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Pilot–ATC Communication Conflicts: Implications for NextGen

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In the planned NextGen aviation operations, it will be critical to ensure shared situational understanding and cooperative problem solving between aircrews and air traffic controllers (ATC). A first step in predicting how future changes will impact flight crews and ATC is to examine the current system and to pinpoint problematic areas that could be ameliorated or exacerbated by advanced automation and heavier traffic density. In this study, we coded Aviation Safety Reporting System (ASRS) reports identified as having communication conflicts between pilots and ATC. Results describe types of conflict, operational context, phase of flight, operator states, and situations conducive to communication conflicts, risk perception differences, and inappropriate resolution strategies. Reports suggest that high workload approach and landing phases are conducive to communication conflicts, that different interpretations of the same information might lead to conflict, and that operator state could impact communication and collaboration between flight crews and ATC. A specific problem was noted when reporters felt that the affective response of the other party was not appropriate to the situation. Although this study reflects the limitations inherent in ASRS data, it can provide insights into potential problem areas and conflict triggers in NextGen operations. This research will enable us to better predict NextGen aircrew–ATC communication breakdowns and conflicts resulting from specific situations or operator states.

The Next Generation (NextGen) air transportation system will be characterized by heavier traffic and higher levels of automation than current operations. Systems such as Automatic Dependent Surveillance–Broadcast (ADS–B) and Cockpit
Display of Traffic Information (CDTI) will provide for all-weather operations equivalent to visual flight operations and on-board self-separation capability. Ground-based automation will support 4-D trajectory management and strategic flow management, with controllers serving more of a supervisory function than a clearance-based control function. En-route communication between aircraft in the air and between aircraft and ground-based traffic management will be largely automated, relying on data-link type systems with the possibility of input going directly to the flight management computers. These advances will significantly increase capacity in both the en-route and terminal airspaces, resulting in higher traffic density, particularly in terminal areas (Federal Aviation Administration [FAA], 2009). What all these changes will mean for the operators in these highly automated systems must be better understood to ensure that safety is maintained in the face of increases in efficiency and system throughput.

A first step in predicting how future changes will impact flight crews and ATC is to examine the present system and identify problems that could be ameliorated or exacerbated by increased automation and heavier traffic density. For example, NextGen arrival and terminal operations will require a high level of collaboration and cooperation between aircrews and ATC, and will likely be managed via voice communication (Federal Aviation Administration [FAA], 2009). Because effective communication will be critical in these phases of flight, it is important to determine where conflicts or communication breakdowns might already be occurring and to take these into account when planning the future system. In this study, we examined Aviation Safety Reporting System (ASRS) incident reports containing evidence of pilot–ATC communication breakdowns. We focused on classifying types of conflicts as well as situational and operator state factors that characterized these incidents, and on identifying any differences in situational understanding and risk perception that contributed to communication conflicts.

**SOURCES OF COMMUNICATION CONFLICTS**

Conflicts Rooted in Time Pressure and Airspace Constraints

The impact of increased traffic flow is likely to be most apparent in the airspace around major metropolitan areas (Zingale, Truitt, & McAnulty, 2008). The phases of flight that occur near airports (i.e., departures and arrivals) will be those with the most time pressure and highest workload for pilots and controllers. These phases might also have the greatest potential for different perspectives and conflicting goals. For example, ATC might need to focus on efficiency and expediency of operations for all aircraft, whereas pilots might be focusing on navigating their own aircraft safely through the heavy traffic volume. These different
perspectives could in turn lead to operational conflicts, different plans for the physical placement of a given aircraft.

Conflicts Resulting From Different Information

In current operations, flight crews get information primarily from on-board radar, automated data messages such as the Automatic Terminal Information Service (ATIS), and ground communications. ATC relies heavily on ground-based sources of information, radar displays, and communications with flight crews. Each of these sources has its own perspective view and update rate. Informational conflicts might arise when flight crews and ATC make requests or decisions based on different sources or different versions of information.

