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Planning for Organization Development in Operations Control Centers

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16. Abstract

The first step in a proposed program of organization development (OD) was to assess organizational processes within the Technical Operations Services (TechOps) Operations Control Centers (OCCs). The aim of the OD program was to improve effectiveness of OCC operations and increase satisfaction of OCC personnel. The assessment was based on an understanding of current and future OCC concepts of operations, a review of organizational practices within the OCCs, and the research literature on developing organizations. TechOps is the agency within the Federal Aviation Administration (FAA) Air Traffic Organization that manages and maintains the National Airspace System facilities, systems, and equipment. The OCCs are part of the maintenance management infrastructure at the regional level with an OCC located within the Eastern, Central, and Western Service Areas. The OCCs were established in 2001 as part of an effort to centralize remote monitoring and coordination of maintenance operations for the FAA. To understand current organizational processes, we interviewed 54 specialists and 12 team leads working at an OCC in one of the Service Areas. We asked the participants questions about their technical background; their jobs within the OCCs to include the interdependencies required for task performance; structure, complexity, and workload inherent in the job; cohesion and trust among specialists and team leads; and outcomes, including perceived operational effectiveness and job satisfaction. Results of these discussions are summarized in the report by topical area. Issues raised by the participants as having a negative effect on their perceptions of effectiveness of the OCCs and their individual satisfaction with the job were classified into three groups. The first grouping was workload. Shift work, staffing, and breaks influenced workload. Participants saw workload at all three OCCs as high, especially during the day shift. The second group, resources, included issues related to training and technology. Some participants indicated that neither the training nor the technologies used in the OCCs were sufficient to meet job requirements. The final group was knowledge of results and included issues related to performance feedback and management involvement. Participants saw a lack of performance standards and little specific feedback on individual or team performance as having a negative impact on organizational performance and individual satisfaction. We proposed interventions to address each of these groups of issues. The interventions were 1) the use of small teams to organize specialists and team leads at each of the OCCs, 2) revision or inclusion of initial, new equipment, and team leader training, 3) implementation of a comprehensive performance feedback system based on individual and team performance, and 4) development of a fatigue risk management approach that included education on fatigue and elimination of midnight shifts through the use of workload sharing among OCCs. Finally, we also recommended assessing the implementation of interventions in an on-going process of organization development and improvement to meet current and future requirements.

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CONTENTS

ACRONYMS

ATO ---------- Air Traffic Organization
AOCC---------- Atlantic Operations Control Center
ATSAP ---------- Air Traffic Safety Action Program
CAMI ---------- Civil Aerospace Medical Institute
CBI ---------- Computer-Based Instruction
CC ---------- Coordination Center
FAA---------- Federal Aviation Administration
FRMS ---------- Fatigue Risk Management System
GAO---------- Government Accountability Office
GNAS ---------- General National Airspace System
ICC ---------- Integrated Control Center
MOCC---------- Mid-States Operations Control Center
NAS ---------- National Airspace System
NASTEP-------- National Airspace Technical Evaluation Program
NOCC ---------- National Operations Control Center
OCC---------- Operations Control Center
OD ---------- Organization Development
PASS---------- Professional Aviation Safety Specialists
POCC---------- Pacific Operations Control Center
RMC ---------- Remote Monitoring and Control
RMLS ---------- Remote Monitoring and Logging System
SD ---------- Standard Deviation
SDS---------- System Development Specialist
SOC ---------- System Operations Center
SOP---------- Standard Operating Procedure
SSC ---------- System Service Center
TechOps--------- Technical Operations
TLX---------- Task Load Index
TOFRM -------- Technical Operations Fatigue Risk Management
TSAP ---------- TechOps Safety Action Program
VOR---------- Very High Frequency Omnidirectional Range Radar

Planning for Organization Development in Operations Control Centers

In the current research effort, we examined an agency responsible for the remote monitoring and coordination of maintenance within the Federal Aviation Administration (FAA). Our goal is to understand how the organization is currently functioning and, if appropriate, to recommend interventions to improve operational effectiveness and employee satisfaction.

Technical Operations (TechOps) within the FAA Air Traffic Organization (ATO) is the agency that maintains and manages the National Airspace System (NAS) infrastructure. More than 6,000 TechOps personnel maintain, repair, and certify nearly 60,000 pieces of equipment. At a high level, there are two major personnel divisions in TechOps: those who maintain the systems and those who manage and coordinate maintenance activities. Those who physically maintain aviation systems are distributed across the United States in System Service Centers (SSCs). The management and coordination of maintenance is accomplished in a more centralized fashion within Coordination Centers (CCs) at the national, regional, and facility or system level. At the national level, there is one CC, the National Operations Control Center (NOCC). The regional CCs are called Operations Control Centers (OCCs). There are three OCCs with one each in the eastern, central, and western service areas. There are approximately 29 CCs at the facility or system level, currently called the Systems Operations Centers (SOCs).

In a recently released revision to the 2005 Concept of Operation (ATO – Technical Operations Services, Concept of Operations, 2005), the functions of the CCs were slightly revised and expanded, and the SOCs are migrating to Integrated Control Centers (ICCs) (ATO – Technical Operations Services, Maintenance Concept of Operations for 2014 and Beyond, 2011). The functions of the CCs are listed in Table 1.

The ATO – Technical Operations Services, Maintenance Concept of Operations for 2014 and Beyond (2011) also provides a list of primary functions performed at each level of centralized management. In general, the NOCC operates at the headquarters level, the OCCs at the service level, and the ICCs at the facility or system level. A fourth level has also been added, the Enterprise Control Center, which will work at the national level to coordinate specific functional areas such as network operations, satellite operations, and cyber operations. While all levels are inter-related and important in the management of technical operations services, the primary focus of our current research effort is at the regional level CC, or the OCCs.

Although the OCCs have been in place for more than a decade, they have not evolved as anticipated (ATO Technical Operations Services Field Evaluation Staff, 2004; King, 2009). The 2004 assessment of the OCCs identified some successes achieved by the OCCs and some areas needing improvement (ATO Technical Operations Services Field Evaluation Staff, 2004). The successes included improved customer service, cost reductions due to centralization of services, and potentially more accurate reporting of maintenance. Other areas were identified as needing improvement. These have included a lack of standardization across OCCs that confuses customers and prevents load sharing among OCCs, a lack of understanding and acceptance of roles and responsibilities between the OCCs and other CCs, and inconsistent advocacy by management, resulting in a lack of cooperation and poor

Table 1
Control Center Functions

2005 Concept of Operations	2014 and Beyond Concept of Operations
Managing and reporting the status of the NAS	Managing and reporting the status of the NAS
Upward reporting	Operational reporting
Communicating information	Communicating information
Performing periodic service certifications (SOC)	Oversight and management of leased or provisional services
	Performing periodic service certifications
	Performing predictive analysis and intervention

coordination between the OCCs and other CCs. There was also a lack of specialized training needed to work in the OCCs and inaccurate databases to support OCC operations. The 2004 review also found a lack of trust, poor communications, and low morale among OCC personnel. The ATO completed a follow-on review in 2009, but the results of that review have not been made public (ATO Technical Operations Services, Operations Control Center 2009 Evaluation, 2009).

Also in 2009, King conducted a brief assessment of the current conditions in the OCCs. He identified a number of human factors issues of concern. One problem he identified was in the role of the OCC specialist. Specialists wanted to do more than coordinate maintenance, a role they perceived to require less technical skill than remote monitoring and maintenance. Although their role in remote monitoring and maintenance had increased, their primary task was still to coordinate maintenance. King concluded that the OCCs today are primarily operating as coordination call centers rather than as centers of technical expertise. High workload, limitations in technology, and inefficient processes were seen as the primary drivers of current problems. Also addressed in King's assessment was the need to plan and evolve the OCCs to meet future challenges, especially as new systems are developed and fielded as part of aviation modernization.

The purpose of the current research effort is to build on the brief assessment done by King (2009), using a more in-depth and systematic process in organization development (OD) to reexamine and assess organizational processes within the OCCs. Based on this assessment, a second purpose is to propose interventions that could be employed to both improve operational effectiveness and employee satisfaction. The focus of OD is on how work is done and what the people who carry out the work "believe and feel" about the efficiency and effectiveness of their work and current organizational processes and procedures. As a process, OD has the potential to improve an organization's effectiveness through planned interventions based on knowledge in behavioral and organizational science (Beckhard, 1969, p.9).

Action Research

Action research is one method or model used in OD. Action research, as first proposed by Kurt Lewin (1958) is a cyclical change process that brings scientists and practitioners together in a collaborative effort to gather data about real-word problems and to develop workable, practical solutions to those problems.

French and Bell (1999) define action research in the following way: Action research is the process of systematically collecting research data about an on-going system relative to some objective, goal, or need of that system; feeding these data back into the system; taking actions by altering selected variables within the system based both on the data and on hypotheses; and evaluating the results of actions by collecting more data. (p. 130)

Action research can be conceptualized as having three stages (French & Bell, 1973, 1978). The first is the planning stage. Planning involves gathering data, developing a preliminary diagnosis, providing feedback of results, and joint action planning. In this stage, workers are consulted about their current work situation, data are analyzed, and the organization is provided with feedback from the assessment and data-gathering phase. This allows both workers and managers to become aware of problems within the organization that are in need of change. Once aware of the problems, action planning can begin to develop interventions that will resolve the issues highlighted during the data-gathering phase. An action stage, with actual implementation of the interventions or changes, follows the planning stage. The third stage is called the results stage. In this stage, the interventions implemented are assessed and change is measured. Feedback loops exist from action to planning, results to action, and results to planning. The process of action research is shown graphically in Figure 1.

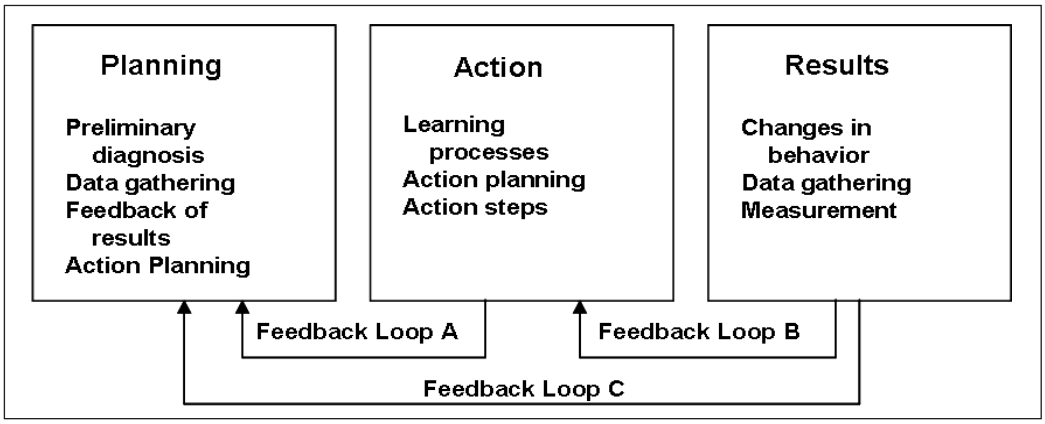

Figure 1. Action Research Model

OD is often a gradual process that involves multiple refinements based on the results of each stage. Although, to be more responsive to rapid change requirements, action research is evolving to focus more on the processes of change, rather than as a static linear model (Rothwell & Sullivan, 2010, pp. 52-67). The current report presents the data gathered from the first steps in the planning stage. Data were gathered from the regional OCCs. These data will help to provide the foundation and information needed for any action planning done to develop interventions to improve the work situation at these facilities. Furthermore, this report not only provides the data from this assessment phase but also provides multiple recommendations based on the integration of these data with a large body of OD and change research. This was done to develop scientifically sound recommendations, bounded by the context of the OCCs.

The focus of OD can be on the organization, the individual, or the group. The current research effort is focused primarily at the level of the individual and the group. However, the ultimate aim of OD is to affect the behavior of the individual, which in turn should have an impact on the way the group and organization operate (Porras & Robertson, 1992). In the current research, an OD approach was used to examine structures, processes, reward systems, and people practices (Galbraith, 2002; Kates & Galbraith, 2007) within the OCCs. Our research goals are to understand how members of the OCC perceive the effectiveness of the OCC and rate their satisfaction with their job in the OCC; to learn what they believe is going well or not so well from the perspective of the individual and the team; and to identify what could be done to improve operations. This aspect of the research is exploratory and constitutes the initial steps in the planning phase of action research.

OCC Description

The three OCCs are the Atlantic OCC (AOCC), the Mid-States OCC (MOCC), and the Pacific OCC (POCC). Organizationally, each OCC reports to their respective Service Area. The AOCC is located in Atlanta, Georgia, and is responsible for managing and coordinating maintenance activities in the Eastern Service Area. The MOCC is located in Olathe, Kansas, and manages and coordinates maintenance activities in the Central Service Area. The POCC is located in San Diego, California, and manages and coordinates maintenance activities in the Western Service Area. Figure 2 (retrieved from http://technet.faa.gov/) illustrates the geographical space assigned to each of the three OCCs. Also shown on the map is the location of the National OCC (NOCC) in Warrenton, Virginia. The NOCC receives information from all OCCs and is responsible for upward reporting.

The organizational structure of the individual OCCs includes four supervisors: one OCC manager and three operations managers. The OCC manager directly supervises the three operations managers, and the operations managers each supervise approximately one-third of the workforce. The workforce at each OCC is comprised of approximately 10 system development specialists (SDSs), seven team leads, and 36 specialists. The SDSs are considered staff positions and are assigned coordination responsibilities with districts or elements outside the OCC or are assigned system or other staff-level responsibilities (e.g., automation, weather, train-

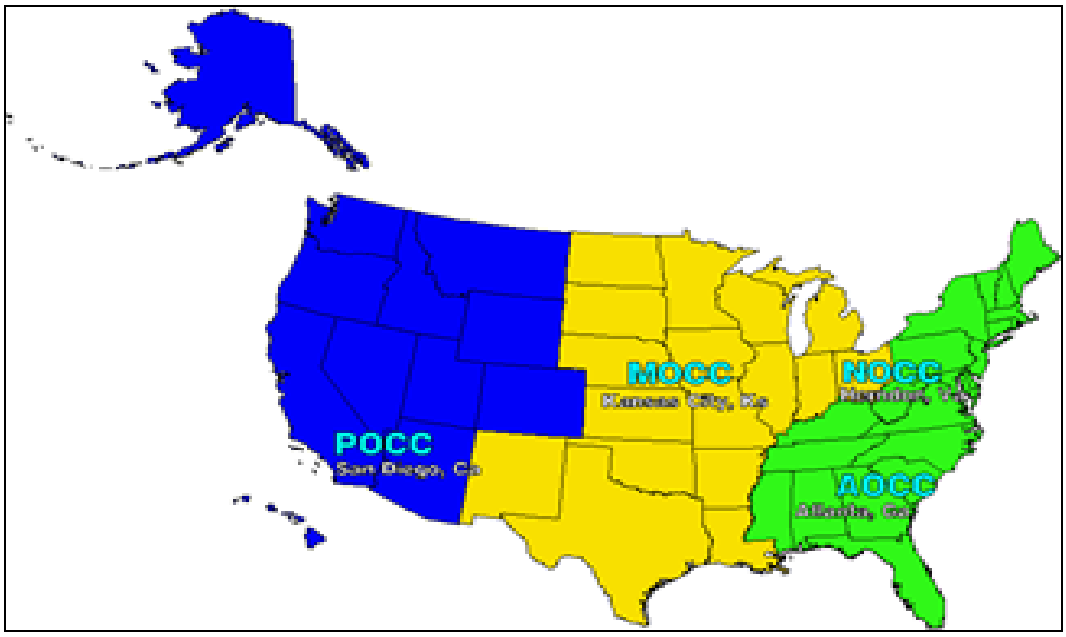

Figure 2. Location and Geographical Region of Responsibility

ing, quality assurance) within their particular service area. The SDSs' interactions with the team leads and specialists vary among the OCCs but are fairly minimal in general. In some cases, they will provide training on new systems to the team leads and specialists or act as an intermediary between a specialist and a field technician, especially if there is a problem. However, on a daily basis, there is little interaction between the SDSs and the specialists. And, for the purposes of the data presented in this report, SDSs were not examined or included in the assessment. The SDSs, team leads, and the specialists are non-supervisory positions and are represented by the Professional Aviation Safety Specialists (PASS) union.

