行政院國家科學委員會專題研究計畫 成果報告

國軍空勤人員適應人體離心機之性別差異與能力量測
研究成果報告(精簡版)

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中 華 民 國 99 年 08 月 04 日

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計畫主持人：林珮珺
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中　華　民　國　99　年　8　月　13　日

行政院國家科學委員會專題研究計畫成果報告

國軍空勤人員適應人體離心機之性別差異與能力量測

Measurement of military aircrews' ability to adapt to human centrifuge and the effect of gender differences

計畫編號：NSC 98-2629-E-006 -001

執行期限：98 年 8 月 1 日至 99 年 7 月 31 日

主持人：林珮珺　國立成功大學交通管理學系

一、中文摘要

本計畫旨在探討空勤人員適應人體離心機的能力，分析有效提昇學員 G 耐力的訓練裝備與項目，是否因性別差異而有所不同。對於生理能力的分析，本計畫將使用回溯性調查研究方法，分析國軍岡山醫院航空生理訓練中心的人體離心機訓練記錄，以二元 Rasch 模式、變異數分析方法，分析比較一般生理參數（性別）、施訓結果與鬆弛性 G 耐力、緊張性 G 耐力、ΔG 兩兩之間的關係，以連結性別與離心機訓練的生理能力量測分析。對於心理能力的分析，將利用問卷調查空勤人員在離心機訓練的壓力來源，進行受測者適應人體離心機壓力源的能力量測。應用因素分析，將影響空勤人員於離心機訓練的壓力來源分解成數個構面，以此作為進一步施行壓力管理的依據。並以項目反應理論中的多元部分計分模式為核心，應用聯合最大概似估計法，估算個別壓力源的難度參數、與受測者適應離心機訓練的能力參數，以供航生教官作為個別人員應加強的訓練依據、或訓練方案設計上修訂的依據。本計畫預期將針對性別規範出人體離心機不同的測驗裝備與教育訓練項目，有效精進不同性別學員的抗 G 動作，與加強學員的 G 耐力，提昇訓練品質，確保飛安。

關鍵詞：人體離心機、項目反應理論、性別差異、G 力昏迷

Abstract

This study investigates the stressor of military aircrews when undergoing centrifuge training and determines what training items cognitively promote trainees' G tolerance in order to thereby lower the incidence of G-induced loss of consciousness (G-LOC) for the crews of high-performance combat aircraft. Questionnaires are used to assess the stress-influence factors of crews in undergoing centrifuge training. Attributes are identified by the aviation physiology professionals and then grouped according to their influence on military aircrews. Aircrews' stress influenced by centrifuge training is decomposed into three constructs by factor analysis, theory lecture, centrifuge equipment and physical fitness. Considerable interpenetration is discernible between these factors and the subjects' age, service age, flight hours and the fighter jet they pilot. The study results are used as the basis to implement stress management and to improve training quality and to ensure safety by effectively identifying and measuring the cognitive stressors when undergoing human-use centrifuge training.

Keywords: human-use centrifuge, G-LOC, stressor

二、緣由與目的

Acceleration (G) is one of the major physical stresses associated with combat flying [1]. The gravitational force (G-force) is the measurement of an object with velocity proportional to the multiples of G and induced in the direction opposing that from which the object receives force. Rapid acceleration of a jet fighter generates G force. A G-force from six to nine is usually defined as a high G-force. With high positive G (>+6G), the blood flow of the aircrew could hardly reach the brain, rapidly causing hypoxia and consequent loss of consciousness. In 1982, two jet fighters of the United States Air Force School of Aerospace Medicine crashed due to G-induced loss of consciousness (G-LOC). Before this incident, the U.S. Air Force (USAF) had paid attention to the severity of G-LOC. Statistics show that there were 18 incidents of G-LOC (14 fatalities) from 1982 to 1990 [16]. The Royal Air Force of the United Kingdom ran a survey in 1987 and showed that 19.3 per cent of the aircrews had suffered from G-LOC [6](Green and Ford, 2006). G-LOC followed by an incapacitation period leads to fatal crashes and great damage. Therefore, how to reduce the incidence of G-LOC and prevent G-LOC have been the main research topics in developed countries.

