PILOT WELLBEING & WORK RELATED STRESS (WRS)

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This paper presents the preliminary findings of an anonymous web-based survey addresing pilot work related stress (WRS) and wellbeing. The initial analysis indicates that pilots are under stress and experiencing wellbeing problems. Specific features of the job can result in wellbeing problems, spanning the three pillars of wellbeing. Critically, sources of WRS can increase a pilot's risk in terms of developing a mental health (MH) issue. Further, sources of WRS can impact on performance and safety. Considerable barriers still remain in relation to reporting MH issues at work. Coping mechanisms addressing sleep/fatigue, diet, exercise and communication/reporting, enable some pilots to thrive in an environment that has negative impacts for others. The vast majority of pilots indicated that issues pertaining to WRS and wellbeing are not being adequately managed in terms of airline safety management systems/processes. Potentially, airline interventions might focus on enhancing existing safety management system processes/technology to address risks associated with WRS and wellbeing, training pilots, and introducing new wellbeing briefing/reporting systems. Further, new digital tools might be advanced to support pilot self management of WRS/wellbeing and risk identification, both inside and outside work.

Work Related Stress (WRS) is defined as the response people may have when presented with work demands and pressures that are not matched to their knowledge and abilities, and which challenge their ability to cope (Leka, Griffiths & Cox, 2003). A high stress situation may not be detrimental to a person, once they have learned to cope with it in a healthy manner. As reported by Joseph (2016), stress coping is an important psychological construct which moderates/mediates the relationship between stressors and behavioural outcomes such as flying performance. Pilots experience many physiological, psychological and environmental stressors. Since the Germanwings 9525 accident (2015), the issue of pilot suicide and detecting/managing mental health issues amongst pilots has been gaining increased attention. Recent studies demonstrate that pilots are suffering with the same wellbeing issues as the general population (particularly those relating to mental health) and possibly to a greater extent (Pasha & Stokes, 2018; Wu et al, 2016). Overall these studies have attempted to measure the prevalence of wellbeing issues (and in particular, mental health issues), and to understand the factors that contribute to this. However, these studies fall short in terms of providing a rich picture of the lived experieince of pilots, and the complex relationship between individual wellbeing factors as conceptuallized in the biopsychoscial approach (Engel, 1977). In addition, there has been little emphasis on understanding (1) the relationship between WRS, pilot wellbeing and safety, (2) how pilots adapt to WRS and associated coping/self-management techniques, (3) the role of other stakeholders in relation to supporting pilots and managing this problem, and (4) potential solutions at different levels.

Prior exploratory interviews undertaken by the authors suggest that aspects of the job are impacting on pilot's physical, social, and emotional/psychological health (Cullen et al, 2017). Research indicates that aspects of the job present a potential threat to flight safety, given the ensuring impairments to task performance (Cahill, Cullen & Gaynor, 2018). In general, pilots try to normalize/adapt to the job and manage wellbeing issues. However, there is much variation in relation to coping ability. Overall, six impact scenarios were identified (Cahill et al, 2018). Of these, participants suggested that the primary focus of wellbeing interventions might be on the prevention of routine suffering, suffering which may degrade performance on the day, and suffering which ends in harm to the person. Following from the above research, this paper reports on the preliminary finding of the first wave of an anonymous web-based survey pertaining to pilot wellbeing. The survey and its analysis are both ongoing. Overall, the paper provides a preliminary descriptive analysis of the findings of the first wave of feedback (N=330, 67% completion rate). First, a brief background to this research is provided. The survey methodlogy is then reported. The high level results are then reported. These results are the discussed and some preliminary conclusions drawn.

