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Survey data collected from 9,400 male commercial airline pilots in 19 countries were used in a replication study of Hofstede's indexes of national culture. The analysis that removed the constraint of item equivalence proved superior, both conceptually and empirically, to the analysis using Hofstede's items and formulae as prescribed, and rendered significant replication correlations for all indexes (Individualism-Collectivism .96, Power Distance .87, Masculinity-Femininity .75, and Uncertainty Avoidance .68). The successful replication confirms that national culture exerts an influence on cockpit behavior over and above the professional culture of pilots, and that "one size fits all" training is inappropriate.

CULTURE IN THE COCKPIT Do Hofstede's Dimensions Replicate?

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In commercial aviation, the task of flying is typically a two- or three-person endeavor. Not only do pilots need to manage the technical aspects of flight; they must also manage their crew interactions and ground-to-air communications in a way that ensures safe and efficient performance. A realistic understanding of the limits of human performance (and its corollary, the potential for error) has encouraged pilot training in the areas of communication, workload management, situation awareness, leadership, and strategies for handling stress. Much of the work has been applied from social and cognitive psychology, and the training strategies that have been developed are known generically as Crew Resource Management (CRM) (Helmreich & Foushee, 1993). CRM training is now mandated in all 185 member states of the International Civil Aviation Organization and is promoted globally. This study was undertaken as part of a larger project to understand the cross-cultural differences in pilots' work attitudes and values as they relate to CRM training

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(Helmreich & Merritt, 1997; Merritt, 1996; Merritt & Helmreich, 1996, 1997; Sherman, Helmreich, & Merritt, 1997).

Turning to the literature in cross-cultural psychology for guidance in this study, the seminal work of Geert Hofstede (1980, 1991) seemed the most relevant. But to what extent would Hofstede's dimensions of national culture, derived from personnel in a large multinational company in the late 1960s and early 1970s, be applicable to this specific subject population, that is, commercial airline pilots flying in the 1990s? Pilots are typically at the technological and modernized forefront of their country's workforce—many are trained or travel overseas as part of their jobs—and it seemed likely that pilots who are working in such a highly regulated, high-technology environment might transcend national influences in favor of a universal standard of behavior. Certainly, in the absence of empirical data, the prevailing view within the aviation community has been one of denial or minimization of any national differences—the assumption has been that pilots operate the same types of aircraft and therefore they should be trained to the same standards using the same techniques. To be able to challenge this assumption, the first task was to collect data from pilots and document differences in attitudes as a function of nationality.

With Hofstede's permission, items from the Work Values Survey (Hofstede, 1982) were included in the Flight Management Attitudes Questionnaire (FMAQ) (Helmreich, Merritt, Sherman, Gregorich, & Wiener, 1993), and data were collected during the period 1993-1997. Sufficient data were collected to allow a replication study of Hofstede's indexes of national culture. If the indexes replicated, then national differences and their implications for pilot training could be discussed in a broader cultural context and with greater confidence. If the indexes did not replicate, there would be empirical support for the belief that the professional pilot culture transcends national differences and that standardized "one size fits all" training is appropriate.

METHOD

ITEMS

The FMAQ (Helmreich et al., 1993) is an exploratory, cross-cultural 82-item questionnaire designed to measure pilots' attitudes toward command, communication, stress, automation, organizational climate, and work values. Sixteen items from the Work Values Survey (Hofstede, 1982) were included in the questionnaire, along with items from an earlier pilot survey (the

Cockpit Management Attitudes Questionnaire) (Helmreich, 1984) and other items that were included specifically to try and capture Hofstede's dimensions within the aviation environment. Work values items were scaled on a 5-point Likert-type scale (*very little or no importance to utmost importance*). The attitudinal items, unless otherwise specified, were scaled on a 5-point Likert-type scale (*strongly disagree to strongly agree*).

PARTICIPANTS

All commercial airline pilots were eligible for the larger study; however, to use the most culturally distinct groups in the replication study, only airlines that were predominantly owned, managed, and operated by members of the same national culture were used, and only responses of pilots whose nationality and nationality at birth matched the nationality of the airline were used. Because of the global scarcity of female pilots, only male pilots were used. Airlines that participated in the project took responsibility for the distribution and collection of the questionnaires. Six airlines, from Argentina, Brazil, Italy, Korea, Mexico and Taiwan, undertook a translation of the questionnaire for their pilots—other airlines deemed it unnecessary. (As English is the official language of aviation, many airlines conduct their operations and training in English.) The translations and back-translations were done by bilingual aviation personnel to ensure equivalence of technical terms. In return for their participation, each airline was given a report, summarizing their pilots' survey responses and providing recommendations for training.

