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Robust Flight Deck Systems: Harnessing the Synergistic Power of the Crew

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Abstract

Robust flight decks are possible in both normal and novel operations. Existing crew resource and error management programs can improve team-centered resilience with Oshry's organization development (OD) principles. The need on the flight deck is to diminish the invisible behavioral gap between espoused theory and theory-in-use by balancing Oshry's four basic elements that make up robust human systems—differentiation, homogenization, integration, and individuation. This low-cost OD vision is offered as a guide for organizations to tailor existing aircrew recurrent training modules. Assessment and diagnosis measures are recommended for continuous improvement, so this OD framework includes adaptive feedback interventions and soft-skills behavioral markers for organizations to consider.

Introduction

Team leaders set the behavioral tone and interaction cues as examples for team members to follow. Since leaders transfer ideas through language, this paper is grounded in communication and leadership praxis. In high-risk environments, teams instead of individuals typically operate complex equipment and technologies. Human–technology aviation systems require humans to cooperate and communicate with clarifying language to increase performance and team situational awareness (TmSA)—use active listening, share critical observations, verbalize and verify critical actions, and monitor and crosscheck crew action and computer management systems (Gunther, 2010; Orlady, 2010).

Purpose

Commercial airline pilots are generally high-achieving successful professionals, “and because they have rarely failed, they have never learned how to learn from failure” (Argyris, 2006, p. 268). Even with proven crew resource management (CRM) programs that exemplify organization development (OD) processes and serve as models for several safety-critical sectors (Gawande, 2009; Kanki, Helmreich, & Anca, 2010; Vicente, 2006), many captains and first officers today display concern about their performance and exhibit unilateral tendencies in dynamic situations under stress or high workload (Salas, Fowlkes, Stout, Milanovich, & Prince, 1999). Often their natural reflexive response is individualistic, unilateral control and win–lose (Argyris, 2006; Klein, 1998; Schwarz, 2005). This is the difference between “espoused” theory in CRM team principles and actual pilot performance “theory-in-use” on the frontline (Argyris, 2006, p. 274). In other words, pilots may be “unaware of the contradiction between the way they think they are acting and the way they really act” (Argyris, 2006, p. 274). This common unconscious paradox identified among high-risk professionals, i.e., doctors, first responders, pilots, business executives, military officers (Argyris, 2006; Klein, 1998), tends to stifle what could be a robust human system. In this paper I discuss and diagnose leadership behavior at the flight deck subsystem level specifically based on Oshry's vision to create robust human systems (Sales, 2006). The need on the flight deck is to diminish the invisible gap between espoused theory and theory-in-use by balancing Oshry's four basic elements to build robust human systems—differentiation, homogenization, integration, and individuation (paraphrased in Sales, 2006).

Brief History

For decades aviation management and union safety representatives formulated mission statements focused on safety, but espoused safety values did not prevent several fatal accidents during the 1970s due to flight deck communication and leadership dysfunction, e.g., Eastern Airlines Flight 401 attributed to fixation and failure to monitor and delegate tasks; the Tenerife disaster and United Airlines Flight 173 in Portland, both attributed to authoritarian captains and crewmember

unassertiveness. Jointly, airline management, outside consultants, and pilot union safety representatives developed and established the first-generation operational CRM program (Blake, Mouton, & CLR Steering Committee and Working Groups, 1982). Now, laws and regulations mandate CRM training in America and in more than 190 countries (Kanki et al., 2010; Vicente, 2006). Fifth-generation program principles that include flexible leadership patterns and proactive open communication make up the understructure to integrate CRM and threat and error management (TEM) (Gunther, 2010; Helmreich, Merritt, & Wilhelm, 1999). CRM is how aircrews communicate and manage resources, and since human-machine systems are fallible, TEM is what aircrews communicate about—identify and prepare for operational threats, and identify, trap, and repair errors (Gunther, 2010). Gunther lists many external threats not controlled by the aircrew, such as

...weather, maintenance, passenger problems, operational pressures [and fatigue], distractions and interruptions, Air Traffic Control (ATC) errors, language/communication problems, etc.... One of the primary countermeasures to managing threats effectively is flight deck leadership. The attributes of flight deck leadership (i.e., setting the example, planning ahead, initiative, fostering communications, etc.) are the foundation for effective strategies to manage threats crews face every day. (pp. 430–431).