Methodology

The objectives of the survey include: (1) to measure routine suffering amongst pilots, (2) to understand pilots experience of WRS/wellbeing issues, (3) to understand pilot attitudes to reporting wellbeing issues (including mental health), (4) to understand the relationship between work related stress, pilot wellbeing, pilot performance and safety, (5) to understand how pilots adapt to WRS and wellbeing issues, (6) to identify pilot coping/self-management techniques, and (7) to examine pilots perceptions regarding the role of their employers/airlines in terms of managing WRS/wellbeing issues. The is a cross-sectional descriptive study. An anonymous web-based questionnaire was developed which elicits feedback pertaining to the topics indicated above. The survey incorporates several standardised instruments to measure levels of common mental health issues. These are these Patient Health Questionnaire -9 (PHQ-9) (Kroenke, Spitzer & Williams, 2001), the Oldenburg Burnout (OLBI 8) (Demerouti, Bakker, Vardakou & Kantas, 2003), and the Oldenburg Burnout (Modified Instrument) (Demerouti, Veldhuis, Coombes & Hunter, 2018). Further, the survey design draws upon prior research undertaken by the authors pertaining to a biopsychosocial model of wellbeing, the factors that can positively and negatively influence a pilot's physical, mental and social health, and the ensuing impact on pilot performance and flight safety (Cahill et al, 2018, Cullen et al, 2017). Ethics approval was granted by the School of Psychology, Trinity College Dublin (TCD). The survey was completed by commercial pilots between 7th November 2018 and 28th February 2019. Using social media chanels, respondents were invited to participate in an anonymous online survey at a time of their choice. Advertising information informed participants that the survey elicits information of a sensitive nature and included a weblink to the survey. Prior to answering survey questions, respondents received background information about the study and completed the electronic consent. Following this, respondents completed questions for each of the nine sections. The survey concluded with a debriefing which included contacts information for relevant support groups. The survey was powered by the SurveyMonkey service and did not collect any identifying information about the person. Further, no internet protocol (IP) addresses were collected. It was assumed that each participant was a pilot and only completed one survey. Several questions in the survey required knowledge that would only be readily available to pilots. An active pilot (co-author in this study: PC) reviewed surveys for potential non-pilot participants. All surveys passed this screening. Descriptive statistics were used to describe the respondents and their responses on various survey items. We evaluated depressive symptoms via the Patient Health Questionnaire (PHQ-9) depression module. Tests for statistically significant group differences have not yet been undertaken.

Results

330 respondents participated in the survey, with 220 completing it fully (66.7% rate). 265 respondents completed the PHQ-9 (80.0%). Overall, the respondents can be described as male (84.5%), full time (91.8%), married (58.2%) and based in home country (80.3%). The repondents can be split into the following age brackets; <25 (4.2%), 25-35 (33.5%), 36-45 (27.8%), 46-55 (23.0%) and 56-65 (10.0%). Respondents had worked as a pilot for the following lengths of time; <2 years (8.5%), 2-5 years (12.6%), 6-10 years (17.1%), 11-15 years (15.7%), 16-20 years (14.7%), 21-25 years (7.2%), 26-30 years (12.0%) and >30 years (12.3%). 62% of respondents held the position of Captain. Over 3/4 (77.7%) of respondents rated their physical health as good/very good, while approximately 2/3 (67.7%) rated their mental health as good/very good. In general, the Pilots surveyed were a reasonably healthy population in terms of their health behaviours. The majority of participants reported obtaining between 7 and 8 hours sleep on non duty days (35.4% reported 8 hours of sleep, while 30.0% reported 7 hours). Respondents reported obtaining considerablly less sleep duirng duty periods (42.9% obtaining 6 hours, and 27.5% 7 hours). The vast majority exercise regularly (22.0% three times a week, 21.3% twice a week, and 16.8% once a week). Further, the majority reported eating a healthy diet (88.5%) while off duty, although a significant proportion (54.5%) reported that they ate an unhealthy diet while at work.

Just under half of the respondents (48.7%) reported that they had spoken to somebody about a MH issue they were experiencing or had experienced. 42.5% of respondents indicated that they have a close-friend pilot colleagues who has experienced MH issues. 12.8% of participants meet the threshold for Clinical Depression. 7.9%, had suicidal thoughts in the previous two weeks. However, although respondents reported experiencing wellbeing problems, the data suggests that Pilots are adapting and coping. Nearly half of respondents (48.1%) agreed to the statement ‘Pilots are suffering, but they are also adapting and coping’, while 8.7% strongly agreed.