Conflicts Resulting From Cognitive Factors and Risk Assessment

Even when pilots and ATC share the same information, cognitive conflicts might arise if they do not interpret it in the same way. For example, differing interpretations of instructions or of information concerning winds, storms, wake vortex activity, and so on, might suggest diverse courses of action. Flight crews might also vary from ATC in their evaluation of the importance or riskiness of a clearance or action, as when they are asked to expedite a takeoff or to reduce spacing behind another aircraft. Prior work on aviation decision making has led to the development of a model of effective decision making under various operational conditions, highlighting the importance of accurate situation assessment (Orasanu & Fischer, 1997) and the central role of risk perception in decision making (Fischer, Orasanu, & Davison, 2003; Orasanu, Fischer, & Davison, 2004). Further work identified differences among pilots, controllers, and dispatchers in their perceptions of risk (Davison & Orasanu, 1999), and pinpointed difficulties associated with managing breakdowns or conflicts between pilots and controllers resulting from these differences in the current aviation system (Bearman, Paletz, Orasanu, Farlow, & Bernhard, 2005). Ambiguous dynamic conditions, schedule and operational pressures, goal conflicts, and high workload might contribute to these conflicts (Orasanu, Martin, & Davison, 2002).

OPERATOR STATE

Empirical laboratory research has shown that a number of operator state factors can influence the quality of situation assessment, information processing, and decision-making behavior (Peters, Västfjäll, Gärling, & Slovic, 2006). This has implications for decision processes and communication conflicts in aviation. The literature typically distinguishes between two forms of affect. Much
of the research has examined how decisions are influenced by incidental affect; that is, emotions that people bring to the task and that are extraneous to the task or decision (Lerner & Tiedens, 2006; Loewenstein & Lerner, 2003; Luce, Bettman, & Payne, 1997). In contrast, operator states elicited by the situation itself or its potential consequences are referred to collectively as integral affect (Luce et al., 1997; Mosier & Fischer, 2010). Influential affective states can be induced in aviation operations by characteristics of situations or tasks, such as information overload, scheduling issues (e.g., early morning or late night flights), unanticipated changes, or weather or safety hazards. Situational factors might not only have a direct impact on operators’ affective states, but could also influence their behavior by eliciting particular affect-based responses.

The influence of operator state might manifest itself in different ways (Mosier & Fischer, 2010). First, it might limit—and thus bias—information search for situation assessment. Anger, for example, is consistently linked with heuristic processing (e.g., Lerner & Tiedens, 2006). This tendency could exacerbate operational phenomena such as automation bias (Mosier, Skitka, Heers, & Burdick, 1998) and automation-induced complacency (Parasuraman, Molloys, & Singh, 1993), which entail curtailed information search. In contrast, anxiety or worry has been associated with systematic information processing, but could also lead to overvigilant attention to all available data, whether relevant or not, and delay of action (e.g., Loewenstein & Lerner, 2003).

Second, operator state can set a frame for coherence, and thus guide the integration of information and cues for situation assessment. That is, pilots or controllers might examine most or all of the information available to them, but the interpretation of information and situations in the operational context, the rationale for their decisions, and perceptions of risk will be impacted by state (Lerner & Keltner, 2001).

Third, operator state might guide the focus of cognition. Anger has consistently been associated with the perception of personal control over a situation, whereas fear and anxiety are associated with the perception that a situation is not under one’s control. Anger, for example, might encourage a “blame” mode, in which operators focus on responsibility and retribution rather than problem solving. Fear or anxiety, in contrast, might elicit a concern for self-protection and safety.

Operator state could also influence risk perception and risk-taking behavior. Anger, for instance, has consistently been associated with risk-seeking behaviors and with the perception of personal control over a situation, whereas fear and anxiety are associated with risk-aversive choices and with the perception that a situation is not under one’s control (Isen, Nygren, & Ashby, 1988; Lerner & Keltner, 2001).

Conflict between flight crews and ATC can both exacerbate particular operator states and be affected by them. For example, anger or tension might lead to a
communication conflict or breakdown and in turn, the presence of anger or tension during an incident could lead to inappropriate conflict resolution strategies.

