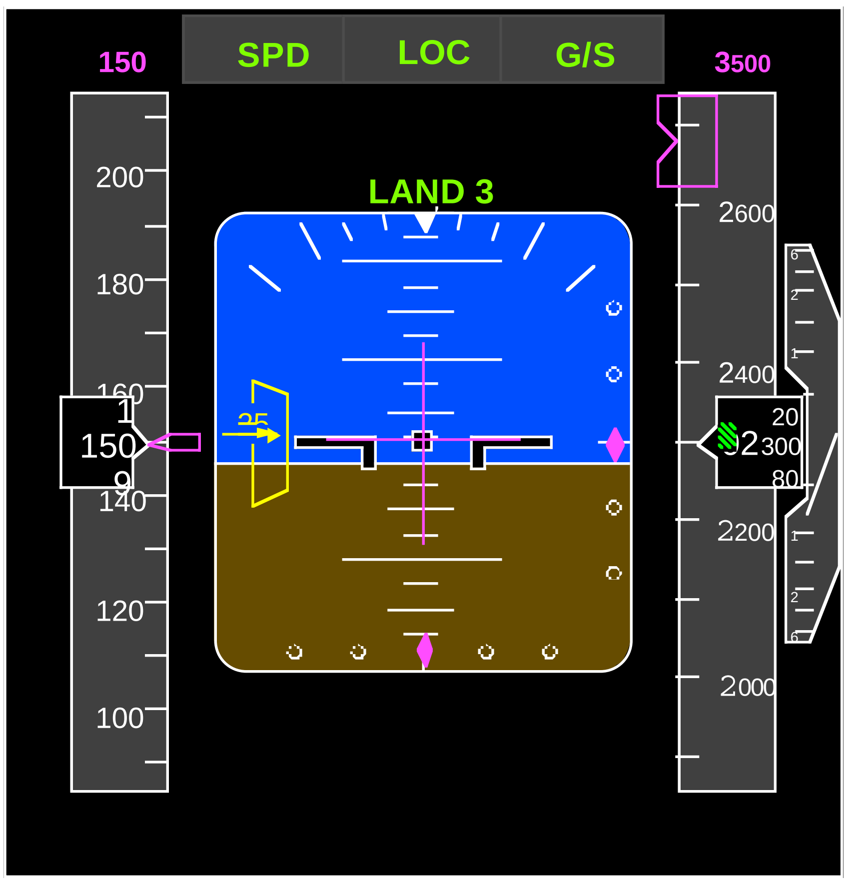
Purpose

The purpose of the Airborne Information for Lateral Spacing(AILS) system is to maintain aircraft separation during closely spaced parallel approaches of less than 3400 ft separation in IMC. Traffic alert and information is provided to the flight crew, similar to the current Traffic Collision and Avoidance System (TCAS).

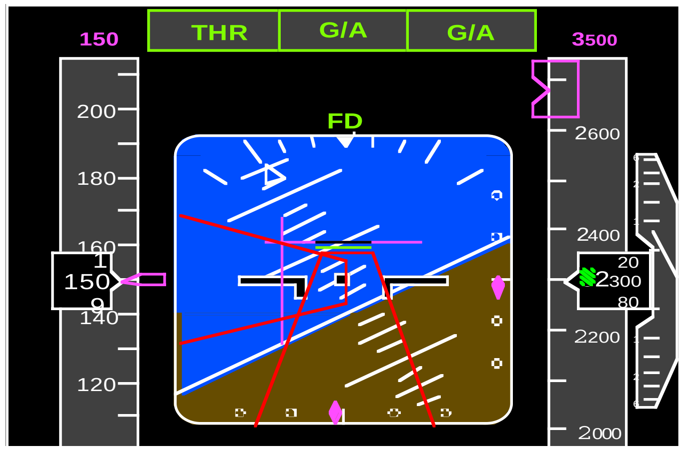
AILS Flight Deck Display Enhancements

On the Primary Flight Display (PFD), AILS includes the following display features:

- The Parallel Traffic Window indicates the location (left or right) of the traffic, pointing toward the ownship reference on the ADI.
- The Slant Range Indicator shows the distance (in hundreds of ft) between the ownship and the traffic.
- The Horizontal Motion Arrow provides additional information on traffic location by indicating that traffic is moving away from its centerline and toward the ownship.

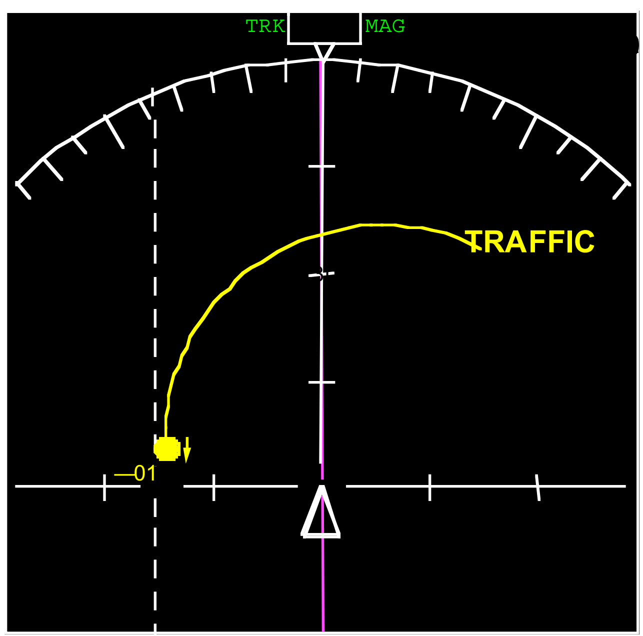


A traffic advisory accompanied by an aural alert is issued, if parallel traffic executes a blunder that results in an intercept course. If the alerting system determines that a maneuver is necessary to maintain separation, a Resolution Advisory is issued and Pitch & Turn Guidance cues and Go-To Bars appear on the PFD.