Using data that were collected during the period 1993-1997, a country-level database was compiled from the responses of 9,417 pilots in 26 airlines in 19 countries: 5 airlines from the United States ($n = 5,139$), 2 from Australia ($n = 540$), 2 from Switzerland ($n = 180$), 2 from Brazil ($n = 440$), and 1 airline each from Argentina ($n = 39$), British Hong Kong ($n = 208$; British pilots), Germany ($n = 228$), Greek Cyprus ($n = 53$), Ireland ($n = 300$), Italy ($n = 484$), Japan ($n = 50$), Korea ($n = 123$), Malaysia ($n = 455$), Mexico ($n = 167$), Morocco ($n = 50$), New Zealand ($n = 385$), Philippines ($n = 86$), South Africa ($n = 170$), and Taiwan ($n = 320$). In line with Hofstede's methodology, country-level scores for each item were calculated by taking the average of two scores: (a) the captains' mean score and (b) the first and second officers' mean score. For those countries represented by more than 1 airline, the airline means for each item were then averaged to form the country mean. (Averaging within position before averaging for an airline and averaging across airlines to derive a country score where appropriate seemed the best approximation of Hofstede's method of weighting each occupational group equally within a country.)¹

ANALYSES

Two sets of analyses were conducted. The first was a direct replication of Hofstede's methodology. Hofstede's items were applied as prescribed by his formulae (Hofstede, 1982), and the resultant pilot-derived country-level scores were correlated with Hofstede's original country scores for each dimension. The second analysis removed the constraint of item equivalence across time and populations. All items in the database, including Hofstede's items and the new items written for the pilot survey, were correlated with Hofstede's index scores. This less constrained approach allowed the data to reveal all possible correlations with Hofstede's indexes, regardless of the pattern previously prescribed or prior expectations for the new items. To determine the most coherent and parsimonious linear composites accounting for the greatest variance in the indexes, items that were significantly correlated with an index were entered into a series of standard and stepwise multiple regressions with Hofstede's index scores as the dependent variables. The resulting composites were then input into a cluster analysis to determine which countries formed cultural clusters.

RESULTS

DIRECT REPLICATION OF HOFSTEDÉ'S INDEXES

Power Distance Index

Hofstede's Power Distance (PD) Index is based on three items (percentage who choose consultative leadership as their ideal leadership style, percentage who choose autocratic or directive leadership as the typical leadership style, and mean response to "how often subordinates are afraid to express disagreement"). The formula provided by Hofstede (1982) was applied to the aggregated pilot scores.

For the 19 countries in the data set, the correlation between the PD scores for Hofstede's study and the PD scores calculated for the pilots was .74. With two small exceptions (Malaysia down by 5 points, South Africa by 6 points), all pilot groups had higher scores than Hofstede's original country scores (see Table 1). Using paired-sample *t* tests to compare the original item scores from Hofstede's data² with the pilot-derived data, two of the three items were found to be significantly different. The pilot groups' scores indicated that subordinates were more afraid to disagree with their superiors than in Hofstede's data ($t = -2.97$, $df = 17$, $p < .01$). Also, the percentage of respondents

TABLE 1
Power Distance and Masculinity Indexes for 19 Countries

	<i>Power Distance</i>						<i>Masculinity-Femininity</i>							
	<i>Hofstede^a</i>		<i>Pilots</i>	<i>Hofstede^b</i>		<i>Pilots^c</i>		<i>Hofstede</i>		<i>Pilots</i>	<i>Hofstede</i>		<i>Pilots</i>	
	<i>Score</i>	<i>Rank</i>	<i>Score</i>	<i>Rank</i>	<i>Score</i>	<i>Rank</i>	<i>Score</i>	<i>Rank</i>	<i>Score</i>	<i>Rank</i>	<i>Score</i>	<i>Rank</i>	<i>Score</i>	<i>Rank</i>
Argentina	49	11*	88	8	1	8	56	14	-6	3	2	12		
Australia	36	14	42	18	-33	11*	61	11	-12	7	49	5		
Brazil	69	5	126	1	104	2	49	16	-8	4*	-82	16		
British Hong Kong	35	15*	59	13*	-102	18	66	6*	-10	6	19	11		
Germany	35	15*	84	9	-46	14	66	6*	-34	14	28	10		
Greek Cyprus	60	6*	63	11	30	7	57	13	-21	13	-24	13		
Ireland	28	18	54	16	-71	17	68	5	-15	10*	108	1		
Italy	50	10	72	10	-54	15	70	2*	-45	18	35	9		
Japan	54	9	61	12	-13	10	95	1	-15	10*	54	4		
Korea	60	6*	105	2	-6	9	39	19	-38	15	-132	18		
Malaysia	104	1	99	6	84	3	50	15	-17	12	-46	15		
Mexico	81	3	101	4	62	4	69	4	-14	9	47	6		
Morocco	77	4	103	3	48	6	46	17	-40	16	-95	17		
New Zealand	22	19	41	19	-59	16	58	12	-8	4*	71	2		
Philippines	94	2	100	5	189	1	64	8	-3	2	-29	14		
South Africa	49	11*	43	17	-43	13	63	9	4	1	44	8		
Switzerland	34	17	59	13*	-106	19	70	2*	-41	17	45	7		
Taiwan	58	8	90	7	50	5	45	18	-51	19	-150	19		
United States	40	13	58	15	-33	11*	62	10	-12	7*	56	3		