The OCCs are operational 24 hours a day, seven days a week. The OCC manager, the operations managers, and the SDSs generally work an administrative-type, day schedule (0700-1600). The team leads and specialists work a 10-hour day on a rotating shift schedule. Shifts worked are days, evenings (eves), and midnights (mids). Start and end times for each shift vary somewhat, but in general days are 0600-1600, eves are 1400-2400, and mids are 2200-0800. All team leads and specialists rotate through each of the shifts and the OCC PASS members establish rotational schedules on an annual basis.

The OCC manager, the operations managers, and the SDSs have offices. The specialists work in a common area called "the floor." The floor is an open space with team leads and specialists working at individual workstations. The team lead's workstations are arranged together, in a fairly central location. The specialist's workstations are arranged across the floor. There are approximately 30 workstations at each OCC. All workstations have two to three computer screens to support operations. Specialists occupy workstations based on availability and preference. Weather maps, news channels, and in some cases, call and workload information are displayed on the walls in the floor area using an electronic system called Symposium. Most of the offices are outside the floor area. At the MOCC and AOCC, a secure door divides the office space from the floor space.

METHOD

Participants

Fifty-four specialists and 12 team leads volunteered to participate in the research. At the time of data collection and based on personnel lists provided by the OCC managers, there were 38 specialists at the MOCC, 33 specialists at the POCC, and 39 specialists at the AOCC, for a total of 110 specialists. There were seven team leads at each OCC, for a total of 21 team leads. Thus, the sample of specialists and team leads participating in this project represented 49% of all specialists and 57% of all team leads at the OCCs. The participant breakdown by OCC is provided in Table 2, with the overall number of specialists and team leads by OCC provided in parentheses. The OCCs are listed in the order in which they were visited and data collected.

As seen in Table 3, participants had been employed by the FAA for an average of 17.42 years (SD=6.26) and at the OCC for an average of 5.21 years (SD=3.60). There was no significant difference among OCCs in how long the participants had been with the FAA ($F(2,63) = 1.85$, $p = .165$) or at the OCC ($F(2,63) = .924$, $p = .402$).

As seen in Table 4, there was no difference between how long the specialists had been with the FAA, compared to the team leads ($F(1,64) = .204$, $p = .653$), but the team leads had been at the OCC significantly longer than the specialists had ($F(1,64) = 8.71$, $p = .004$). This was as expected, given that team leads were generally selected from among the specialists who had demonstrated some capability in the OCC.

Measure

We used a semi-structured interview protocol to guide the discussion with the specialist or team lead (see Appendix A for a list of questions). The interview protocol was derived from the literature on assessing organizational practices and included items to examine structures, processes, reward systems, and people practices within the

Table 2
Research Participants

	Date	Participating Specialists/ All Specialists	%	Participating Team Leads/ All Team Leads	%	Total	%
MOCC	December 16-22, 2010	17 (38)	45%	4 (7)	57%	21 (45)	47%
POCC	January 24-30, 2011	18 (33)	55%	4 (7)	57%	22 (40)	55%
AOCC	March 14-20, 2011	19 (39)	49%	4 (7)	57%	23 (46)	50%
Total		54 (110)	49%	12 (21)	57%	66 (131)	50%

Table 3
Years With the FAA, Years at the OCC

		N	Mean	Standard Deviation	Minimum	Maximum
Years With the FAA	MOCC	21	19.29	5.86	3	28
	POCC	22	17.45	7.15	5	27
	AOCC	23	15.70	5.41	8	23
	Total	66	17.42	6.26	3	28
Years at the OCC	MOCC	21	5.95	3.81	1	15
	POCC	22	5.27	3.52	1	10
	AOCC	23	4.48	3.48	1	10
	Total	66	5.21	3.60	1	15

Table 4
Years With the FAA, Years at the OCC for Specialists and Team Leads

		N	Mean	Standard Deviation	Minimum	Maximum
Years With the FAA	Specialist	54	17.26	6.33	3	28
	Team Lead	12	18.17	6.15	9	27
	Total	66	17.42	6.26	3	28
Years at the OCC	Specialist	54	4.63	3.48	1	15
	Team Lead	12	7.83	3.01	2	10
	Total	66	5.21	3.61	1	15

OCCs (Jansen, Hocevar, Rendon, & Thomas, 2008; Kates & Galbraith, 2007). Also included were items to address factors such as perceived interdependence (Pearce & Gergerson, 1991; Rossi, 2008; Rossi & Coovert, 2009), information sharing (Staples & Webster, 2008), cohesion (Craig & Kelly, 1999), and trustworthiness (Adams & Sartori, 2006; Adams & Webb, 2003), as well as perceived team effectiveness and job satisfaction (Defense Equal Opportunity Management Institute, Directorate of Research, 2008). These topics were selected primarily based on their importance in understanding work practices in multi-team systems (Hunter & Pierce, 2009) but were also based on observations and informal discussions with OCC personnel (King, 2009; Pierce, King, & Dzindolet, 2010). Topics addressed in the interviews included the technical background of the participants; workflow and interdependencies required for task performance; structure, complexity, and workload inherent in the job; cohesion and trust among specialists and team leads; and outcomes, including perceived operational effectiveness and job satisfaction. Varied response formats were used to design the questions. Some questions within each topic area were open-ended, while other questions required a yes or no response or were designed to have participants rank their opinions from 1 (very low) to 7 (very high). Table 5 provides an overview of the semi-structured interview protocol. Although an attempt was made to cover all topics contained in the interview protocol, not all questions were asked of all participants. In addition, one question was added to the interview protocol based on comments made by participants.

Procedures

An e-mail describing the research and objectives was provided to specialists and team leads at each of the OCCs (see Appendix B) approximately one month prior to the research visit. Specialists and team leads were told that the focus of the research was to review how work is currently being done within each of the OCCs and to asses how the OCCs might evolve to meet future challenges in aviation maintenance. Specialists and team leads were asked to participate in the research some time during their regularly scheduled shift. Participants met individually with the researcher and were informed that their responses would be confidential and would be reported anonymously or as aggregate data.

Each interview was approximately one hour in length and was led by a single researcher. In some cases, a second researcher observed the interview and asked follow-up questions as appropriate. Discussions were audio taped with the permission of the participant. There was no attempt to control the sequence of people interviewed.

Table 5
Overview of the Semi-Structured Interview Protocol

Topic	Description	Questions Open-ended Format	Questions Scale Format
Background	Brief summary of the work history of the participants.	3 Items	
Technical Background	The role of expertise within the OCCs.	9 Items	
Tasks, Workflow and Interdependency	The need for and the extent to which specialists and team leads work together.	12 Items	
Cohesion	The strength of interpersonal relationships among specialists and team leads.	6 Items	5 Items
Workload and Complexity	The perceived difficulty level of the jobs of OCC specialists and team leads.	5 Items	
Effectiveness and Satisfaction	Current levels of perceived organizational effectiveness and job satisfaction and recommendations for improvement.		3 Items

The researchers were available from approximately 0800 until 1700 each day, and specialists and team leads met with the researchers during their shift as their workload permitted. Most meetings with specialists and team leads were held in a private conference room or office. The only exceptions were two meetings held during the evening shift at the POCC. These meetings were held at the participants' workstations to allow them to take incoming calls, if needed.

Analyses

All interviews were transcribed. The transcriptions were analyzed using both qualitative and quantitative methods. The qualitative analysis was conducted by expert review of the transcripts. Specifically, the first author of this report read each transcript, noting critical issues identified by the participants. Then, notes on each participant were reviewed for consistent and repetitive patterns by OCC and across all OCCs. Based on the themes identified in the transcripts, the first two authors of this report selected comments made by participants for illustration and inclusion in the report. The qualitative analysis achieved three objectives. First, reviewing the transcripts provided a more holistic understanding of what was happening at each of the OCCs. It also provided an understanding of the similarities and differences among and between the three OCCs in terms of structure, processes, reward systems, and people practices as well as in the perceptions of the specialists and team leads. A second objective achieved was the identification and understanding of factors influencing employee perceptions of operational effectiveness and job satisfaction. The third objective achieved through qualitative analysis was the identification of exemplars for use in illustrating key points.

For the quantitative analysis, two raters individually reviewed each transcript to identify responses to yes or no questions and extract ratings for those items in which participants were asked to rank their opinions from 1 (very low), to 7 (very high). When participants did not provide a yes or no response or a ranking, two raters reviewed the transcript and, if possible, assigned a response for the question. A consensus between the raters was reached through review and discussion. If a question was not asked, no answer was assigned.

The results for both the qualitative and quantitative analyses are presented by the topics addressed in the interviews (see Table 5). The analyses and subsequent results are designed to provide an overall picture of how the specialists and team leads interviewed believed the OCCs were operating, how effective they judged the OCCs to be, their level of job satisfaction, and their suggestions for improving the OCCs. Results will be incorporated into recommendations made by the authors that can then be considered for implementation during the second or action phase of OD.

RESULTS

Technical Background

The questions on technical background were designed to assess the expertise of the participants, determine the extent to which specialists and team leads knew the expertise of their coworkers, examine how or if expertise was maintained in the OCC, and identify areas of expertise or skills needed to succeed in the OCC.

As can be seen in Table 6, most of the participants believed that they had technical expertise in one or more technical area and that technical expertise was needed to work in the OCC. The technical areas of expertise identified by the participants are shown in Table 7. Most specialists participating in the research had worked in the field as FAA technicians prior to the OCC. All OCCs had experts in all technical areas. The expertise reported most often was in navigational aids, with the related area of communication being highly represented as well. At the MOCC and AOCC, the next highest area of expertise was in radar systems. However, the POCC had fewer radar experts and more environmental experts than the MOCC or AOCC.

Most participants reported that they thought it was helpful for specialists and team leads to know the expertise of others in the OCC (see Table 8). Most also reported that they were aware of coworkers' areas of expertise and that their coworkers knew their areas of expertise.

However, most also said that they were not able to maintain their expertise in the OCC (see Table 9). Rather, many participants stated while commenting on this question that a new type of expertise was needed and was usually developed through experience in the OCC. That was an ability to see relationships among the systems within the General National Airspace System (GNAS). Other skills mentioned as being important to OCC operations included interpersonal skills, typing skills, an understanding of air traffic control and weather, and capabilities such as multi-tasking and maintaining situation awareness. Interpersonal skills included being able to work with many different groups and having the ability to discuss problems in a way that these groups understood. One participant described it this way, "You're constantly shifting gears talking with air traffic, airway facilities, Lockheed Martin, FTI Telco. You can have the same conversation in four different languages in a matter of five minutes."

Table 6
Technical Expertise

Do you consider yourself an expert?					
	N	Yes	No	Did Not Say	Not Asked
MOCC	21	17	4	0	0
POCC	22	19	3	0	0
AOCC	23	19	3	1	0
Is technical expertise needed to work in the OCC?					
	N	Yes	No	Did Not Say	Not Asked
MOCC	21	18	2	0	1
POCC	22	21	0	0	1
AOCC	23	15	0	0	8

Table 7
Areas of Expertise

In what area or system is your expertise?				
	MOCC	POCC	AOCC	Total
Navigational Aids	10	8	10	28
Communication	9	7	9	26
Automation	2	1	2	5
Radar	5	3	6	14
Environmental	2	7	3	12
Other*	3	3	1	7

*Other included air traffic control, electronics, and automated network installations

Table 8
Extent to Which Technical Expertise Is Known

Is it helpful to know the expertise of others in the OCC?					
	N	Yes	No	Did Not Say	Not Asked
MOCC	21	21	0	0	0
POCC	22	17	0	1	4
AOCC	23	17	0	0	6
Do you know the area of expertise of others in the OCC?					
	N	Yes	No	Did Not Say	Not Asked
MOCC	21	18	3	0	0
POCC	22	19	0	1	2
AOCC	23	20	1	0	2
Do others know your area of expertise?					
	N	Yes	No	Did Not Say	Not Asked
MOCC	21	19	1	1	0
POCC	22	19	0	1	2
AOCC	23	18	2	0	3

Table 9
Maintain Expertise

Are you able to maintain your expertise now that you work in the OCC?					
Expertise Maintained	N	Yes	No	Did Not Say	Not Asked
MOCC	21	1	17	0	3
POCC	22	4	11	1	6
AOCC	23	5	7	0	11

Tasks, Workflow, and Interdependency

These questions were designed to elicit information on the primary tasks of the team leads and the specialists and to understand how the work flowed through the OCC, with a focus on the level of interdependency required or exercised in completing each task. Also addressed was the extent to which specialists and team leads believed their work to be more individual or team-based or both individual and team-based.

Tasks performed by team leads. In general, most team leads reported that their role was to oversee operations; monitor events in the service areas; evaluate events for impact and assess the need to notify others of events; and support, mentor, coach, or correct specialists as needed. Team leads also reviewed and closed unscheduled maintenance tickets to ensure accurate coding. Team leads were trained and responsible for investigating aircraft accidents as the technical operations aircraft accident representative. On day shifts, and on average, there were three or four team leads on duty. That number usually decreased to one or two on eves and one on mids. Team leads were not supervisors. At the MOCC and AOCC, team leads were not assigned teams. They worked with the specialists on duty during their assigned shift. At the POCC, team leads were assigned teams of five to seven specialists. The team leads at the POCC worked directly and rotated with their assigned teams. During busy periods of the day, multiple team leads and/or teams could be on duty at the same time.

Although the tasks were the same, there was variability in how the team leads operated. Some preferred for specialists to bring all questions to them, while some preferred specialists to solve most of their own problems or work with one another and come to them only if necessary. Some team leads were more likely to walk around and talk to specialists than other team leads who preferred to stay at their workstation and observe operations, interacting with specialists only as needed. Some team leads mentioned that, except for aircraft accident investigation training, they received no specialized training. For some team leads, correcting specialists was a problem because specialists might or might not respond appropriately to criticism. As non-supervisors, team leads did not have disciplinary authority. Some team leads suggested that team-building skills would be helpful.

Tasks performed by specialists. Participants identified two primary tasks routinely performed by specialists. The first involved documenting and coordinating maintenance requests submitted by field technicians. Maintenance requests were submitted digitally or through a phone call to the OCC. Phone calls coming into the OCC were answered in a rotational fashion by specialists assigned to answer the phones. In response to all requests for maintenance, the OCC specialist created a new or modified an existing ticket in the Remote Monitoring and Logging System (RMLS). The RMLS was the primary system used by the specialists and team leads to schedule and coordinate maintenance activities.

The ticket was maintained in the RMLS until the maintenance action was completed or closed. Tickets were generally accessed multiple times during the maintenance process. At a minimum, there was initial coordination to preplan the maintenance event, final coordination just prior to the maintenance event, and closure when the action was completed. There was no attempt to route calls to a particular specialist, nor did specialists respond to calls based on their areas of expertise. When the OCCs were first established, attempts were made to route calls to functional experts, but the process was discontinued because of workload and staffing issues that caused some specialists to be overloaded, while others were under-utilized. It was also decided that a high level of system-level expertise was not needed at the OCC. As mentioned previously, most specialists believed that system-level expertise was not maintained in the OCC (see Table 9), nor was it needed. A broader "system of systems" level understanding was required.

Thus, the specialist who answered the phone call was responsible for addressing the issue presented by the caller. The specialist created a ticket for initial calls or retrieved and made appropriate entries on a ticket for calls relating to previously created tickets. Therefore, the first area of interdependency identified within the OCC was the sequential nature of coordinating maintenance. The actions of one specialist affected the work of the next specialist in the chain of events. If the information in the ticket was inadequate or inaccurate, the next specialist to work the ticket was expected to correct it. Each time specialists performed an action related to a ticket, their initials and the initials of the caller or the person called were recorded on the ticket.