On the Navigation Display (ND), AILS allows the display to be scaled below the current 10 nm limit and provides a control to select distance in feet or nm. Other AILS features on the ND include:

- The Parallel Runway and Centerline cue which indicates the location of the parallel runway and intended path for the other aircraft.
- The Traffic Trend Vector which indicates what direction the traffic is heading.



HOW TO USE THE AILS DISPLAYS

During the approach phase, the aircrew monitor the AILS traffic information on the PFD and ND. If parallel traffic executes a blunder that results in an intercept course, a Traffic Advisory is issued along with an aural alert. If the alerting system determines that a maneuver is necessary to maintain separation, a Resolution Advisory is provided. Pitch & Turn Guidance cues and Go-To Bars appear on the PFD. For the pilot-flying, the response to the RA is to disconnect the autopilot, engage the Go-Around thrust control on the throttles, and manually fly the presented pitch and turn commands. Typically the pitch guidance is satisfied first, with the bank following. An aural "MONITOR ATTITUDE" alert indicates that both guidance components have been satisfied. With the aural alert "CLEAR OF CONFLICT" indicating that the conflict has been resolved, the pilot-flying is then responsible for following Air Traffic Control directives. The non-flying pilot will typically assist the pilot flying in monitoring the progress of the approach and providing situation awareness in the event of a Resolution Advisory. The non-flying pilot will also assist the pilot flying in executing a modified missed approach procedure.

ATC-PILOT INTERACTION WITH AILS TECHNOLOGY

- The final controller is responsible for aircraft separation until AILS approach clearance is given to the aircraft. The final controller will notify both aircraft of the parallel traffic prior to turning final — and will apply standard separation between aircraft during turn on to final approach.
- Both aircraft will confirm that they have their traffic in sight (under electronic surveillance) and assume separation responsibility prior to losing standard separation. After approach clearance is issued and prior to the final approach fix, communications will be switched from the final controller to the tower local controller. After receiving AILS approach clearance, the aircraft are solely responsible for separation.
- In the event of a blunder or intrusion incident, the flight crew maintains separation responsibility. ATC will not assume separation responsibility until the initial conflict has been resolved by the flight deck crews.
- Once the initial conflict has been resolved and safe separation achieved, ATC will assume responsibility for separating the two aircraft involved in the incident from all traffic, and to vector the aircraft back into the approach sequence.

Roll Out and Turn Off (ROTO)

Purpose:

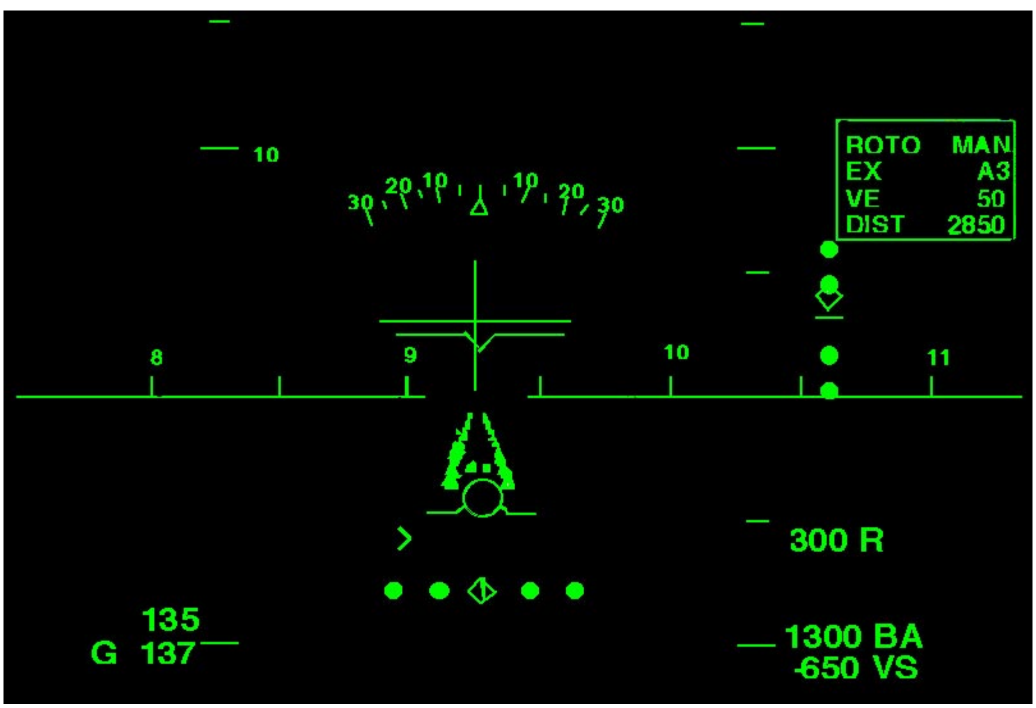
The purpose of the Roll Out and Turn Off Head-Up Display (ROTO HUD) is to increase runway throughput and reduce runway occupancy times. The ROTO HUD provides speed and turn guidance to assist pilots in exiting the runway quickly and safely in low visibility conditions.