45.6% strongly agreed that there are low levels of speaking out and/or reporting about mental health among Pilots, while 40.3% agreed. The vast majority of participants indicated that they would talk to a partner/spouse (79.5%) about a MH issue, closely followed by a friend (55.0%). Only 24.9% indicated that they would talk to a close friend colleague. 13.5% indicated that they would speak to a peer support group. A very small number (2.2%) indicated that they would speak with their line manager. Overall, participants indicated a considerable level of stigma in relation to reporting mental health issues at work. 78.0 % indicated they would not disclose a MH issue to their employer. 55.6% reported that if they were "unfit for flight" due to a mental health issue, they would provide a different reason. When asked about their reasons for this, the vast majority of respondents (68.6%) indicated 'fear of loss of license and loss of long-term earnings'. Other reasons included 'fear of stigmatisation by employer' (57.7%) and 'potential negative impact on career progression' (52.6%). On a more positive note, the vast majority agreed that they would look for help, if they had a MH issue (47.8% agreeing and 29.0% strongly agreeing). Further, 70.5 % strongly agreed with the statement 'Promoting mental health awareness (recognising problems in one's self or others) is important from a safety perspective', while 27.2% agreed.

Just over half of participants (51.0%) indicated that they find the job stressful 'now and again', while 23.5% indicated that the job is 'frequently stressful'. Pilots were asked to rate their ability to cope with WRS. The majority (69.6 %) agreed that they can tolerate the pressures of their work very well, while 13.8% strongly agreed. However, most participants (51.7%) agreed that 'they feel worn out and weary after work', while 22.9% strongly agreed. Respondents reported the top 3 most common sources of WRS as working irregular hours (70.2%), working ani-social hours (57.5), and the divergence of values between management and pilots (57.5%). Overall, the data indicates that sources of WRS have a negative impact on pilot wellbeing. Sleep difficulties (78.2%) were reported as the most common wellbeing issue that respondents either attributed to the job, or believed to be worsened by the job. This is followed closely by musculoskeletal symptoms (71.6%) and then digestive symptoms (53.8%). Other impacts include social isolation (42.2%), marital/family discord (36.9%), respiratory symptoms (32.9%) and psychological distress (31.1%). Although psychological distress was ranked the lowest in terms of wellbeing impact, the vast majority of respondents indicated that the environment in which Pilots work can contribute to the onset of, or worsen an existing a mental health issue (59.8% participants agreed, while 26.2% strongly agreed).

Data anlaysis suggests that sources of WRS impact on performance and flight safety. The vast majority of respondents (60.4%) agreed to the statement that 'certain sources of Work-Related Stress (WRS) have an impact on my performance', with 18.7% strongly agreeing. Further, 52.6% of respondents agreed to the statement 'Certain sources of WRS have an impact on my performance and by implication, have the potential to impact on flight safety', while 21.1% strongly agreed. Respondents were invited to identify specific performance impacts in relation to different sources of WRS. 82.4% of responedents reported 'working within the close confines of the cockpit' as the having the strongest impact, specifically, in relation to distraction and inability to focus on current task. Working irregular hours (73.6%) and working long duties (76.4%) were rated as having most impact on decision making. Over half of the respondents (52.4%) agreed to the statement that they are 'mostly coping well and that periodically, they may make a mistake but they will identify their own mis-take and correct their actions, thus ensuring that a safety event does not occur', with 7.8% strongly agreeing. Equally, the vast majority (56.7%) agreed to the statement 'if something were to give on the day, and I were to make a mistake, it is most likely that my fellow pilot would detect this and take a corrective action, thus ensuring that a safety event would not occur', with 12.6% strongly agreeing.

Pilots were asked to select from list of common methods of coping with (1) non WRS (stress outside work) and (2) WRS (stress inside work). 60.2% reported adopting coping strategies for non WRS, while 53.9% reported using coping strategies for WRS. In relation to coping strategies for non WRS, 30.8% reported using positive diet each day. Only 1.6% used relaxation devices/tools on a daily basis. On a several times per week basis, respondents reported using sleep and rest (54.6%), exercise (53.6%) positive diet (48.8%) and relaxation (13.0%). In relation to daily activities to manage WRS, the strongest focus appears to be on sleep and rest (28.0%), diet (27.6%) and exercise (14.0%). In terms of activities performed several times a week, respondents reported exercise (51.2%), positive diet (46.4%), sleep/rest (47.1%) . 21.9% respondents reported talking with colleagues while 17.6% reported talking with family and friends. The data analysis indicates that pilots do not use relaxation methods as frequently as other methods (3.1% every day, 11.8% several times a week and 8.1% once a week). In addition, it indicates that pilot use of professional supports is infrequent (2.0% several times a week, 0.7% once a week).