EXPLORING THE RELATIONSHIPS AMONG CONFLICTS, OPERATOR STATES, RISK PERCEPTIONS, AND CONFLICT RESOLUTION STRATEGIES

This study was a follow-up to analyses by Bearman and his colleagues (Bearman et al., 2005; Bearman, Paletz, Orasanu, & Thomas, 2010), who identified a set of ASRS incidents involving a communication conflict or breakdown between pilots and ATC reported between June 2000 and January 2003. They compared one subset of these reports in which weather issues were or were not involved, and a second subset with transcripts from Apollo 13. For this study, we examined all of the 128 reports identified by Bearman et al. with the goal of characterizing the context in which these incidents of communication breakdown occurred and the individual and situational factors that contributed to them. Patterns with respect to time of day, phase of flight, and airport were noted, as well as the types of conflicts that were prevalent. We examined whether and what operator states surfaced in accounts of conflict or communication breakdowns between flight crews and ATC. We were also interested in evaluating the relationships among conflicts, operator states, risk perceptions, and conflict resolution strategies. Because this was an exploratory study, no hypotheses were generated. Rather, we asked several questions and looked for patterns and problems to guide further research. Although the data come from pre-NextGen operations, they suggest some of the issues and potential areas for communication breakdowns and conflicts as NextGen changes are implemented.

METHOD

Data consisted of a set of 128 ASRS incident reports filed between June 2000 and January 2003 that had been identified as involving communication breakdowns or conflicts between controllers and pilots (Bearman et al., 2005). Over half of these reports \((n = 67, 52.3\%)\) were from Part 121 major air carrier pilots. Twelve \((9.4\%)\) reports came from Part 135 (commuter or regional) pilots, 42 \((33\%)\) from Part 91 (general aviation) pilots, and 4 \((3.2\%)\) from rotary aircraft pilots. Three reports \((2.1\%)\) came from ATC.

To avoid contamination across the types of variables being coded in the reports, separate teams at San Francisco State University were trained to code each variable: type of conflict, operator state, differences in risk perception, and inappropriate resolutions. Coding was an iterative process, and reports were revisited and discussed until there was consensus on each coded variable. One team of
coders picked out precise phrases in the reports that were associated with each of three types of conflict: (a) operational conflicts, which concerned a mismatch between the actions or the plans that each party had concerning the physical operation of the aircraft; (b) informational conflicts, which involved a difference in the information held by each party; and (c) cognitive conflicts, which entailed a difference in the evaluation or interpretation of commonly held information (Bearman et al., 2005). Each conflict type was coded only once per report. However, reports could contain evidence of more than one type of conflict, and it was often the case that unresolved conflicts of one type (e.g., different information) led to or were accompanied by other conflicts (e.g., different operational plans).

A second coding team identified operator state words that were present in the reports, either referring to the reporter (typically a pilot) or to another party (e.g., ATC). The list of operator state words was compiled from measures of state and trait affect such as the Positive and Negative Affect Scale (Watson, Clark, & Tellegen, 1988), and the State–Trait Anxiety Inventory and State–Trait Anger Expression Inventory (Forgays, Forgays, & Spielberger, 1997; Spielberger, 1983, 1988) and included terms such as intimidated, frustrated, surprised, hostile, sorry, disconcerted, concerned, aggravated, and fatigued. The team also coded affective words describing the situation itself (e.g., chaos, confusion) as well as action words that had an affective tenor (e.g., brushed me off, ridiculed). Coders also noted reports indicating a difference in risk perception between pilots and ATC. Finally, a separate coding team identified reports in which conflicts were resolved inappropriately or unprofessionally, for example, with social pressure, confrontation, lack of concern, scolding, ridicule, or threats of punishment.

RESULTS AND DISCUSSION

Conflicts

*When and where are communication conflicts likely to occur?* ASRS breaks flights down into eight phases: takeoff, initial climb, climb, cruise, descent, initial approach, landing, and taxi. The final phases of flight, approach, landing, and taxi appeared in more than half of the reports (n = 66; 52%), and were the phases in which problems were likely to occur. This makes sense, as flight crews and ATC are likely to communicate most often with each other during these phases, and traffic and workload are high for both pilots and ATC. Fifty-one reports (40%), for example, described events during the initial approach. Many of the initial approach incidents involved requests for changes in approach path or runway from pilots (n = 14) or ATC (n = 15), suggesting that collaborative negotiation of paths into airports will be an important factor in NextGen.