A second point of interdependency was related to the number of phone calls taken by the specialists. In general, the day shift was the busiest shift in the OCC and had the most specialists on duty, followed by eves and mids. The vast majority of phone calls from field technicians were received during the day shift, with usual peaks between 0600-0800, 1100-1300, and 1600-1800. In response to each phone call, specialists performed a variable number of actions that may take very little or a great deal of time to complete, depending on the nature of the call. For example, specialists often coordinated with outside entities affected by an outage. If the maintenance action was preplanned, coordination might have already been done using batch processing during a less busy time of the day. However, in some situations, immediate actions were required by the specialist. If so, that specialist's status was logged as "not ready," and he or she was no longer in-the-rotation for additional calls, and the other specialists would take all incoming calls. If one or more specialists were in a not-ready status for an extended period of time, especially during times when call volume was high, the workload of the remaining specialists was increased and there would be increased wait times for callers or even some dropped calls.

The second primary task performed by specialists was to conduct remote monitoring and control (RMC). RMC responsibilities were divided by system or geographic region, or sometimes both. For example, one RMC assignment might be for "Northern Very High Frequency Omnidirectional Range Radars (VORs)." One specialist would be given the assignment of monitoring all VORs in the northern sector of the service area. RMC responsibilities were assigned to specialists on a rotating schedule. Assignments were made differently across OCCs. Team leads made assignments at the MOCC and POCC. An automated assignment tool made assignments at the AOCC to ensure they were random. Notifying those on RMC duty when an event was planned at a monitored site was another area of interdependency. Most, but not all, stated that they would notify others of expected intrusions to prevent them from having to respond to the alerts created by the event. Also, in some, but not all cases, those on monitoring duty would help other specialists when call volume was high and their workload permitted.

Although all work in the OCC was done in a sequential fashion, in that there was no need for multiple specialists to collaborate on a task, the level of task interdependency was still considerable in that how well and how quickly one specialist worked affected the workload of other specialists. When asked if their work was done as an individual, as part of a team, or both, respondents at both the MOCC and POCC believed that their work required more teamwork or both individual and teamwork than just individual work (see Table 10). More AOCC participants reported that their work was individual than at the MOCC or POCC, but when responses for team and both individual and team were combined, teamwork was still reported as a significant aspect of the work done at the AOCC.

Table 10
Work as an Individual, Team, or Both

In completing each of your tasks, do you work individually or as part of a team?						
	N	Individual	Team	Both	Did Not Say	Not Asked
MOCC	21	2	10	7	1	1
POCC	22	0	14	8	0	0
AOCC	23	9	6	8	0	0

Table 11
Carry Fair Share of the Workload

Does everyone in the OCC do their fair share of the work?					
	N	Some Do Not Carry Fair Share	All Carry Fair Share	Did Not Say	Not Asked
MOCC	21	19	1	1	0
POCC	22	9	11	0	2
AOCC	23	12	6	5	0

Table 12
Prefer to Work in Small Teams

Would you prefer to work as a member of a small team?					
	N	Yes	No	Did Not Say	Not Asked
MOCC	21	4	6	1	10
POCC	22	21	1	0	0
AOCC	23	15	3	0	4

On highly interdependent tasks—even sequential task interdependency, as was seen in the OCCs— the accuracy and speed of the specialists affected the workload of others. When asked if everyone on the floor carried their fair share of the workload, the majority of participants at the MOCC and AOCC said that "no, not everyone carried their fair share of the workload," while at the POCC the majority believed that everyone carried their fair share of the workload (see Table 11). One participant said, "You know we have a board where we can see who's available to take calls and how many calls are in a queue. I sometimes have to turn my back to that so that I'm not frustrated by what I see."

The primary difference among the OCCs on the organization of work was the use of small teams at the POCC. Specialists and team leads at the POCC were organized as small teams in which five to seven specialists were assigned to one of seven team leads. The small teams rotated through the shifts (days, eves, or mids) as a team. Specialists and team leads almost always worked with their own team, but sometimes they also worked with other teams during shifts that required multiple team coverage. The MOCC and AOCC did not assign specialists to small teams. Rather, at the MOCC and AOCC, specialists and team leads rotated through the shifts on pre-defined, individualized schedules. In general, specialists and team leads at the MOCC and AOCC did not rotate on the same schedule. Some participants at all OCCs were asked if they would prefer to work and rotate in small teams or to work and be assigned to shifts on an individual basis. As can be seen in Table 12, the majority of POCC and AOCC participants would prefer to work in small teams. At the MOCC, fewer of those asked preferred to work in small teams. However, since nearly half of the MOCC participants were not asked this question, it is not clear what the majority would have preferred. This question was added to the interview protocol based on comments made by a number of the participants at the MOCC indicating that this was an issue of importance to them in OCC operations.

Participants were asked to explain why they would or would not prefer to work and rotate with a small team (see Table 13). In summary, reasons given for specialists preferring to work in small teams included improved team

Table 13
Reasons for Small Team Preferences

For Small Teams	Against Small Teams
Learn strengths and weaknesses	Stuck with poor performers
More and better information sharing	Stuck with bad team lead
Accountability	Personality conflicts
Reciprocity – helping one another	No variety
Higher camaraderie/esprit de corps	Harder to swap schedules
More socialization outside work	Causes problems with shift coverage – too few on day shifts, too many on night shifts

processes such as information sharing, helping behaviors, and motivation. Reasons against preferring to work in small teams focused on the negative aspects of teamwork, specifically, working with poor or difficult team members, as well as possible problems with individual flexibility and scheduling.

Workload and Complexity

The next set of questions addressed subjective workload. Participants were asked to rate their subjective workload for tasks they did on a regular basis with a focus on work done on the busier day shift rather than eves or mids. Subjective workload was assessed for each of the workload sub-scales described in the NASA-Task Load Index (TLX) on a scale from 1, very low, to 7, very high (Hart & Staveland, 1988). Using descriptions from the NASA-TLX, the sub-scales rated were mental demand, physical demand, temporal demand, quality of own performance, effort, and frustration. Shown in Table 14 are the questions, along with the means and standard deviations (SD) for each sub-scale by OCC. Unlike typical workload analyses, sub-scale scores were not weighted and no overall workload score computed. Except for physical demand, the specialists and team leads at all OCCs rated all workload sub-scales as high.

To better understand workload in the OCCs, especially mental demand, the next few questions addressed the use of standard operating procedures (SOPs) versus problem-solving in he OCC. We asked participants if they primarily used SOPs to do their work or problem-solving (see Table 15). The majority of POCC and AOCC participants reported that they used SOPs to do their job, rather than use problem-solving. MOCC participants indicated that problem-solving or both SOPs and problem-solving were used as often as SOPs in doing their job.

Participants were also asked if there were SOPs for doing their work and, if so, were they well-defined and kept up-to-date. The majority said that there were SOPs and that the SOPs were well-defined and kept current (see Table 16). The issue did not seem to be the existence of SOPs, but rather finding and applying the correct SOP. One specialist said, "You're going to hone your Sherlock Holmes skills. You have to understand that there is more than one way to attack a problem."

Cohesion

The next set of questions assessed the level of cohesion within the OCCs. Specialists and team leads were asked to rate on a scale from 1, very little, to 7, very much the extent to which they were committed to each other and their task. At all three OCCs, specialists and team leads indicated that they got along well together (see Table 17), took a personal interest in one another (see Table 18), and would defend each other from outside criticism (see Table 19). The differences among the OCCs on responses to these questions were small.

Also, when asked, the majority of specialists and team leads at all OCCs felt that they were part of the team (see Table 20).

However, as shown in Table 21, there was some variability in the extent to which they felt that the team was high in team spirit (e.g., esprit de corps), with only 7 of 17 AOCC respondents indicating that they felt team spirit was high. At the MOCC, 14 of 19 asked said team spirit was high. The highest reported level of team spirit was at the POCC, with 16 of 17 saying that team spirit was high.

The other two questions commonly used questions to assess the cohesion of a group, asked specialists and team leads the extent to which team members engaged in activities together outside of work, and how many people they talked to about personal matters at work. As can be seen in Table 22, fewer people reported engaging with others in outside activities at the AOCC than the MOCC and POCC. A reason given by some for not getting together with others at the AOCC and MOCC was an inability to synchronize schedules, since shift rotations were individualized.

However, when at work, almost everyone reported talking about personal matters with at least one to two people, with many talking to more than two people about personal matters (see Table 23).

Table 14
Subjective Workload Assessments

NASA-TLX Workload Sub-scales & Question		**MOCC**	**POCC**	**AOCC**	**Total**
Mental Demand					
How mentally demanding is your job (e.g., thinking, deciding, remembering, searching, etc.)?					
	Mean	6.24	6.14	6.57	6.32
	SD	1.30	.91	.51	.95
	N	21	21	23	65
Physical Demand					
How physically demanding is your job (e.g., pushing, pulling, turning, controlling, etc.)?					
	Mean	1.76	3.38	2.57	2.57
	SD	1.14	2.40	1.53	1.85
	N	21	21	23	65
Temporal Demand					
How hurried or rushed are you at work?					
	Mean	5.71	6.05	6.09	5.95
	SD	1.85	1.66	1.00	1.52
	N	21	21	23	65
Performance					
How successful are you at accomplishing your job?					
	Mean	5.90	6.10	5.87	5.95
	SD	1.09	.90	1.14	1.04
	N	21	21	23	65
Effort					
How hard did you have to work to accomplish your level of performance (mentally and physically)?					
	Mean	5.76	6.19	5.91	5.95
	SD	1.26	1.17	1.24	1.22
	N	21	21	23	65
Frustration Level					
How insecure, discouraged, irritated, annoyed, or stressed are you while doing your job?					
	Mean	4.95	4.10	4.48	4.52
	SD	1.83	2.50	1.81	1.90
	N	21	20	21	62

Table 15
SOPs Versus Problem-Solving

Do you primarily follow predetermined methods or standard operating procedures (SOPs) to accomplish your tasks in the OCC or are you creating new methods or strategies to do some of your work?						
	N	SOPs	Problem Solve	Both Equally	Did Not Say	Not Asked
MOCC	21	9	6	3	0	0
POCC	22	18	1	2	0	1
AOCC	23	11	3	4	1	0

Table 16
SOPs Exist, Are Well-Defined, and Are Kept Up-to-Date

Do SOPs exist for doing your work?					
	N	Yes	No	Did Not Say	Not Asked
MOCC	21	20	1	0	0
POCC	22	21	0	0	1
AOCC	23	22	1	0	0
If SOPs exist, are they well-defined?					
	N	Yes	No	Did Not Say	Not Asked
MOCC	21	5	4	1	11
POCC	22	9	1	0	12
AOCC	23	10	2	0	11
If SOPs exist, are they kept up-to-date?					
	N	Yes	No	Did Not Say	Not Asked
MOCC	21	8	3	3	7
POCC	22	13	2	1	6
AOCC	23	13	0	0	10

Table 17
Get Along Well Together

To what extent do you think the members of your team get along well together? (1 very little to 7 very much)			
	N	Mean	SD
MOCC	21	6.05	1.20
POCC	22	6.45	.92
AOCC	23	5.52	1.88
Total	66	6.00	1.44

Table 18
Take a Personal Interest in One Another

Do members of your team take a personal interest in one another? (1 very little to 7 very much)			
	N	Mean	S.D.
MOCC	21	5.43	1.86
POCC	22	5.45	1.77
AOCC	23	4.70	2.03
Total	66	5.18	1.90

Table 19
Defend Each Other From Outside Criticism

Do you think the members of your team would defend each other from criticism from outsiders? (1 very little to 7 very much)			
	N	Mean	S.D.
MOCC	21	5.81	2.46
POCC	22	5.82	1.84
AOCC	23	4.96	2.38
Total	66	5.52	2.25

Table 20
Part of the Team

How much a part of the team do you feel?					
	N	Yes	No	Did Not Say	Not Asked
MOCC	21	15	1	1	4
POCC	22	17	0	2	3
AOCC	23	15	4	1	3
Total	66	47	5	4	10

Table 21
Team Spirit

Is there a high spirit of teamwork on your team?					
	N	Yes	No	Did Not Say	Not Asked
MOCC	21	14	5	0	5
POCC	22	16	1	0	2
AOCC	23	7	10	0	6
Total	66	37	16	0	13

Table 22
Outside Activities

Do members of your team engage in activities together outside of work?					
	N	Yes	No	Others Do, But I Don't	Not Asked
MOCC	21	12	1	7	1
POCC	22	15	4	1	2
AOCC	23	9	6	6	2
Total	66	36	11	14	5

Table 23
Personal Talk

With how many people do you occasionally talk about personal things?					
Talk About Personal Matters?	N	No One	1 to 2 People	More Than 2	Not Asked
MOCC	21	0	1	15	5
POCC	22	2	3	16	1
AOCC	23	0	7	14	2
Total	66	36	11	14	5

Effectiveness and Satisfaction

The final set of questions dealt with the perceived effectiveness of the OCC and job satisfaction. Participants were asked to rate how effective their OCC operated, on a scale of 1, very low, to 7, very high (see Table 24). There was a significant difference among OCCs in effectiveness rating ($F(2,63) = 7.66$, $p = .001$). The POCC reported the highest level of perceived effectiveness, which was significantly higher than that reported by both MOCC and AOCC. There was no difference in perceived effectiveness between the MOCC and AOCC.

Participants were also asked to rate how satisfied they were with their job, from 1, very low, to 7, very high (see Table 25). Participants at the POCC reported significantly higher job satisfaction than participants at the MOCC ($F(2,62) = 4.46$, $p = .015$). There were no other significant differences.

When asked what could be done to improve either OCC operations or their own job satisfaction, items mentioned by at least 20% of the participants are shown in Table 26. This table does not represent the number of participants who may have thought a particular topic was important, rather it is the number of people who mentioned the item when asked what could be done to improve operations and/or satisfaction. The items mentioned most often were improving shift work scheduling and to providing training designed specifically for OCC operations. The next topic was providing specialists with feedback on their performance. Participants also mentioned staffing as a factor affecting either operations or their own satisfaction. Specifically, they felt that there were not enough specialists available to handle the workload, especially on the day shift. A lack of management involvement in day-to-day operations was also seen as a

Table 24
OCC Perceived Effectiveness

In your opinion how well does your OCC operate? (1 not at all well to 7 very well)			
	N	Mean	SD
MOCC	21	5.29	1.42
POCC	22	6.24	.70
AOCC	23	4.91	1.20
Total	66	5.46	1.26

Table 25
Job Satisfaction

Are you satisfied with your job as a whole? (1 not at all to 7 very much)			
	N	Mean	SD
MOCC	21	5.10	1.95
POCC	22	6.29	.96
AOCC	23	5.87	.76
Total	66	5.75	1.38

Table 26
Topics Mentioned as Affecting Satisfaction at the OCCs

	Mentioned		Not Mentioned	
	Number	Percent	Number	Percent
Shift Work	33	50.0%	33	50.0%
Training	33	50.0%	33	50.0%
Performance Feedback	28	42.4%	38	57.6%
Staffing	26	39.4%	40	60.6%
Management Involvement	22	33.3%	44	66.7%
Breaks	14	21.2%	52	78.8%
Technology	15	22.7%	51	77.3%

problem. The final two items mentioned by at least 20% of the specialists were the need for better technology to support their work and the need for a formal break schedule. These items are grouped into three areas for discussion – fatigue and workload (shift work, staffing and breaks), resources (training and technology), and knowledge of results (performance feedback and management involvement).

Workload

The first area reported to affect operations and satisfaction included shift work, staffing, and breaks. These topics as addressed by the specialists and team leads related to workload and fatigue due to workload. As was seen in Table 14, all aspects of workload, except physical workload, were judged as high at all OCCs.