Overall, it seems that pilot engagement is quite low. Only 18.0 % agreed with the statement 'my employer and I share the same set of values', while 1.7% strongly agreed. 38.3 % of participants rated the level of engagement between themselves and their employer as very poor, while 39.6% rated it as poor. The majority of respondents indicated that ensuring and maintaining positive mental health for Pilots should be a key priority for all airlines (82.2% strongly agreed, while 16.9 agreed). However, it appears that this is not being taken seriously at an airline level. Only 10.2% of respondents agreed with the statement 'Ensuring and maintaining positive mental health for pilots is a key priority for my airline', while 7.6% strongly agreed. Most participants agreed that the process for supporting positive mental health and managing mental health problems in Pilots should be clearly defined at an airline level (62.5% strongly agreed while 34.8 % participants agreed). However, a very small number (8.5 %) agreed that this process is clearly defined at their airline, while 2.7% strongly agreed. Further, a small number of respondents (6.7%) agreed with the statement 'The Safety Management practices at my airline adequately address issues concerning the support & management of Pilot mental health & wellbeing', with 0.4% strongly agreeing.

Discussion & Conclusion

The wellbeing of pilots is being negatively affected by certain sources of WRS. Critically, wellbeing impacts span the three pillars of wellbeing, and are not limited to MH. Further, sources of WRS have implications from a human performance and flight safety perspective. In accordance with safety management system approaches, specific wellbeing issues and associated performance/safety risks need to be identified, measured and managed. Certain strategies enable some pilots to cope in a work environment that is detrimental for others. If these strategies can be better understood, lessons might be learned in terms of enabling pilots to increase their resilience to wellbeing challenges (including MH challenges). Also, these might be considered in relation to the design of solutions/interventions at different levels (for example, pilots, airlines and the regulator). Specifically, this research indicates that airlines are not adquately managing these issues. Overall, airline organizations might increase their support for preventative mental health treatment. Potentially, airline interventions might focus on enhancing existing safety management system processes/technology to address risks associated with WRS and wellbeing, training pilots (i.e. in relation to wellbeing awareness, coping strategies and self-assessment), and introducing new wellbeing briefing/reporting systems. In addition, future research might address the introduction of digital tools to support pilot management of specific sources of WRS both inside and outside work. The results of this study should be interpreted with potential limitations in mind. Next steps will involve detailed analysis of survey data. A further analysis is planned following a second wave of data collection (February to October 2019). Particpatory co-design activities will also be undertaken with different stakeholders to address wellbeing interventions at different levels.

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TRAFFIC FLOW MANAGEMENT FOR TRAJECTORY BASED OPERATIONS: SUPPORTING EFFECTIVE PREDEPARTURE REROUTES

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There are a number of tools and procedures identified as applicable to initial Trajectory Based Operations (iTBO). This includes Strategic Planning and Traffic Flow Management such as the use of Ground Delay Programs, Airspace Flow Programs and Collaborative Trajectory Operations Program initiatives (CTOPs). It also includes a focus on route management (including the Pre-Departure ReRoute (PDRR) and AirBorne ReRoute (ABRR) tools and airport surface management (as part of the Tower Flight Data Management program or TFDM). This paper focuses on enhancements to support the effective use of the Pre-Departure ReRoute tool (PDRR). These enhancements emphasize the importance of integration between the Traffic Flow Management System (TFMS) and TFDM.

PDRR provides access to displays which allow the traffic manager to view the flight lists (demand) associated with the different departure fixes for an airport. While this information on departure fix demand is very important, the decision about which flights to reroute and about which flights to reroute first requires real-time information about which flights have already pushed back and about the current lineup in the departure queue.

Multi-route Trajectory Options Sets (TOSs) provide a mechanism for the flight operator to communicate constraints on the reroutes that a particular flight is prepared to accept. By submitting a TOS for each flight, the flight operator is able to provide the FAA (through TFMS) with a prioritized set of alternative routes that a flight is prepared to accept. The dispatcher has reviewed this set prior to submission and the flight crew has a list on the flight release.

Thus, this TOS can provide the FAA traffic manager with information about what tactical reroutes (within 45 minutes of departure) a flight is prepared to accept without the need to further coordinate with dispatch or to return to the gate for additional fuel.