DESCRIPTION OF THE ROTO HUD:

TWO ROTO MODES:

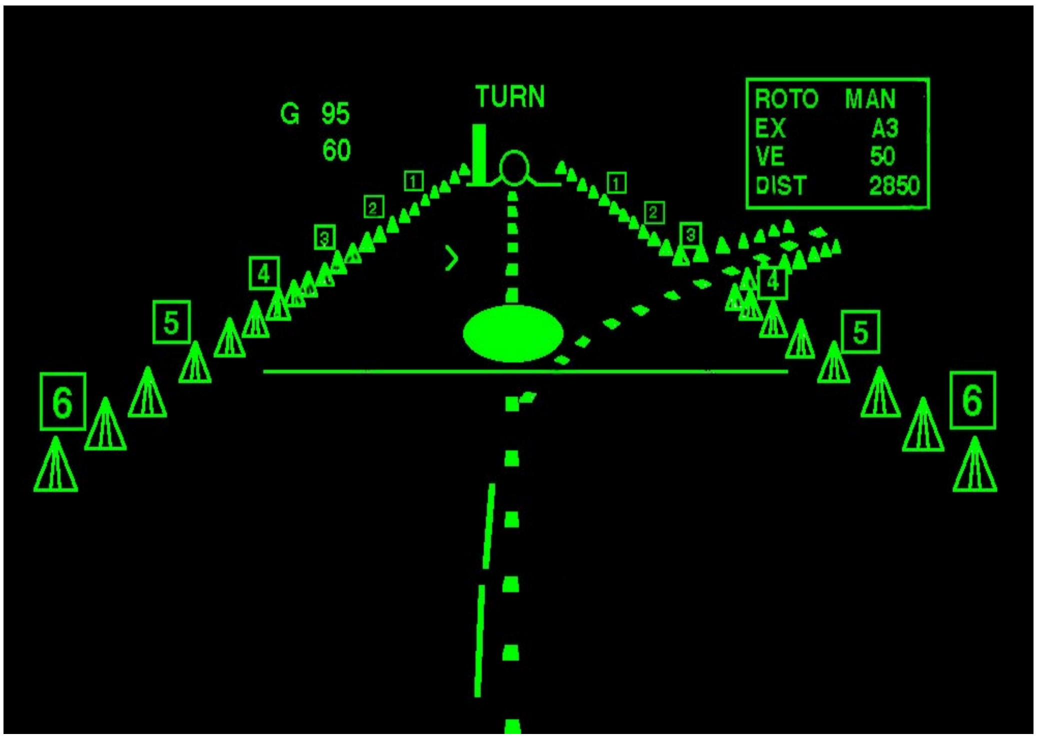
- Automatic mode: ROTO will automatically select the first turn-off that the aircraft can safely make with out exceeding a nominal deceleration level (6.5 ft/sec). If the pilot cannot decelerate in time to make the turn off, ROTO will automatically switch to the next turn off.
- Manual mode: The pilot can select the desired exit using the ROTO runway selection control panel after a valid ILS frequency has been selected. If ROTO detects that the aircraft cannot decelerate to make the turn off, the turn symbology will not be displayed. The pilot will manually select the next desired exit.

In the air, ROTO symbology is added to standard HUD flight symbology. Once a valid ILS frequency has been selected, and the pilot has selected an operating mode (automatic or manual) a ROTO box appears in the upper right hand corner of the HUD to indicate the chosen runway exit, the acceptable turn off speed, and the nominal braking distance. Virtual cones demarcate the edges of the runway and selected turn off.



ROTO HUD: Airborne symbology

Immediately upon touchdown, the flight symbology transitions to the ROTO ground symbology, which provides current and predicted speed information. A ground speed error bar (on the left wing of the aircraft symbol) indicates whether the deceleration rate is too high or too low for the intended turnoff. As pilots approach the turnoff, guidance is provided to indicate when the pilot should begin the turn. The ellipse indicates where the aircraft will be when the desired exit speed is reached. The horizontal line across the runway indicates where the pilot should begin the turn. Two 2 second trend vectors provide information to aid pilots in positioning the aircraft on the exit centerline during the turnoff from the runway.



ROTO HUD: Ground Symbology

HOW TO USE THE ROTO HUD:

It is expected that most aircraft will be equipped with one head-up display centered over the left seat, therefore only the Captain will have access to ROTO information.

Upon touch down, the pilot follows the ROTO guidance to decelerate the aircraft to the nominal exit ground speed. The pilot s goal is to minimize the ground speed error bar while keeping it above the flight path symbol wing. As the aircraft approaches the turn off, the pilot lines up the ellipse on the turnoff line. If the ellipse is above the turn off line (as in the picture above), the aircraft will reach the desired speed too late. When the word TURN begins flashing the pilot commences the turn to exit the runway.

ATC-PILOT INTERACTION USING ROTO TECHNOLOGY

It is expected that pilots will always own the runway and maintain the right to choose their runway exit. However, it is envisioned that ATC could be equipped with tools that they could use to recommend an optimal turn-off to ensure efficient routing for all aircraft.