The average cost for training a heavy-jet pilot is over US$800,000, and no country can afford to lose a well-trained pilot. North Atlantic Treaty Organization (NATO) air forces, including the USAF, have centrifuge-training programs in place. Intensive periodic human centrifuge training, similar to the hypoxia-recognition test in the hypobaric chamber, has been recommended, not only for high-performance aircraft pilots but for any pilot who can perform aerobatics. This training will allow each pilot to recognize, in a controlled and safe environment, his consciousness endpoint when undergoing +Gz manoeuvres [Alvim 1995]. One of the important results of high-G research is the demonstration that subjects could be trained to tolerate high-G loads for prolonged periods (9-G up to 45 sec) in a human centrifuge by an optimally effective anti-G straining manoeuvre (AGSM) [Modak 2002]. The current USAF-approved AGSM is the L-1, which combines a regular 3-second strain (valsalva) against a closed glottis, interrupted by a rapid exhalation and inhalation (< 0.5 seconds), with a tensing of all major muscle groups of the abdomen, arms, and legs.

Since 1989, the Taiwanese air force has purchased high-performance jet fighters (e.g., F-16A/B and Mirage 2000-5) and developed the Ching-Kuo Indigenous Defensive Fighter (IDF) in cooperation with major US aerospace industries to replace aged fighters for security efforts across the Taiwan Strait since 1989. That means that military aircrews need to increase their G-tolerance and physical capabilities in order to pilot high-performance jet fighters. Because of crashes that were due to the unconsciousness of aircrews with high-G intolerance during missions, the Taiwanese air force also purchased the human-use centrifuge (Fig. 1) along with Taiwanese second-generation jet fighters in order to lower the incidence of G-LOC by training the aircrews of high-performance combat aircrafts. A human-use centrifuge is a large ground-based machine that uses accelerated centrifugal force to simulate G-force during air combat flights.