Fifteen (12%) of the reports came from three airports that have some of the highest traffic levels in the United States: Atlanta (ATL, n = 6), Chicago O’Hare
(ORD, \(n = 5\)), and Los Angeles (LAX, \(n = 4\)). The rest of the reports were scattered across airports, VORTACs, waypoints, and ATC facilities. Most reports contained multiple communication conflicts, often of different types. All but two of the reports from the heaviest traffic airports concerned incidents during approach and landing. Heavy traffic and ATC “cramming” were primary factors in these incidents, as well as requests from ATC to accept problematic visual clearances or runways. Pilots also cited radio congestion and problems contacting ATC. Issues of radio congestion can be eased with the increase of data-link communications; however, data link is not likely to be used in the terminal area in the early or midterm phases of NextGen. Additionally, data link has the disadvantage of eliminating party line information telling crews what aircraft around them are doing and might lead to other types of problems.

**What kinds of conflicts occurred?** Most reports contained multiple interrelated or cascading conflicts. Operational conflicts were the most frequent, and occurred in 120 (94%) reports. For example:

The controller . . . told us he had assigned us 13000 ft and to read back the clearance. We again told him that we could not accept the clearance at that altitude . . . (ASRS #502282)

This suggests that a starting point for many incidents is a mismatch between what pilots and controllers want the aircraft to do.

Information conflicts were found in 74 (58%) reports, and often reflected a failure of one party to obtain or to pass along the most updated information (e.g., ATIS, traffic, restricted airspace, runway in use, characteristics or limitations of aircraft). For example:

This near midair collision (NMAC) could have been totally avoided had the tower controller told us about the traffic and/or communicated this to departure control . . . (ASRS #495758)

Weather was cited as a contributing factor in 36 (28%) reports. Displays and range of available weather information were different for ATC ground radar and aircraft radar, and this also caused information conflicts. New automated information systems such as SWIM or the 4-D Weather Cube might ameliorate these conflicts. Fifty-four (42%) reports contained cognitive conflicts, and many of these concerned different interpretations of instructions, or differences in perceptions of the safety of the situation or requested action. For example:

The controller advised me that I was not permitted to climb. I advised him that I was cleared to resume my own navigation. He then advised me that “resume own navigation” did not mean I was allowed to climb . . . (ASRS #481640)
The following is a sample report with italicized informational (I), operational (O), and cognitive conflicts (C), and inappropriate or unprofessional language or resolution (IR). It illustrates that breakdowns of one type (e.g., lack of shared information) can disrupt the creation of shared situational models, and lead to further conflicts, and result in inappropriate interactions.

With Dallas/Fort Worth winds for the past 2 hours showing 180 degrees at 22 knots gusting to 32 knots (I), I advised my First Officer to inform approach on initial contact to request runway 18Right . . . the controller was reluctant to honor our request (O) & asked the reason for it. I replied that it was due to operational consideration due to existing surface winds. He replied his winds were 120 degrees at 13 knots (I) & asked if that was something I was unable to handle (IR). I told him the ATIS winds & once again requested runway 18R. He immediately slowed us to 200 knots. We were . . . vectored to runway 18R where the tower continued to report winds at 180 degrees at 25 knots gusting to 32 knots. I am concerned that the controller considered his flow more important than my decision to use a more logical runway (C). He then seemed to try to intimidate me (IR) by giving me winds that were not reported anywhere else throughout the arrival & when I did not retreat, the reduction to 200 knots seemed punitive in nature (IR). Pilot-in-command decisions take priority over flow & ease of operations (C). This controller may need to be reminded of this fact . . . (ASRS #540883)

What contextual factors were associated with communication conflicts? Most conflicts (n = 91, 71%) occurred during daylight, perhaps reflecting higher traffic loads during the day with more opportunities for communication and, thus, communication conflicts. Confusion (confuse[d], confusing) was mentioned in 26 (20%) reports and workload (overwork[ed], overload[ed], busy) was cited in 32 (25%) reports. Words related to the situation, such as confusion, tense, critical, and frantic, appeared in 29 (23%) reports, and typically described an adverse or difficult environment. Loss of situation awareness (SA) appeared in 15 (12%) reports. Pilot reports described their own lack of SA, or discussed ATC as having “lost” or having a “lack of” or “losing sight of the big picture” or “losing positional awareness” or not knowing an aircraft’s location. ATC loss of SA was also associated with heavy workload (i.e., not being able to efficiently handle the amount of traffic) and becoming confused during their interactions with pilots.