These threats are not pilot crew errors. Threats tend to change aircrew behavior in contrast to an integration of CRM/TEM principles because assumptions and values are grounded in regulations, company policies, and union statements that embody a pilot-in-command with legitimate authority and ultimate decision-making capacity. Robust CRM/TEM involves integration of legitimate authority into a team culture that harnesses the synergistic power of the crew. In safety-critical environments there is no question about the need for the wisdom of a final decision-maker with quick actions such as for a rejected takeoff near critical engine failure speed—V1, but humans are fallible in complex systems and team building may benefit from a balancing of Oshry's OD system elements.

The Vision: Building Robustness by Balancing Oshry's Four Basic Elements

Differentiation, the first element in robust systems, refers to "how and how much a system elaborates differences, tolerates internal richness, and interacts with a complex environment" (paraphrased in Sales, 2006, p. 334). Pilots successfully operate in a dynamic environment with sophisticated equipment, weather, security, radio communications, and multiple layers of interaction with people—standard briefings and procedures. Given the incredible

amount and complexity of information pilots have to process, even routine tasks such as busy airport taxi operations, takeoff and landing, fuel balance, altitude and route changes, etc. can overwhelm attention and working memory during critical phases of flight (Loukopoulos, Dismukes, & Barshi, 2009). Yet even under extreme pressure, as a whole, the flight deck operates with the lowest human error rate in history in any of the public safety-critical sectors—aviation, airport security, nuclear, healthcare, and environment (Gawande, 2009; Vicente, 2006). External environmental elements/unpredictables, the confluence of threats outside pilot control produce nonlinear problems and aircrew errors that require open communication and individuation to create resilience, as in the following cases:

- AF Flight 447, Atlantic Ocean—fatigue, pilot crew confusion, weather, human-technology coherence errors, and airspeed and flight control law failures;
- Colgan Air Flight 3407, Buffalo, NY—fatigue, pilot crew confusion, weather, human-technology coherence errors;
- UA Flight 232, Sioux City—complete flight control hydraulic failure;
- USAIR Flight 1549, Captain Sully and crew on the Hudson—failure of all engines due to migratory bird ingestion.

Even with a robust CRM/TEM leadership systems model demonstrated by crewmembers on UA Flight 232 and USAIR Flight 1549, there still exists an insidious patriarchal command structure with limited tolerance for sharing power on the flight deck, predominately in high power/distance work "cultures like China, Latin America and some Asian countries that stress respect for rank, elders and leaders [as] paramount" (Anca, 2010, p. 438). Inflexible power sharing and decision-making structures tend to be brittle and are amplified by human-technology coherence errors, confusion, omissions, complacency, and when crewmembers are startled.

Oshry "adds dominance...as an...analytical lens for understanding the impact of position in formal and informal systems" (paraphrased in Sales, 2006, p. 332) and clearly describes the dangerous tensions typical in this leadership dynamic. "Others feel constrained, confused, oppressed, and angry in the context of a Dominant-controlled culture" (paraphrased in Sales, 2006, p. 333). The old mantra that a ship's captain is god not to be questioned or usurped needs "generative" and "adaptive learning" (Senge, 2006, p. 767) models to displace—which are about creating and coping capacities respectively. Training and dialogue about how to use CRM principles to engage threats and errors have the potential to slowly erode patriarchal boundaries and transform the flight deck system into a true partnership by balancing differentiation with homogenization.

The fact that pilots rarely fly with the same crew from one trip sequence to the next gives special credence to Oshry's homogenization—shared safety values, professionalism norms, standard operating procedures (SOPs), jargon, knowledge, and understanding. Even with these commonalities, we have to support each other in order for the system to work in normal and novel events, and in what the future holds.

