The Transformation of CRMbased Training and it Effects on Aviation Safety in the U.S. from 1960 to 2013

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Agenda

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- (5) Results
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- (7) Conclusion

Introduction – Purpose of Study

The purpose of this study was to analyze the **NTSB** accident database and assess accident reports in order to determine if there was a significant change in Crew Resource Management (CRM)-related accidents associated with the progression of CRM training

1970s

1980s

1990s

2000s



- Rate of catastrophic incidents did not decline as anticipated
- It became apparent that accidents tended to be "attributed less to mechanical failure and more to human error" (Alkov, 2009, p.3)
- NASA conducted interviews which revealed that
 - Many near miss accidents were result of a breakdown in communication and that
 - Critical information was not relayed to pilot in command



Between 1980 and 1989, causal factors for accidents attributed to flight crew were still in excess of 70% of all accidents (Wiener, Kanki, & Helmreich, 1993)

United Airlines was the first U.S. airline to introduce a CRM program in 1981, and many airlines followed by the mid 1980s

All cockpit crew members received training on teambuilding, leadership styles, and decision-making

United reported success and change in corporate culture
By the late 1980s, Cockpit Resource Management was replaced by Crew Resource Management

1970s

1980s

1990s

2000s



- Mandatory compliance for scheduled airlines
- Included flight attendants, dispatchers and maintenance personnel
- FAA introduced Advanced Qualification Program (AQP), which allowed carriers to develop customized training
- Scope of CRM was broadened to include human factors issues
- CRM became integral part of flight training

1970s

1980s

1990s

2000s



- Focus on the limitations of human performance and ways to reduce error
- Organizational culture is still an obstacle to effective implementation
- CRM is regarded as a countermeasure with three main goals:
 - error avoidance
 - trapping emerging errors before they amplify risk
 - Mitigating the consequences of any errors committed

1970s

1980s

1990s

2000s



- Line Oriented Flight Training (LOFT) allows the use of simulators to expose crews to non-standard or emergency situations
- Identification of systemic threats to safety
- Implementation of CRM into critical areas of flight like maintenance and dispatch
 - Beyond flight into medicine, firefighting, and railway systems

Methodology

The aviation accident and incident data was collected from the NTSB online database

A list of keywords identified as essential in CRM failures was created by the researchers based on identified core components and standard practices of current CRM theory

The keywords were used as the query list in the database to search for accident and incident probable causes

Methodology

Keyword	Target Hits
Crew	1377
Personnel	1005
Group	169
Attitude	147
Decision	130
Management	130
Communication	94
Reporting	91
Compliance	87
Monitoring	86
Error	74
Coordination	65
Team	29
Human	22
Resource	21
Situational	12
Skill	4
Mitigation	2
Professionalism	2
Culture	1

The list of keywords used to query the database

Statistical Analysis

- Descriptive statistics were conducted first to gather averages and standard deviations of generations of CRM policies
- The accidents and incidents were tallied by year
- The total number of commercial departures for each year were collected from Department of Transportation (DOT)
- In order to empirically analyze the conditions of accidents and incidents related to CRM, a segmented regression of interrupted time series was used
 - The outcome variable for this analysis was accidents and incidents per one million departures
 - The predictor variable was time
 - Two-tailed p-values of 0.1 were chosen

CRM Policy	Years		
	Effective		
Pre CRM Policy	1962-1989		
AC 120-51	1990-1992		
AC 120-51A	1993-1995		
AC 120-51B	1996-1997		
AC 120-51C	1998-2000		
AC 120-51D	2001-2003		
AC 120-51E	2004-		

CRM Accidents and Incidents per million departures



- Continual increase until the early 2000s
- Peak occurred in 1997, with 10.11 accidents/incidents per one million departures

Mean Accidents and Incidents per million departures after CRM policy changes

CRM Policy	Years Effective	Accidents and Incidents	S.D.
Pre CRM Policy	1962-1989	4.51	1.52
AC 120-51	1990-1992	4.58	0.76
AC 120-51A	1993-1995	7.18	1.63
AC 120-51B	1996-1997	9.36	1.06
AC 120-51C	1998-2000	8.91	1.05
AC 120-51D	2001-2003	6.62	0.99
AC 120-51E	2004-	4.52	1.36

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Policy Segment	effect	р	s.e.		
Pre 1990	0.07	**	0.03		
1990-1998 CRM	0.76	***	0.21		
Post 1998 CRM	-1.19	***	0.22		
Policy Intervention Period I	-2.12	+	1.15		
Policy Intervention Period II	-1.76		1.13		
Constant	3.51	***	0.49		
+ p <0 .10. * p < 0.05, ** p < 0.01, *** p < 0.001					

- A segmented regression interrupted time series analysis was performed to determine if different trends existed before and after CRM policy implementation
- There were noticeable differences in terms of the accident and incident rates between three policy periods
- However, the second series of iterations in Policy Intervention Period II did not appear to have any added benefits beyond the general effect of CRM policy already being established

CRM accidents and incidents per million departures trend line with government policy interventions



Pre 1990 ---- 1990-1998 - - 1999-2013

Discussion

Based on the analysis, there appeared to be a significant effect on accident and incident rates among commercial aircraft with the implementation of CRM policy

- Initial increase after the first adoption of CRM policy
- By the last series of iterations, accident and incident rates began to reduce significantly
- Based on the analysis it is difficult to tell if the latter evolutions of CRM are as important in reducing CRM accidents and incidents as ensuring that there is a focus on CRM training among the airlines and employees
 - The initial rise and following decline of accidents and incidents could be indicative of an initial compliance with the initial CRM policies, but a delayed application in practice among airlines

Conclusion

- Using the NTSB accident database, the researchers assessed accident reports in order to determine if there was a change in CRM-related accidents associated with the progression of CRM training
 - Based on the analysis, there appeared to be a significant effect on accident and incident rates as a result of the CRM training
 - The results suggest that the focus on CRM training in the aviation industry has made an impact in reducing human error

As CRM understanding and implementation continues to advance in international and airline policies it will be necessary to ensure a full comprehension and practical application of knowledge gained by industry, and scientific research to ensure the best possible gains in safety