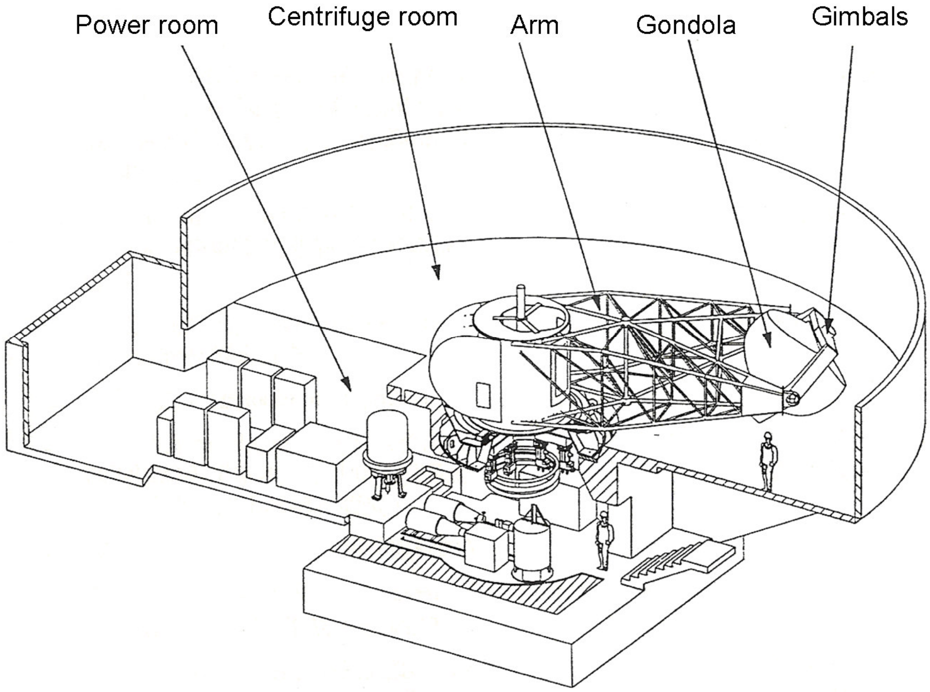

Figure 1. Human-use centrifuge

The current G-environment in air warfare is very dangerous, especially to those fighter pilots who are unfamiliar with the physical effects caused by continuous high G-force, and those who do not fully understand how to avoid its consequence [2]. Several physiology aviation studies have aimed to identify the causes of G-LOC, and find ways to improve trainees' G-tolerance and reactions to G-force [3][4][5][6][7][8][9][10][11][12][13]. However, the effectiveness of human-use centrifuge training is not yet ideal; whereas 80.3 percent of trainees considered lectures related to the theories of preventing G-LOC to be very important or relevantly important, only 55.6 percent thought they had benefited from human-use centrifuge training [2]. Therefore, there is a need to determine the stress influence factors that affect the usefulness of these complex and strict human-use centrifuge training programs. To ensure and enhance the effectiveness of the human-use centrifuge training program, this study assesses which training items increase/reduce the amount of stress that aircrews experience during human-use centrifuge training

三、相關文獻

1. G-Induced Loss of Consciousness

Burton [5] defines G-LOC as a state of altered perception wherein (one's) awareness of reality is absent as a result of sudden, critical reduction of cerebral blood circulation caused by increased G-force. Humans' daily activities normally take place in one +G environment. Our muscles, blood circulations, viscera, and nervous systems are accustomed to existing forces and pressures. When jet fighter pilots perform aerial acrobatics that require acceleration of circular motion, such as continuously rapid changes of direction during air combat, climbing after diving, and aerial bombardments, aircrews experience a reduction of cerebral blood flow, which shifts toward the lower extremities due to the centrifugal force caused by fast turns. The first organs to be affected are the eyes - tunnel vision, greyout or blackout may occur. However, at this point, the aircrews still remain conscious and are able to pilot the aircrafts. If ischemia continues or worsens, though, brain cells are upset due to hypoxia, which and leads to complete loss of consciousness and loss of control of the aircraft.

2. Acceleration (+G) versus time (s)

Figure 2 shows the tolerance to acceleration (+G) without the use of any G-protection device or Anti-G Straining Manoeuvre (AGSM) over time (in seconds). The area above and to the right of the solid black line represents a situation of loss of consciousness; the area between the solid black and grey lines represents situations in which the trainee's vision is disrupted (e.g., greyout or blackout), normally without losing consciousness; the area below the grey line and left of the lines represent situations in which a person suffers no visual disturbance or loss of consciousness [14][15].

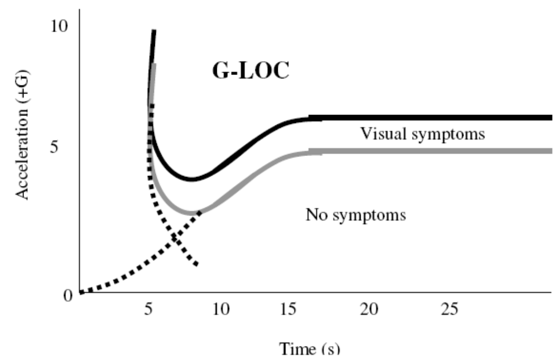

Figure 2. Acceleration (+G) versus time (s)

When blood supply to the head decreases, first, peripheral vision starts to deteriorate, followed by loss of central vision follows. When the blood supply returns to the head, the recovery of vision may be immediate. The loss of brain function is faster than loss of vision, though. After being resupplied with blood, the brain experiences an incapacitation period that lasts about 30 seconds before recovering. During the incapacitation period, involuntary limb spasm and fantasy may occur. After the incapacitation period ends, some extra time (up to two minutes) is required before aircrews are fully recovered and able to have cognition and act. The incapacitation and recovery periods are the main reasons why aircrews that suffer G-LOC cannot immediately correct the state of their aircraft after losing control, and crashes occur. G-LOC results in incapacitation, which can be characterized by an unconscious period (absolute incapacitation) and a subsequent period of confusion/disorientation (relative incapacitation). The sum of the absolute and relative incapacitation periods represents the total incapacitation period and may be equated to the overall length of time during which a pilot would be in uncontrolled flight, should G-LOC occur [Whinnery 1987].