Shift work. Reports of dissatisfaction with shift work were high, especially at the POCC and AOCC (see Figure 3). Specialists indicated that the rotations were not done in a predictable fashion and were poorly planned. They also reported that they were often scheduled to work all three shifts in a relatively short timeframe. The union representatives in the OCCs established shift rotations on a yearly basis. At the MOCC and AOCC, shift rotations were developed for individuals. At the POCC, shift rotations were developed on a small team basis.

Although participants expressed concern regarding how the shift rotation schedule worked, they also made commented that specialists wanted to work rotating shifts because it provided an opportunity for them to work shifts that were not as busy as the day shift. They saw working eves and mids as an opportunity to recover from the high workload of the day shift. The issue, for most was not the rotating shift, per se, rather how they rotated through the shifts seemed to be the problem. However, some indicated a preference to work a single shift. Individual specialists were allowed to swap shifts at the MOCC and AOCC so as to avoid certain shifts and manage their personal level of fatigue. Because they worked in small teams, it was harder for specialists at the POCC to swap shifts. Limited flexibility in managing shifts was one of the reasons given for not wanting to work in small teams (see Table 13).

Staffing. Specialists mentioned staffing as an issue in operational effectiveness and as a factor affecting their satisfaction at all OCCs (see Figure 4). Staffing was mentioned more often as a concern at the AOCC than the MOCC or POCC. However, comments across OCCs highlighted the need for additional specialists on day shifts to meet high workload demands, especially in number of calls received. Specialists and team leads indicated that the number of phone calls received on the day shift was extremely high, with calls often waiting in a queue and little down time. Specialists and team leads generally thought that eves and mids were staffed adequately, unless there were significant events such as weather that could result in under-staffing.

Factors affecting staffing included both the quantity and quality of the work performed by the specialists. If specialists' work on tickets was incomplete or inaccurate, the next specialist interacting with the ticket was expected to correct the problem. If specialists were not available to take calls because they were dealing with a complex action, or if they were too slow or on break, then the

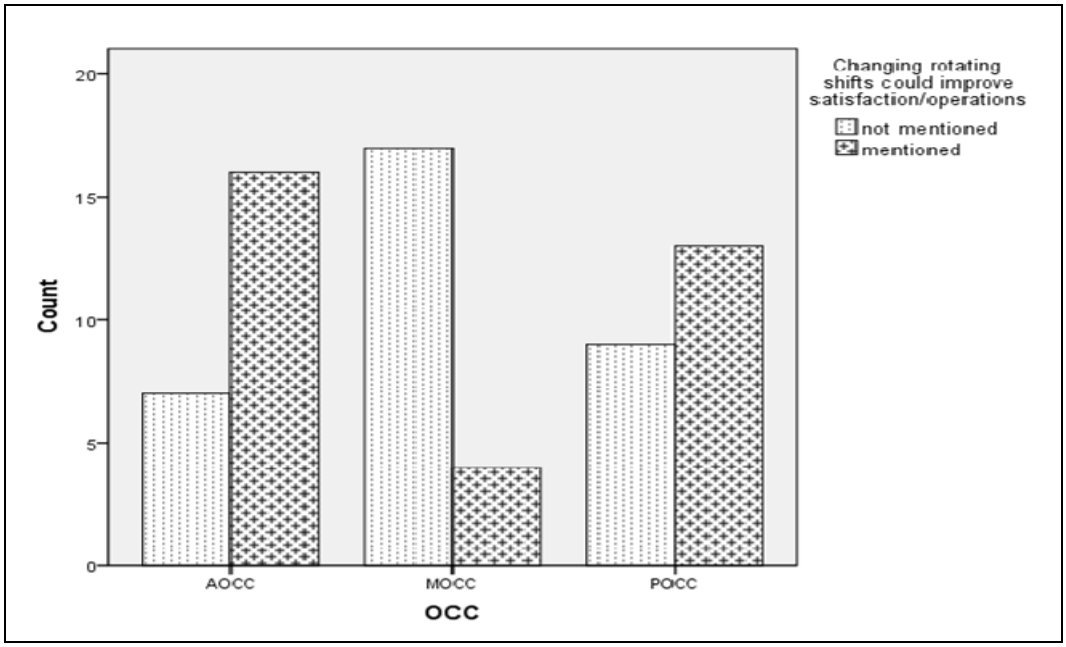

Figure 3. Rotating Shifts as a Factor in Satisfaction/Effectiveness by OCC

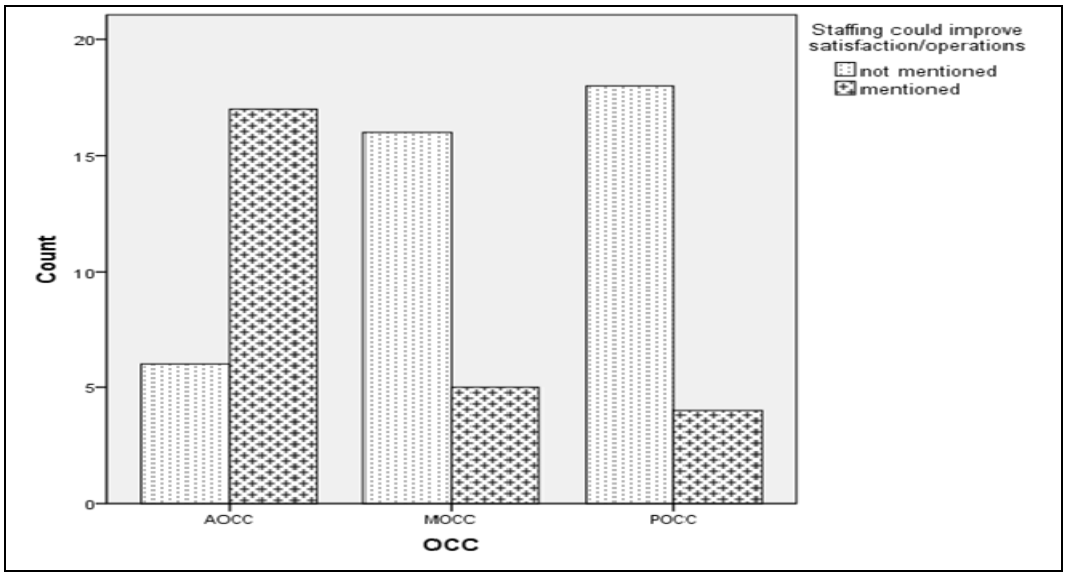

Figure 4. Staffing as a Factor in Satisfaction/Effectiveness by OCC

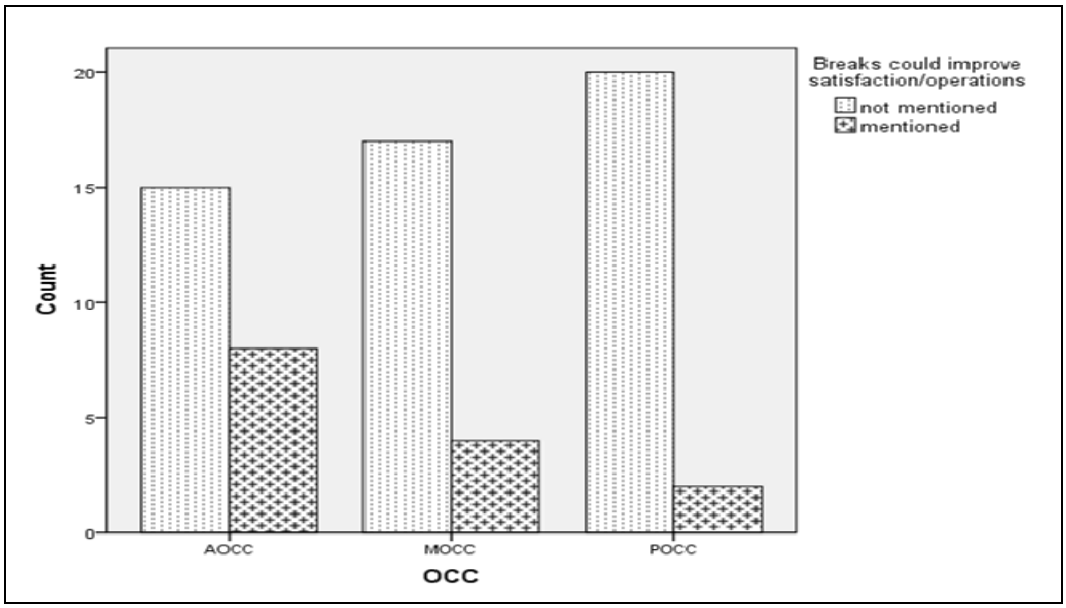

Figure 5. Breaks as a Factor in Satisfaction/Effectiveness by OCC

other specialists had to take up the slack. As mentioned previously, almost all MOCC specialists and more than half the AOCC specialists said that not everyone carried their fair share of the workload (see Table 11). Comments highlighted problems with quality, how well tickets were completed, and quantity— how many tickets were completed. Performance of all specialists had an affect on workload and satisfaction.

Breaks. Another area related to workload and fatigue affecting perceived effectiveness and/or satisfaction was the lack of a formal or agreed-upon policy for breaks (see Figure 5). The specialists had negotiated to work a straight 10-hour shift with no formal lunch period. Most said that they ate lunch at their desk while continuing to do their work whether they were monitoring systems or coordinating maintenance. They also said they took short breaks as needed. However, not everyone thought that the breaks were handled fairly. Some specialists took a lunch break away from their workstation, and some who were at their workstation during lunchtime did not take calls. Furthermore, some specialists took more short breaks than others. This resulted in an atmosphere of resentment and frustration, especially when workload was high. The primary issue seemed to be that there was no consistent understanding of the break policy. Some specialists took lunch breaks away from their workstation, while others

did not. Some specialists continued to answer calls while eating at their workstation; others did not. And some specialists took more breaks than others.

When a specialist wanted to take a break, he or she would check out with a team lead. Specialists at the MOCC and POCC said that they would use the Symposium display to request breaks during periods of low workload. The Symposium display showed total calls received, calls in the queue, and the availability of all specialists. It was projected on the walls at the MOCC and POCC. At the AOCC, the Symposium display had been discontinued because it was thought that some people were abusing it to avoid work. Those who were using the display to manage their breaks saw not having the display as a hindrance.

Resources (Training and Technology)

The next items reported as having an affect on operations and/or satisfaction were training and technology. Training and technology were grouped as resources provided by management to help specialists and team leads do their jobs. Some judged both resources as inadequate.

Training. A similar approach for training new hires was used at all OCCs. Basically, new hires spent the first four to six weeks at the OCC in a training laboratory completing courses on NAS equipment. Training regimens were slightly altered based on the expertise and needs of the trainee. The courses were presented using computer-based instruction (CBI) techniques. Following completion of the assigned courses, most new hires were paired with another specialist on the floor to observe operations. The amount of time spent observing varied among and within OCCs but generally lasted approximately two weeks. After the observation period, specialists began taking phone calls, sometimes with the support of another specialist, but mostly on their own.

At each OCC, a number of specialists and team leads commented on the approach to training used for new hires at the OCCs (see Figure 6). They primarily indicated that the current approach to training was ineffective and should be revised. Specifically, the CBI courseware was seen as providing more detail on each system than was needed to work in the OCC. They also indicated that there was too much information presented in the CBI courses than could be retained and that the most important information regarding alerts and the relationship of the system to other systems in the NAS was not routinely covered. One participant put it this way, "So I did academics for four months. Course after course after course after course, it was brutal. When you do 24 courses in four months you really don't learn anything."

Many specialists and team leads also stated that the skills needed to work in the OCC were not covered during initial training. These skills, as mentioned previously, included interpersonal, typing, understanding of air traffic control and weather, and capabilities such as multi-tasking and maintaining situation awareness. There was also a concern expressed that there was a lack of training on new systems as they were fielded and added to the list of systems monitored in the OCC. Finally, some team leads indicated that there was a lack of training in team building or leadership. In general, specialists and team leads did not suggest how the skills should be trained, or even if the skills could be trained, but merely indicated a need to have personnel in the OCCs with these skills and/or capabilities.

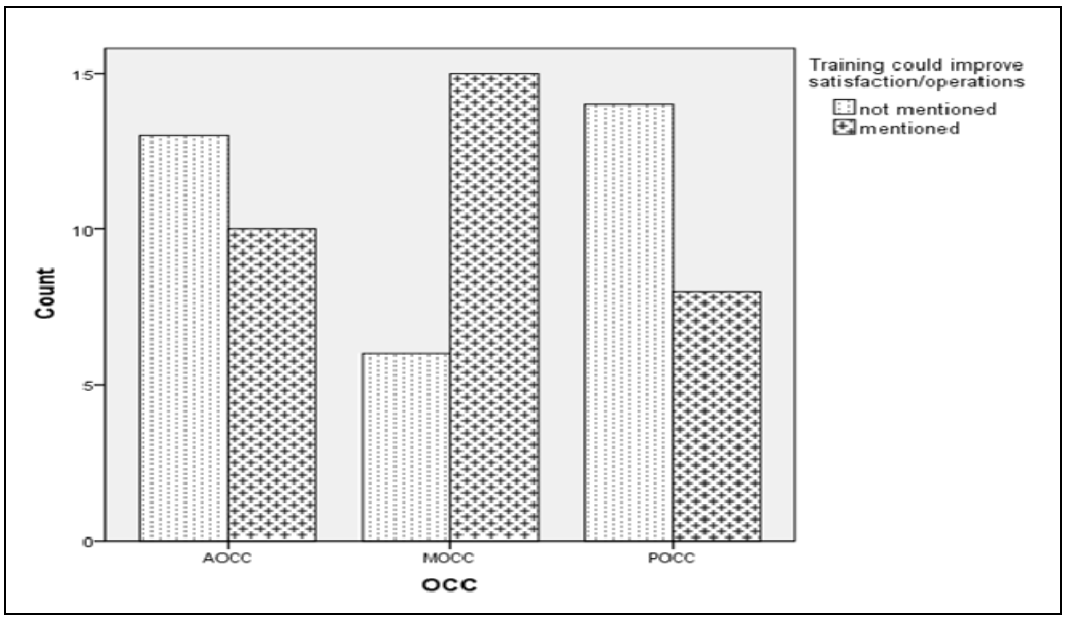

Figure 6. Training as a Factor in Satisfaction/Effectiveness by OCC

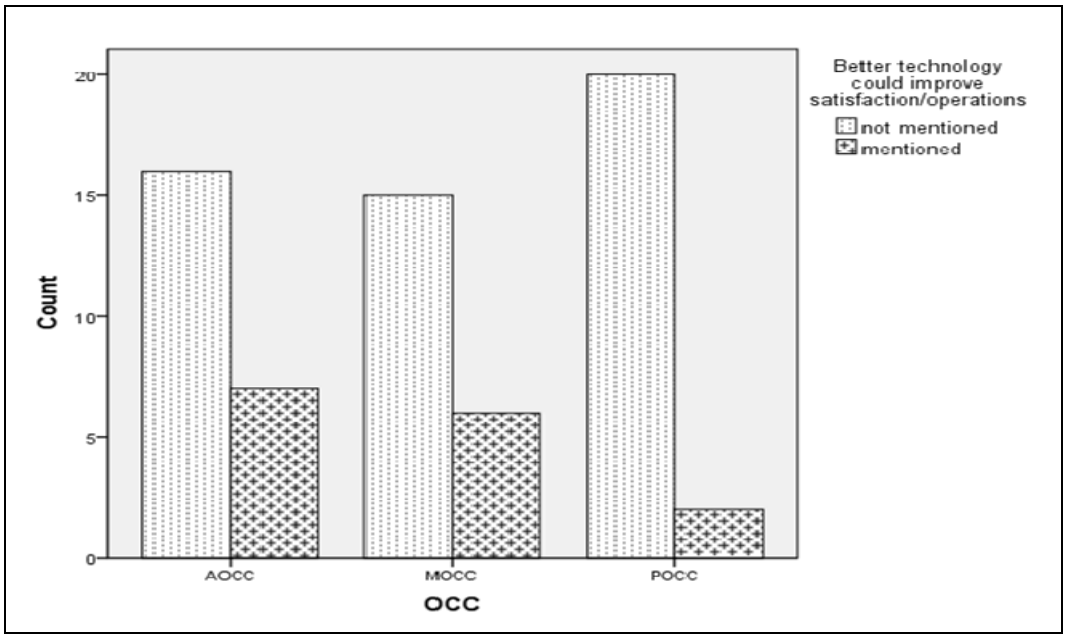

Figure 7. Technology as a Factor in Satisfaction/Effectiveness by OCC

Technology. Technology was mentioned as an issue at all OCCs, but employees at the MOCC and AOCC (see Figure 7) made most comments. The OCCs all used the same basic RMLS technology to do their work, but the extent to which the databases were maintained and the contact lists kept up-to-date in the RMLS varied among OCCs. Specifically, personnel at the MOCC and AOCC reported more problems with database management than personnel at the POCC. Other issues mentioned were the need to use a work-around in coding maintenance outages to avoid having field technicians perform unnecessary certifications and an inability to link related services with one another, such as localizers and glide slopes, when scheduling maintenance. Also mentioned was a sense that those developing technology for use in the OCCs were not as familiar with the job of the specialist as they needed to be and were developing systems that did not fully support operations. It was also mentioned that the suggestions made by specialists for improving the technology were not adequately considered and little feedback was provided to them when they did submit suggestions for improving technologies.