a. Hofstede's original scores and rankings.

b. Pilots' scores calculated using Hofstede's items and formulae.

c. Index based on items selected from second analysis. Item scores in this index were standardized to equalize influence, then summed, averaged, and multiplied by 100 to form the index.

* $p < .05$.

reporting autocratic or directive leadership as typical was significantly higher in the pilot groups ($t = 8.53$, $df = 18$, $p < .001$; average difference = 22%). Pilots in every country perceived that they work for a more autocratic or directive leadership than other occupational groups reported in Hofstede's earlier study.

Masculinity-Femininity Index

Hofstede's Masculinity-Femininity (MAS) index is based on four work goal items (important to work with people who cooperate with others, to have security of employment, to have opportunity for high earnings, and opportunity for advancement to higher jobs). The original MAS (and Individualism-Collectivism [IND]) indexes were computed from factor scores derived from a factor analysis of standardized country means on 14 work goals. Because this procedure cannot be replicated with other data sets (different countries, different sets of items), Hofstede (1982) offers a formula to approximate the scores based on regression analysis and unstandardized group means. The formula was adopted here.

A second score was calculated for each country. Preliminary analyses indicated the presence of cultural response sets in the work values items (Merritt, 1996). Pilots from the Philippines, Mexico, and Brazil showed strong extremity or sincerity bias, whereas Korean and Japanese pilots exhibited a neutrality bias, indicating that some form of transformation was necessary before groups could be compared. (Hofstede also warns against working with raw scores in the work values items; however, because of the way the index was originally derived, he was constrained to provide a formula that used raw scores.) Consequently, in line with Leung and Bond's (1989) within-subject transformation, each individual's scores were standardized across the 17 work values items in the FMAQ and then aggregated by the method mentioned previously to form country-level scores. These scores were substituted in a simplified additive version of Hofstede's formula.

The pilot scores calculated by Hofstede's formula for unstandardized group means were correlated .16 with the country scores from Hofstede's study (see Table 1), and the formula derived from the within-subject standardized scores of the same items rendered a slightly higher but still very weak correlation of .23.

Using Hofstede's formula, the pilot scores for MAS were consistently and significantly *lower* than the country scores reported by Hofstede (a mean difference of 42 points; $t = 6.1$, $df = 18$, $p < .001$). This result may seem initially counterintuitive—one might think that pilots everywhere share a certain "macho" attitude, compared with other, more subdued occupations such as

teaching and nursing. Furthermore, the replication study used only male pilots, which in itself should have produced elevated scores. Direct comparison of individual item scores between Hofstede's data and the pilot data is not possible because of the standardization procedure used by Hofstede. However, the pattern of scores for the four items in the MAS index can be compared. For example, in Hofstede's data, the "feminine" item regarding security of employment was ranked the least important of the four items in 14 of the 19 countries (and second to least important in the other 5 countries). By comparison, security of employment was given the highest ranking by pilots in 16 countries (and second most important in the 3 other countries). Similarly, the "masculine" item regarding advancement to higher level jobs was ranked the most important in 11 of the 19 countries in Hofstede's data but was ranked the most important in only two pilot groups (Brazil and South Africa). This reversal of preferences (high scores for the feminine items, low scores for the masculine items) accounts for the poor replication and lower MAS scores for pilots.

Individualism-Collectivism Index

As with the MAS index, Hofstede's IND index is based on four work goal items (important to live in an area desirable to self and family, to have sufficient time left for personal or family life, to work with people who cooperate [the item loads on both the MAS and IND indexes], and have good physical working conditions). The last item was seen as functionally nonequivalent across the two surveys because the physical cockpit environment is standard across aircraft and airlines, and so it was omitted from the FMAQ.