The mechanical structures of modern

high-performance military fighters can sustain continuous, high G-force. Their use of a fly-by-wire system amplifies the aircraft’s ability to rapidly generate G-force (>6G/sec) and receive continuously high G-force (>6G, >30sec)(More than 6Gs for more than 30 seconds). Although the development of aviation technology significantly increases the performance of jet fighters, and thus the advantages in air combat, the performance of jet fighters is restricted by pilots’ physiological limitations. G-LOC is one of the challenges. The ability of high-performance jet fighters to rapidly generate high G-force may put aircrews into unconsciousness without any warning such as greyout or blackout. This usually happens to aircrews that are unprepared to receive G-force (e.g., rear-seat aircrews), or when aircrews stop an anti-G straining manoeuvre (AGSM) due to distraction of attention (e.g., searching for enemies). The centrifuge is an ideal ground-based simulator where lessons can be learnt, a critical evaluation of a pilot’s AGSM can be made, and proper technique can be taught [2].

3. uman-Use Centrifuge Training Program

Human tolerance of G-force depends on its magnitude, duration and direction as well as the posture of the body [1]. In the 1990s, U.S. and NATO air forces started to require that their aircrews take human-use centrifuge training programs. These programs provide the aircrews of higher-performance jet fighters with training in an artificial G environment that is under control [17]. The effectiveness of a human-use centrifuge training program has been endorsed by many countries as helping in the following: 1) to understand the physical impacts of G-force on the aircrews and the effects of a high-G environment on the human body in order to thereby have accurate AGSM training and effective protection equipment (e.g., anti-G-suits, pressure breathing); 2) to avoid risks of in-flight G exposure and to reduce training cost; and 3) to improve the adaptation or compensation of the cardiovascular system by repeated exposure to the high-G environment of a human-use centrifug

四、研究方法與結果

1. Methodology

This study assessed the sources of stress for aircrews taking centrifuge training and measured which training items cognitively promote trainees’ G tolerance in order to thereby help lower the incidence of G-LOC. A questionnaire was distributed individually to military aircrew in Taiwan who are scheduled to take human-use centrifuge between January 2009 and December 2009. Military aircrew members were reached immediately after undergoing human-use centrifuge training and asked to complete the self-administered questionnaire. It contained 30 items identified from military instructors and aviation physiology experts, measured using a five-point Likert scale (1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree). Respondents were asked to measure the stress-influence items. The questionnaire was piloted on a small sample (48) of subjects to assess its content validity, internal consistency and reliability. It was then directly distributed to 611 military aircrew members scheduled to take centrifuge training in 2009. Out of these, 460 respondents returned completed usable questionnaires, which, with the 48 pilot responses, provided a total of 508 usable responses. Table 1 summarizes the sample characteristics. Among the 508 respondents, all military ranks are well represented (39 medical technicians; 74 student-officers; 105 Second Lieutenants; 82 First Lieutenants; 48 Captains; 51 Majors; 87 Lieutenant Colonels, and 22 Colonels). Forth percent of the respondents have more than 500 flight hours and about one-third (32%) have more than 1,000 flight hours. About 34 percent of the respondents are pilots of Taiwanese second-generation jet fighters (including F-16A/B, Mirage 2000-5 and IDF). Lastly, more than 27 percent of the respondents have served in the air force for more than ten years.

