Shared Leadership in Multiteam Systems: How Cockpit and Cabin Crews Lead Each Other to Safety

Nadine Bienefeld and **Gudela Grote**, ETH Zurich, Zurich, Switzerland

Objective: In this study, we aimed to examine the effect of shared leadership within and across teams in multiteam systems (MTS) on team goal attainment and MTS success.

Background: Due to different and sometimes competing goals in MTS, leadership is required within and across teams. Shared leadership, the effectiveness of which has been proven in single teams, may be an effective strategy to cope with these challenges.

Method: We observed leadership in 84 cockpit and cabin crews that collaborated in the form of six-member MTS aircrews (N = 504) during standardized simulations of an in-flight emergency. Leadership was coded by three trained observers using a structured observation system. Team goal attainment was assessed by two subject matter experts using a checklist-based rating tool. MTS goal attainment was measured objectively on the basis of the outcome of the simulated flights.

Results: In successful MTS aircrews, formal leaders and team members displayed significantly more leadership behaviors, shared leadership by pursers and flight attendants predicted team goal attainment, and pursers' shared leadership across team boundaries predicted cross-team goal attainment. In cockpit crews, leadership was not shared and captains' vertical leadership predicted team goal attainment regardless of MTS success.

Conclusion: The results indicate that in general, shared leadership positively relates to team goal attainment and MTS success, whereby boundary spanners' dual leadership role is key.

Application: Leadership training in MTS should address shared rather than merely vertical forms of leadership, and component teams in MTS should be trained together with emphasis on boundary spanners' dual leadership role. Furthermore, team members should be empowered to engage in leadership processes when required.

Keywords: aircrew behavior, aviation safety, high-risk teams, leadership, multiteam systems, shared leadership, team performance, team work

Address correspondence to Nadine Bienefeld, ETH Zurich, Department of Management, Technology, and Economics, Organization Work and Technology Group, Weinbergstrasse 56/58, CH-8092 Zurich, Switzerland; e-mail: n.bienefeld@gmail.com.

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INTRODUCTION

> On June 2nd 1982, what had started as a normal flight from Dallas to Toronto ended in a fatal tragedy: After a failure in communication and coordination between the cabin and cockpit crew, the captain had underestimated the risk posed by the smoke and hidden fire in the cabin and vital time was lost until an emergency landing was initiated. Although pilots eventually brought the aircraft safely to the ground, 23 people were killed by the toxic smoke or the fire that engulfed the airplane shortly after touch-down and could no longer be evacuated. (National Transportation Safety Board, 1983)

This description of the Air Canada 797 accident sadly illustrates that in safety-critical contexts, such as aviation, a failure in cross-team collaboration can have severe consequences. In an emergency aboard an aircraft, cockpit and cabin crews—despite their differences in tasks, roles, and responsibilities—need to work together interdependently to make rapid decisions and fulfill a multitude of problem-solving tasks in a dynamic and highly stressful environment. Their common goal of saving the lives of all passengers and crew can be attained only if each team attains its goals and if those goals are aligned. If, for example, cockpit crews achieved a safe landing, but cabin crews failed to protect or evacuate passengers or vice versa, their joint mission would fail altogether.

Most researchers thus far have focused on within-team processes, thereby overlooking the effects of cross-team collaboration necessary to attain such common goals (DeChurch & Zaccaro, 2010). This approach is particularly true for team research in aviation, where the focus of investigation has been set on cockpit crews (see Chute & Weiner, 1995, for an exception). It is the aim of this study, therefore, to widen the focus of research from single teams to "teams of teams" or so-called *multiteam systems* (MTS; Mathieu, Marks, & Zaccaro, 2001).

An MTS is defined by three core characteristics (Mathieu et al., 2001), which in the following are illustrated by the example of cockpit and cabin crews (hereafter "MTS aircrews"): First, during any safety-critical situation aboard an aircraft (e.g., smoke and fire, technical problems, security threats, or medical emergencies), cockpit and cabin crews need to swiftly change from normal to emergency tasks to respond to unexpected events (Criterion 1). Second, they share input, process, and outcome interdependencies (Criterion 2), in that they have a joint mission and need to transfer critical information and coordinate their activities within and across teams, operate with the same environmental constraints, and use the same equipment. And third, the overall success depends not only on the attainment of each component team's goal but on the fulfillment of the overall MTS goal (Criterion 3).

This vital need to accomplish separate, and sometimes competing, team goals and simultaneously strive toward the fulfillment of an overall MTS goal places unique challenges on leadership, which is paramount for the success of these systems (DeChurch & Marks, 2006). Thus far, authors of only two studies have investigated leadership in MTS: First, DeChurch and Marks (2006) found, in an insightful laboratory study, that MTS success was determined by leaders who performed coordinating and strategizing leadership functions both within and across teams to manage and align multiple goals within the system. Second, in a qualitative analysis of historic events in successful versus unsuccessful MTS, DeChurch and colleagues (2011) identified a set of critical leadership functions (e.g., gathering information, planning, coordinating) that contributed to MTS success at three levels of analysis: within teams, across teams, and with external constituencies.

These findings suggest that multiple leaders are required to guide and align the activities of MTS members within and across teams. Thus far, however, the focus of investigations has been placed either on leadership functions and the target, rather than the origin of leadership (DeChurch et al., 2011), or on formal leader roles that were preassigned to a set of chosen study participants representing external MTS-leader teams (DeChurch & Marks, 2006). For real-world MTS, we still know little about *who* the natural leaders are and how leadership by different leaders in the system distinctively impacts team and MTS goal attainment. Does a successful MTS rely exclusively on vertical leadership by formal leaders, or do formal leaders *and* team members participate in a shared leadership process to enhance team and MTS effectiveness?