Hofstede's formula for calculating the index based on raw scores and regression analysis was applied, with two approximations made for the missing item. In one composite, every country was accorded a score of 3 (midpoint on the scale—"moderate importance") on the missing item. A second, more refined, estimate was based on the item's relationship with the other Collectivist item in the index. Scores for the missing item (good physical conditions) were consistently lower than the other Collectivist item in the index formula—across the 19 countries in this study, and across all 40 countries in *Culture's Consequences* (Hofstede, 1980), the ratio between the two scores was .69. This information was incorporated into a second formula to allow some variance in the approximated item derived from the individual country and the other collectivist item in the formula. In addition to these two index approximations, item composites were calculated as they had been for the MAS index, based on the within-subject standardization procedure.

Hofstede's original country scores were correlated .48 with the index that substituted a constant for the missing item, .61 with the index with the more flexible substitution (see Table 2), and .67 with the index based on within-subject standardized scores.

The elevated scores and restriction of range for the pilot-derived IND scores are worthy of comment. When the index was calculated with the flexible substitution (.69 of the other collectivist item), the range of scores was 40 (115-155; $SD = 12.5$). Hofstede's country scores by comparison have a range of 74 (17-91; $SD = 26.0$), and the highest score is still lower than the lowest score observed in the pilots' data. These results suggest that pilot scores for Individualism are elevated and more convergent, relative to Hofstede's original country scores.

Uncertainty Avoidance Index

Hofstede's formula for the Uncertainty Avoidance (UA) index is based on three items (how often you feel nervous or tense at work; the organization's rules should not be broken, even when it is in the company's best interests; and the percentage who say they plan to work for the company for 5 years or less). The third item was omitted from the FMAQ for not having functional equivalence—the volatility of the aviation industry and the financial disincentives for changing employers (loss of seniority, pay, and bidding privileges) make security of employment paramount to most pilots. (Recall also the undifferentiated and high scores for the security-of-employment item in the MAS index, which supports the decision to omit the third UA item.) To calculate the UA index with this item missing from the pilot data, two approximations to Hofstede's formula were made. In one composite, every country was given a constant of 21% to substitute for the missing item. This constant was taken from Appendix 2 of *Culture's Consequences* (Hofstede, 1980) as being the average percentage reported in the 40-country study. A second approximation took the actual percentage figure reported in Hofstede's data for each of the 19 countries. Clearly this number, taken as it is from Hofstede's original calculations and inserted directly into the formula, should greatly enhance the possibility of a favorable replication.

Hofstede's country scores for UA did not correlate significantly with either of the two composites (.25 for the formula with a constant, .31 for the formula with the precise substitution; see Table 2), warranting further investigation at the individual item level. There were no significant differences between the pilots' country scores and Hofstede's country scores for one of the items ("the organization's rules should not be broken"); however, there

TABLE 2
Individualism and Uncertainty Avoidance Indexes for 19 Countries

	Individualism						Uncertainty Avoidance					
	Hofstede ^a		Pilots	Hofstede ^b		Pilots ^c	Hofstede		Pilots	Hofstede		Pilots
	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score
Argentina	46	10	31	4*	-24	11	86	3	30	14*	49	6
Australia	90	2	27	7*	99	3*	51	12	47	7	-51	14
Brazil	38	12	13	16	-98	17	76	6	56	4	62	4
British Hong Kong	89	3	31	4*	114	1	35	18*	37	13	-103	19
Germany	67	8	21	13	2	10	65	9	42	9*	-48	13
Greek Cyprus	35	13	8	17	-34	12	112	1	52	5	13	9
Ireland	70	6	27	7*	89	5	35	18*	20	19	-90	18
Italy	76	5	18	14*	71	6	75	7	42	9*	-8	10
Japan	46	11	23	9*	25	9	92	2	40	11*	149	1
Korea	18	18	-5	19	-138	19	85	4	85	1	129	2
Malaysia	26	16	1	18	-76	14	36	17	43	8	23	8
Mexico	30	15	23	9*	-79	15	82	5	30	14*	29	7
Morocco	20	17	21	12	-103	18	54	11	66	3	68	3
New Zealand	79	4	36	1	99	3*	49	13*	29	16	-82	17
Philippines	32	14	23	9*	-54	13	44	16	40	11*	-22	11
South Africa	65	9	31	4*	38	8	49	13*	25	17	-56	15
Switzerland	68	7	35	2	57	7	58	10	22	18	-37	12
Taiwan	17	19	18	14*	-93	16	69	8	73	2	56	5
United States	91	1	32	3	104	2	46	15	51	6	-78	16

a. Hofstede's original scores and rankings.

b. Pilots' scores calculated using Hofstede's items and formulae.

c. Index based on items selected from second analysis. Item scores in this index were standardized to equalize influence, then summed, averaged, and multiplied by 100 to form the index.