Knowledge of Results

The final area mentioned as affecting perceived operational effectiveness and/or satisfaction was performance feedback and management involvement. These factors were grouped because they highlighted a need expressed by OCC personnel to better understand how well they were doing in regard to specific standards of performance.

Performance feedback. The gist of these comments was that little or no feedback was provided by their managers on individual or team performance (see Figure 8). Feedback, when it was provided outside the formal review process, was mostly negative and aimed generically at the group, rather than those making the mistakes. A method proposed as useful in providing individual feedback was to "pull tapes," which meant that specialists and managers met one-on-one to listen and review a specialist's performance on phone calls. This process was used at times at all OCCs but had been mostly abandoned for unknown reasons. Specialists reported that individual feedback provided during annual reviews was fairly general and positive. It was thought that awards were not based on performance. Specialists also reported not to know what was expected of them. They reported that there were no standards for performance, both in terms of number of phone calls handled or ticket accuracy. They indicated that they would like to have more specific feedback on how they, personally, and the entire OCC were doing. They wanted feedback from their managers and from those they interacted with on the phone, especially the field technicians.

Management involvement. A number of comments related to the lack of management involvement in floor operations (see Figure 9). At the MOCC and AOCC, these comments focused primarily on the role of managers versus team leads. The concern was that because the team leads were not supervisors, they were not able to effectively handle personnel issues such as poor performance and

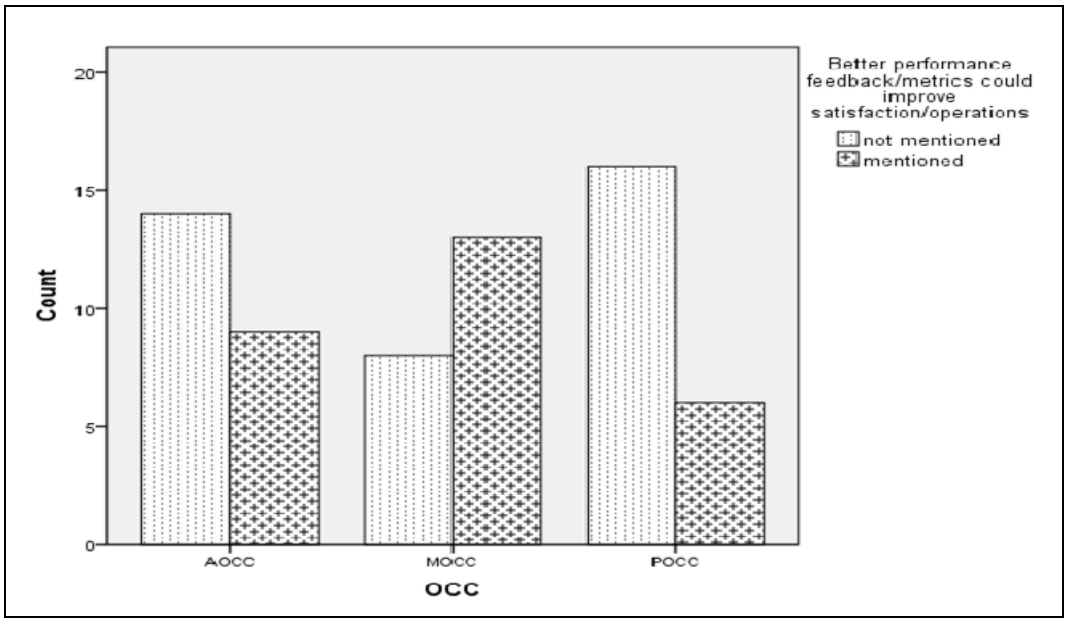

Figure 8. Performance Feedback as a Factor in Satisfaction/Effectiveness by OCC

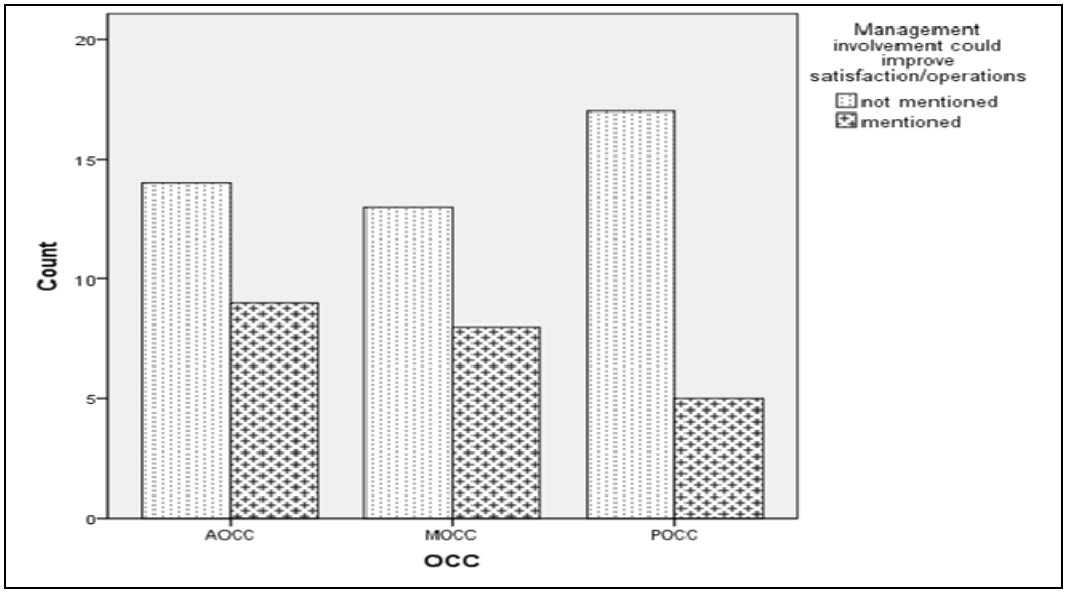

Figure 9. Management Involvement as a Factor in Satisfaction/Effectiveness by OCC

tardiness. This was especially problematic because the workload of all specialists was interdependent. If some specialists were not working as hard or well as others, it had an impact on everyone. As one specialist explained, "Whenever a manager's on the floor there's a lot less ACW and AUX (terms indicating that the specialist is not ready to take phone calls) and a lot more available – you can just watch it flip." Another participant said, "To improve my satisfaction is to know that everybody is going to work as hard as I'm going to work. And without the proper leadership that's not going to happen. I'd eliminate the manager's offices and put a podium up at both ends and have the managers do their work out here." Also, and as mentioned previously, specialists wanted more feedback from management on their work in relationship to what was expected of a specialist in the OCC and the performance of others.

Results Summary

Data gathered in interviews at the MOCC, POCC, and AOCC were analyzed and shown in the results section. Specialists and team leads described their own technical expertise and the technical expertise they believed was needed to work in the OCC. In general, they believed that they had the technical expertise to do the work and that information sharing among specialists and team leads was important. They also provided information on how work was done in the OCCs, with an assessment of their workload, the complexity of the work, and the relationships among those doing the work. Workload was seen as high, especially on day shifts and, although there were up-to-date SOPs for much of the work done in the OCCs, there was ambiguity in diagnosing some situations and finding and applying the correct SOPs. Relationships among specialists and team leads were generally seen as supportive, although there was concern that not everyone carried their fair share of the workload. Most considered their work to be team-oriented, but the extent to which specialists and team leads wanted to work on assigned small teams varied. Working as a member of a small team, rather than individually, was seen as limiting schedule flexibility by some, while others considered the small team environment to facilitate information sharing and helping behavior among team members. Finally, specialists and team leads were asked to rate the extent to which they felt that their OCC was effective and how satisfied they were with the job. Although there were some differences among the OCCs, perceived effectiveness and job satisfaction were generally rated as high. Finally, specialists and team leads were asked to identify factors that they thought would improve operations or their own satisfaction. Those factors were grouped into three categories: workload, resources, and knowledge of results for use in developing strategies for improving operations or satisfaction. A brief summary is provided in Table 27. Strategies will be presented in the discussion section of this report.

DISCUSSION

Overall, specialists and team leads expressed pride in the work they were doing in the OCCs and believed the work was important to the safe operation of the NAS. However, they also identified a number of factors they believed were limiting the effectiveness of the OCCs and their satisfaction at work. These factors were categorized as relating to workload, availability of resources, and knowledge of results. After examining both the qualitative and quantitative data gathered at the OCCs, we looked to the research literature on organizations and fatigue to aid in the development of potential interventions, which is the next stage in the action research process. The discussion will present an overview of the potential interventions derived from the research.

To address the first broadly defined issue of workload, we are suggesting a number of changes be made

Table 27
Summary of Results

Factors	Summary
Workload Shift work Staffing Breaks	Participants reported the job as being high in workload, with workload being influenced by rapidly rotating shifts or poorly designed shift work schedules, inadequate staffing during peak hours, and a perceived inability to take breaks, especially during peak hours.
Resources Training Technology	Participants identified challenges in initial, new equipment, and team leader training, as well as a need to improve the technology used to schedule and coordinate maintenance.
Knowledge of Results Performance Feedback Management Involvement	Participants believed that a lack of performance feedback had a negative impact on personal development and prevented poor performers from being held accountable for their work.

throughout the OCCs that will work together to address this issue. First and foremost, we recommend the use of small teams to organize specialists and team leads within the OCCs. We believe that an organization comprised of small teams would help to resolve a number of the issues brought to light about workload balance and complexity. Second, we suggest the implementation of a fatigue risk management system to deal with issues related to shift work scheduling and fatigue mitigation. To address the second broadly defined issue of resource availability, we suggest implementing several new training courses, as well as revising and streamlining current training programs. And, finally, to address the third broadly defined issue involving knowledge of results, we recommend implementing a comprehensive and usable performance feedback system. Additionally, we have incorporated several suggestions that stemmed from comments made about the use of technology for communicating information across OCCs. The following sections provide an in-depth discussion of each of these recommendations.

Small Teams

The first recommendation is to organize the OCCs into small teams with a team lead assigned a team of three to five specialists. The POCC is the only OCC currently organized into small teams, although small teams have previously been attempted at the other OCCs. POCC specialists and team leads see having a small team to work with as having a positive impact on operational effectiveness and satisfaction. A participant at the POCC said, "The team concept and having your team makes coming in here at all hours of the day and night a little bit better because you're going into a familiar place with familiar people, who you know exactly how they're going to act during those hours." Another participant at the POCC put it this way, "Even if there's personality conflicts and differences, everybody still knows we have to work as a team or we're not going to make it, and we want our team looking good, we want our stuff right, we've got X amount of duties that have to be done. Fortunately, I'm on a team where anybody and everybody just piles in and does whatever needs to be done." As mentioned previously, shift assignment at the MOCC and AOCC is individualized, and the composition of specialists and team leads working a shift is variable. Specialists and team leads work their shift with others who happen to be assigned to work the same shift. One participant at the MOCC commented, "You can drive through the gate and you can see what your day is going to be like by what cars are here." In general, specialists and team leads do not know who they will be working with each day.

It is possible for employees at the MOCC and AOCC to operate as individuals because the work in the OCCs is primarily done individually. In general, team members do not work together when answering or making calls to coordinate maintenance or in monitoring remote systems. However, as observed by a participant, "My observation… is that you do your work very individually, but because you open tickets that were filled out by somebody else, because you all have to answer the calls and stuff like that, and if you're not answering them, I'm answering them. There's a team aspect but it is at the lower level—it's not like you're problem-solving together." Thus, although interdependence in the OCCs may not involve collaborative problem-solving, there is interdependence in both the quality and quantity of work done. When task interdependence is low, teams are not recommended (Steiner, 1972). However, if interdependence is high, good teamwork processes are essential.

In fact, interdependence is a defining characteristic of teams and is referred to in most definitions of teams. For example, Alderfer (1977) simply defines teams as two or more interdependent people working together in differentiated roles to achieve some organizational outcome. Interdependence is defined as the extent to which group members interact and depend on one another to accomplish work (Campion, Medsker, & Higgs, 1993) and is usually conceptualized as being comprised of four dimensions – task, resource, reward, and goal (Rossi, 2008). Interdependence may also be considered structural and psychological (Barrick, Bradley, & Colbert, 2007) with structural interdependence relating to the nature of the task and psychological interdependence reflecting the need of individuals to work together to attain their goals.

Work in the OCC has components of both structural and psychological interdependence. Structural interdependence is reflected in the extent to which the quality of an individual's work has an impact on the work of others, as well as in the need of specialists to share information and learn from one another. Psychological interdependence is seen in how workload is shared among the specialists. OCCs are better able to achieve their goals to the extent that everyone contributes. Thus, there is a level of interdependence among the specialists and team leads that justifies the use of small teams as essential for operations. Following is a brief review of the advantages and disadvantages and strategies for implementing small teams within the OCCs.

Advantages of small teams in the OCCs. Regardless of the technical expertise of the specialists hired to work in the OCCs, once assigned to an OCC, their work requires them to have some knowledge of all the systems in the NAS and to understand the relationships among systems. They must also act as boundary spanners – working and coordinating with people in multiple different fields such as air traffic controllers, contractors, and field technicians.

Most specialists reported having expertise in only one or two areas (navigational aids, communication, automation, radar, and environmental systems) before coming to the OCC (see Table 7 for an overview of expertise areas identified by participants). The CBI courses taken soon after they were hired to work in the OCC were seen as only a first step in developing the knowledge needed to work in the OCC and, while much of the information to do the job existed in SOPs, finding and applying the right SOP, especially under time pressure, was difficult. Hence, the specialists relied heavily on the expertise of other specialists on the floor for help and to learn what they needed to know to do their job. As one participant explained, "I think the best experience was sort of on the fly. In other words you come across it, and basically you wind up tapping a coworker just behind you. Hopefully, one of them had experienced this before and could help you out."

Through face-to-face experience and information-sharing on the floor, specialists and team leads learned who had what expertise and who would be willing to help, if asked. Smith-Jentsch, Kraiger, Cannon-Bowers, and Salas (2009), working with air traffic controllers, determined that team members with greater experience working together requested and accepted help from one another more readily than those with less experience working together. Knowing who knows what, which is referred to as transactive memory, is important when knowledge needed to do the task is distributed among team members (Lewis, 2004; Moreland, Argote, & Krishman, 1996; Wegner, 1987). Openly sharing information, especially unique information, has also been found to have a positive impact on team performance by promoting trust and cohesion among team members (Beal, Cohen, Burke, & McLendon, 2003; Mesmer-Magnus & DeChurch, 2009). Given the interdependent nature of the work and the distribution of knowledge among the specialists and team leads in the OCCs, transactive memory and open information sharing are important components in effective operations. Having the same people work together and interact on a regular basis helps to facilitate more effective team and individual performance.