When or what type of conflict situation is associated with differences in risk perception between pilots and ATC? Risk perception differences occurred in 33 (26%) reports. These were always associated with operational conflicts, and often (n = 24) contained cognitive conflicts also, reflecting different priorities of pilots and ATC. Pilots’ expressed priority was aircraft safety. In many reports, a pilot expressed concern or discomfort about a clearance he or she was
given or requested a different plan from ATC (operational conflict); for example, “In my judgment, he pressured us to accept an unsafe clearance . . . created an unsafe environment in flight” (ASRS #512667). Pilots reported that ATC prioritized issues of spacing and flow over concerns of individual aircraft, and did not share their interpretation of situation elements as unsafe (cognitive conflict).

**Operator States**

*What operator states were evident in reports?* Four categories of affective state words emerged from the data and were coded as follows:

1. Operator states elicited in direct response to the situation. These represented integral affect, as they were task- or situation-relevant (e.g., concerned, tense; 22 words).
2. Operator states elicited in response to what ATC asked the pilot to do. These reflected integral affect if they were related to the task, clearance, or the impact of the task or clearance on safety, or to differences in risk perception or safety and priorities (e.g., unsafe, confused, puzzled, comfortable; 30 words).
3. Operator states elicited in response to the way ATC issued a clearance or asked the pilot to do something. These were related to the interaction rather than to the situation (e.g., frustration, pressured, chastised; 18 words).
4. Inferred state of ATC. These words described the pilots’ perceptions of ATC affective state or facets of performance. They could refer to characteristics elicited by the situation (e.g., harassed, stressed) or to characteristics of ATC performance or the interaction (e.g., hostile, angry, rude, pleasant; 75 words).

Coders noted the number of reports containing affective words describing the situation itself (18%; 23 reports) and the number of reports indicating a difference in risk perception between the reporter and ATC (27%; 35 reports). For example, a pilot whose risk perception differed from the controller’s reported, “In my judgment, he pressured us to accept an unsafe clearance. His comments to us were unprofessional and created an unsafe environment in flight . . .” (ASRS #512667).

Forty-five reports (including two of the three reports from controllers) contained descriptions of the reporter’s own affective state and 46 reports contained inferences of the state of the other party. A total of 76 reports (60%) contained words in one or both of these categories. A surprising result was the number of words in pilot reports that inferred the state of ATC. In these reports, pilots described their perceptions of ATC affective state or facets of performance. They
referred to states elicited by the situation (e.g., harassed, stressed) or to states that were evident from ATC performance or from the interaction (e.g., hostile, angry, rude, pleasant). Findings replicate some of the affect-related effects that have been found in other research, for instance the relationship between anger and a focus on blame or retribution:

I tried to make a suggestion that in the future it would be helpful if the controller could be more specific as to just where he wanted me to fly . . . I was then cut off by the controller . . . The controller stated in an angry tone of voice that, “no, no it wasn’t my bad, it was your bad! You asked me for a favor and I helped you out, but you didn’t do me any favors.” (ASRS #509488)

Evidently, the inferred state of ATC was a salient factor in some of these conflicts. This was most apparent when pilots perceived ATC as not responding appropriately to the situation or to their requests—for example:

The controller rudely informed us that we were to maintain 170 knots to the final approach fix and that we had traffic 3 mi behind us and he needed spacing. I did not appreciate the controller’s attitude, and feel that in these extreme weather conditions they should not be stacking aircraft so close. (ASRS #495480)

What circumstances were likely to result in inappropriate resolutions? Inappropriate resolutions occurred in 20 reports (16%), many of which also contained descriptions of affect-laden actions. Inappropriate behaviors or resolution strategies included terms such as brushed off, confrontational, lack of concern, intimidated, want to argue, and scolding. In four reports, heavy ATC workload such as managing three or more aircraft on approach was cited as a situational factor, and pilots complained that ATC was not listening to or was ignoring them. Eight reports contained differences in risk perceptions as described earlier. In a recurring pattern, a pilot expressed a safety concern or discomfort about the situation or about a clearance that reflected ATC priorities (e.g., reducing spacing to enable a faster traffic flow—OC), and the concern about the situation was dismissed or not taken seriously by ATC (CC):

My crew and I . . . are very concerned about [the controllers’] apparent lack of concern before, during or after this event. Why were we turned from a southerly to northerly heading into the direct path of another aircraft? (ASRS #486349)