* $p < .05$.

was a significant difference for the other item (“how often do you feel nervous or tense at work?”) ($t = 8.2, df = 18, p < .001$)—with one minor exception, namely, all pilot groups said they were less nervous or tense at work than their IBM counterparts across seven occupations. (Either the IBM corporation of the 1960s and 1970s was a high-stress, life-threatening work environment for manual laborers, clerks, technicians, and managers or it seems that pilots are rather cavalier about the stress involved in the commercial aviation environment.)

To summarize the first set of analyses: Using Hofstede’s items and formulae as prescribed, the best correlations between Hofstede’s index scores and the pilot-derived scores were as follows: Power Distance (.74), Individualism Collectivism (.67), Uncertainty Avoidance (.31), and Masculinity-Femininity (.23).

CONCEPTUAL REPLICATION OF HOFSTEDÉ’S INDEXES

In the second set of analyses, the aim was to find the subsets of items that best predicted Hofstede’s indexes, regardless of the items and formula originally prescribed. All items, including those written for the new survey as well as those from Hofstede’s survey, were correlated with Hofstede’s index scores. The results were striking. Of the 48 items that were entered into a correlation matrix with Hofstede’s index scores, 25 items were significantly correlated with Hofstede’s IND index and 24 were significantly correlated with the PD index (21 items overlapped both indexes). Four items were significantly correlated with the MAS index, and four were correlated with the UA index ($p < .05$ in two-tailed tests, for $N = 19$ countries).

The question of which items proved to be the best subset for predicting each index was investigated with the intercorrelation matrix and multiple regression. Using standard and stepwise regression, and by inspecting the relative significance levels of the beta weights, it was possible to determine which items were the best predictors of each index. At the same time, there was a concern that the final composites should not only correlate with Hofstede’s index scores but that they should be intercorrelated in a fashion similar to Hofstede’s indexes (e.g., significant negative correlation between PD and IND). To achieve this goal, some items were added to the composites; although not affecting the composites’ predictive power per se, they did serve to discriminate the pilot-derived indexes from each other a little more successfully. Table 3 lists the 17 items that were selected to define the survey-derived composites. The correlations between Hofstede’s index scores and

TABLE 3
Item Composites Derived From
Second Analysis of All Items in the Survey

Individualism—3 items
Percentage who preferred to work for a consultative leader (vs. autocratic, directive, or consensus leader)
(Important to have) sufficient time for personal and family life
(Important to have) challenging tasks from which you get a personal sense of satisfaction
Power Distance—5 items
First officer should never assume command of the aircraft
Percentage who preferred to work for a consultative leader (R)
Decision-making ability is as good in emergencies as in routine flights
(Important to have) changing work routine with new unfamiliar tasks (R)
Personal problems can adversely affect performance (R)
Masculinity—5 items
(Important to have) challenging tasks from which you get a personal sense of satisfaction
How often do you feel nervous or tense at work—(seldom)
How often are subordinates afraid to disagree with their superiors—(seldom)
The organization's rules should not be broken, even when the employee thinks it is best (R)
Written procedures are required for all in-flight situations (R)
Uncertainty Avoidance—4 items
If I perceive a problem, I will speak up (R)
Captain should encourage crew-member questions (R)
In abnormal situations, I rely on superiors to tell me what to do
(Important to) find the truth, the correct answer, the one solution

NOTE: R = reverse-scored.

the best pilot-derived composites were as follows: Individualism-Collectivism (.96), Power Distance (.87), Masculinity-Femininity (.75), and Uncertainty Avoidance (.68). Clearly, this second, less methodologically constrained approach rendered a considerably stronger replication of Hofstede's indexes.

Table 4 is a summary of the two analyses. It shows the intercorrelations for all the indexes in the study—Hofstede's original indexes (intercorrelations for the 19 countries in this study), scores derived for the pilots using Hofstede's items and formulae, and composites derived from all the survey items. Note that in maximizing the replication correlations, the resulting interindex correlations for the pilot data were much higher than observed in Hofstede's original data.