The availability of multi-route TOSs for FAA traffic managers offers the potential to reduce coordination and communication demands for the Air Traffic Control Tower (ATCT) controller, the flight crew, the dispatcher and the traffic manager. An additional benefit is that flights are less likely to have to return to their gates for additional fueling (or cancelation).

This paper describes an operational concept based on these considerations which has been recommended to the FAA by the Collaborative Decision Making Program Flow Evaluation Team (FET) and The Collaborative Decision Making Program Steering Group (CSG).

Operational Concept

This concept focuses on the integration of PDRR and TFDM (FAA, 2018) so that traffic managers can easily see the actual line-up of traffic on the airport surface in order to prioritize the order for making reroutes. It allow traffic managers to simply select a flight shown on the airport surface display in order to access information on the alternative routes in theTOS associated with that flight.

The scenario below assumes that multi-route TOSs are being submitted by the flight operators for pre-departure reroutes that can be made by a traffic manager at the Cleveland ARTCC (ZOB) using PDRR. (In the future, these reroutes might be made locally by the ATCT/TRACON at the affected airport Detroit (DTW) instead.

The goal of this scenario is to illustrate the functionality and procedures necessary to support effective use of PDRR to manage departures. The focus is an airport (DTW) using RNAV SIDS with departure fixes dedicated to that airport (see Figure 1).

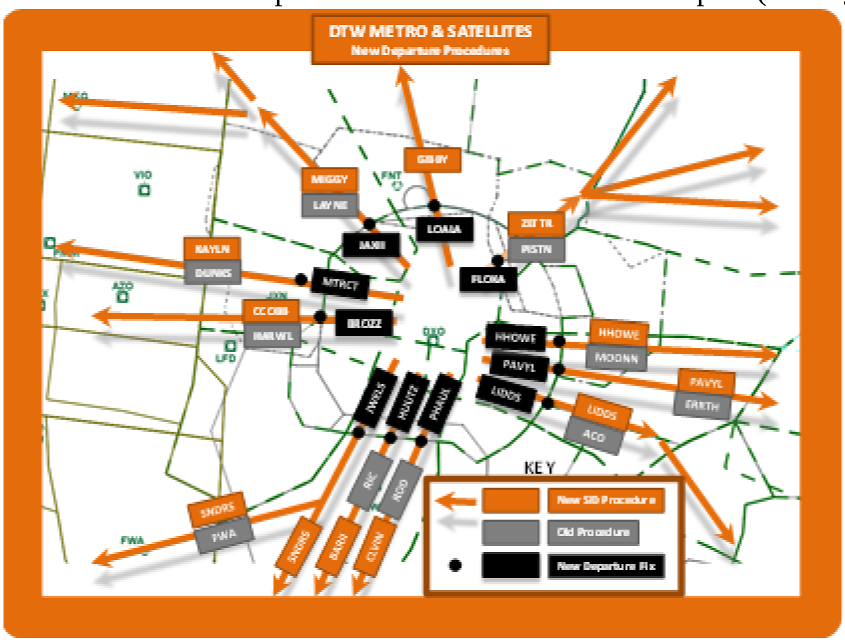

Figure 1. RNAV SIDS for departures out of DTW.

This scenario deals with a weather event in which a frontal system extends from just south of the Southgate departure fixes for DTW (see Figure 1) down into the Indianapolis ARTCC (ZID) airspace. This weather is moving from west to east and progressively impacts the Southgate departure fixes. Later it impacts departures to the southeast via LIDDS. During this period, storm cells to the south also are affecting ZID traffic, resulting in Miles-in-Trail (MIT) restrictions on the DTW departure fixes feeding ZID (JWELS, HUUTZ and PHAUL).

1800Z. Based on a forecast that this frontal system will impact Southgate departure fixes and the southern-most Eastgate departure fix sometime between 2000Z and 0030Z, ATCSCC sends out an FYI SWAP advisory for this time range indicating:

SOUTHGATE DEPARTURES OUT OF DTW (JWELS, HUUTZ and PHAUL) AND EASTGATE DEPARTURES VIA LIDDS AND CAN EXPECT CDRS/SWAP DUE TO WEATHER. USERS SHOULD FILE NORMAL ROUTES BUT CONSIDER SUBMITTING A TOS INCLUDING ALTERNATIVE EASTGATE, SOUTHGATE AND WESTGATE DEPARTURE FIXES (JWELS, HUUTZ, PHAUL, PAVYL, LIDDS and BROZZ) AND FUEL ACCORDINGLY IN ORDER TO EXPEDITE DEPARTURES.