The promise of Next Generation Air Transportation System (NextGen) technology to reduce environmental impact and increase airspace capacity, fuel efficiency, and crew situational awareness will likely impede pilot ability to switch attention without omission errors and reduce working memory, particularly by replacing primary voice ATC communications with controller–pilot data link communications in busy terminal airspace operations, and by shifting responsibility of time-based traffic separation and severe weather avoidance to the flight deck (Loukopoulos et al., 2009; Orlady, 2010; U.S. FAA, 2010). In other words, NextGen flight deck technology use in congested operations that are highly variable and demanding may reduce TmSA from the current levels achieved through voice communications. The reality of day-to-day airline operations is nonlinear—unpredictable (Loukopoulos et al., 2009). Hamman and Rutherford (2010) found the following human–technology dynamic:

The main feeling of the line pilot is disengagement with the design process. New devices show up designed by an engineer with very little understanding of the line operational environment. This has led to the affectionate saying about automation: Automation is an amplifier because it

amplifies the low workload times in the flightdeck and it amplifies the high workload times. (p. 581).

Oshry refers to this complexity as integration. For example, it takes professionalism and pilot crews utilizing CRM/TEM, SOPs, ATC, dispatch, maintenance, aircraft and external systems, federal air marshals, flight attendants, gate agents, baggage handlers, and passengers as a whole to ensure safe use of air and ground space. Specifically on the flight deck, captains can integrate and individuate crewmembers during the preflight briefing: “We are in this together to reach our destination, and humans and technology are fallible, so say something if you are concerned, uncomfortable or observe anything that is a threat, unsafe, or not SOP.” This CRM preflight briefing example creates a safe space and invites openness and critique for individuals to speak up when they observe or perceive something is not right. The aviation environment is too complex for one person to process everything, so captains need to create a proactive communication environment during preflight and other standardized briefings to increase team member participation. This includes a workplace where the “most task-saturated” team member “set[s] the pace for the whole crew” by verbalizing readiness (Loukopoulos et al., 2009, p. 119), where flight attendants will call the flight deck with safety concerns, where first officers will stop the aircraft to avert ground conflicts, where dispatch will send significant weather and turbulence updates en route, where either pilot will call “go-around” for unstabilized approaches or runway incursions, and where pilots can hand-fly with basic skills pitch, power, and roll settings when automated flight

Table 1
Aviation flight deck leadership development and succession planning process.

Phase I: Laying the foundation—self assessment

1. What do I know about myself as a leader?
2. What have I learned through feedback from my peers, instructors, and check airman/evaluators?
3. What do I see as my strengths? (How do I know?)
4. What kind of data from feedback do I need to expand my self-awareness? (From whom? How will I get it?)
5. What is shifting in my life/career that may impact my self-development choices?
6. What is shifting in the organization?
7. Where do I see myself in five years?
8. What kinds of practical learning experiences do I need to reach my goals?
9. What are larger life issues/concerns that I need to consider?

Phase II: Leveraging strengths—utilizing feedback

1. What do others see as my strengths as a leader? (How can I use these strengths to enhance my effectiveness?)
2. What activities or experiences can I undertake to develop my strengths? (What support or resources will I need to make this happen?)
3. What are my areas needing improvement and how do I want to approach improving them?

Phase III: Developing capabilities

1. What areas do I want to grow as a leader? (What new behaviors do I want to develop to enhance my leadership capabilities? What behaviors do I want to use less frequently?)
 2. What activities or experiences will help me develop my leadership capabilities? (What resources or support will I need to make this happen?)
 3. What do I want to accomplish? (What does success look like? What are the milestones that will help me assess how I am doing?)
-

Note. Adapted from Distelhorst, D. J. (n.d.). Session 3: System-wide interventions. In D. Distelhorst (Ed.), *An OD practitioner's tool kit: Twenty years of accumulated OD wisdom & methodologies* (pp. 55–88). Spokane, WA: Gonzaga University Bookstore.

control systems fail. Balancing these four elements creates resilience—the capacity for successful adaptation in the face of challenging or threatening circumstances.