TABLE 4
Index Intercorrelations

	<i>H-IND</i>	<i>H-PD</i>	<i>H-MAS</i>	<i>H-UA</i>			
H-PD	-.77**						
H-MAS	.45	-.29					
H-UA	-.42	.11	.04				
					<i>HP-IND</i>	<i>HP-PD</i>	<i>HP-MAS</i>
HP-IND	.67**	-.59	.49	-.38			
HP-PD	-.77**	.74**	-.49*	.25	-.61**		
HP-MAS	.28	.01	.23	-.24	.34	-.24	
HP-UA	-.53*	.32	-.63**	.31	-.68**	.51*	-.51*
					<i>P-IND</i>	<i>P-PD</i>	<i>P-MAS</i>
P-IND	.96**	-.76**	.57*	-.42			
P-PD	-.73**	.87**	-.34	.15	-.74**		
P-MAS	.77**	-.55	.75**	-.26	.83**	-.56*	
P-UA	-.78**	.52*	-.16	.67**	-.75**	.45	-.62**

NOTE: IND = Individualism-Collectivism; PD = Power Distance; MAS = Masculinity-Femininity; UA = Uncertainty Avoidance. The first set of indexes, preceded by *H*, are Hofstede's original country scores; the second set, preceded by *HP*, are pilot scores derived from Hofstede's items and formulae; the indexes preceded by *P* are pilot scores derived from subsets optimized from all items in the survey. Correlations in italics represent the success with which Hofstede's indexes could be replicated.

* $p < .05$. ** $p < .01$.

CLUSTER ANALYSES

A series of cluster analyses were conducted on the pilot-derived composites to determine which countries formed cultural clusters. Figure 1 is a dendrogram derived from a hierarchical cluster analysis using the average-linkage-between-groups method. Note how the five Anglo countries³ cluster together and then are joined by the three Western European countries and South Africa to form a strong cluster almost immediately, whereas the Philippines and Japan are the last countries to cluster. Because there is no definitive means of determining the number of clusters, four-, five-, and six-cluster solutions were considered. In the solutions, Japan is distinguished from all other groups by its high UA score, just as the Philippines is distinguished by its high PD score; Korea, Taiwan, and Morocco as a group are distinguished by the lowest IND and MAS scores; Brazil, Mexico, and Malaysia have the second highest PD scores; and the Anglo and Western European countries are notable for having the highest IND scores and the lowest PD and UA scores. These clusters can be used to describe various pilot profiles.

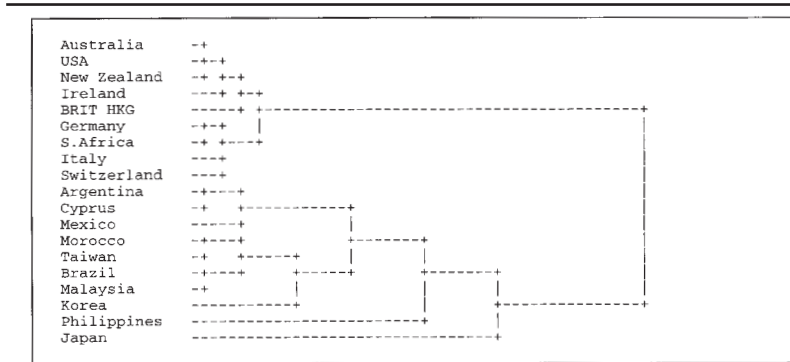


Figure 1: Dendrogram of 19 Countries Based on Composite Scores From Conceptual Replication

DISCUSSION

Two sets of analyses were conducted to determine the extent to which Hofstede's dimensions of national culture are relevant in the high-technology, modernized world of commercial aviation. The first analysis applied items and formulae from the original Work Values Survey (Hofstede, 1982) and was successful in replicating the IND and PD indexes, but not the MAS or UA indexes. The second analysis provided a more successful and realistic replication by removing the constraint of item equivalence across time and populations. The resulting replication correlations were considerably higher than those observed in the more stringent replication, and they more accurately defined the dimensions in this particular professional environment. As the MAS and UA indexes were replicated in the second but not the first replication, it may be interesting to discuss these dimensions first.

The five items of the MAS composite define high MAS behavior as enjoying a challenge, being seldom nervous or tense at work, not being afraid to disagree, not being concerned with the organization's rules, and eschewing the need for written procedures in all in-flight situations. In other words, high MAS behavior reflects a "derring-do" machismo that is often associated with the pilot stereotype. Recall that the sample is all male, and all pilots, which may account for the failure of any "feminine" quality-of-life items to emerge.

It is important to note that the items that defined the MAS index for Hofstede's sample did not work for the pilots, not because the underlying values were necessarily different but because economic conditions were different. For example, "security of employment" had the highest mean rating of 17 work values for pilots in the 19 countries, primarily because of the current

volatility in the aviation industry and the work rules that apply to pilots—a change of employer can produce a significant drop in seniority, pay, and bidding privileges. Similarly, pilots did not rate the “opportunity for high earnings” as highly as did the respondents in Hofstede’s study because pilots have already selected into a financially rewarding profession (and it is easier to say such things are unimportant when one already has them). Hoppe (1990, 1993) reported a similar finding for this item in his replication study of highly educated elites in 19 countries.