Table 1. Sample characteristics n=508

Variable		Sample size	Percentage
rank	Colonel	22	4.3%
	Lieutenant Colonel	88	17.3%
	Major	51	10.0%
	Captain	48	9.4%
	First Lieutenant	82	16.1%
	Second Lieutenant	105	20.7%
	student-officer	73	14.4%
	medical technicians	39	7.7%
flight hour	0-200	227	44.7%
	201-500	76	15.0%
	501-1000	45	8.9%
	1001-2000	75	14.8%
	2001-over	85	16.7%
aircraft	M2000-5	22	4.3%
	F-16	72	14.2%
	IDF	79	15.6%
	F-5E/F	112	22.0%
	AT-3	17	3.3%
	Others	206	40.6%
service age	≤ 5 years	305	60.0%
	> 5 years and ≤ 10 years	64	12.6%
	> 10 years and ≤ 15 years	53	10.4%

	> 15 years	86	16.9%

Using factor analysis helps the air force understand what training items cognitively promote trainees' G tolerance in order to thereby lower the incidence of G-LOC for the crews of high-performance combat aircraft and plan suitable stress management. This study conducted factor analysis in order to find a way to condense the information contained in the 30 original variables into a smaller set of new, composite factors (dimensions) with a minimum loss of information – that is, to search for and define the fundamental constructs (dimensions) assumed to underlie the original 30 variables. Factor analysis is an algebraic method for determining the general dimensions or factors that exist within a set of concrete observations. Once these dimensions have been determined, the two primary uses of factor analysis – summarization and data reduction – can be achieved. In summarizing the data, the underlying dimensions derived from factor analysis, when interpreted and understood, describe the data in terms of a much smaller number of concepts than conveyed by the original 30 variables. In data reduction, factor analysis determines the important dimensions that underlie the crews' stressors. To search for structure among the 30 variables, this study conducts an exploratory factor analysis. In this sense, factor analysis does not establish any a priori constraints on the estimation of components or the number of components to be extracted.

The analysis of data is conducted in two stages. First, 30 stressor items are factor analyzed, by factoring the principle components with a Varimax rotation procedure to identify the underlying dimensions of attributes perceived by military aircrew members when taking centrifuge training. All factors (dimensions) had an eigenvalue greater than one. and only factor loadings greater than 0.5 are included in each factor grouping. Cronbach's alpha is used to assess the reliability of the identified selection factors. Finally, an analysis of variance is used to assess whether stressor variations exist among respondents in terms of ranks, jet fighters, and service ages. A Scheffe multiple range test (with the alpha level set at 0.05) is performed to specify which means are statistically significant.

2. Results

To select the best items to be used on the final version of measurement, from which future measurements will be drawn in part or in whole, this study first conducts item analysis regarding how subjects responded to each item and how each item relates to overall performance [18][19]. Item analysis also ascertains whether the removal of any particular item would increase the reliability of the assessment. The method of extreme groups compares item responses by splitting respondents into three groups based on total scores, wherein the upper group contains the top 25 percent and the lower group contains the bottom 25 percent. Appendix A shows the results of an independent sample test for individual items, and all items were found to be useful measures of individual differences in ability to adapt to the stress of human-centrifuge training.

3. Analysis of variance

First, the KMO index of 0.899 (p-value=0.000) indicates that the data are likely to factor well based on correlation and partial correlation, and that the data support the use of factor analysis. Further, it suggests that the data may be grouped into a smaller set of underlying factors. 26 attributes met the 0.5 cut-off point and are included in subsequent analysis. Factor analysis of the ultimate 26 stressors resulted in three factor groupings, which explained 60 percent of the stressor variance. All the factor loadings were greater than 0.50 (see Table 2), indicating a good correlation between the stressors and the factor grouping to which they belonged. The relatively high Alpha Coefficients for three factors (theory lecture, α=.922; centrifuge equipment, α=.888; physical fitness, α=.867) indicate that the factors were internally consistent. Each factor was named according to the higher loadings and common characteristics of included variables.

Table 2. Rotated component matrix

Rotated Component Matrix

	Component		
	1	2	3
T2	.847	-.035	-.047
T6	.823	-.090	-.036
T7	.820	-.075	.022
T4	.817	-.087	.075
T1	.806	-.069	-.038
T5	.800	-.035	-.065
T3	.796	-.058	.013
T10	.780	-.132	.067
T8	.749	-.144	.154
T9	.546	.004	-.082
E4	-.117	.822	.190
E6	-.065	.812	.186
E8	-.148	.808	.145
E10	-.069	.789	.151
E9	-.102	.770	.093
E5	.008	.756	.200
E3	-.076	.746	.160
E7	-.065	.530	.107
P4	.051	.010	.789
P3	.002	.149	.743
P7	.014	.090	.724
P2	-.029	.264	.710
P8	.016	.225	.701
P9	-.010	.043	.689
P10	-.052	.274	.655
P1	.027	.331	.558