Only recently, Zaccaro and DeChurch (2011) proposed that apart from top-down vertical leadership, shared leadership may be effective in MTS, but this hypothesis has not been tested yet. In this study, we follow up on this proposition and aim to examine empirically the effectiveness of shared leadership in MTS. For this purpose, we observed 84 six-member MTS aircrews composed of cockpit and cabin crewmembers who had to work together closely and interdependently toward the attainment of team and MTS goals in response to simulations of an in-flight emergency.

Shared Leadership in MTS

Shared leadership has been defined as "a dynamic, interactive influence process among individuals in groups for which the objective is to lead one another to the achievement of group goals" (Pearce & Conger, 2003, p. 3). This concept builds on functional leadership theories (Zaccaro, Rittman, & Marks, 2001) and includes vertical top-down leadership by formal leaders as well as bottom-up or horizontal leadership by team members.

Several studies have confirmed positive effects of shared leadership on the performance of single teams, particularly when interdependence and complexity of tasks were high (see Friedrich, Vessey, Schuelke, Ruark, & Mumford, 2009, for a review). Furthermore, shared forms of leadership were found to be effective in teams operating in extreme or safety-critical situations (e.g., firefighting or medical action teams) because when levels of complexity, time pressure, and task load rise, vertical leadership structures can fail since even the most competent formal leader cannot cope with the large amount of leadership tasks required by himself or herself anymore. Also, in such time-critical situations, formal leaders may themselves be fully absorbed by problem-solving tasks, or they might be physically separated from the rest of the team (Klein, Ziegert, Knight, & Xiao, 2006; Künzle et al., 2010).

In the event of an emergency on board, MTS aircrews are faced with the same challenges: Captains and pursers, in their capacity as formal leaders, must simultaneously attend to a multitude of leadership and problem-solving tasks and may need informal leadership support from first officers and flight attendants. We therefore assume that if formal leaders and team members engage in a shared leadership process and thus fulfill more leadership tasks, the MTS as a whole is more likely to be successful. Hence, we propose the following:

> *Hypothesis 1:* In successful MTS aircrews, formal leaders (captains, pursers) and team members (first officers, flight attendants) display significantly more leadership than in unsuccessful MTS aircrews.

Shared leadership within teams. To attain component team goals, leaders and team members must fulfill a number of problem-solving tasks. Although for cockpit and cabin crews, the majority of these tasks are prescribed by procedures and checklists, leadership is needed to distribute duties, allocate resources, or coordinate tasks. As argued before, the leadership demands required in emergency situations are likely to surpass the capacity of individual formal leaders, and shared leadership is expected to be more effective. Hence, if team members in component teams participate in the shared leadership process to back up and support their formal leaders, team goal attainment in these component teams is likely to be higher. Furthermore, according to Marks, DeChurch, Mathieu, Panzer, and Alonso (2005), higher goal attainment in component teams contributes to the overall MTS success. Thus, we hypothesize the following:

> *Hypothesis 2:* Only in successful MTS aircrews is leadership shared *within* teams, in that team members' informal leadership adds incrementally to team goal attainment beyond the leadership of formal leaders.

Shared leadership across teams. Apart from leadership within teams, the specific challenge of leadership in MTS is to synchronize actions and goals across component teams (DeChurch et al., 2011; DeChurch & Marks, 2006). Mathieu et al. (2001) proposed that MTS leaders need to execute boundary-spanning activities (see Marrone, 2010) to align component team goals toward the overall MTS goal. Furthermore, in a recent study, Davison, Hollenbeck, Barnes, Sleesman, and Ilgen (2012) found that the success of MTS was dependent on boundary-spanning activities made by formal leaders in core teams of the system.

In MTS aircrews needing to deal with an onboard emergency, pursers are required to span the boundary across cabin and cockpit crews to gather and transfer crucial information for problem solving from and to teams on both sides of the boundary. Captains—due to their immobile position in the cockpit and closed cockpit door—are unable to gain and maintain an overview of the situation and therefore cannot lead across teams. Likewise, first officers are tied to the cockpit, and flight attendants are instructed to communicate to pursers instead of pilots so that boundary-spanning activities stay centralized in one person.

Therefore, only pursers have an opportunity to lead across teams. If pursers engage in a shared leadership process with captains and first officers, they may enhance cockpit goal attainment because pilots' decisions and actions strongly depend on the information and guidance received from across the boundary. Furthermore, according to DeChurch and Marks (2006), leadership across teams is key to the overall MTS success. Thus, we posit the following:

> *Hypothesis 3:* Only in successful MTS aircrews is leadership shared *across* teams, in that pursers' leadership adds incrementally to cockpit goal attainment beyond captains' and first officers' leadership.