Implementation Through Assessment and Training

In order to uncover our reflexive processes and move to a more robust flight deck system, Oshry's vision could be integrated into recurrent proficiency training cycles using Distelhorst's (n.d.) Leadership Development Plan Phase I Laying the Foundation—Self Assessment as a distance learning module accompanied by selected readings from Loukopoulos et al. (2009), Klein (1998), Argyris (2006), Salas et al. (1999), Sales (2006), Schwarz (2005), Senge (2006), and Oshry (1999, 2003). This home-study module could lay the foundation for integration into proficiency training modules. Pilots would apply Distelhorst's

Development Plan Phase II and III (see Table 1) and Oshry's robust leadership systems model based on ongoing analysis of actual flight deck communications from de-identified flightcrew testimony/interviews, anonymous error reports—Aviation Safety Action Program, Line Operations Safety Audits, and Flight Operations Quality Assurance. Thematic findings could periodically modify existing CRM/TEM training modules to represent evolving operational threats (see Table 2).

Keeping in mind that true strength and generative learning are found not in perfection, but in understanding our own limitations, crews debrief with trainers about specific event sets (Tannenbaum & Cerasoli, 2013) to assess/diagnose CRM/TEM team performance soft skills using a NOTECHS behavioral instrument (see Table 3). Training departments can de-identify the data to evaluate and modify the syllabus. In order to support a safety/just culture

Table 2
Aviation flight deck modules of training.

OD module	Description	Implementation
Leadership Development Plan Phase I	Distelhorst's Phase I: Laying the foundation—provides a self-assessment tool to reflect on leadership strengths and areas for growth.	Developed as part of a distance learning module in preparation for on-site currency training.
Leadership Development Plan Phase II	Distelhorst's Phase II: Leveraging strengths—utilizes feedback from others to determine what and how to approach areas of improvement.	Integrated into CRM/TEM on-site currency training and debriefs.
Leadership Development Plan Phase III	Distelhorst's Phase III: Developing capacities—identifies areas for growth, goals, and ways to develop leadership capabilities.	Integrated into CRM/TEM on-site currency training and debriefs.
Leadership model	Oshry's vision of robust leadership model will outline the mindset shift needed to balance differentiation, homogenization, integration, and individuation.	Integrated into distance learning module and CRM/TEM on-site currency training.
Leadership skills	Will outline the methods of systems thinking and critical thinking and focus on the concepts of shared decision-making, flexible leadership, team situational awareness, and communication that invite openness and critique to maximize resources and facilitate a robust flight deck.	Integrated into CRM/TEM simulator event set scenarios. The key assumption is "leadership capacity develops while leading" (Distelhorst, n.d., p. 75).
Performance support and appraisal process	Will outline performance expectations, provide coaching, and give effective performance feedback to improve flight deck communication.	Modeled during CRM/TEM debriefing after each simulator session about specific event sets.
Manage performance problems	Will use robust analysis to uncover underlying issues and outline a process for managing problems through dialogic communication and a no-threat performance improvement process.	Integrated into CRM/TEM simulator scenarios and debriefs.
Leadership for a world of difference	Will raise awareness of the flexible leadership knowledge, skills, and abilities needed to enable groups of culturally different people to work together effectively—making difference a resource rather than a problem.	Integrated into distance learning and CRM/TEM on-site currency training/debriefs.
Conflict utilization	Will outline ways to channel conflict productively, set norms that avoid unproductive conflict, and provide processes for conflict management.	Integrated into distance learning, CRM/TEM simulator scenarios, and event set debriefs.
Manage pre-flight briefings	Will be used prior to each simulation to practice facilitative communication needed to ensure robust flight operations. This is where the captain sets the tone for open communication.	Integrated into CRM/TEM simulator training scenarios and debriefs.

Note. CRM/TEM principles include the OD systems approach. Adapted from Distelhorst, D. J. (n.d.). Session 3: System-wide interventions. In D. Distelhorst (Ed.), *An OD practitioner's tool kit: Twenty years of accumulated OD wisdom & methodologies* (pp. 55–88). Spokane, WA: Gonzaga University Bookstore.

Table 3
NOTECHS assessment form—flight deck team.