1801Z. As recommended, many, but not all, flight operators begin to submit TOSs to the FAA for use in PDRR for flights included in this FYI advisory. These TOSs contain alternative routes using JWELS, HUUTZ, PHAUL, LIDDS, PAVYL and BROZZ as departure fixes. These flights are fueled for these alternatives that have been reviewed by the responsible dispatchers.

These alternative routes (and associated fuel requirements) are listed on the flight release for the pilots. The TOS that is submitted contains both the CDR (Coded Departure Route) eight letter code (if the alternative route is a CDR), as well as the full route string for that flight, and the prioritization for these routes is indicated by submitting the Relative Trajectory Cost (RTC) of each alternative route in the TOS for a given flight. For those flights for which no TOS has been submitted, the filed route is used for modelling purposes, but that route will not show up as a route in the TOS and will not appear in the list of TOS options in PDRR. In general, flight plans are submitted 60-120 minutes before the scheduled departure time of a flight.

Note also that, if a CTOP is in effect for a given flight, then the dispatcher is expected to file the route assigned by CTOP (and that route is used to assign ground delay if any). If the dispatcher determines that some other route needs to be filed, the flight is assigned a new delay based on the Flow Constrained Area (FCA), if any, that that route flies through. (Since this scenario assumes only PDRR is using the TOSs and that no CTOP initiative is in effect, the remaining discussion does not cover any additional considerations that could arise in the use of TOSs for CTOP alone or in conjunction with PDRR.)

2100Z. The frontal system moving west to east located just south of the DTW Southgate departure fixes is still west of the departure routes fed by those fixes (JWELS, HUUTZ and PHAUL). However, it is already impacting flights departing JWELS that are filed through SNDRS, resulting in a 15 MIT restriction for flights using SNDRS from 2100-2200Z.

2130Z. Cells associated with the front are beginning to significantly affect airspace in ZID making it necessary for flights to deviate from their routes. This results in a 10 MIT as one restriction initiated by ZOB for flights departing the Southgate departure fixes (JWELS, HUUTZ and PHAUL) from 2130-2230Z. This overrides the SNDRS restriction so it is canceled effective 2130. These fix restrictions are made available electronically to the flight operators in real time via some mechanism (This is a future enhancement that could be added to the National Operations Display or NOD.) PDRR is used by a traffic manager at ZOB to tactically reroute some flights within 45 minutes of departure that have been filed to depart via JWELS, HUUTZ or PHAUL so that they can depart using the a route in their TOS that includes the Eastgate departure fixes LIDDS and PAVYL and the Westgate departure fix BROZZ. To do this:

- The traffic manager looks at a surface management display to see how many flights are filed to depart using the restricted fixes (see Figure 2). This display indicates where these flights occur in the departure timeline and how many flights are included. It also indicates where they are on the surface (still at the gate, in the ramp area or in the active movement area). The traffic manager also looks at the display of departure fix loadings in the PDRR and looks at the timeline in order to help decide which departure fixes to consider for each reroute. The view of departures (organized by departure fix) also provides information on which of these flights have associated TOSs. Based on this awareness of activity on the airport surface and the upcoming demand for the departure fixes, the traffic manager decides which flights (if any) to reroute to LIDDS, PAVYL or BROZZ in order to ensure they are ready to depart when the aircraft reaches the runway threshold. Note that, without access to this surface information, the traffic manager would have had to talk with the Tower in order to determine which flights to reroute first.
- Based on the surface map indicating where flights filed to depart via the now restricted fixes (JWELS, HUUTZ and PHAUL) are located on the airport surface, the traffic manager proceeds to make reroutes as deemed necessary. (Note that just because a flight is filed to depart JWELS, HUUTZ or PHAUL does not necessarily mean it needs to be rerouted.)
- To reroute a flight with a TOS that is filed to depart JWELS, HUUTZ or PHAUL as indicated in PDRR, the traffic manager clicks on that flight on the surface map and opens a display in PDRR to look at its TOS (with the routes ordered in terms of their associated RTCs).