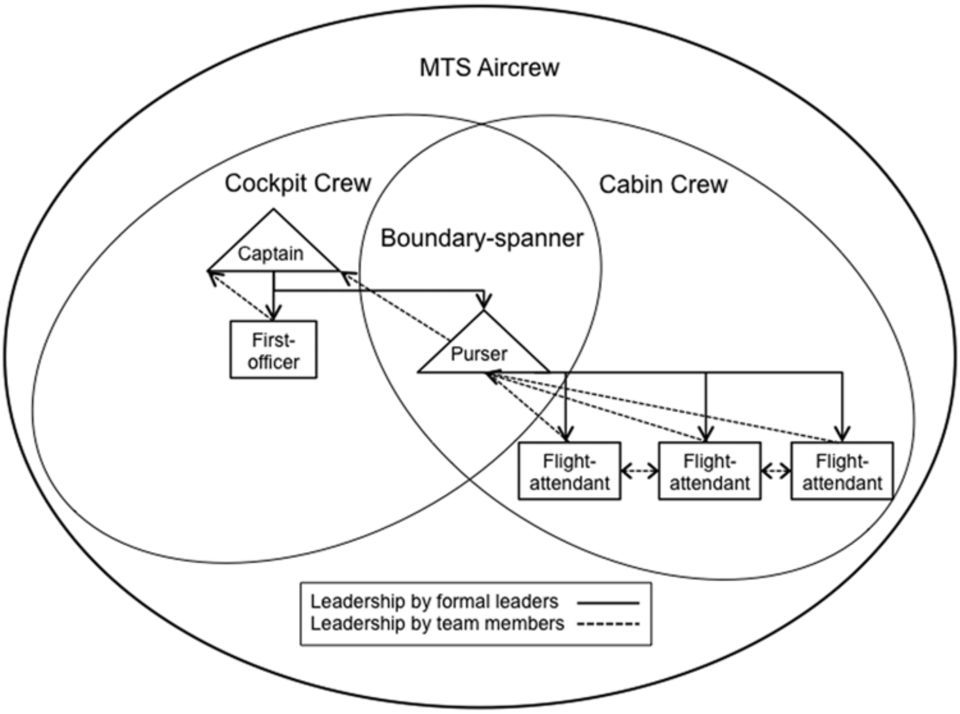

Figure 1. Depiction of potential for shared leadership in multiteam system aircrews consisting of formal leaders (triangle) and team members (rectangle).

In sum, we posit that in successful MTS aircrews, formal leaders and team members participate in a shared leadership process within and across teams and thus predict the attainment of team and MTS goals. Figure 1 delineates these leadership interactions for various emergency and/or normal situations.

METHOD

Participants

A total of 504 cockpit and cabin crewmembers from a European airline participated in this study. Concordant with participants' actual job positions, 84 six-person, two-team MTS aircrews were formed randomly by drawing lots. Each cockpit crew consisted of one captain and one first officer, and each cabin crew included one purser and three flight attendants. Job experience at the airline ranged from 9 to 37 years for captains (M = 26.18, SD = 5.16), 1 to 31 years for first officers (M = 13.02, SD = 6.58), 2 to 37 years for pursers (M = 14.46, SD = 9.91), and 1 to 29 years for flight attendants (M = 11.94, SD = 7.64). The average age of participants in years was 51 for captains, 38 for first officers, 44 for pursers, and 37 for flight attendants. All pilots, 39% of pursers, and 31% of flight attendants were male.

The level of crew familiarity represented normal working conditions, because random selection of participants was based on crewmembers' normal flight schedules (i.e., unfamiliar crewmembers come together for a specific flight and disband again afterward). Participation was voluntary, and withdrawal from participation was possible any time. All candidates agreed to participate, and nobody withdrew. Participants' anonymity was guaranteed and no incentives were given.

Procedure

The study took place during approximately 120 days spent on site in the recurrent safety refresher training course that was offered to all

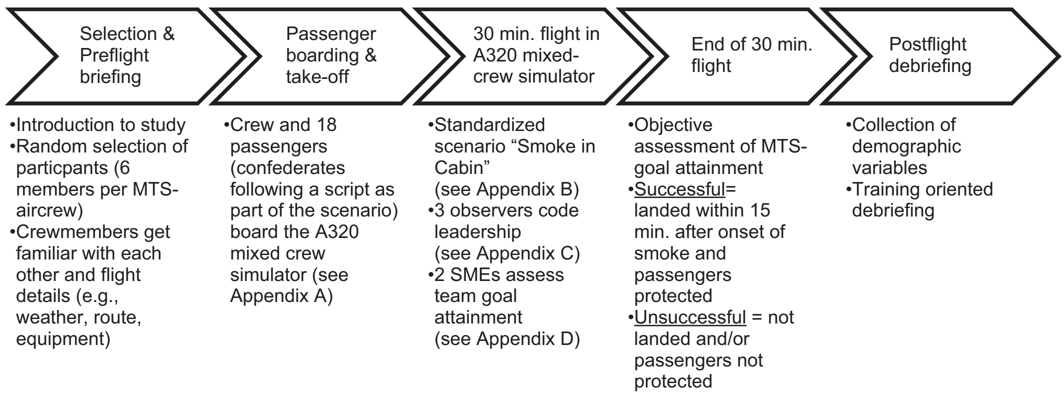

Figure 2. Study procedure and study measures used in each phase of data collection.

cockpit and cabin crewmembers at the respective airline. Figure 2 outlines the standardized study procedure.

Scenario

Based on the report of the Air Canada accident described earlier, a standardized 30-min scenario was created during which crewmembers had to (a) manage a number of proceduralized problem-solving tasks under time pressure and (b) interact with 18 passengers (trained confederates who acted according to a script as part of the scenario). The Airbus A320 mixed-crew flight simulator—a high-fidelity simulator equipped with a two-man cockpit and a fully furnished passenger cabin—was used for this purpose (see Appendix A, Figure A1). For a detailed description of the scenario, see Appendix B. The scenario was developed by the first author together with two subject matter experts (SMEs) and validated by one training captain and three safety instructors, who all confirmed its high face validity.

Measures

Leadership. Based on Yukl's (2006) well-established framework of leadership functions, we designed a coding scheme for the operationalization of leadership capturing 10 distinct and mutually exclusive leadership behaviors (Appendix C). It is important to note that these leadership codes did not carry any effectiveness ratings. As such, we ensured that the coding of leadership (independent variable) was distinctly separate from the assessment of team goal attainment (dependent variable) and MTS goal attainment (grouping variable).

Data coding. By means of event sampling based on verbal team interactions, three observers coded the occurrence of leadership by frequency and type of leadership functions carried out by formal leaders and team members (leadership taxonomy by Yukl, 2006; see Appendix C). Union restrictions generally prohibited video recordings. An exception could be negotiated concerning 10 videos used exclusively for calculating interrater reliability. For the main data collection, observations had to be carried out in real time. To facilitate real-time coding, observer training was extensive (initial training plus 4 weeks in the field), and TrackVivo—a software tool for high-speed recording of concurrent behavioral events in live settings—was employed (SmarTrack, 2009). Furthermore, each observer was assigned to focus on the interactions of two crewmembers only, so that parallel events could be captured simultaneously.