Taxiway Navigation and Situation Awareness (T-NASA)

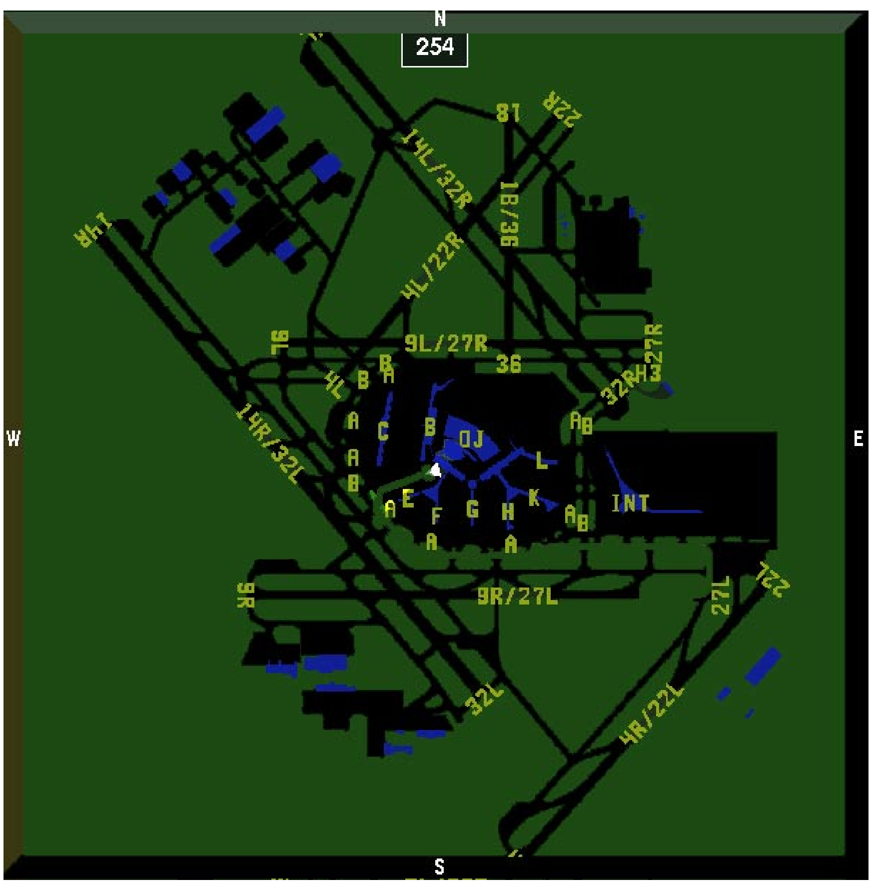
Purpose:

The Taxiway Navigation and Situation Awareness (T-NASA) display suite consists of three components: A Taxi Map, a Taxi Head Up Display (HUD), and directional auditory alerts to warn pilots of approaching traffic and hold shorts. All components are designed to increase taxi speed, route navigation accuracy, and situation awareness in low visibility conditions.

Description of T-NASA Displays

T-NASA Taxi Map

The **T-NASA Taxi Map Overview Mode** presents a north-up, fixed view of the entire airport surface, runway and concourse locations, much like a paper taxi chart. Pilots have found that this mode is best used to preview the airport layout while airborne — but it is also available on the ground to aid in planning a route before taxiing, and to view traffic sequences while holding short of runways.



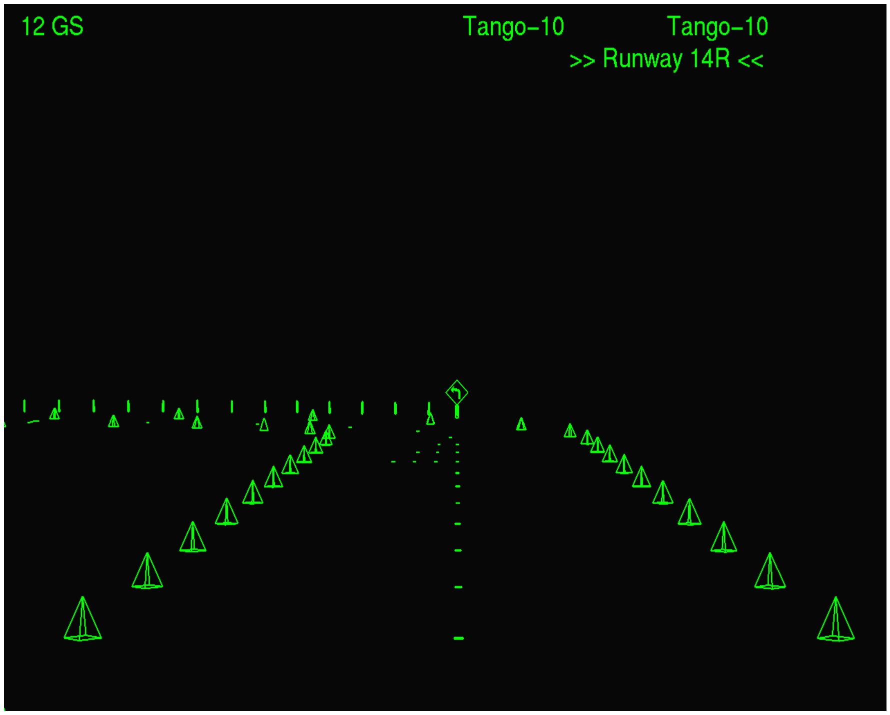
T-NASA Overview Mode.

The **T-NASA Taxi Map Perspective Mode** presents a view of the airport from above and behind the ownship. Similar to the EHSI, the taxi map is oriented track-up so that it rotates around the fixed aircraft symbol. The cleared taxi route is presented via a magenta path. Hold short instructions issued by ground control are highlighted on the taxi map by a flashing yellow line, and the magenta path beyond the hold bar turns yellow. The position of the ownship and other aircraft are presented and updated in real time. Ground speed (upper left corner), compass heading (upper center), and cardinal direction bars (surrounding moving frame) are provided. There are four ranges levels to choose from that show progressively greater levels of detail.