The traffic manager views the TOS route options for that flight that show both the CDR code (if applicable) and the full route string, and as appropriate selects the route using LIDDS, PAVYL or BROZZ as the departure fix. This is submitted to the En Route Automation Modernization system (ERAM) as a route amendment.

- PDRR also is used to reroute flights that do not have a multi-route TOS, but without the benefit of pre-coordination with the responsible dispatchers and flight crews.
- For many, but not all, flight operators, when this route amendment is submitted, the dispatcher receives an alert indicating that this flight will be cleared to depart on this new route. This alert indicates both the CDR code (if applicable) and the full route string. This alert also indicates whether the amended route was contained in the TOS and was therefore included on the release for that flight. In response to this alert, the dispatcher informs the flight crew that they should expect to be cleared by the ATCT controller for departure on this pre-coordinated route. To make it easy for the crew to identify which of the alternative routes on their flight release to expect, the dispatcher indicates the CDR code (if applicable) in this communication.
- The crew checks the fuel and weather conditions to make sure they can still accept this route. Assuming they can, they prepare for departure on this reroute.
- The ATCT controller receives a flight strip with the CDR code (if applicable) and full route string indicated.
- The ATCT controller clears the flight by voice to depart on the new route to depart via LIDDS, PAVYL or BROZZ (depending upon which flight amendment was made). At DTW, at present this likely will be done with a full route clearance. (At EWR, in contrast, 70-80% of the time this will be done using the CDR code for an abbreviated clearance. DTW could consider doing this in the future as well to increase efficiency and reduce workload.) Alternatively, Data Comm is used to electronically deliver the new route to the flight deck. In this case, the message includes both the CDR code (if applicable) and the full route string. The CDR code (if applicable) makes it easier for the pilots to quickly ensure that the cleared route is in fact on their flight release. (If not, they would need to clear it with dispatch.)
- The pilots accept the clearance and depart on schedule via LIDDS, PAVYL or BROZZ (depending upon which flight amendment was made).

This process eliminates the departure delay for those flights that have submitted TOSs that include routes using LIDDS, PAVYL and/or BROZZ. Some of the flights that do not have a multi-route TOS may have to pull over until they can coordinate with dispatch and ATC in order to find an acceptable reroute, or may even have to return to a gate to get additional fuel.

2200Z. The frontal system has moved east quickly enough to directly impact the Southgate departure fixes, resulting in significant airborne deviations for departing flights and responses from pilots prior to departure that they are unable to depart using these fixes due to the weather. Departures via those three fixes are therefore halted. These fix closures are communicated electronically to the flight operators in real time via the NOD or some future equivalent.

As with the previous step at 2130Z, the traffic manager identifies those flights filed to depart via the three Southgate departure fixes and when possible uses their TOSs as displayed in PDRR to make reroutes as appropriate.

Note however that, like today, even if a flight doesn't have a route option for a LIDDS, PAVYL and/or BROZZ departure in its TOS it could still be offered a reroute. However, without the pre-coordination provided by the TOS, there may be a much greater delay to accomplish the needed coordination involving the flight crew, dispatch and ATC. In some cases, the result for such flights is that they have to go back to the gate for refueling or cancellation.

2200-2300Z. As the weather progressively moves past the three Southgate departure fixes, flights are allowed to depart via each fix as it opens up.

2300Z. The restriction (closure) on the Southgate departure fixes is allowed to expire. Departures via LIDDS are now starting to deviate so a 20 MIT restriction is put into effect from 2300-0000Z. Similar to the management of reroutes at 2130Z, some of the flights filed to depart LIDDS are rerouted to depart via PHAUL using their TOSs in the RAD. This restriction is communicated electronically to the flight operators in real time via the NOD.

2330Z. Departures via LIDDS are halted due to significant airborne deviations for departing flights and responses from pilots prior to departure that they are unable to depart using these fixes due to the weather. Similar to the management of reroutes at 2130Z, some of the flights filed to depart LIDDS are rerouted to depart via PHAUL using their TOSs in PDRR when available. This restriction is communicated electronically to the flight operators in real time via the NOD.

0000Z. The front passes east beyond LIDDS and the restriction on LIDDS departures is allowed to expire.