It is interesting that the two items regarding rules and procedures, which were originally envisaged as tapping the UA index, should load on the pilots’ MAS index, because it highlights the importance of context in understanding the dimensions. The commercial aviation environment is highly regulated and highly proceduralized—there are operating manuals and checklists for all known situations. Because of the dangerous and sometimes fatal consequences of error in this environment, the profession itself is more uncertainty avoidant in its operation than other less risky occupations. Pilots are schooled to redundancy in checklist usage and emergency procedures as a way to anticipate and manage abnormal situations. In other words, UA is a professionally instilled value, a means of managing error in a high-risk environment.

So why should the two rules and procedures items appear on the MAS index for pilots? It may be that high MAS pilots view procedures and checklists as unnecessary constraints. This attitude is borne out by the phrase “checklists are for the lame and the weak,” a phrase heard when the author was observing some pilot training in the United States (the United States was ranked third on the pilots’ MAS index). The instructor had asked a very experienced pilot group why pilots would choose to deliberately ignore checklists and fly as they saw fit (a problem that had been identified as endemic in this airline), when a pilot in the group offered the phrase by way of explanation. In other words, in an environment where rules are set and working conditions are constrained, the high MAS pilot may choose to step outside those constraints.

Uncertainty Avoidance, as stated earlier, is a large part of the commercial aviation environment, but can it still be detected at the national level, over and above the already high professional expectation? A four-item composite was correlated .68 with Hofstede’s UA index, suggesting that it could, but perhaps not as strongly as seen with the other indexes. The four items suggest that in a high-UA cockpit, one follows orders and concentrates on the flight plan as set, without deviating. One does not ask questions, nor does one want questions encouraged that could raise uncertainties. Either the flight plan will

solve the problem, or by not asking questions, the problem is simply not acknowledged or allowed to exist. A finding from some related research might help explain this attitude. As part of their survey, pilots from one of the high-UA East Asian countries (Korea, Japan, and Taiwan were all ranked in the Top 5 on the pilots' UA composite) were asked how the company's introduction of expatriate pilots (predominantly senior captains from the United States who were conversant only in English) had affected the operation of the flight deck. The overwhelming response from these pilots, despite the obvious communication difficulties posed by two languages in the cockpit, was (translated) "everything will be okay as long as everyone follows standard operating procedures (SOPs)." The American expatriates (the United States was ranked 17 of 19 countries) who also answered the survey were considerably more forthcoming with perceived problems, including their perceptions of the other pilots' "inflexibility" and inability to deviate from the SOPs when necessary. Integrating the low- and high-UA preferences of these two pilot groups has been an ongoing issue for this airline.

The PD index also provided some surprises in terms of definition. Recall that Hofstede's three-item PD formula was relatively successful in replicating scores ($r = .74$); however, the five-item pilot composite was more successful ($r = .87$) and more specific in its description. As well as the item that overlapped both indexes (the percentage who prefer a consultative leader—low-PD pilots preferring consultative leadership), other items suggest that in a high-PD cockpit, the first officer should never assume command of the aircraft; decision-making ability and performance should be consistent and unaffected by emergencies or personal stressors; and a set routine is preferable to one with unfamiliar tasks. Although these items were not originally conceived as being related, as a composite they reflect the notion that in a high-PD country, pilots are more likely to see the role than the person in that role.⁴

Recall also that pilot PD scores calculated from Hofstede's formulae were significantly higher than Hofstede's original sample, primarily because pilots perceive that they work for more autocratic leadership. Again this is a reflection of the work environment rather than underlying cultural values. Just as commercial aviation embodies some high-UA concepts in its risk management, so too it adopts some high-PD concepts to stabilize the environment. The highly complicated, seniority-based system of bidding monthly for trips means that pilots fly with many different pilots throughout their careers, usually changing every month and in some instances every week. Emphasis on the command role rather than the person is one way to stabilize the work environment while accommodating the constantly shifting

patterns of personnel. Again, it is important to note the occupational context—it is likely that first officers in Ireland expect and accept a higher PD environment in the cockpit than Irish clerks might tolerate from their direct supervisors in the office.