Taxi Map: Perspective Mode

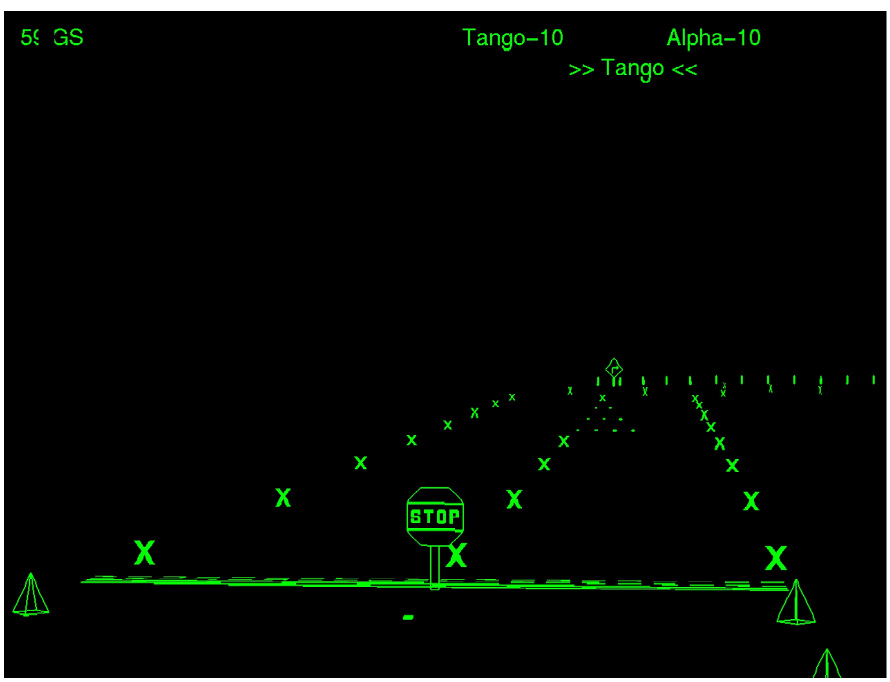
T-NASA TAXI HUD:

The **T-NASA Taxi HUD** displays the cleared taxi route in the form of a series of virtual "cones" located along both edges of the cleared taxiway and a series of small squares that overlay the taxiway centerline. Ground speed is displayed in a digital format in the upper left hand corner of the HUD. In the upper right portion of the HUD, the taxiway that the aircraft is currently on, as well as the taxiways that are coming up on the right and left are presented in text form. When approaching a turn, the taxi HUD presents a virtual turn sign, which indicates the angle of the upcoming turn.



Taxi HUD: Route symbology

When a hold short instruction is issued by ground control, the hold bar appears on the HUD and enhances the hold bar on the airport surface. A virtual stop sign appears on the HUD to reinforce the hold short command, and the edge cones beyond the hold convert to X s. After the hold has been removed by ground control, the X s revert back to cones.



Taxi HUD: Hold Symbology

How to use the T-NASA Displays:

It is expected that most aircraft will be equipped with one head-up display centered over the left seat, therefore only the Captain will have access to the HUD information. However, both pilots will have their own taxi map located on the navigation displays (ND). Directional audio alerts will be provided through each pilots headphones. An audio alert from the right side will indicate that an aircraft is approaching from the right — a left auditory alert will indicate the threatening traffic is approaching from the left.

Pilots may preview the taxi map while airborne — the overview mode will display the airport surface layout, as well as runway and concourse location. At least initially, the taxi route will not be available while airborne.

At touch down, the taxi map perspective mode will automatically appear on the NAV display. The ROTO HUD will automatically transition to the T-NASA taxi HUD after turning off the runway.

ATC-Pilot Interaction

- Smart routing algorithms designed to increase productivity and efficiency for airport surface operations will determine taxi routes.
- In the Near Future:
  - After clearing the runway, pilots will call Ground Control (GC) for clearance.
  - GC will provide a taxi clearance by voice and send the clearance via datalink to the T-NASA taxi HUD and taxi map.
  - Pilots will acknowledge by voice and datalink response buttons on glare shield.
  - All hold and route amendment instructions will be provided by voice and will be datalink to the taxi HUD and map in pending form until acknowledged by the flight crew.
- In the Distant Future:
  - The taxi clearance may be datalinked to the T-NASA taxi map while airborne or as exiting the runway.
  - Pilots will acknowledge the route using datalink response buttons on the glare shield.
  - At runway turnoff, pilots will continue taxiing, without talking to ground control (except for emergencies).
  - All hold and route amendment instructions will be datalinked directly to the cockpit accompanied by a datalink message tone, and will appear on the Taxi HUD and taxi map as pending changes until acknowledged by the flight crew.

APPENDIX C: TERMINAL AREA PRODUCTIVITY SURVEY

Pilot Survey

Center-TRACON Automation System / Flight Management System (CTAS/FMS)
Purpose: Increase safety, efficiency, and capacity in and around the terminal airspace by providing speed, altitude and route amendments including downwind leg extensions to adjust meter fix arrival times and threshold arrival times.