One coding unit was defined as a distinct communication utterance involving at least two crewmembers. Each leadership act was recorded in terms of an initiator and a recipient. A new unit started as soon as the speaker, the recipient, and/or the topic changed. In case of several separate leadership functions being addressed within one utterance, each function was coded in a consecutive manner. All other communications or activities not classified as leadership were not coded.

Observers and interrater agreement. The first author and two graduate psychology students with experience as pilots or flight attendants served as on-site observers. As a protection against biases, all three coders were blind to the assessment of team goal attainment and, apart from the first author, were blind to the study hypotheses. To check for interrater reliability, the observers independently coded video data of a test sample of 10 crews (12% of data) also in real time. Within-group agreement of raters was calculated using the *rwg* index (James, Demaree, & Wolf, 1984) and resulted in substantial interrater agreement for the different leadership codes, ranging from *rwg* = .82 (planning) to *rwg* = 1.0 (delegating).

Team goal attainment. Two independent SMEs blind to our hypotheses assessed goal attainment of cockpit and cabin crews in real time using PROLOFT (Bienefeld, 2009), a scenario-specific and checklist-based goal attainment scale consisting of 22 items with scores that could range from 0 to 60 points (Appendix D). Fulfillment of tasks required coordinated team actions. Each item contributing to team goal attainment was rated for correctness, completeness, and timeliness. Level of importance was calculated by weighting each item by a factor of 1 (*little importance*) to 3 (*high importance*). This scale was developed by the first author in accordance with the airline's emergency checklists and flight operations manuals. It was validated by five SMEs over the course of three discussion rounds using Delphi technique (Clayton, 1997). To establish interrater reliability, two raters independently rated video data of a test sample of 10 crews (12% of data) also in real time. Cohen's (1960) kappa for the performance raters was $\kappa = .85$ for cockpit performance and $\kappa = .92$ for cabin performance, indicating good reliability (Landis & Koch, 1977).

MTS goal attainment. MTS goal attainment was measured objectively (successful vs. unsuccessful) on the basis of the outcome of the simulated flight. The MTS goal could not be achieved by the efforts of one team alone, because the following two conditions had to be fulfilled within 15 min from the onset of the smoke: (a) Aircraft landed at the closest suitable airport (two airports were within reach), and (b) passengers were relocated to a smoke-free area, smoke was contained, and passengers and cabin were fully prepared for the emergency landing and evacuation. This dichotomous measure was chosen on the basis of findings from real accidents stating that these conditions determine the chances of survival in case of smoke or fire aboard an aircraft (e.g., Burian, 2005).

Control Variables

Job experience at the airline in years and gender were included as control variables in our analyses, since prior research indicates that these variables can potentially influence leadership (e.g. Eagly, Darau, & Makhijani, 1995; Mumford et al., 2000).

ANALYSES AND RESULTS

Analyses

To control for small variations in the duration of the scenario, the raw data frequencies of leadership were transformed to rates per minute by dividing the total sum of leadership observed in each job position by the exact duration of the scenario in minutes. The leadership variable used in all analyses is an aggregate of the total number of observed leadership functions per minute in each job position. Each aircrew consisted of one captain, one first officer, one purser, and three flight attendants; therefore, we averaged the total scores of the three flight attendants per crew to form a single score for this job position also. Team goal attainment was calculated as the total score of the 22 weighted items of the PROLOFT scale per crew. In all of our hypotheses, we aimed to examine differences in leadership in successful versus unsuccessful MTS aircrews; therefore, we split the data by the dichotomous grouping variable MTS goal attainment (successful vs. unsuccessful). Out of a total of 84 MTS aircrews, this procedure resulted in 60 successful versus 24 unsuccessful MTS aircrews. Descriptive statistics of study variables are displayed in Table 1.

Results

To test Hypothesis 1—that formal leaders and team members demonstrate significantly more leadership in successful than in unsuccessful MTS aircrews—we computed independent-sample *T* tests for each group of formal leaders

TABLE 1: Descriptive Statistics of Leadership and Team Goal Attainment for Cockpit and Cabin Crews in Successful Versus Unsuccessful Multiteam System (MTS) Aircrews

Crewmember	Goal Attainment	MTS Successful[a]				MTS Unsuccessful[b]			
		Min.	Max.	*M*	*SD*	Min.	Max.	*M*	*SD*
Cockpit crew	Cockpit goal attainment	28.10	47.62	38.56	4.53	28.33	48.57	38.11	6.22
Captains	Leadership	0.35	0.82	0.66	0.10	0.12	0.71	0.50	0.20
First officers	Leadership	0.24	0.71	0.45	0.12	0.00	0.35	0.22	0.13
Cabin crew	Cabin goal attainment	30.48	51.19	38.86	5.52	15.00	32.62	25.70	5.77
Pursers	Leadership within	0.00	0.71	0.50	0.16	0.12	0.71	0.41	0.16
	Leadership across	0.00	0.71	0.40	0.23	0.00	0.35	0.16	0.11
Flight attendants	Leadership	0.00	0.70	0.40	0.24	0.12	0.59	0.39	0.13

[a]$n = 60$.
[b]$n = 24$.

TABLE 2: Results of Independent *T* Tests of Leadership in Successful Versus Unsuccessful Multiteam System (MTS) Aircrews

Crewmember	Successful MTS Aircrews[a]		Unsuccessful MTS Aircrews[b]			
	M	*SD*	*M*	*SD*	*t*(82)	*p*
Formal leaders						
Captain	.66	.10	.50	.20	−3.72	.000
Purser within	.50	.16	.41	.16	−2.17	.033
Purser across	.40	.23	.16	.11	−6.13	.000
Team members						
First officer	.45	.12	.22	.13	−7.37	.000
Flight attendant	.40	.24	.39	.13	−0.12	.907

[a]$n = 60$.
[b]$n = 24$.

(captains, pursers) and team members (first officers, flight attendants). As shown in Table 2, significantly more leadership was demonstrated by captains, pursers (within and across), and first officers in successful MTS aircrews, thus corroborating Hypothesis 1 for all team members except flight attendants.