Factor 1, labeled “Theory lecture”,

had ten attributes attached, explained 27.83 per cent of the variance, and had a reliability coefficient of 0.922. Factor 2, labeled "Centrifuge Equipment", had 8 stressor attributes attached, explained 21.39 per cent of the variance, and exhibited a reliability coefficient of 0.888. Factor 3, labeled "Physical fitness", had 8 attributes attached, explained 9.94 percent of the variance, and had a reliability coefficient of 0.867. The second stage of the data analysis applied the analysis of variance to the resulting stressor factors to determine their significance for the aircrew (Table 3), the jet fighters (Table 4), the flight hours (Table 5), the service age (Table 6), and the age of subjects (Table 7).

A significant difference was found between pilot and non-pilot subjects with regard to the factor of 'Physical fitness'. The results in Table 3 show that non-pilot subjects rated 'Physical fitness' as significantly more stressful than pilot subjects did. Table 4 indicates that ANOVA results in the fighter jet group were prone to variation in respect of the 'Theory lecture' and 'Centrifuge equipment' factors. The second-generation fighter jet group rated the 'Centrifuge equipment' factor as significantly more stressful than the non second-generation group did, but the non second-generation fighter jet group rated the 'Theory lecture' factor more likely to reduce the stress than the second-generation group did. As for flight hours, Table 5 shows that respondents with less than 500 flight hours group rated 'Theory lecture' as likely to reduce stress more than respondents who had over 500 hours. Furthermore, respondents with over 500 hours generally rated the 'Centrifuge equipment' factor as significantly more stressful than those with less than 500 hours. Table 6 indicates that ANOVA results in the service age group were prone to variation in regard to the 'Theory lecture' and 'Centrifuge equipment' factors. Respondents with less than two years of service generally rated the 'Theory lecture' factor as likely to reduce stress more than respondents with over two years of service. Also, respondents with more than 2-years of service generally rated the 'Centrifuge equipment' factor as significantly more stressful than respondents with less than 2-years of service. As for the crews' ages, Table 7 shows that respondents younger than 25 rated the 'Theory lecture' factor as likely to reduce the stress more than respondents older than 25; and respondents older than 25 rated 'Centrifuge equipment' as significantly more stressful than did respondents younger than 25 years old.

Table 3. Difference between stress-influence factors based on the aircrew

aircrew	Non-Pilot (112)	Pilot (396)	F-ratio	p-value

Theory lecture	4.463	4.532	1.910	0.168
Centrifuge equipment	2.682	2.778	0.857	0.355
Physical fitness	3.483	3.207	11.91	0.001**

*p-value <0.05; **p-value < 0.01

Table 4. Difference between stress-influence factors based on the fighter jet variable

fighter jet	Non Second -Generation (335)	Second- Generation (173)	F-ratio	p-value
Theory lecture	4.556	4.439	7.089	0.008**
Centrifuge equipment	3.3516	3.3796	40.74	0.000**
Physical fitness	3.2046	3.2134	0.001	0.974

*p-value <0.05; **p-value < 0.01

Table 5. Difference between stress-influence factors based on the fight hour variable

fight hour	Less than 500 hours (303)	More than 500 hours (205)	F-ratio	p-value
Theory lecture	4.555	4.460	5.032	0.025*
Centrifuge equipment	2.575	3.031	36.351	0.000**
Physical fitness	3.296	3.225	1.080	0.299

*p-value <0.05; **p-value < 0.01

Table 6. Difference between stress-influence factors based on the service age variable

service age	Less than two years (278)	More than two years (230)	F-ratio	P-value
Theory lecture	4.559	4.464	5.246	0.022*
Centrifuge equipment	2.532	3.033	45.92	0.000**
Physical fitness	3.291	3.241	0.544	0.461