1. The number of interactions and communications between ATC and the flight deck to make the necessary CTAS speed, altitude, and route adjustments will mean extra workload for the Pilot Not Flying.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

2. In our current operating procedures, we turn LNAV off when we are below 3000 feet. With CTAS we d have to stay on LNAV longer.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

3. Remaining coupled to the FMS longer (i.e. closer to the ground) is a procedural change — but it should not pose a problem.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

4. With speed, altitude and route changes arriving by datalink, a pilot could become complacent and not pay attention to what the aircraft is doing.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

5. With CTAS speed, altitude and route changes arriving by datalink, pilots would lose their situational awareness. We won t have as clear a picture of the aircraft around us, because we can t hear them.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

6. With CTAS automatically datalinking new routes to the flight deck, the pilots workload would be too low — I d be less attentive than I am now.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

7. If a pilot accidentally hit the Reject button when he meant to accept the data linked route change, it could be more workload to get the information back. Errors like this would increase our workload over our present day levels.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

8. There is no room for quick modifications. If a pilot knowingly rejects a route because it is not acceptable (i.e. due to weather, terrain, or aircraft characteristics), it could create more workload to call ATC to explain why the route was rejected and get an amendment.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

9. If the downwind extension happened close to an airport, workload could be higher if the crew has already begun to configure the aircraft for landing.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

10. My airline s Standard Operating Procedures should include a requirement that the crew must calculate the vertical profile, and double check /verify that CTAS is correct.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

11. We will lose the interpersonal dialogue between the controller and pilot. A controller may ask a pilot to try to make a certain altitude and the pilot will try to make it work — or negotiate another option. This interaction will be lost with datalink.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

12. Mixed fleets (some aircraft equipped with CTAS and others not equipped) will not work. If you have one or two aircraft using datalink, and the rest using voice, the datalinked aircraft will not be included in other pilots situation awareness.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

13. CTAS will not work in the terminal area. There are too many variables (i.e. airspace, terrain, weather, wake turbulence) and things change too quickly.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

14. CTAS should use a follow-me bug on the Nav Display. ATC would decide where the aircraft should be at what time, and the computer would generate the follow-me path. Pilot can then judge the best way to carry out the necessary maneuvers.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

15. Datalink will interfere with current cockpit procedures (i.e. force pilots to change from primary task to address datalink messages).

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

16. CTAS will be great when it all works, but hiccups in the terminal air space could mess up the entire system. When something goes wrong (i.e. a missed approach, or an aircraft does not make an assigned altitude crossing) things will be bad. There is no room for error with CTAS.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

AIRBORNE INFORMATION FOR LATERAL SPACING (AILS)

Purpose: To maintain aircraft separation during closely spaced parallel approaches of less than 3400 ft. separation in IMC.

17. The Closely Spaced Parallel Approach in IMC conditions would be considered a different procedure. A separate briefing card would be required for this approach.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

18. If the first officer was flying the approach and received an AILS alert, the first officer should clear the conflict. Once clear, the captain should take over the missed approach.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

19. If a pilot receives an AILS traffic advisory, the pilot should contact ATC immediately:

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

20. If a pilot receives an AILS traffic advisory, the pilot should contact the other aircraft immediately.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

21. If a pilot receives an AILS traffic advisory, the pilot should monitor the traffic advisory, follow the AILS resolution advisory, and contact ATC once clear of contact.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

22. In a HUD equipped aircraft, the captain gets all necessary flight information from the HUD so has no reason to check the primary flight display or navigation display. It is a serious safety concern that AILS information is not displayed in the HUD.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

23. In HUD equipped aircraft, the first officer should monitor the AILS display and communicate to the captain. If a missed approach was necessary, the first officer should initiate the procedure because he s already looking at the instruments and would be in a better position to do a missed approach than the captain.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

24. Controllers should monitor the parallel approach, and step in before either plane receives a traffic advisory.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

25. Controllers should receive a red alert accompanied by an aural alarm AFTER pilots receive their red alert and resolution advisory. ATC should step in and resolve the conflict at this time.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

26. ATC should call the encroaching aircraft and tell him to correct his flight path as soon as he sees the problem.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

27. ATC should contact the aircraft ONLY after they are clear of conflict and provide heading and altitude vectors.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

28. Separation between aircraft should be the pilot s responsibility during closely spaced parallel approaches in IMC.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

29. Separation between aircraft should be ATC s responsibility during closely spaced parallel approaches in IMC.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

30. The aircraft should be datalinked to ATC, so that ATC knows the aircraft received the alert and is carrying out the Resolution Advisory.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

31. Both aircraft need to be on the same tower frequency and one controller should be dedicated to monitor the runway pair. The dedicated controller could override tower.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

32. AILS resolution advisories need to be coordinated to ensure both lateral and vertical separation.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

33. Both aircraft need to be equipped with AILS. It should be a requirement.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

34. Closely spaced parallel approaches should not be performed with manual lands. The aircraft must be auto-coupled.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

ROLL OUT AND TURN OFF GUIDANCE (ROTO)

Purpose: To increase runway throughout and reduce runway occupancy times. ROTO provides speed and turn guidance to assist pilots in exiting the runway quickly and safely in low visibility conditions.

35. It would be better if the first officer had a ROTO display. Redundancy and back ups are always important.

Level of Agreement:	Level of Criticality:
_____I strongly agree	_______Not Critical
_____I agree˚	_______Somewhat Critical
_____I neither agree nor disagree (neutral)	_______Very Critical
_____I disagree	
_____I strongly disagree	

36. Keep the ROTO display a captain-only function. If the co-pilot has the ROTO display also, it might promote too much eyes-in time.

Level of Agreement:	Level of Criticality:
_____I strongly agree	_______Not Critical
_____I agree˚	_______Somewhat Critical
_____I neither agree nor disagree (neutral)	_______Very Critical
_____I disagree	
_____I strongly disagree	

37. In the manual mode, being head-down to select the runway exit is a problem. It will add to the workload and crew communications during an already busy time.