To test Hypothesis 2—that shared leadership of formal leaders and team members predicts team goal attainment in each component team only in successful MTS aircrews—we computed two separate hierarchical regression analyses: one for cabin crews and one for cockpit crews.

Cabin crews. As displayed in Table 3, leadership of pursers, entered as a second predictor into the hierarchical regression model after controlling for job experience and gender, was a significant predictor for team goal attainment in successful MTS aircrews (β = .42, ΔR^2 = .16, p = .002) but not in unsuccessful MTS aircrews.

TABLE 3: Hierarchical Multiple Regression Analyses Predicting Cabin Crew Goal Attainment From Shared Leadership Within Teams in Successful Versus Unsuccessful Multiteam System (MTS) Aircrews

	β				
Variable	Step 1	Step 2	Step 3	R^2	ΔR^2
Successful MTS aircrews[a]					
Step 1					
Job experience purser[c]	.06	−.07	−.08	.02	.02
Job experience flight attendant[c]	.10	.03	.02		
Gender purser[d]	.12	−.00	−.18		
Gender flight attendant[d]	−.18	−.11	.07		
Step 2					
Leadership purser within		.42	.42	.18	.16**
Step 3					
Leadership flight attendant			.28	.25*	.07*
Unsuccessful MTS aircrews[b]					
Step 1					
Job experience purser[c]	−.27	−.27	−.27	.14	.14
Job experience flight attendant [c]	.04	.04	.05		
Gender purser[d]	−.45	−.45	−.46		
Gender flight attendant[d]	.25	.25	.29		
Step 2					
Leadership purser within		−.01	.36	.14	.00
Step 3					
Leadership flight attendant			−.37	.15	.01

[a]$n = 60$.
[b]$n = 24$.
[c]In years working at respective airline.
[d]0 = male, 1 = female.
*$p < .05$. ** $p < .01$.

Furthermore, leadership demonstrated by flight attendants, entered as a third predictor, significantly predicted team goal attainment beyond pursers' within-team leadership ($\beta = .28$, $\Delta R^2 = .07$, $p = .035$) but, again, only in successful MTS aircrews. Hence, we can accept Hypothesis 2 for cabin crews and confirm that only in successful MTS aircrews did shared leadership of both formal leaders and team members predict team goal attainment. Whereas for pursers the effect size was medium, with 16% additional variance explained, it was only small for flight attendants, with 7% explained variance.

Cockpit crews. As shown in Table 4, captains' leadership, entered as a second factor after controlling for job experience, was a significant predictor for team goal attainment, both in successful ($\beta = .38$, $\Delta R^2 = .13$, $p = .005$) and in unsuccessful ($\beta = .53$, $\Delta R^2 = .25$, $p = .014$) MTS aircrews. Leadership demonstrated by first officers, entered as a third predictor, however, had no influence on team goal attainment beyond captains' leadership either in successful or in unsuccessful MTS aircrews. Hence, we cannot confirm Hypothesis 2 for cockpit crews.

To test Hypothesis 3—that pursers' leadership across teams explains a significant amount

TABLE 4: Hierarchical Multiple Regression Analyses Predicting Cockpit Crew Goal Attainment From Shared Leadership Within Teams in Successful Versus Unsuccessful Multiteam System (MTS) Aircrews

	β				
Variable	Step 1	Step 2	Step 3	R^2	ΔR^2
Successful MTS aircrews[a]					
Step 1					
Job experience captain[c]	−.19	−.08	−.08	.04	.04
Job experience first officer[c]	.10	.00	.02		
Step 2					
Leadership captain		.38	.37	.17*	.13**
Step 3					
Leadership first officer			.12	.18*	.01
Unsuccessful MTS aircrews[b]					
Step 1					
Job experience captain[c]	.26	.06	.12	.08	.08
Job experience first officer[c]	−.24	−.14	−.15		
Step 2					
Leadership captain		.53	.44	.33*	.25*
Step 3					
Leadership first officer			.18	.35*	.02

Note. Gender in cockpit crews was constant (100% male) and was therefore not included as a control variable.
[a] $n = 60$.
[b] $n = 24$.
[c] In years working at respective airline.
$*p < .05$. $**p < .01$.

of variance in cockpit goal attainment beyond control variables and captains' and first officers' leadership—we computed a hierarchical regression model with captains' and first officers' job experience and leadership entered in Step 1, pursers' job experience and gender in Step 2, and pursers' leadership across teams in Step 3. As can be seen in Table 5, only in successful MTS aircrews did pursers' leadership across teams have a significant effect on cockpit goal attainment beyond control variables and captains' and first officers' leadership ($\beta = .60$, $\Delta R^2 = .31$, $p < .001$). Hence, we accept Hypothesis 3 and confirm that only in successful MTS aircrews was leadership shared across teams and pursers' cross-team leadership predicted cockpit goal attainment beyond captains' and first officers' within-team leadership. The corresponding effect size is large, as shared leadership by the purser accounted for 31% of the variance in goal attainment by the cockpit crew even after controlling for leadership actions and experience of the cockpit crew as well as pursers' experience.

DISCUSSION

This study provides empirical evidence from observations of real-world MTS aircrews for the effectiveness of shared leadership in predicting team goal attainment and MTS success. Confirming Hypothesis 1 for all crewmembers except flight attendants, formal leaders and team members displayed significantly more leadership within and across teams in successful MTS aircrews. This result is in line with the notion proposed by Zaccaro and DeChurch (2011), that shared forms of leadership could be the most effective leadership form in MTS. Also, this finding replicates in MTS what others have found in single teams: In emergency

TABLE 5: Hierarchical Multiple Regression Analyses Predicting Cockpit Crew Goal Attainment From Shared Leadership Across Teams in Successful Versus Unsuccessful Multiteam System (MTS) Aircrews