The results for the IND index may be the platform from which to understand the other index results. When calculated by Hofstede's formula, the pilots' Individualism scores were considerably higher (a mean difference of 82 points) and less variable (standard deviations of 11 versus 26) than those in Hofstede's sample, suggesting two possible explanations. Either in line with the convergence hypothesis of modernization (Inkeles & Smith, 1974; Segall, Dasen, Berry, & Poortinga, 1990), the countries in this study have converged on some common, more modern-individualistic values in the past 25 to 30 years or, alternately, it is specifically a reflection of the pilot profession, its high-technology environment, and its tendency to attract independently minded individuals. Other occupations from the same countries may have considerably lower IND scores than observed in this elite profession.

The IND index also drew the most and the strongest item-index correlations. The replication correlation for IND was very high (.96) and very easy to establish—as few as two items could have provided a replication of .90 or higher. More items were significantly correlated with Hofstede's IND index than any other index. At the same time, 24 of the 25 items that were correlated with the IND index were also correlated with at least one if not two of his other indexes. As a result, the interindex correlations were all higher than observed in Hofstede's data and backfitting with confirmatory analysis failed to disentangle these indexes.⁵ All these results suggest that for this sample of countries and pilots, IND is a pervasive force that interacts with, and influences, the other dimensions in a much stronger fashion than observed in Hofstede's data. The explanation for this predominance of IND may be found in a discussion of the person-environment attributes that constitute the generic commercial aviation environment.

As mentioned earlier, the commercial aviation environment embraces high-UA behaviors such as checklists, manuals, and standard and emergency operating procedures as a way of managing error in a high-risk environment. The environment also incorporates some high-PD principles—the workplace is hierarchically designed (there is always a captain and one or more junior officers in the cockpit), and duties and responsibilities are delineated according to command roles. Superimposed on this workplace setting is the process of self-selection into the profession. In most countries, obtaining a commercial pilot's license is a costly endeavor (usually borne by individuals or their families) involving many hours of technical, engineering-level study; hence, pilots tend to come from the educated middle classes or higher in almost all

countries. (Exceptions exist, e.g., airlines that recruit their pilots exclusively from the military.) Also, the pilot image is traditionally portrayed as a solo enterprise of power and daring (man and machine). Individuals who are attracted to piloting are therefore likely to be more individualistic and more concerned with achievement and masculine style than perhaps individuals who are attracted to farming, teaching, or nursing as a profession. In summary, the person-environment match in commercial aviation in many parts of the world is a mix of high UA, PD, IND, and MAS attributes.

It is these environmental and personal attributes that shape the professional pilot culture and create the expectation that one-size-fits-all training is appropriate for all pilots. But this study has shown that even in a highly specialized, highly regulated profession such as aviation, national culture still exerts a meaningful influence on attitudes and behaviors over and above the occupational context.

CONCLUSION

The aim of this study was to determine if Hofstede's indexes could be replicated in the commercial aviation environment such that differences in pilot behavior and training could be discussed in a broader cultural context. The study confirms that the effects of national culture can be seen over and above the professional pilot culture, and that one-size-fits-all training is not appropriate. The study also highlights the need for understanding respondents' occupational context. As such, the results reported here may extend to any occupation that is hierarchical in nature and involves teams of individuals interacting in high-risk, high-technology environments (e.g., surgical teams, nuclear power plant personnel).

Finally, it is important to note that although this article's focus was limited to a replication of Hofstede's work with national culture, the larger research project of which this study is a part emphasizes that national culture underlies but also interacts with many other influences to shape performance, for example, the historic and economic context, and organizational and professional cultures (Helmreich & Merritt, 1998).

NOTES

1. Please note that there is a great deal of information about within-country variance that is ignored with this analytic approach. Complete appreciation of the data required individual-level analyses, both intra- and interculturally, to complement these country-level analyses (Merritt, 1996).

2. Country scores for the individual items were available from the appendixes of Hofstede's (1980) *Culture's Consequences*. Also, Professor Hofstede kindly supplied me with data for four countries that were added to his database after the 1980 book had been published.

3. The term *Anglo countries* was coined to refer to those countries whose inhabitants are predominantly monolingual, speaking only English. These countries include Australia, New Zealand, Great Britain, the United States, and Canada (excluding Quebec).

4. For example, in Brazil, the country with the second highest Power Distance (PD) scores, the captain is always addressed as "Captain," without any reference to his last name and most certainly not his first.

5. Using a correlation matrix derived from the items that significantly correlated with one or more of Hofstede's indexes, the only parameters that were fixed were four factors specified to have the resultant intercorrelations observed in Hofstede's data. That is, items were free to load on any factor, as long as the resultant factors correlated in the same fashion as seen in Hofstede's data. Despite hundreds of iterations, the program (LISREL) was simply unable to locate factors with such a pattern of intercorrelations.

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