Level of Agreement:	Level of Criticality:
_____I strongly agree	_______Not Critical
_____I agree˚	_______Somewhat Critical
_____I neither agree nor disagree (neutral)	_______Very Critical
_____I disagree	
_____I strongly disagree	

38. Currently, we do not conduct an approach briefing. With ROTO, we d have to add the runway exit to our approach briefing.

Level of Agreement:	Level of Criticality:
_____I strongly agree	_______Not Critical
_____I agree˚	_______Somewhat Critical
_____I neither agree nor disagree (neutral)	_______Very Critical
_____I disagree	
_____I strongly disagree	

39. There is no way I would be prepared to select an exit at the time of my approach briefing.

Level of Agreement:	Level of Criticality:
_____I strongly agree	_______Not Critical
_____I agree˚	_______Somewhat Critical
_____I neither agree nor disagree (neutral)	_______Very Critical
_____I disagree	
_____I strongly disagree	

40. I don t want ROTO making turn-off decisions for me — just show me all exits so I know what my options are.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

41. I don t see a need for the manual mode at all. I d just leave it in auto the whole time.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

42. I d rather that the first officer is looking out for light cues on the airport surface so I know if I m off centerline.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

43. My airline should implement standard phraseology such as A5 is to the left, I ll take it and Can t make A5, I ll take the next one .

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

44. As a pilot, I think it would be ok for the controller to <u>always</u> state a preferred exit as long as we weren t held to it. We d try for it.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

45. If an exit is blocked by another aircraft, the tower controller should tell the pilot which exit to take.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

TAXIWAY-NAVIGATION AND SITUATION AWARENESS

Purpose: The T-NASA taxi map, taxi HUD, and directional audio alerts are designed to increase taxi speed, route navigation accuracy, and situation awareness in low visibility conditions.

46. The first officer should continually cross-check their taxi map display with the captain s HUD using a defined verbal protocol.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

47. The first officer should cross-check their taxi map display with the clearance provided by the ground controller (via radio).

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

48. My airline should include a Standard Operating Procedure which states that the first officer should call out ALL taxi turns i.e. 90 degree right turn next — 45 degree left turn now

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

49. The T-NASA taxi map should show the taxi route while airborne, even though the route may have to change once the pilot is on the ground.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

50. The T-NASA taxi map should NOT show the taxi route while airborne. The exit and/or route might change due to conditions on the ground. The taxi map should just display the runway and the assigned gate.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

51. Upon receiving a route change while taxiing with T-NASA, the first officer should verify that the route is correct, zoom to the biggest scale to make sure the route goes to the right gate, and tell the captain Route looks good .

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

52. Before crossing an active runway, the first officer should zoom his taxi map to the biggest scale, to ensure that the runway is clear, and communicate this to the captain.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

53. For crossing an active runway, it would be ideal if ATC provided a crossing time. Pilots can figure out the best speed to get there to avoid stopping at an active runway.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

54. It is better to slow or speed up traffic so nobody has to stop, then to have aircraft stop for an active runway or occupied taxiway.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

55. Eliminating voice/radio contact with the ground controller in favor of a datalink system would not bother me.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

56. I d be nervous just following the magenta line with no voice control.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

57. Busy airports are so dynamic and crossing active runways is difficult. I don t think it would be feasible to update routes and issue holds via datalink.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

58. Busy airports are so dynamic and crossing active runways is difficult. I think it would be <u>faster</u> to update routes and issue holds via datalink than via the current voice/radio methods.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

ATC Survey

Center-TRACON Automation System / Flight Management System (CTAS/FMS)
Purpose: Assist controllers in providing speed, altitude and route amendments including downwind leg extensions to adjust meter fix arrival and threshold arrival times.

1. The number of interactions and communications between ATC and the flight deck to make the necessary CTAS speed, altitude, and route adjustments will mean extra workload for the controllers.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

2. With CTAS determining all speed, altitude and route changes, a controller could become complacent and not pay attention to what the air traffic is doing.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

3. I d let CTAS assign routes and I would watch the patterns. When I see that it isn t going to work, then I d step in. However, this could be problematic. If a controller changes a routing, it may have a negative impact on other CTAS routes.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

4. If a pilot accidentally hit the Reject button when he meant to accept the CTAS datalinked route change, it could be more workload to get the information back. Errors like this would increase our workload over present day levels.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

5. With CTAS determining all speed, altitude and route changes, a controller could lose awareness of the big picture of traffic flow patterns.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

6. CTAS will radically change the nature of our job. We will no longer be separating aircraft, just monitoring them.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

7. We will lose the interpersonal dialogue between the controller and the pilot. For example, a controller may ask a pilot to try to make a certain altitude and the pilot will try to make it work — or negotiate another option. This interaction will be lost with datalink.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

8. CTAS will not work in the terminal area. There are too many variables (i.e. airspace, terrain, weather, wake turbulence) and things change too quickly.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

9. In the terminal area, ATC doesn t have time to issue clearances by datalink and wait for a response.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

10. CTAS should use a follow-me bug on the Navigation Display. ATC would decide where the aircraft should be at what time, and the computer would generate the follow-me path. Pilot can then judge the best way to carry out the necessary maneuvers.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

11. CTAS will be great when it all works, but hiccups in the terminal air space could mess up the entire system. When something goes wrong (i.e. a missed approach, or an aircraft does not make an assigned altitude crossing) things will be bad. There is no room for error with CTAS.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

12. Mixed fleets (some aircraft equipped with CTAS and some not equipped) will increase workload for controllers.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

AIRBORNE INFORMATION FOR LATERAL SPACING (AILS)

Purpose: To maintain aircraft separation during closely spaced parallel approaches of less than 3400 ft. separation in IMC.