*p-value <0.05; **p-value < 0.01

Table 7. Difference between stress-influence factors based on the subject age variable

age	Less than 25 (230)	More than 25 (278)	F-ratio	p-value

Theory lecture	4.598	4.448	13.20	0.000**
Centrifuge equipment	2.484	2.986	46.24	0.000**
Physical fitness	3.243	3.289	0.461	0.498

*p-value <0.05; **p-value < 0.01

4. Discussion

This study has identified three distinct factors (dimensions) influencing military aircrews' stress when taking centrifuge training, namely theory lecture, centrifuge equipment and physical fitness. Instructors could use the instrument to obtain information on all stress- influence factors related to the centrifuge training. The air force can improve the training program by investigating the needs of the crews by using data collected with the questionnaire.

五、成果自評

本研究成果與計畫書相符，並於2010年7月28日於日本淡路島第40屆電腦與工業工程國際研討會發表。目前完成初步稿件撰寫，但不便於投稿前完全揭露，本結案報告僅節錄部分內容。

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Appendix A

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
T1	Equal variances assumed	5.111	.025	-4.124	252	.000
	Equal variances not assumed			-4.124	251.261	.000
T2	Equal variances assumed	9.195	.003	-4.915	252	.000
	Equal variances not assumed			-4.915	238.628	.000
T3	Equal variances assumed	43.337	.000	-5.933	252	.000
	Equal variances not assumed			-5.933	209.786	.000
T4	Equal variances assumed	64.830	.000	-6.136	252	.000
	Equal variances not assumed			-6.136	222.024	.000

T5	Equal variances assumed	.635	.426	-4.841	252	.000
	Equal variances not assumed			-4.841	246.977	.000
T6	Equal variances assumed	10.410	.001	-4.349	252	.000
	Equal variances not assumed			-4.349	240.400	.000
T7	Equal variances assumed	18.250	.000	-5.842	252	.000
	Equal variances not assumed			-5.842	235.097	.000
T8	Equal variances assumed	79.606	.000	-5.878	252	.000
	Equal variances not assumed			-5.878	212.130	.000
T9	Equal variances assumed	.929	.336	-3.295	252	.001
	Equal variances not assumed			-3.295	251.538	.001
T10	Equal variances assumed	42.311	.000	-5.585	252	.000
	Equal variances not assumed			-5.585	223.010	.000
E1	Equal variances assumed	3.128	.078	-2.875	252	.004
	Equal variances not assumed			-2.875	247.957	.004
E2	Equal variances assumed	2.931	.088	-2.116	252	.035
	Equal variances not assumed			-2.116	250.298	.035
E3	Equal variances assumed	8.639	.004	-11.247	252	.000
	Equal variances not assumed			-11.247	246.679	.000
E4	Equal variances assumed	15.376	.000	-13.687	252	.000
	Equal variances not assumed			-13.687	242.556	.000
E5	Equal variances assumed	.746	.389	-14.685	252	.000
	Equal variances not assumed			-14.685	250.033	.000
E6	Equal variances assumed	5.399	.021	-13.553	252	.000
	Equal variances not assumed			-13.553	248.172	.000
E7	Equal variances assumed	2.213	.138	-6.029	252	.000
	Equal variances not assumed			-6.029	149.113	.000
E8	Equal variances assumed	22.911	.000	-11.542	252	.000
	Equal variances not assumed			-11.542	228.290	.000
E9	Equal variances assumed	3.338	.069	-10.227	252	.000
	Equal variances not assumed			-10.227	250.447	.000
E10	Equal variances assumed	20.031	.000	-12.459	252	.000