	β				
Variable	Step 1	Step 2	Step 3	R^2	ΔR^2
Successful MTS aircrews[a]					
Step 1					
Job experience captain[c]	−.08	−.12	.00	.18*	.18*
Job experience first officer[c]	.02	.07	−.16		
Leadership captain	.37	.38	.35		
Leadership first officer	.12	.07	.09		
Step 2					
Job experience purser[c]		.21	.15	.24*	.06
Gender purser[d]		−.10	−.15		
Step 3					
Leadership purser across			.60	.55***	.31***
Unsuccessful MTS aircrews[b]					
Step 1					
Job experience captain[c]	.12	.09	.06	.35	.35
Job experience first officer[c]	−.15	−.14	−.13		
Leadership captain	.44	.48	.54		
Leadership first officer	.18	.19	.18		
Step 2					
Job experience purser[c]		.04	.04	.37	.02
Gender purser[d]		−.12	−.11		
Step 3					
Leadership purser across			−.11	.38	.01

Note. Gender in cockpit crews was constant (100% male) and was therefore not included as a control variable.
[a]$n = 60$.
[b]$n = 24$.
[c]In years working at respective airline.
[d]0 = male, 1 = female.
*$p < .05$. **$p < .01$. ***$p < .001$.

situations and when complexity and interdependence of tasks are high, shared leadership by formal leaders and team members is required (Klein et al., 2006; Künzle et al., 2010).

Shared Leadership Within Cabin Crews

The results regarding Hypothesis 2 showed that in cabin crews, shared leadership by pursers and flight attendants was a significant predictor for team goal attainment only in successful MTS aircrews. In successful MTS aircrews, flight attendants—on their own initiative—stepped up and engaged in leadership behavior whenever pursers were absorbed with other duties (e.g., boundary spanning). As soon as pursers resumed their formal leadership role, these flight attendants would step down again and follow pursers' instructions. This dynamic type of shared leadership has been described as rotating (Carson, Tesluk, & Marrone, 2007) and appears to have enhanced the teams' ability to perform tasks in urgent and unpredictable situations, despite the hierarchical structure inherent in these teams. Similar results were found by Klein et al. (2006) in medical teams and by Bigley and Roberts (2001) in incident command units. In those two studies, however, leadership was explicitly delegated to subordinates by formal leaders, whereas in our study, flight attendants in successful MTS aircrews initiated leadership behavior proactively.

In unsuccessful MTS aircrews, on the other hand, not only did pursers demonstrate significantly less leadership overall, but flight attendants failed to proactively participate in the leadership process. As a result, we observed a "leadership vacuum" generating confusion and chaos among flight attendants as to who should be doing what, when, and how. Various factors, such as personality, motivation, skills, group climate, or formal leader behavior, could have predicted shared leader emergence in these teams (see Carson et al., 2007; Friedrich et al., 2009). It would be a worthwhile endeavor to further explore these factors in future studies.

Shared Leadership Within Cockpit Crews

The results regarding Hypothesis 2 were less consistent for cockpit crews: First officers' leadership did not predict team goal attainment beyond captains' leadership in either successful or unsuccessful MTS aircrews, perhaps due to a ceiling effect given the high levels of captains' leadership (see Table 2). Our observations showed that first officers mainly carried out captains' instructions or performed problem-solving tasks and actual flight duties. Besides, first officers never engaged in cross-team communication with pursers, although they would have had the option to do so.

Captains' high levels of leadership consistently predicted team goal attainment regardless of whether MTS aircrews as a whole were successful or not. This finding is in line with what others have found regarding the positive effects of captains' leadership on cockpit performance in studies that did not involve consideration of the overall MTS success (e.g., Ginnett, 1993; Hackman, 1993). However, when MTS success was considered in this study, 24 MTS aircrews failed their overall mission regardless of captains' within-team leadership efforts. This finding confirms what DeChurch and Marks (2006) and Marks et al. (2005) have observed: Teams in MTS can fail collectively if component team goals are misaligned, even if individual teams attain their goals. Our observations in unsuccessful MTS aircrews substantiate the fact that cockpit and cabin crews were not synchronized because their procedures did not match, their actions were counterproductive, or the timing of tasks was not coordinated. Therefore, it is important that leaders in MTS direct their leadership not only within, but also across, teams.

Shared Leadership Across Teams

Due to the fact that captains, in our study, did not and could not lead across teams (fixed position in the cockpit and physical separation from cabin crews), we expected pursers to fulfill the role of cross-team leader. The results concerning Hypothesis 3 confirmed that only in successful MTS aircrews, pursers' leadership across teams predicted cockpit goal attainment beyond captains' and first officers' leadership. Furthermore, in line with Hypothesis 2, only in successful MTS aircrews did pursers' within-team leadership predict team goal attainment.

When combining the results of Hypothesis 2 and 3, it appears that in successful MTS aircrews, pursers performed a dual leadership role in that they effectively directed their leadership within and across teams and thereby contributed to goal attainment in both teams. These findings support the proposition by Davison and Hollenbeck (2011): Boundary spanners, due to their position at the intersection between teams in MTS, are key factors in defining the success of the overall MTS because they gather, filter, and distribute information critical to team goal attainment on both sides of the boundary. This was precisely what we observed in our study: Only when pursers skillfully performed this challenging dual leader role within and across teams were MTS aircrews successful as a whole.

Davison et al. (2012) argued that "boundary-spanners are often stuck in the middle and unable to be well coordinated with all the parties that might demand accommodation" (p. 14), which is what appears to have happened in unsuccessful MTS aircrews. Pursers may have simply been overwhelmed with the many leadership challenges they had to face, and they did not receive any support from flight attendants. In successful MTS aircrews, however, flight attendants supported pursers by proactively engaging in a shared leadership process, thus freeing valuable resources in pursers and enabling them to span the boundary and lead within and across teams.