Captain and first officer		Developing	Very poor	Proficient	Mastery	Not observed	Comments
CRM element							
Cooperation	1 Teambuilding & maintaining 2 Consideration of others 3 Support of others 4 Positive conflict management						
Captain and first officer							
CRM element		Developing	Very poor	Proficient	Mastery	Not observed	Comments
Leadership & management skills	1 Use of flexible authority & assertiveness 2 Providing & maintaining standards 3 Planning ahead, fostering comm. & coordination 4 Workload management						
Captain and first officer							
CRM element		Developing	Very poor	Proficient	Mastery	Not observed	Comments
Decision-making & adaptability	1 Problem definition & diagnosis 2 Option generation—ideas, solutions 3 Risk assessment & option selection in context, i.e., judgment 4 Outcome review, able to adapt in context						
Captain and first officer							
CRM element		Developing	Very poor	Proficient	Mastery	Not observed	Comments
Team situational awareness (TmSA)	1 Awareness of aircraft systems 2 Awareness of external environment 3 Awareness of time—past, present, future 4 Awareness of human resources—internal and external						
Captain and first officer							
CRM element		Developing	Very poor	Proficient	Mastery	Not observed	Comments
Communication & coordination	1 Crew has shared mental model of each task 2 Crew utilizes standard operating procedures (SOPs) 3 Crew verbalizes, verifies, and monitors critical action and automation 4 Manage threats and errors with proactive language						
Overall Assessment of Flight Deck Team							
CRM elements		Developing	Very poor	Proficient	Mastery		Comments
1	Cooperation						

TABLE 3
(Continued)

Overall Assessment of Flight Deck Team							
CRM elements	Developing			Very poor	Proficient	Mastery	Comments
2	Leadership & management skills						
3	Decision-making & adaptability						
4	TmSA						
5	Communication & coordination						

Note. Adapted from FAA Advisory Circular AC 120-71A (2003); Tannenbaum & Cerasoli (2013). Do team and individual debriefs enhance performance? A meta-analysis. *Human Factors*, 55(1), 231–245; and The JARTEL group (2012) NOTECHS Behavioral Marker System. Measurement Instrument Database for the Social Sciences. Retrieved April 5, 2013 from www.midss.ie.

Note 2. “Developing” replaces the term “very poor.” Very poor assessments are associated with top-down evaluations and a unilateral trainer’s perspective. Developing supports key safety culture concepts and helps promote learning during a facilitative training/debrief process. This co-assessment process harnesses collective knowledge and supports a just culture-learning organization philosophy. Both trainer and pilot crew fill out the CRM NOTECHS Assessment Form together about specific simulator event sets.

environment, the behavioral instrument is implemented in a nonpunitive crew concept developmental assessment process. This process describes a learning organization design philosophy for aviation. Since assessment frameworks are not universal, each organization will need to tailor Oshry’s vision and these training instrument examples to their unique culture and operating environment.

Conclusion

Captains’ invitational use of CRM elements to harness the synergistic powers of aircrew makes the flight deck subsystem robust and more resilient for all stakeholders. Core OD principles that hold the CRM/TEM process together for normal and novel operations include effective communication—listen actively, share critical observations, encourage divergent views, verbalize SOPs—leadership flexibility, division of duties, and Oshry’s openness to balance differentiation, homogenization, integration, and individuation. CRM/TEM and Oshry’s openness make human multiprocessing possible with a systems thinking framework for frontline workers. “A holistic, *problem-driven* way of looking at the world with a focus on *relationships* between system elements—encourages us to think about relationships *between* people and technology” (Vicente, 2006, pp. 46–49). “Leadership development is ‘the expansion of a person’s capacity to be effective in leadership roles and processes...to enable groups of people to work together in productive and meaningful ways’” (quoted in Distelhorst, n.d., p. 75, from the *Handbook of leadership development*, 1998, Center for Creative Leadership). As leaders we must go beyond the rational, objective, unilateral view of ourselves to a deeper, inner landscape where we affirm the allegiance of individual core values with CRM core values by cultivating community for the sake of both knowing and doing, and by creating a learning organization for aviation where stakeholders can “uncover, examine, and debunk the myth that institutions are external to us and constrain us” (Palmer, 2007, p. 205).

A robust flight deck system can foster an environment that balances a mechanistic dynamic driven by rational management, legitimate authority—federal aviation regulation pilot-in-command rules—SOPs, and technology systems through open communication and flexible leadership. By balancing Oshry’s elements we reveal our reflexive behaviors to promote true partnership and individualism, change conversation and culture for resilient flight decks, and recognize that each person brings value to the whole flight operation for optimal team performance.

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