In addition, members of a small team are more likely to develop a team mental model (Cannon-Bowers, Salas, and Converse, 1993; Smith-Jentsch, Mathieu, & Kraiger, 2005). A team mental model (used interchangeably with the term "shared mental model") is an organized understanding or mental representation of knowledge shared by team members (DeChurch & Mesmer-Magnus, 2010). It can relate to features of the team's task or how the team works together (Klimoski & Mohammed, 1994). Having a team mental model will enable teams to anticipate the needs of their team members and to implicitly coordinate their behavior, which will, in turn, improve team effectiveness (Cannon-Bowers et al., 1993). Kozlowski and Ilgen (2006) consider transactive memory and team mental models as emergent states developed through team learning and consider team learning to be a dynamic behavioral process based on interaction and exchange among team members.

Teams provide a safe environment for its members to engage in information sharing, asking for and giving help and feedback, and discussing difficult situations or mistakes (Edmonson, 1999), which supports individualized coaching and mentoring by peers and team leaders. Thus, working within a small team environment should result in better performance through more information sharing and the development of shared mental models, as well as a transactive memory system. An additional benefit will be seen if the small team members also have expertise in each of the areas required by the OCC.

Cooperation and collaboration may also be increased within a team environment. Teams that support one another can enhance effectiveness by sustaining effort on mundane tasks (Harkins, 1987). Team members are also likely to notice when others on their team are having trouble and understand what form of help is needed. Team members assume responsibility for helping one another more than non-team members (Latane, 1986). However, the size of the team matters. In large teams with variable membership, understanding how to help and assuming responsibility for helping one another is less likely than in smaller teams. Not only are members of small teams more likely to notice and provide help when needed, they are also more likely to notice and hold others accountable for their performance.

Thus, a small team environment decreases the likelihood of social loafing. Social loafing refers to the reduced effort and motivation that team members tend to exert when working collectively on a task (Karau & Williams, 1993) or the ability of specialists to free ride on the work of others (Latane, 1986; Latane, Williams, & Harkins, 1979; Steiner, 1972). Working in small teams decreases the likelihood of social loafing and free riding by making individuals' contributions identifiable and holding team members accountable. The tendency of some specialists to exert less effort than others in the OCCs was seen as a significant problem. One participant described it this way: "We used to call it 'riding the pony,' when you're not ready you're not available to take the next call. So the die-hards, the people that are pushing that competitive spirit take 9-10 calls an hour, which is what we really need."

Other factors necessary to reduce social loafing are: making members feel their contributions are indispensable, allowing members more control over task outcomes, and increased meaningfulness of the work (Guzzo &

Shea, 1992). Small teams help, encourage, and motivate other team members to perform. This is especially true, given the nature of interdependence in the OCCs, with the accuracy and speed of others directly affecting the workload for all. In summary, teams provide opportunities for mutual learning and social support (Liu & Batt, 2010) and the mechanisms to ensure that team members maintain an acceptable level of performance.

Disadvantages of small teams in the OCCs. The downside to organizing by small teams in the OCC is the impact they could have on the flexibility needed to assign the appropriate number of people to work each shift. If not managed properly, the team concept could result in too many specialists assigned to work certain shifts with low workload or too few specialists on busy day shifts. However, scheduling practices that permit some specialists to opt out of working mids by switching to other shifts or taking leave would help alleviate overstaffing on mids. There could be a formal rotational process implemented in which one person from a team assigned to work mids is assigned an alternate schedule. Also, forming enough teams to ensure that team membership does not exceed five should help prevent overstaffing. Some specific strategies for managing schedules are presented in a later section of this report on fatigue risk management.

Another downside mentioned by specialists and team leads was having to work with other specialists or team leads that they did not like or thought were poor performers. Regarding team assignments, one participant said, "There were goods and bads. You do kind of learn other people's strengths and weakness. But you also grow weary of working with some people all the time because you become aware of their strengths and weaknesses. I prefer not to be assigned to the same group of people all the time." The team process, itself, may address these concerns in that teams often come together and resolve personality differences through shared work, and individual performance improved through increased helping behavior and individual accountability. A participant succinctly captured that point in the following comment: "Your good people are going to bring your bad people up." However, another strategy that could be employed is to reorganize the teams on an annual or bi-annual basis.

Planned changes in group membership can reenergize teams. Reorganizing teams on a regular, but not too often basis, allows individuals an opportunity to get to know and learn from more people throughout the organization, promotes an organizational identity as well as a team identity, and decreases the likelihood of negative team dynamics (Guzzo & Shea, 1992). At the POCC, this comment was made about reorganizing teams: "You're like a family on the team. Well, why can't we switch that around, a couple of people every year and now pretty soon the guy that I kind of don't like on the other team, well pretty soon he is on my team for a year, I get to know him. Now we're buddies, we talk about football…Now we're friends so now, when he's on the other team, I'm less likely to say 'that stupid idiot,' because I worked with him for a year and I know him and I like him. Now again, I don't like that concept because I'd rather be on the team with everybody forever." So, initially there may be some resistance to reconfiguring teams on a regular basis, but if established as an integral part of the program from the beginning, the advantages to long-term performance would likely offset the disadvantages.

The end result is that the advantages to a small team environment such as increased information sharing and the development of team mental models and transactive memory systems, which have been shown to improve performance (for a review, see Kozlowski & Ilgen, 2006), seem to outweigh the disadvantages, especially if the teams are implemented in a flexible way to address the scheduling concerns expressed by the participants in this research. Having specialists and team leads participate in deciding how the small teams will be implemented will help to address and alleviate some of the concerns mentioned. However, as with any proposed intervention, if poorly designed or executed, the solution may not achieve the expected results. In action research, continuous data collection and feedback during implementation is one way to uncover and mitigate the impact of unintended consequences. It is also important to tailor the intervention to the organization. Some factors that should be considered in implementing small teams at the OCCs are presented in the next section.

Recommendations for implementing small teams within the OCCs. There are a number of things that should be considered in implementing small teams. We suggest that to the extent possible, teams should be given autonomy to make day-to-day decisions on how to meet work goals. This will require that the team members clearly understand their mission and that their goals are aligned with organizational requirements. Empowerment, or self-management, will increase the extent to which the team will feel and take responsibility for meeting team goals, which should result in better performance and higher satisfaction.

Autonomous teams are also more likely to contribute to organizational improvement through their participation on organizational work groups. In the case of the OCCs, an important consideration is input into training and technology required to do the job. A formal mechanism should be established to include input from OCC teams and/or individual team members on the design of training and technology for specialists and team leads. Those doing the job are often in the best position to know what

types of training and technology would best support job performance. A number of participants in this study identified both training and technology as factors affecting effectiveness and satisfaction. Among other things, comments emphasized a need for more input into how specialists and team leads were trained and what technology was developed or selected to support job performance. The participants indicated that those most affected by the training and the technologies used to do the job should have more input into development. Increased participation through communication and cooperation between the teams and/or individuals doing the job and those responsible for designing training or technical systems that affect floor operations should increase effectiveness and satisfaction with the job. Training is another strategy considered independently from establishing small teams.

Another area for consideration is how feedback should be used to support both team and individual performance. As mentioned previously, the remote monitoring and coordination tasks of the OCC are not highly interdependent in a traditional sense, but rather the interdependencies are based on workload, accuracy, sharing information, and helping behavior. The quality and quantity of individual work affects the workload of others on the team, and individual performance improves to the extent that team members share their knowledge with one another. Promoting team goals, providing team-based feedback, and rewarding teamwork will highlight the interdependent nature of the work and encourage helping behavior among specialists, resulting in higher levels of team performance. However, it will be important to also continue to highlight individual performance to maintain individual accountability and avoid negative team processes. Feedback is such an important aspect in performance that it is considered separately from small teams as a unique strategy for improving effectiveness of the OCC and satisfaction of the specialists and team leads.

The next factor in implementing a small team approach is team composition. To the extent possible, expertise in each of the technical areas identified as important to OCC operations should be represented on each team (e.g., navigational aids, communication, automation, radar, and environmental systems). A participant commented that "If you're going to create teams and have teams, you should strive to have your subject matter expert for this field, this field, and this field working together." Having a heterogeneous team with expertise in each of the critical areas represented will allow team members to learn from one another and have a ready source for help when problems arise. Also, a plan for integrating new team members should be established. For example, there should be no more than one new team member added to a team per year, and team member turnover should be minimized to the extent possible. This will allow team members adequate time to get to know one another's strengths and weaknesses (transactive memory), as well as their personalities. It will also allow for the best possible integration and coaching of new team members on-the-job. Although, as mentioned previously, a strategy for reconfiguring teams may also be considered to allow team members an opportunity to work with other specialists and team leads in the OCC. It is recommended, however, that the timeframe for reconfiguring teams be at least one year to support team development and operations. The tenure of team members within the OCCs should also be considered when establishing teams, given that specialists with more experience will have a better understanding of relationships among systems in the NAS and will have encountered most of the situations likely to occur in the OCC.

A second aspect of composition is team size. The size of the team will have to be considered to ensure that the team is large enough to represent each area of technical expertise but not so large as to hamper team identity (e.g., one's perception of belonging, Pratt, 1998) or cause a problem of overstaffing during low workload shifts. A team size of three to five members would likely meet both criteria. A flexible policy for reassignment should also be considered, especially when the team is scheduled to work shifts requiring less staffing. Based on concerns raised at the OCCs, it is also recommended that team members continue to be allowed to swap schedules in some situations. Having team members occasionally swap schedules with others should not affect the long-term performance of the team and would also facilitate inter-team communications and relationship building.

Finally, team processes are important. For example, workspace design should be considered to maximize information sharing among team members. It is recommended that team members doing similar jobs be seated together. In this way, the ability of team members to support one another will be maximized. This should not be an issue when there is only one team on a shift, but when multiple teams are scheduled to work, having the team members seated near one another will promote teamwork. The design of the workspace can also encourage the development of a team identity. It is also recommended that the Symposium system be used in all OCCs to allow individuals and teams situational awareness of the current workload, to back-up others when needed, and manage their breaks. Another aspect of what teams do is related to scheduling and shift work. The schedules and the shifts the teams work affect workload and fatigue, which was reported to be very high in the OCCs. Workload affects the ability of teams to engage in team processes such as information exchange, helping behavior, and motivation.

Strategies for reducing workload and fatigue are discussed in a separate approach.

Each of the areas described above enable team processes. A summary of the enablers considered in this research is presented in Table 28.

If implemented properly, the use of small teams can foster an environment that encourages high involvement work processes. High involvement work processes use teams to increase individual involvement and participation in organization-level practices and provide greater access to system level feedback, with both resulting in greater levels of satisfaction and commitment to the organization. Workman and Bommer (2004) established high involvement work processes using problem-solving teams and quality circles and found a significant, positive effect on both satisfaction and commitment in a computer call center (Workman & Bommer, 2004). This is also highlighted by the data we collected for this effort. Employees of the POCC, which currently uses a small team structure, reported higher levels of satisfaction with their jobs and rated the effectiveness of the organization as higher. In the Workman and Bommer (2004) study, the positive affect of high involvement work practices was especially apparent if employees had a high preference for group work, although satisfaction and commitment did not decrease for those with a low preference for group work. Thus, employees in a work situation similar to the OCCs benefit from high involvement work processes implemented using small teams, whether or not they preferred group-work (Workman & Bommer, 2004).

Training and Technology

The next area to be considered for OD is training. Training was mentioned as an issue by 50% of the participants in this study. Training comments were related to initial training, new equipment training, and team leader training. A related factor was the technology used to do the job. The majority of the comments related to technology focused on the inadequacy of the software and databases used for training and job performance.

Initial training. Based on the many comments regarding the perceived efficacy of the laboratory-based CBI training, laboratory training for new hires should be reconsidered. The CBI courses were seen by some as providing too much irrelevant information and not enough information regarding the relationship among NAS equipment or factors important in RMC. Some specialists even recommended that training be centralized and provided at the FAA Academy in Oklahoma City. This recommendation might be considered within the context of a more comprehensive, long-term approach for training improvement, but for more immediate implementation, we recommend that the current training programs be streamlined to remove the irrelevant information and updated to include more relevant information on the relationship among NAS systems.

Others expressed concern about having to complete all the CBI courses prior to working on the floor. They believed there was too much time spent in training before applying the information learned. There are several possible approaches that could be used to address these training concerns. The simplest would be to merely alternate completion of the current CBI-training courses with work on the floor. Of course, the type of work a new hire could handle would be affected by previous experience and training completed. It might be necessary to create a system such that new hires were assigned more routine coordination work and those with more experience given more complex requests. This would likely take time to develop and require the development of a phone or call screening system that would allow calls to be routed to specialists based on their level of expertise. Alternatively,

Table 28
Enabling Team Processes

Enablers	Impact
Autonomy	Team members are more engaged in their work and more committed to their team and the organization.
Individual and Team Performance Feedback	Individual-level accountability is maintained, while a sense of interdependency needed for teamwork is promoted.
Composition	Having the expertise needed to do the job contained within the team will help to ensure that team members have ready access to support, will be more likely to seek help, and will know who will most likely have the help needed.
Size	Team identity is easier to establish and maintain in smaller, rather than larger teams, but the expertise needed within the team is also a consideration.
Workspace Design	Workspace design can be used to promote a team identity and team processes such as information sharing, helping behavior, and motivation.

new specialists might be assigned tasks considered less difficult. As one participant explained, "They put you in pendings and notifications and basically approvals of events so that you can get used to making calls and feel comfortable on the phone calling air traffic or calling airport operations and so on and so forth. It kind of breaks you in really nice." A phased approach might also be implemented along with a trial period at the OCCs such that OCC specialists hired from among the FAA technical workforce would have a 6-12 month trial period at the OCCs and could return to their previous job without penalty if it did not work out.

A second approach would be have new hires complete a laboratory-based training program geared specifically to the needs of the OCC with more emphasis on the relationship of equipment in the NAS and an understanding of factors important in system monitoring. Some of the other abilities mentioned as important in OCC operations—interpersonal skills, typing skills, and multi-tasking—should probably be considered in personnel selection, rather than as a focus for training. To develop and implement a new training program, however, would take additional research to define, in more detail, the knowledge and skills needed to operate in the OCC.

A third strategy, and the one we recommend for immediate implementation, is for specialists and team leads to more actively participate in training new personnel, using a peer-based, on-the-job approach. Observing and then being observed by an experienced peer could be used to supplement or even replace much of the laboratory-based instruction. This approach could be especially effective in conjunction with the recommendation to organize the OCCs into small teams. If organized into small teams, the best approach might be to have a peer-trainer on each team. The peer-trainer could possibly be the team lead or, if assigned to a specialist, the role of peer-trainer could be considered as an additional role in the OCC, which could help to increase task variety and job satisfaction.

New equipment training. Participants expressed concern about training on new equipment. Specialists and team leads believed that having technical expertise was necessary to work in the OCC. Many also believed that they could not maintain the same level of expertise as they had in the field while working in the OCC, nor was it necessary to do so. More important was the field experience and maintaining a general understanding of how the systems operated and working with others who had experience with the range of systems. However, as new systems are introduced into the NAS, such as the Automatic Dependent Surveillance-Broadcast (ADS-B), there are no experts, past or present, to rely on for help. Adequate training on the new systems is required. It is likely that a centralized approach to new equipment training would ensure that all specialists were trained to the same standard. We recommend that training for the OCCs on new equipment be developed in a collaborative fashion among the OCCs and the FAA training community.