Taken together, our results suggest that shared leadership by formal leaders and team members can be a powerful predictor for team goal attainment and MTS success and that the role of boundary spanners (i.e., pursers) performing a dual leadership role within and across teams is the key factor in this process. In aviation, where leadership has traditionally been centralized with captains, such a shift in the leadership paradigm might not be well received. Our results have clearly shown, however, that in situations in which team *and* MTS goals must be attained, captains' sole leadership may no longer suffice. Also, in light of prevailing safety and security procedures connected to the locked cockpit door and the introduction of increasingly large aircraft, pursers and flight attendants will all need to actively engage in leadership because they must cope with problems—such as air rage or medical emergencies—without any help from the cockpit.

Limitations and Future Research

As with any research, this study has limitations that must be considered when interpreting the results. First, because we were interested in discovering *who* exhibited leadership in MTS aircrews rather than *how* leadership was demonstrated, we chose to measure leadership frequencies based on Yukl's (2006) taxonomy of leadership functions. Although this is an objective, valid, and frequently used way to assess leadership behavior, it does not provide information on leadership strategies or processes, for which other methodologies, such as qualitative assessments of leadership, interaction pattern, lag sequential, or social network analyses, would be needed (see Grote, Kolbe, Zala-Mezö, Bienefeld, & Künzle, 2010; Scott, 1988; Stachowski, Kaplan, & Waller, 2009; Tschan et al., 2006; Weingart, 1997). Also, because we used an aggregate of 10 leadership functions to test our hypotheses, our analyses do not identify which particular leadership activities were most strongly associated with successful team and MTS outcomes. To provide this information, additional analyses are needed that would reach beyond the scope of this article.

A second limitation concerns the generalizability of results to other tasks and contexts. In this study, we chose a task based on a real case (National Transportation Safety Board, 1983) that is representative of cockpit-cabin interaction requirements in most types of in-flight emergencies (e.g., smoke and fire, severe technical problems, medical emergencies). Other tasks, however, may elicit different leadership behavior, especially if they are routine in nature. Authors of future studies could analyze leadership interaction requirements for various emergency versus routine tasks and aim at replicating our findings across different scenarios and in different contexts. Future studies could also include additional teams interacting with MTS aircrews, such as air traffic control, maintenance, or other ground services. Furthermore, it should be considered in future studies that on larger aircraft, physical barriers (i.e., different cabin sections) exist, requiring additional boundary-spanning activities even within the cabin, and that passengers could be involved as active helpers during in-flight emergencies.

Third, our sample consisted of cockpit and cabin crewmembers from one airline only. There might be differences to other airlines in terms of company climate or national culture. And finally, although observations of simulated events provide an ideal opportunity to capture the richness of people's behavior in fieldlike environments, we recognize that our participants may behave differently in a real emergency.

Practical Implications

Our results have important implications for the selection and training of MTS aircrews and others operating in safety-critical domains. The findings highlight the importance of combining leadership requirements within and across teams in effective ways and making optimal use of shared leadership for that purpose. In particular, boundary spanners need to be better prepared and supported in their role beyond what is currently offered in team training. Awareness of the necessity for mobilizing all resources in the MTS and for delegating some leadership tasks in emergency situations has to be fostered, and an understanding of crucial leadership tasks that have to remain with the boundary spanner has to be ensured. As part of training, the complementary roles and responsibilities of team members need to be discussed, and a willingness to share leadership tasks should be created. Explicitly delegating tasks as well as explicitly taking on tasks should be practiced jointly by all members of the respective MTS to sharpen a sense of shared goals and foster team spirit across teams, while also clearly delineating individual and team responsibilities.

For MTS aircrews specifically, we recommend that for the role of purser, individuals with high leadership potential be selected. The realization of this potential should be supported through training that focuses on the duality of within- and across-team leadership. Leadership roles should also be made explicit in the airline's policies and procedures. A recent study showed that pursers hesitate to speak up or proactively engage in leadership behavior across teams due to the rigid hierarchy that is characteristic for MTS aircrews (Bienefeld & Grote, 2012). Captains—who are positioned at the top of the hierarchy—should learn more about what it takes to establish a sense of leader inclusiveness (see Nembhard & Edmondson, 2006) in ad hoc aircrews, thereby empowering pursers without undermining a captain's authority (Bienefeld, 2012).

Moreover, based on the concept of rotating leadership (Carson et al., 2007), training should highlight the need to actively involve flight attendants in a shared leadership process and train them on how to proactively engage in leadership behavior in situations in which formal leaders have failed to explicitly ask for help. This recommendation is based on our finding that flight attendants in successful MTS aircrews showed initiative and stepped up to share the lead with pursers, whereas in unsuccessful MTS aircrews, this type of behavior was not observed. In addition to selection and training, we recommend that airlines should appoint one highly experienced flight attendant as "second in command" during the preflight briefing on every flight and to specify this duty in the respective policies and procedures.

Finally, because we observed a lack of shared leadership across teams in unsuccessful MTS aircrews, we recommend that component teams receive joint leadership and crew resource management training (see Salas, Wilson, Burke, & Wightman, 2006). More specifically, we suggest practicing shared leadership strategies, such as rotating leadership (Carson et al., 2007), in simulated settings. Also, cross-training methods could be employed that entail swapping roles, thereby helping teams to develop shared mental models of team interaction and facilitating coordination across roles and teams (see Marks, Sabella, Burke, & Zaccaro, 2002).

CONCLUSION

This study is the first to examine shared leadership in a real-world MTS operating in a safety-critical domain. Our results complement and expand on laboratory studies on leadership in MTS and add to the growing body of MTS research by demonstrating that shared leadership by formal leaders and team members—at least in cabin crews—contributed to the attainment of team and MTS goals. Specifically, we identified boundary spanners' leadership as the key to MTS success, because their dual leadership role within and across teams determined goal attainment in both teams and thus was a unique predictor for MTS success. Members of MTS need to be trained to manage the leadership challenges imposed on them. As for the Air Canada accident described at the opening, had those crewmembers been trained to manage the particular leadership challenges they had to face, the results might have been different. We hope, therefore, that many "teams of teams" operating in safety-critical domains today will benefit from this research and "lead each other to safety."