Notional Display Illustrating the Integration of PDRR with Surface Information

To complement this scenario, below we provide a notional example illustrating how access to surface data could significantly improve performance (reducing communications and coordination between the ATCT and the Center traffic manager who is using PDRR, and streamlining the inputs required of the Center traffic manager using PDRR in order to make a route amendment). This display (shown in Figure 2) makes use of a previously developed prototype surface management simulation (Smith et al., 2012) to provide a concrete illustration using a hypothetical airport (KMJA) that includes associated departure fixes WICKR, WILEY and NOBLR.

The display below shows that two closed fixes to the west, WICKR and WILEY have been highlighted in the Selection Tool (left window). This results in the highlighting of those flights in the flight list (center window) filed to depart via one of the two closed fixes (WICKR and WILEY). Those flights also are highlighted on the surface map. In this display, the traffic manager has noted that the first flight in the departure queue that is filed to depart via one of the two closed fixes is DAL8889. The traffic manager has double clicked on that flight on the surface map and its data has appeared in a PDRR display. The traffic manager can now select the third option (a route using NOBLR, an open departure fix to the north) in order to select that TOS option as the reroute.

Conclusion

The scenario illustrates how, using an airport surface display that is linked to PDRR, a traffic manager can:

- Use a selection tool to highlight flights that were filed to depart using a departure fix that has been constrained by weather . They are highlighted in both the flight list and on the airport surface display (see Figure 2).

- View the impacted flights have been highlighted in the flight list and on the airport surface display.
- Use the visual display of the locations of these impacted flights on the airport surface in order to determine which are in the active movement area, which have pushed back and but are still in the ramp area, and which are still at their gates.
- Use this information to identify the aircraft that is closest to the departure runway.
- Clicking on that aircraft on the surface map (or in the flight list) to view the available pre-coordinated route options in the TOS in a PDRR display (see Figure 2).
- If judged appropriate, using PDRR to select one of these options as the reroute for that flight. (If a flight doesn't have a TOS, or if the route judged most effective by the traffic manager is not in the TOS, the traffic manager can still open up the PDRR display by clicking on the flight on the airport surface map and then making some other route amendment.)
- This process, supported by appropriate enhancements to PDRR and TFDM, offers an approach to significantly reduce the level of effort and coordination time involving the ATCT controller, Center or TRACON traffic manager, pilot and dispatcher when making a tactical pre-departure reroute. It further provides a mechanism to communicate and consider flight operator priorities and constraints when such a reroute is made.

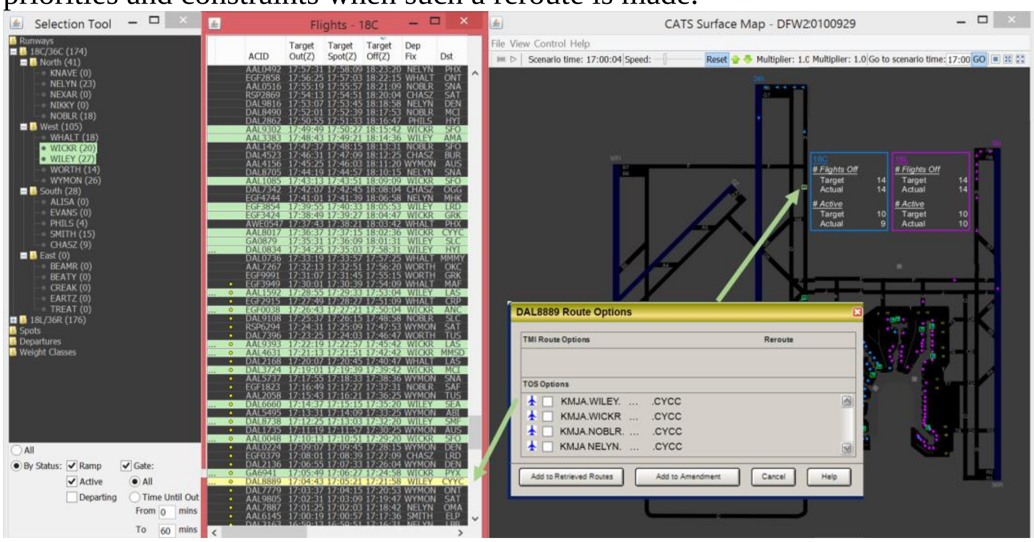

Figure 2. Notional display illustrating the linkage of PDRR with surface management displays.

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