Team leader training. A final issue raised in the area of training was a lack of team leader training. Specialists selected to act as team leads were trained in accident investigation, but they were not given special training in team leadership and there seemed to be a great deal of variability in how team leads operated and interacted with the specialists. A training program for developing leadership skills could be tailored for the OCCs with a focus on empowerment and team building among peers. Another strategy might be to increase the number of specialists allowed to rotate through team lead positions. This type of cross-training improves the ability of team members to help one another and increases satisfaction by adding task variety. Another issue related to team leader training is allowing team leads to take more responsibility for managing operations. The role of the team lead seemed to be somewhat ambiguous. Team leaders are not supervisors, but they are responsible for ensuring that the work is accurate and timely. Thus, their role should be more clearly defined, and perhaps they should be given more legitimate authority or autonomy to work with their team members. If they are to be effective as leaders and experts, they need a certain level of respect in terms of both their expertise and their legitimate authority. One such small step in that direction would be to grant them the authority to approve schedule changes between team members. And related to this issue of team leader training was a concern expressed regarding the need for increased management involvement in floor operations. It is likely that establishing teams, providing team leads with team building and leadership training, and empowering team leads to manage floor operations with more autonomy might mitigate concerns about the perceived lack of management involvement. However, this issue should be monitored as strategies are implemented.

Technology. Furthermore, it is recommended that specialists and team leads be given more opportunities to participate in updating or recommending updates to systems and databases needed to support their work in remote monitoring and coordination. Having specialists and team leads doing the job of remote monitoring and coordination involved in the design of systems for training and operations will ensure that the perspective of those actually doing the job is considered. This should increase the experienced meaningfulness of the work and, ultimately, effectiveness and satisfaction.

Performance Feedback

Performance feedback is an essential component in individual training and development and in an individual's motivation to work. Hackman and Oldham (1976, p. 258) define feedback as the "degree to which carrying out the work activities required by the job results in the individual obtaining direct and clear information about the effectiveness of his or her performance." Performance feedback is also an important component in interdependent groups (Campion et al., 1993). Performance feedback is necessary to provide a sense of accomplishment and meaningfulness in the work and allow teams to regulate their own behavior (Campion et al., 1993; Hackman & Oldham, 1976).

For performance feedback to be meaningful, however, it should be tied to some agreed-upon standard of performance. Comments from specialists and team leads in the OCCs indicated that there was little or no specific feedback provided on individual, team, or organizational performance and that the standards for job performance were ambiguous. As one participant said, "I think, to me, the fact that we don't have a little bit more of a feedback program here… does hinder us in the sense that those that perform at maybe a lower level aren't really shown where the bar's at." Another participant said, "We've been open for 10 years and we haven't got a set of metrics that says you're good, you're good, you're exceptional, you on the other hand, need some work. How can you manage what you can't measure?"

We recommended that a set of performance metrics and standards of performance be defined for OCC operations. These performance metrics and standards of performance should be defined in such a way that the specialists and team leads can use them to assess their own performance, as well as the performance of their team. Work on defining objective measures has begun at the POCC, so we recommend that this work be continued and expanded to include the other OCCs and an agreed-upon process be developed to objectively measure the performance of individuals and teams within the OCCs. We also recommended that, as has been done at the POCC, specialists and team leads, those most familiar with the job and who will be affected most by the process, be encouraged to participate in developing performance metrics. Self-management and participation in decision-making are high involvement work processes (Workman & Bommer, 1993). They will enhance team effectiveness by increasing the extent to which members have a sense of responsibility and ownership of the work (Campion et al., 1993). Having those most familiar with the job participate in development of metrics will also help to guard against unintended consequences. For example, rewarding speed at the cost of accuracy. As one participant said, "If you paid Babe Ruth to hit singles, he would have never hit one out of the park. He would have never hit a home run." Another participant said, "Just because you answer a lot of phone calls doesn't mean that you served the NAS and provided the customer with reliable service."

The performance metrics should be similar across OCCs, but given the variability of workload due to day of the week and shift worked, it is likely that the standards of performance will be based on an extended timeframe such as quarterly, bi-annually, or even annually. As one participant said, "So your workload can be quite different from quarter to quarter. But once you compile the annual data, then you can get a pretty clear picture of which team seems to be doing more of the workload." However, the shortest timeframe practical for establishing standards should be used to enhance the usefulness of the performance feedback system.

We also recommend that individual and team feedback be provided on a regular basis and that the individual and team feedback be specific and placed within the context of other individuals and teams at the OCC to provide specialists and team leads with a referent by which to compare their own performance and the performance of their team. One participant described his feedback this way: "We have bi-annual reviews, you know, you're doing fine. Okay. I guess I'm doing fine then." This type of feedback does not help specialists and team leads improve their performance. In providing specific feedback, the performance of other individuals and teams could be anonymous to prevent embarrassment or conflict, but it would still allow individuals and teams to compare their and their team's performance with others and to use that information as a basis for evaluation and goal setting.

We further recommend that a process be established for specialists to get more individualized feedback on their performance. One way to do this would be to have team leads or managers meet individually with specialists to review recorded phone conversations between specialists and the technicians or others with whom they coordinate in the field. While this process has been tried and may still be in effect at one or more OCC, it is not used consistently to review individual performance. It was mentioned by specialists as a way they would like to receive feedback that would enable them to improve their performance. A strategy to increase individual participation in the process might be to have specialists pull their own tapes for review, asking them to select one in which they handled a situation well and one in which they were uncertain about how to respond or may have acted incorrectly. The reviews could then focus on providing feedback on performance and on coaching how to handle unique or complex situations. Reviews could be held in conjunction with mid-term reviews with managers and team leads participating in

the reviews. These developmental reviews should not, however, be tied to merit raises or promotions. This will allow for a more accurate assessment from both management and the individual employee. If at all possible, this type of review should be held at a different time than the traditional review used for raises.

Another type of performance feedback that could be used to improve operations and increase satisfaction is stakeholder feedback. The vast majority of specialists and team leads participating in this research were field technicians prior to becoming OCC specialists. They understood and identified with the role of the field technician and saw a component of their job as helping field technicians get their work done. In some cases, specialists sought feedback from the field technician on how well they were doing their job, but a more institutionalized approach could be used to provide this information to the OCCs. This type of customer feedback may already be collected within a NAS Technical Evaluation Program (NASTEP) evaluation, but based on discussions with specialists and team leads, the data are not routinely made available to them. Therefore, we recommend a customer survey be implemented to gather feedback from those who regularly interact with the OCCs — field technicians, air traffic controllers, and military personnel—and regularly provide the summarized results to specialists and team leads.

The final recommendation in this section is to use performance feedback to reward both individuals and teams to motivate individual effort and promote a pro-social focus. Rewarding individual effort avoids social loafing, a pitfall of team-only rewards, while rewarding the team will ensure that members cooperate and coordinate their efforts. Pearsall, Christian, and Ellis (2010) found a hybrid approach to both motivate individual effort and promote helping behavior among team members working on an interdependent task. To be most effective, the relationship between performance and rewards should be defined in a transparent manner. As mentioned previously, performance may vary from day to day or even week to week based on task assignment and shift worked; however, these differences will eventually be minimized as all personnel rotate though jobs and across shifts.

Managing Fatigue and Shift Work

The final set of recommendations relates to how fatigue is managed in the OCCs. Specialists and team leads believed that both shift work and workload (as influenced by staffing and breaks) affected fatigue. However, a number of work and personal factors also affect fatigue. The relationships of the factors and their interactions that can influence fatigue are illustrated in a model adapted from NASA, as shown in Figure 10 (Australian National Transport Commission Report, 2004). These factors have implications for safety-related occupations such as TechOps, as well as organizational and individual costs. Understanding the impact of shift work on fatigue can

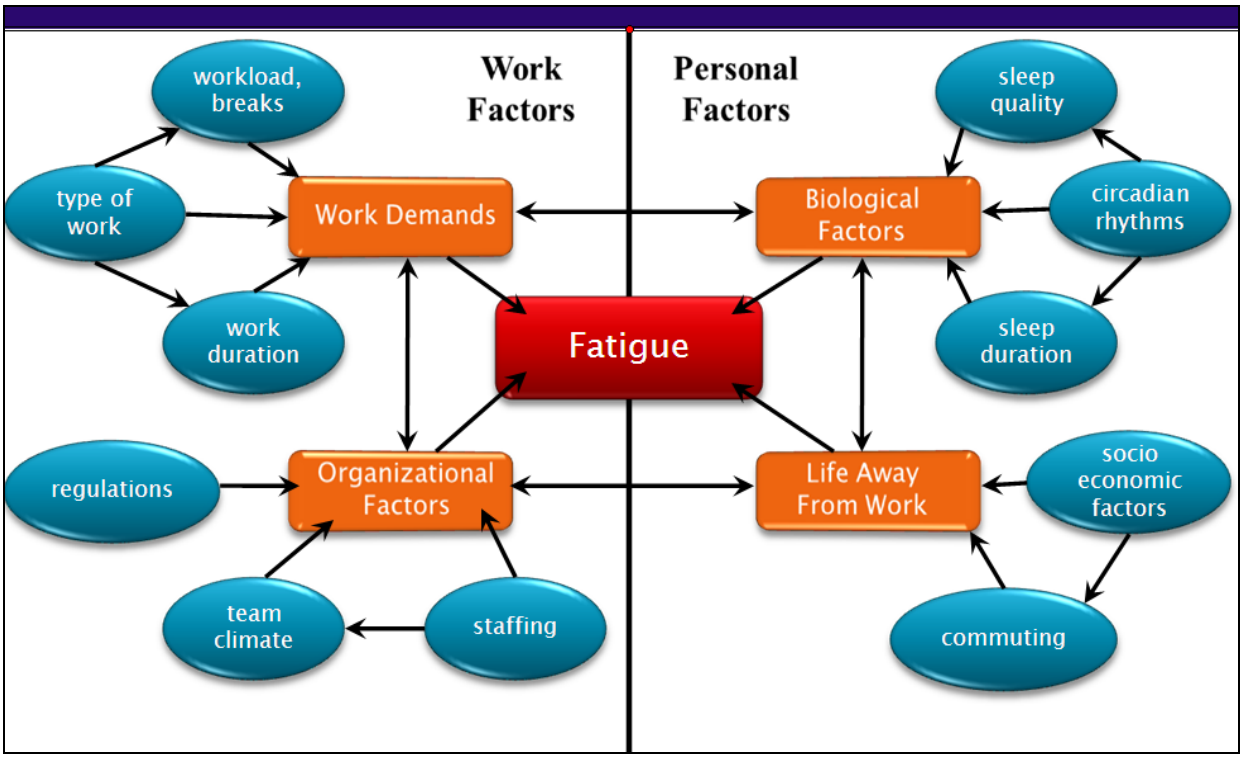

Figure 10. Origins of Fatigue

help to mitigate undesirable effects and minimize fatigue conditions that may contribute to error. The goal is to manage shift work-related disruptions and to develop countermeasures to minimize or eliminate the potentially adverse outcomes.

The affect of fatigue on performance has been an important research topic in the FAA, with a focus primarily on air traffic controllers (for a review see Della Rocco & Nesthus, 2005) and flight attendants (Avers, King, Nesthus, Thomas, & Banks, 2009b; Roma, Mallis, Hursh, Mead, & Nesthus, 2010). Recently, research on fatigue was extended to the TechOps community with the formation of the Technical Operations Fatigue Risk Management (TOFRM) work group. TechOps management established the TOFRM work group to gain an understanding of the basics of fatigue science and fatigue hazards and risks in the TechOps environment and to provide fatigue management insights to leadership to consider.

The TOFRM work group is currently conducting a baseline study to assess fatigue in the TechOps workforce and has jointly reached several initial findings and proposed several fatigue related recommendations. These findings and recommendations were presented to FAA leaders in December 2011 (AJS – Technical Operations Fatigue Risk Management Work Group). They are as follows:

1. Fatigue education and awareness is a key component of any successful fatigue risk management program. Recommendations:
   a. A comprehensive, science-based fatigue education program should be developed and implemented.
   b. This should be coordinated with existing FAA educational programs to raise fatigue awareness.
2. More substantial empirical data is needed concerning the impacts of, and contributors to, fatigue in TechOps. Recommendations:
   a. Management and labor should jointly support the TechOps Fatigue Baseline Study and subsequent research studies.
   b. Fatigue-related data collection should utilize a common taxonomy across all safety reporting programs: Air Traffic Safety Action Program (ATSAP), TechOps Safety Action Program (TSAP), etc.
3. Fatigue risk management best practices include a continuous, repeatable, collaborative process to proactively manage fatigue risk and address issues. Recommendation:
   a. Tech Ops should participate in the development and sustainment of the ATO Fatigue Risk Management System (FRMS).
4. Additional findings that will be addressed with future recommendations include:
   a. Policies, orders, and directives, or lack thereof, can contribute to fatigue risk.
   b. Certain shift scheduling practices may contribute to increased levels of fatigue.
   c. There is no formal ATO policy for employees to self-declare when too fatigued to perform their operational duties.
   d. Fatigue science indicates that routine breaks during work periods improve cognitive performance.
   e. Under certain circumstances, such as extreme weather events, natural disasters, etc., controlled rest periods may be needed to allow employees to mitigate fatigue.

There are multiple educational efforts underway with the TechOps Supervisors Committee and training development. The TOFRM work group has modified a maintenance fatigue e-learning training course developed for maintenance workers in the air traffic industry. The TOFRM work group, along with fatigue scientists, have also reviewed and modified the maintenance fatigue course to make it specific to the TechOps work environment. This course contains three lessons covering fatigue basics, sleep basics, and fatigue management. It is a comprehensive presentation of fatigue issues with recommendations for both fatigue awareness and mitigation. These resources should be available for use at the OCCs within the near future.

While fatigue may have been the underlying issue, shift work was the factor raised most often by specialists and team leads as affecting perceived effectiveness and/or satisfaction (see Table 26). In previous research, shift work has been shown to impact sleep, performance, circadian rhythms, social and family relations, and even influence health status (Cruz, Boquet, Hackwork, Holcomb, & Nesthus, 2004; Cruz, Della Rocco, & Hackworth, 2000). The focus of the TOFRM work group thus far has been primarily on fatigue management, but they will address scheduling and shift practices in the future. Work schedules can directly influence how much time is available for sleep, which in turn impacts fatigue.

Another factor reported by specialists and team leads as affecting fatigue was workload, with an emphasis on staffing and breaks. The number and the complexity of phone calls influenced workload. In past reviews, workload in the OCCs was seen as high (ATO Technical Operations Services Field Evaluation Staff, 2004; King, 2009). Despite the addition of techniques to improve or streamline operations such as digital tech requests and batch coordination, perceptions of workload have remained high (see Table 14). One reason that perceived

workload remained high is that the number of pieces of equipment requiring maintenance had increased, as indicated in Table 29, which was taken from a 2010 report on the FAA Technician Workforce developed by the U.S. Government Accountability Office (GAO-11-91). Thus it is likely that the OCC's management and coordination of maintenance activities has increased as well.

These staffing challenges place a burden on scheduling the OCC staff to maintain a 24/7 operation where the safety of the NAS is the major objective. While actual staffing and scheduling recommendations and policy will be forthcoming from the TOFRM work group recommendations, there are some specific guidelines for shift work scheduling in a 24/7 operation that can be considered now. As identified by Miller (2006), there are nine principles of shift work highlighting the impact of shift work scheduling on the individual in a 24/7 environment. These principles focus on the stability of the circadian rhythm, chronohygiene, or circadian rhythmic health, and worker satisfaction. Circadian rhythm refers to the internal clock governing the sleep-wake cycle of the individual. It is roughly a 24-hour life cycle linked to sunlight cues. Chronohygiene is the effective maintenance of that cycle. The principles are:

Circadian Stability

1. Principle 1: Minimize shift-lag fatigue by incorporating the local daylight/darkness cycle including guidelines on sleep hygiene
2. Chronohygiene
   Principle 2: Short shift length
   Principle 3: Minimum consecutive night shifts
   Principle 4: Recovery after each night shift
   Principle 5: Maximum number of free days on the weekend
   Principle 6: At least 104 days off per year
3. Worker satisfaction
   Principle 7: Equity among shift workers for types of work days and free days
   Principle 8: Predictability of specific work and free days
   Principle 9: Good quality time off

In applying these principles of shift work to the OCCs, we recommend that disruptions to shift lag (similar to jet lag) be minimized by establishing schedules that allow enough sleep time to adequately recuperate. This is especially true when rotating to mids and then back to an eve or day shift. Specifically, it is recommended that there be adequate time following one shift and the next shift to accommodate a sleep period of at least eight hours. That should include an additional two to four hours in excess of the 8-hour sleep period for transition. The NTSB has found that some controllers working quick turnaround shifts with nine or less hours off between shifts make more runway incursions (as reported in Orasanu et al., 2011).