APPENDIX A

Airbus A320 Mixed Crew Flight Simulator

Figure A1. The Airbus A320 mixed-crew flight simulator is a special form of high-fidelity simulator equipped with a two-man cockpit and a fully furnished passenger cabin seating up to 20 passengers, thus creating a realistic environment for cross-disciplinary team training. With the use of hydraulic mechanisms, various airplane movements can be simulated, and the training of emergency situations is enabled through different manipulations, such as system malfunctions, alarms, and smoke. To further increase face validity, the mixed-crew flight simulator is equipped with the original intercommunication system, electronic signs and signals, emergency equipment, and audio simulation of engine noises and systems.

APPENDIX B

Standardized Scenario: "Smoke of Unknown Origin in Cabin"

	1		2		3	
	Cabin Crew	Cockpit Crew	Cabin Crew	Cockpit Crew	Cabin Crew	Cockpit Crew
Tasks	**Passenger boarding (18 confederates)**	**Pre-takeoff checklist**	**Passenger row 5R reports acrid smell**	**Weather update and ATC contact**	Smoke procedure in cabin	Initiate emergency descent and landing
	Secure cabin for takeoff	**Taxi on runway**	**Discovery of smoke behind overhead panel**	Info received	Planned emergency preparation	Smoke of unknown origin checklist
	Takeoff	**Takeoff**	Info to cockpit	Analysis of situation	Touchdown	Touchdown
	Climb	**Climb**	Smoke procedure		Evacuation	Evacuation
	Fasten-seatbelt sign off	**Fasten-seatbelt sign off**				
	Passenger service					
Smoke	None	None	Light	None	Heavy	Light

Note: Timing of events in bold and smoke levels were standardized manipulations as part of the scenario. Other events could vary depending on crewmembers' decisions and actions. ATC = air traffic control.

APPENDIX C

Leadership Coding System With Examples

Leadership Code Based on Yukl (2006)	Observable Behavior	Example
Delegating	Somebody delegate tasks or roles to somebody else	"Get me the fire extinguisher, quick!" "Inform ATC and declare emergency, now!"
Clarifying	Somebody proactively acquires, organizes, and evaluates information to gain an overview, identify the causes, or elaborate solutions and requirements for problem solving	"Did you see flames or just smoke? Have you used a fire extinguisher yet?" "How much time do we have until landing to prepare the passengers? What do we need to expect after touchdown?"
Monitoring	Somebody monitors needs and requirements and controls the actions of others	"Did you brief the passengers on how to open the doors?" "Did you put on your smoke hood?"
Correcting	Somebody speaks up, intervenes, or corrects faulty actions or decisions made by others	"Hey, you have to put on your smoke hood right now!" "No, I think we should aim for the closer airport!"
Decision making	Somebody makes and communicates decisions to others	"We will initiate an emergency landing now." "We will prepare the passengers with the star-items checklist."
Informing	Somebody verbalizes a problem, provides interpretation of a problem, or suggests a solution to a problem with the intention to influence others	"The smoke is really dense now! We have to land as soon as possible!" "I switched off Pack 2 but it had no effect. We should switch it on again."
Planning and organizing	Somebody plans and communicates next steps, determines the sequence of actions, or coordinates the pace and timing of activities	"We will wait until the captain has made the announcement, then we will brief the passengers." "Once we are on the ground, I will give a cabin crew at station call while we evaluate the situation."
Consulting	Somebody asks others for their opinion	"Considering this information, which one [airport] should we aim for?" "Should I inform the passengers or is it better if they hear it from you?"
Coaching	Somebody instructs others on how a task or procedure should be done or provides clarification about decisions or plans	"Look, you have to activate it like this . . ." "All of you focus on smoke and firefighting and search the area for heat sources."
Recognizing others	Somebody gives feedback to others	"Well done, continue like that!" "That's a good idea, let's do that!"

Note. ATC = air traffic control.

APPENDIX D

Sample Items From PROLOFT, a Checklist-Based Scenario-Specific Rating Tool for Team Goal Attainment in Cockpit and Cabin Crews

Crew/Item	Priority	Weight
Cabin		
Location, type, and character of smoke identified	High	3
Location, type, and character of smoke communicated to pilots	High	3
Passengers relocated to smoke-free area in consultation with pilots	High	3
Smoke hood on and activated	High	3
Passengers instructed on smoke protection	High	3
Necessary smoke and firefighting equipment provided	High	3
Search for heat source executed as prescribed by procedure	Medium	2
Passenger care (calming down, assuring, motivating)	Low	1
Cockpit		
Oxygen masks on	High	3
Air traffic control (ATC) instructed	High	3
Emergency descent initiated with due consideration to terrain	High	3
Nearest aerodrome chosen under consideration of weather conditions, runway length, and facilities	High	3
Passengers informed about decision and plan	Low	1
Smoke of unknown origin checklist completed	Medium	2
Fire brigade and rescue services advised via ATC	Low	1
Time checks communicated to cabin	Medium	2

Note. The two complete 22-item checklist rating systems for the assessment of cabin crew and cockpit crew goal attainment are available (in German) from the first author.

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KEY POINTS

- In successful multiteam system (MTS) aircrews, higher levels of leadership were found in both formal leaders and team members.
- In successful MTS aircrews, shared leadership by pursers and flight attendants predicted team goal attainment.
- Boundary spanners' (pursers') dual leadership within and across teams was key to MTS success in that it predicted goal attainment in teams as well as MTS success.
- Component teams should be trained together with emphasis on boundary spanners' dual leadership role.

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Nadine Bienefeld received her PhD in organizational psychology and human factors in 2012 from ETH Zurich, Switzerland. Her research interests include leadership, speaking up, and boundary spanning in multiteam systems with a focus on high-risk teams in aviation and health care.

Gudela Grote is a full professor of work and organizational psychology at ETH Zurich, Switzerland. She received her PhD in industrial/organizational psychology from Georgia Institute of Technology, Atlanta, in 1987.

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