If the pilot felt that ATC was responding inappropriately to his or her concern, or that the affective tenor of ATC response was not proper or was unprofessional (e.g., social pressure, punishment, ridicule), conflict could be extended or exacerbated.
CONCLUSIONS AND APPLICATIONS

Our analyses revealed that conflicts often occurred when flight crews and ATC based their plans for a given aircraft on different perspectives, priorities, sources or versions of information, or when they interpreted situations differently. The ASRS reports analyzed in this study suggest that the final phases of flight are particularly conducive to communication breakdowns, in part as a result of changes or renegotiations of flight paths to the ground. It will be important in NextGen terminal operations to guard against communication conflicts during approach and landing phases, particularly during off-nominal events when traffic density, time pressure, and workload are likely to be high, precise trajectories and spacing will be required, and voice communication rather than data link will be used. NextGen implementations will incorporate increased collaboration among air and ground decision makers, as well as increased autonomy for flight deck crews. It will be essential that all parties share the same picture of the situation so that changes to flight trajectories will promote both system efficiency and individual aircraft safety.

Some conflicts noted in these reports might be ameliorated by new technology. For example, many of the new automated systems in development for NextGen will be designed to ensure that flight crews and ATC have access to the same information (e.g., ADS–B; System Wide Information Management [SWIM]; 4-D Weather Data Cube; see FAA, 2009). However, information displays in the cockpit will be layered and pilots and ATC might not access the same sources at the same time. Additionally, cognitive conflicts associated with information interpretation, as well as with differing perspectives and goals as noted in current operations, might continue in NextGen. In particular, different interpretations of information (e.g., weather, traffic) from various sources in terms of implications for safe and efficient operations could continue to surface. A collaborative and cooperative relationship between aircrews and ATC will be essential to avoid such conflicts.

The data also suggest that operator state might impact communication and collaboration between flight crews and ATC. Although these reports were selected for communication breakdowns or conflicts rather than operator state words, half of the reporters described themselves or the other party with affective overtones or characterized actions with affect-laden terms. A specific problem was noted when reporters felt that the affective response of the other party did not match his or her own, or was not appropriate to the situation. Vocal tone was a salient indicator of response appropriateness. The move to data-link communications might have a positive impact on this dynamic in that text communications will be scripted to a great extent and pilots and ATC will not have access to the tone of each other’s voices. However, other sources of communication conflict such as delayed clearance delivery, repeated uploading of requests, or
providing incomplete information could occur. Additionally, voice communications in NextGen are likely to be used primarily in terminal operations as well as in off-nominal or emergency situations—precisely the situations likely to evoke affective reactions—increasing the possibility that operator state will impact these critical communications.

It should be noted that the anonymous and voluntary nature of ASRS reports guarantees that it is a rich source of data, but also imposes inherent limitations with respect to data analyses and the generalization of results. For example, almost all of the reports in this sample were from pilots, and the ATC perspective is inadequately represented. This is a common characteristic of the ASRS database, in that pilots have an extra incentive to file ASRS reports: the FAA “waives fines and penalties, subject to certain limitations, for unintentional violations of federal aviation statutes and regulations which are reported to ASRS” (see http://asrs.arc.nasa.gov/overview/confidentiality.html). Pilots might also be motivated to file reports when they feel that they did not have control over a situation or incident. Flight crews ultimately need to be responsive to ATC requests and clearances, and the ASRS system offers the opportunity to at least register their disagreement.

Although this study reflects the limitations of the database, it can provide insights into potential problem areas and conflict triggers in NextGen operations. For example, the reports suggest that the high-workload approach and landing phases, which are likely to be managed via voice communication at least through midterm NextGen implementation, are conducive to communication conflicts, particularly when changes to flight plans or runways are imposed or requested. NextGen operations will require these phases of flight to be precisely timed and flown at major airports, as traffic is predicted to almost double from current levels and spacing between aircraft will be reduced. Although precision flight operations such as 4D trajectories and continuous descent might decrease the required number of interactions with ATC, the potential disruptive impact of any communication conflicts on traffic flow might be amplified. Future research will need to investigate the relationship among communication conflicts and dependent variables such as information use, interaction with automation, and diagnosis and decision processes.

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