Recommendations. We recommend that mids be as short as possible and that the number of mid shifts worked within a one-week period be kept to a minimum. It is recommended that a scheduled rest day, or two, follow a night shift to allow for recuperation. It is also recommended that schedules maximize time off between shifts and align as many days off together as possible to allow for recuperation. Unless there is an emergency, it is recommended that no more than six successive shifts be scheduled in a work week. It is recommended that the OCCs explore staffing options which both maintain safety and minimize the time teams, and individuals are required to work night shifts.

Educational interventions with a focus on the impact of fatigue can also mitigate the effect of shift lag. They can promote sleep hygiene by providing both the rationale for sleep hygiene and some techniques to accomplish it. The final three principles relate to worker satisfaction. We recommend that scheduling be equitable across teams and individuals, with input from those teams and individuals on development of the schedules. Also important for satisfaction is schedule predictability. Although there may be situational emergencies that require changes to planned schedules, we recommend that schedules be as stable as possible.

No specific recommendations can be made regarding the selection of a forward (days, eves, mids) or backward (mids, eves, days) rotating shift. Research has shown that there is not a significant difference in sleep, vigilance, or performance with the direction of shift rotation (Cruz et al., 2003; Cruz, Boquet, Detwiler, & Nesthus, 2003; Boquet et al., 2004). Nor can a recommendation be made for a fast (multiple shifts per period of time worked) or slow rotation (one shift per period of time worked) for

Table 29
Technician Staffing, Equipment, and Facility Levels

Year	1999	2004	2009
Number of Technicians	6,198	6,345	6,147
Number of pieces of NAS equipment	40,360	41,082	63,846
Number of ATC facilities	651	690	581

shift work. For a review of the advantages and disadvantages of schedule alternatives see Della Rocco and Nesthus (2005) and Orasanu et al. (2011, in review). While slow-rotating shifts provide for the same shift schedule throughout each work week, successive night shifts significantly contribute to fatigue. There is also the problem that, just as a person is accommodating to a particular schedule, the schedule changes during the next work week. Fast rotation of shifts minimize the number of night shifts in succession but requires multiple quick changes in the sleep/wake cycle that can be problematic with regard to fatigue. Regardless of the direction of shift rotation and the speed with which shifts rotate, as mentioned previously, it is important to maximize the time between one shift and the next and to minimize the number of midnight shifts worked.

Study participants mentioned other options for addressing fatigue. First, in regard to shift work, there was a suggestion to create a permanent day shift, staffed by volunteers. Another alternative, within the context of small teams, would be to establish one small team to work a day shift-only schedule. The downside would be in workload. Day shifts have a much higher workload than the other shifts. A solution would be to rotate the day-only schedule among all the small teams. For example, if there were six teams at an OCC, each small team could rotate into the day shift-only schedule for three to six months, every two to three years. This would minimize the negative effects of working mids and high daytime workloads and ensure that employees saw the schedule option as equitable. The impact of having a day shift-only team would also need to be considered in establishing standards of performance and providing feedback.

Our participants made a second shift work recommendation to eliminate the mid shift at all OCCs. The strategy proposed was to close each of the OCCs for a period of time during the timeframe when there was the least amount of work. One participant explained that "…you could take a sliding window where each OCC could close and only run two shifts and not have a mid-shift. If the AOCC closes, say you know at midnight or whatever, you know for four hours from midnight to 4 [a.m.]. Then that's the least amount of phone calls, you don't get a lot of business, you know, but the MOCC and the POCC could take their workload. Two hours later, the MOCC closes for four hours. Now you've got two of them closed, but you still got the NOCC open and the POCC open – it's no big deal." To operationally illustrate this concept, a hypothetical timeline is shown in Table 30, in which the AOCC operates from 0500-0100 and is closed from 0100-0500. Calls into the AOCC during that time would roll over to the MOCC or POCC. The MOCC operates from 0600-0200 and is closed from 0200-0600, with calls into the MOCC rolling over to the AOCC or POCC. Like the MOCC, the POCC operates from 0600 to 0200 and is closed from 0200-0600, with calls rolling over to the AOCC or MOCC. The earlier start time at the POCC accommodates calls from an adjacent time zone.

The ability to roll-over calls from one OCC to another OCC is required in case an OCC becomes non-operational due to environmental or situational factors. The procedure is practiced monthly by the OCCs. A process of having regular roll-overs could possibly strengthen the relationship and improve the roll-over process among OCCs. Regularly exercising the roll-over function could also result in other benefits. For example, if effective during the midnight hours, the roll-over process could be extended to address workload issues among OCCs due to weather, operational emergencies, or simply differences in service area requirements. Establishing and practicing roll-over on a daily basis could be a first step in creating a virtual OCC, one in which workload would be seamlessly distributed across all OCCs. As one participant proposed, "So there would have to be a big leveling of the playing field in that arena. Not only the processes but the data and everything, but they're not obstacles, in my opinion, that can't be overcome; they just have to be worked out. And then you could have that leveling of a playing field and have one virtual OCC that would operate more efficiently, than the three separately are doing right now." Moving from three service-area-specific OCCs to one virtual OCC, while appealing from a workload perspective, would highlight differences among OCCs that would need to be understood and managed. Introducing limited, but regular, roll-over would help in identifying and resolving issues in advance of full implementation of a virtual OCC.

The strategy of closing each OCC for fours hour per night and using the roll-over capability to ensure coverage

Table 30
Hypothetical Alternate OCC Timeline

AOCC	2100	2200	2300	2400	*0100*	*0200*	*0300*	*0400*	0500	0600	0700	0800
MOCC	2000	2100	2200	2300	2400	0100	*0200*	*0300*	*0400*	*0500*	0600	0700
POCC	1800	1900	2000	2100	2200	2300	2400	0100	*0200*	*0300*	*0400*	*0500*

* Times highlighted and italicized indicate when the OCC is closed

at all OCCs would begin to address the fatigue issue by eliminating the four hours normally worked during the midnight shift at each OCC. Dijk, Duffy, and Czeisler (1992) found that most errors made during midnight, or graveyard shifts, as they are sometimes called, were between the hours of 0300-0600 (as cited in Orasanu et al., 2011).

During the compressed daily work period, two or three shifts would be possible, depending on the staffing needs of the OCC. For example, a hypothetical two- or three-shift model is shown in Table 31. One participant explained: "So what you've done is by eliminating the complete midnight shift, every day of the week, all that staffing can then be applied to the day shift and the evening shift. With the sliding window, there would always be at least two OCCs open – NOCC and at least one of the OCCs. But you've removed the midnight shift as a player."

The proposed timeline and shifts are hypothetical to illustrate the concepts. There may be issues that were not considered in this analysis, such as the impact on differential pay received by employees working midnight shifts, incompatible phone systems, or other factors that will need to be considered. It is recommended, however, that the OCCs work together to review and consider implementing a strategy to minimize the affect of shift work on employee fatigue. Strategies proposed in this section included training employees to manage fatigue, develop a shift work schedule that minimizes the negative affects on employee well-being, develop alternate schedules, and use a roll-over capability to reduce the need for OCCs to have midnight shifts.

SUMMARY AND CONCLUSIONS

The participants made many recommendations that would improve both effectiveness and satisfaction in the OCCs. The first intervention proposed was to establish and implement small teams within the OCCs. Other interventions discussed were in training, performance feedback, and fatigue management and schedules. The recommendations were supported by the research literature in OD and they were tied directly to issues raised by the specialists and team leads at the OCCs. Shown in Table 32 are the expected relationships between recommendations and factors affecting perceived effectiveness of the OCCs and the satisfaction of specialists and team leads. For example, implementing small teams was proposed to reduce workload, improve the use of resources, and facilitate knowledge of results. Whereas, training recommendations would likely only affect workload and resources, with little impact on knowledge of results.

Table 31
Hypothetical Shifts with Alternate Timeline

	Early Day	Late Day	Eves
Strategy 1 – 2 Shifts			
AOCC	0500-1500		1500-0100
MOCC	0600-1600		1600-0200
POCC	0600-1600		1600-0200
Strategy 2 – 3 Shifts			
AOCC	0500-1500	1000-2000	1500-0100
MOCC	0600-1600	1000-2000	1600-0200
POCC	0600-1600	1000-2000	1600-0200

Table 32
The Relationship of Recommendations to Factors Seen as Affecting Operations and Satisfaction

	Small Teams	Training	Performance Feedback	Fatigue Risk Management
Workload Shiftwork Staffing Breaks	X	X	X	X
Resources Training Technology	X	X		
Knowledge of Results Performance Feedback Management Involvement	X		X	

Organization development is designed to be an ongoing, collaborative process between an organization and a change agent familiar with theories and practices of applied behavioral science. The current research serves as an initial assessment of organizational processes within the OCCs, with a set of proposed interventions designed to improve organizational effectiveness and employee satisfaction. We proposed interventions that could be implemented, individually or in combination, given the requirements and/or constraints within the TechOps OCC environment. However, some of the recommendations may be easier than others to implement, and the time required and cost for implementation will vary. It is also likely that some interventions will have a higher priority than other interventions. These issues and others are considered in action planning, the next step in the OD process.

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APPENDIX A

Questions Used to Stimulate Discussions With OCC Participants

Background

1. How long have you worked for the FAA/TO? in the OCC? What is your job title in the OCC?
2. What job in TO did you have before this one?
3. Briefly, how would you describe your job in the OCC? What do you see as your primary tasks?

Technical Background

1. Do you consider yourself an expert? If so, in what area is your expertise?
2. Do others in the OCC know what your expertise is in?
3. Do you know the area of expertise of others in the OCC?
4. Is knowing the expertise of others in the OCC helpful or important to your job?
5. Do you use your expertise in doing your job in the OCC? If so, how?
6. How do you maintain your expertise? How do others maintain their expertise?
7. Do your colleagues or team leader ask you for advice? Do you ask others for advice?
8. What expertise is needed in the OCC?
9. Does the OCC have the personnel with the expertise needed to do the job?

Task, Workflow, and Interdependency

1. In completing each of your tasks, do you work individually or as part of a team?
2. If on a team, how do you define your team (e.g., people in TO, all the people in your OCC, specialists in the OCC, people you work with on a shift, etc.)?
3. To what extent do your tasks require you to work with others in the OCC?
4. What type of information is routinely shared among OCC personnel?
5. What do you need from others to do your job and what do others need from you?
6. What means do you use to collaborate with others (e.g., phone, email, chat, face-to-face, other)?
7. **Added question** – Do you and/or would you prefer to work as a member of a small team?
8. Does everyone in the OCC do his or her fair share of the work? If not, how do others in the OCC respond/help?
9. Is team collaboration supported and/or rewarded by the organization? If so, how?
10. Are there clearly established goals for collaboration? If so, do leaders emphasize the importance?
11. Which of the following patterns best describes the workflow on each of your tasks (see workflow illustration)?
12. Do you think it is worthwhile for the OCC to work as a team?
    a. If so, how would you structure the teams within the OCC? Would it be possible for specialists to specialize in a functional area?

Cohesion (Questions refer to team identified above. If no team is identified skip this section)

1. With how many people on your team do you interact/cooperate with regularly?
2. To what extent do you think the members of your team get along together?

   1 Not Well to 7 Very Well
3. Do members of your team take a personal interest in one another?

   1 Not at All to 7 A Great Deal
4. With how many people do you occasionally talk about personal things?

   No one, 1 or 2, More than 2
5. With how many people on your team do you engage in one of the following activities: go to dinner, go to the movies, visiting?

   No one, 1 or 2, More than 2
6. Do you think the members of your team would defend each other from criticism from outsiders?

   1 Not at all to 7 A Great Deal
7. How much a part of the team do you feel?
8. Is there a high spirit of teamwork on your team? What would increase it?
9. To what extent do you think your team is united in trying to reach its goals for performance?

   Do any of your team members have conflicting goals or aspirations for team performance?
10. Are you happy with your team's desire to complete their tasks?
11. Overall do you feel that you can trust the people with whom you collaborate?

Workload and Complexity

1. How would you assess your current workload level? 1 low to 7 high
   a. Mental Demand – How mentally demanding is your job (e.g., thinking, deciding, remembering, searching, etc.)?
   b. Physical Demand – How physically demanding is your job (e.g., pushing, pulling, turning, controlling, etc.)?
   c. Temporal Demand – How hurried or rushed are you at work?
   d. Performance – How successful are you at accomplishing your job?
   e. Effort – How hard did you have to work to accomplish your level of performance (mentally and physically)?
   f. Frustration – How insecure, discouraged, irritated, annoyed, or stressed are you while doing your job?
2. How did the new workstations affect your workload? Easier, Harder, No Difference
3. Do you primarily follow predetermined methods or standard operating procedures (SOPs) to accomplish your tasks in the OCC or are you creating new methods or strategies to do some of your work, solving problems, being creative, etc.?
4. If using predetermined methods or SOPs, are they well defined? Are they updated regularly and how are you made aware of the changes?

5. If creating new methods, how do you share your ideas, "best practices" with others in your OCC, across the three OCCs?

Effectiveness and Satisfaction (Outcomes)

1. In your opinion, how well does your OCC operate?

   1 not very well to 7 very well

2. Are you satisfied with your job as a whole?

   1 Not at all to 7 A Great Deal

3. How would you improve operations or increase your satisfaction in the OCC?

Additional Comments

1. Is there anything about your job that I haven't asked that you think I should know to better understand your work?
2. Is there anything you would like to see happen as a result of this research? Not happen?

The following sections were covered in some of the interviews, as time permitted.

Selection and Training

1. How were you selected to work in the OCC?
2. How long does it take a new specialist to learn OCC tasks?
3. What makes OCC tasks easy or hard to learn?
4. How do you know if you are doing a good job?
5. How do you know if a new OCC employee is trained?
6. What could be done to improve selection or training of OCC personnel?

Environment (type of work, noise, temperature, lighting, workstation design)

1. How has your work environment changed since moving from your previous job to the OCC?
2. How comfortable are you with your work environment?

   1 not very comfortable to 7 very comfortable

3. Does the OCC physical work environment support you in doing your job?

   1 Not at all to 7 Completely

4. How would you change your work environment to make it better?

APPENDIX B
Defining the Research Purpose for Voluntary Participation

TO: OCC Specialists

FROM: Linda Pierce, FAA Civil Aerospace Medical Institute (CAMI)

SUBJECT: Voluntary Participation in Research

The purpose of this email is to request your participation in a research project entitled "OCC Roadmap to 2014." The focus of this research is to review how work is currently done within each of the OCCs and to assess how the OCCs might evolve to meet future challenges in aviation maintenance.

If you agree to participate, I will ask you to meet with me for approximately 1 hour during your shift. During our meeting, I'll ask you questions about the nature of your work and work environment, your areas of expertise and how you were selected and trained for work in the OCC, how you share information and work with others within the OCC, and the extent to which you are satisfied with OCC processes or have suggestions for process improvements. The results of our meeting will be confidential. With your permission, I will tape record our discussions, but tape recordings will be transcribed without personally identifying information and then destroyed to ensure your anonymity.

The sponsor for this research is AJW-131. The research is conducted under the Air Traffic Program Directive / Level of Effort Agreement between the Human Factors Research and Engineering Group (AJP-61), FAA Headquarters and the Aerospace Human Factors Division (AAM-500) of the Civil Aerospace Medical Institute

The research will be conducted under my direction, and I will be your point of contact for questions. My contact information is Linda Pierce, Ph.D., Personnel Research Psychologist, FAA Civil Aerospace Medical Institute, Oklahoma City (405) 954-6835, (linda.pierce@faa.gov).

Regards,

Linda Pierce