13. If a pilot receives an AILS traffic advisory, he should contact ATC immediately:

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

14. If a pilot receives an AILS traffic advisory, he should contact the other aircraft immediately.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

15. If a pilot receives an AILS traffic advisory, he should monitor the traffic advisory, follow the AILS resolution advisory if necessary, and contact ATC once clear of contact.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

16. It will be difficult (high workload) to pair aircraft that can conduct a closely spaced parallel approach together without violating wake turbulence rules.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

17. Controllers should monitor the parallel approach, and step in before either aircraft receives a resolution advisory.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

18. Controllers should receive a red alert accompanied by an aural alarm AFTER pilots receive their red alert and resolution advisory. ATC should step in and resolve the conflict at this time.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

19. Controllers should receive an AILS chime and visual warning to notify them when one aircraft is diverging into another aircraft s path on a closely spaced parallel approach.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

20. ATC should contact the encroaching aircraft and tell him to correct his path.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

21. ATC should contact the aircraft ONLY after they are clear of conflict and provide heading and altitude vectors.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

22. I would like the AILS display in the tower, but probably won t use it much. My eyes are a much more sensitive instrument.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

23. I d like to have a no transgression zone marked on my AILS display.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

24. Even if separation is the responsibility of the pilots, AILS needs to give the information (alerts) to the controller as well as the pilot.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

25. Separation between aircraft should be ATC s responsibility during closely spaced parallel approaches in IMC.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

26. ATC would need to be absolved if the AILS system comes along (like TCAS). Pilots will have to be responsible for separation.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

27. The aircraft should be datalinked to ATC, so that ATC knows the aircraft received the AILS alert and is carrying out the Resolution Advisory.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

28. Both aircraft need to be on the same tower frequency and one controller dedicated to monitor the runway pair. The dedicated controller should be able to override tower.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

29. AILS Resolution Advisories need to be coordinated to ensure both lateral and vertical separation.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

30. Both aircraft need to be equipped with AILS. It should be a requirement to fly a closely spaced parallel approach.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

31. Closely spaced parallel approaches should not be done with manual lands. The aircraft must be auto-coupled.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

ROLL OUT AND TURN OFF GUIDANCE (ROTO)

Purpose: To increase runway throughout and reduce runway occupancy times. ROTO provides speed and turn guidance to assist pilots in exiting the runway quickly and safely in low visibility conditions.

32. As a tower/ground controller, I would find it helpful to know what runway exit the captain was planning so that I could try to keep that exit clear and keep other ground traffic flowing better.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

33. As a tower/ground controller, I do not need/want to know the intended runway turn off.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

34. If tower/ground controllers were notified of an aircraft s intended turn-off, and the captain could not make that turn off, it would mean more work for controllers.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

35. As a tower/ground controller, I don t want to have to suggest a runway turn-off to each aircraft. I am too busy to do that.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

36. I think it would be ok for the tower/ground controller to always suggest a preferred exit that would increase airport traffic flow and shorten taxi time to the gate — even though pilots wouldn t be obligated to take it.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

37. The tower controller should tell pilots which exit to take, if one (or more) exit is blocked.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

TAXIWAY-NAVIGATION AND SITUATION AWARENESS

Purpose: The T-NASA taxi map, taxi HUD, and directional audio alerts are designed to increase taxi speed, route navigation accuracy, and situation awareness in low visibility conditions.

38. The T-NASA taxi map should show plots the taxi route while airborne, even though the route may have to change once the pilot is on the ground.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

39. The T-NASA taxi map should NOT show pilots the taxi route while airborne. The exit and/or route might change due to conditions on the ground. It should just display the runway and the assigned gate.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

40. For crossing an active runway, it would be ideal if ATC provided a crossing time. Pilots can figure out the best speed to get there to avoid having to stop.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

41. At least initially, controllers will send a taxi route via datalink as well as verbally. This may be too task intensive (time consuming) for controllers.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

42. T-NASA should provide ground controllers with guidance and alerts for potential conflicts and if an aircraft is off route, but the controller should retain control over the actual assignment of routes and hold commands.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

43. T-NASA should generate routes for each aircraft — and the ground controller would be responsible for stopping (holding) aircraft if necessary to avoid collisions.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

44. It is better to slow or speed up traffic so nobody has to stop, then to have aircraft stop for an active runway or occupied taxiway.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

45. Eliminating voice/radio contact in favor of a datalink system would not bother me.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

46. The controller should be responsible for stopping (holding) aircraft. If a controller fails to issue a hold command which may lead to a collision then T-NASA should step-in and issue the hold command.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

47. I d be nervous just sending clearances via datalink without receiving a verbal acknowledgment (ATC would receive just a datalink acknowledgment).

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

48. Busy airports are so dynamic and crossing active runways is difficult. I don t think it would be feasible to update routes and issue holds via datalink.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

49. Busy airports are so dynamic and crossing active runways is difficult. I think it would be faster to update routes and issue holds via datalink than via the current voice/radio methods.

Level of Agreement:
_____I strongly agree
_____I agree˚
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

50. Ground operations (taxiing) should be a voice-only environment

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical

51. Mixed fleets (some aircraft equipped with T-NASA and some not equipped) will increase controller workload.

Level of Agreement:
_____I strongly agree
_____I agree°
_____I neither agree nor disagree (neutral)
_____I disagree
_____I strongly disagree

Level of Criticality:
_______Not Critical
_______Somewhat Critical
_______Very Critical