	Equal variances not assumed			-12.459	236.482	.000
P1	Equal variances assumed	2.267	.133	-12.158	252	.000
	Equal variances not assumed			-12.158	250.003	.000
P2	Equal variances assumed	29.686	.000	-16.295	252	.000
	Equal variances not assumed			-16.295	218.001	.000
P3	Equal variances assumed	28.474	.000	-13.877	252	.000
	Equal variances not assumed			-13.877	228.098	.000
P4	Equal variances assumed	43.584	.000	-12.994	252	.000
	Equal variances not assumed			-12.994	202.964	.000
P5	Equal variances assumed	7.203	.008	-8.695	252	.000
	Equal variances not assumed			-8.695	236.938	.000
P6	Equal variances assumed	18.579	.000	-9.034	252	.000
	Equal variances not assumed			-9.034	209.887	.000
P7	Equal variances assumed	1.097	.296	-11.575	252	.000
	Equal variances not assumed			-11.575	251.929	.000
P8	Equal variances assumed	3.305	.070	-13.888	252	.000
	Equal variances not assumed			-13.888	249.705	.000
P9	Equal variances assumed	36.213	.000	-9.968	252	.000
	Equal variances not assumed			-9.968	201.673	.000
P10	Equal variances assumed	6.334	.012	-13.878	252	.000
	Equal variances not assumed			-13.878	249.303	.000

出席國際學術會議心得報告

計畫編號	NSC 98-2629-E-006 -001 -
計畫名稱	國軍空勤人員適應人體離心機之性別差異與能力量測
出國人員姓名 服務機關及職稱	林珮珺 國立成功大學交通管理系
會議時間地點	99 年 7 月 25 日~99 年 7 月 29 日 日本淡路島
會議名稱	(中文)第 40 屆電腦與工業工程國際研討會 (英文)The 40th International Conference on Computers and Industrial Engineering (CIE40)
發表論文題目	(中文)探討空勤人員適應人體離心機之因素 (英文) How Military Aircrew Adapt to the Stress of Centrifuge Training

Abstract

This study investigates the stressor of military aircrews when undergoing centrifuge training and determines what training items cognitively promote trainees' G tolerance in order to thereby lower the incidence of G-induced loss of consciousness (G-LOC) for the crews of high-performance combat aircraft. Questionnaires are used to assess the stress-influence factors of crews in undergoing centrifuge training. Attributes are identified by the aviation physiology professionals and then grouped according to their influence on military aircrews. Aircrews' stress influenced by centrifuge training is decomposed into three constructs by factor analysis, theory lecture, centrifuge equipment and physical fitness. Considerable interpenetration is discernible between these factors and the subjects' age, service age, flight hours and the fighter jet they pilot. The study results are used as the basis to implement stress management and to improve training quality and to ensure safety by effectively identifying and measuring the cognitive stressors when undergoing human-use centrifuge training.

1. 參加會議經過

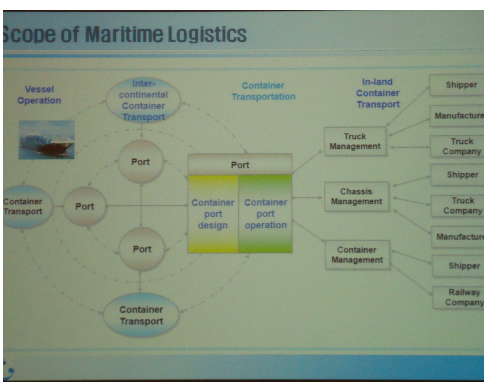
本次日本行的目的旨在參加第40屆電腦與工業工程國際研討會，後學曾在國科會的資源挹注下，於2003年、2004年在美國舊金山參加第31屆與34屆的電腦與工業工程國際研討會（CIE31；CIE34），很幸運會後受到審查委員的青睞，得以將修改的論文，發表於Computer & Industrial Engineering特刊中，並參加過在台北主辦的第36屆電腦與工業工程國際研討會（CIE36）。後學先於2010年1月將國科會補助專題計畫的內容，以摘要方式投稿至研討會主辦單位，二月份接獲初步接受通知，開始準備全文稿件，進行全文投稿，五月份主辦單位通知全文將被收錄於研討會會議論文集，即辦理研討會註冊、繳費的程序。2010年7月25日號搭乘中華航空班機抵達日本關西國際機場，接著搭乘利木津巴士進入大阪市，途中已遇見多位來自台灣的學者，同樣是為了參加第40屆電腦與工業工程國際研討會。

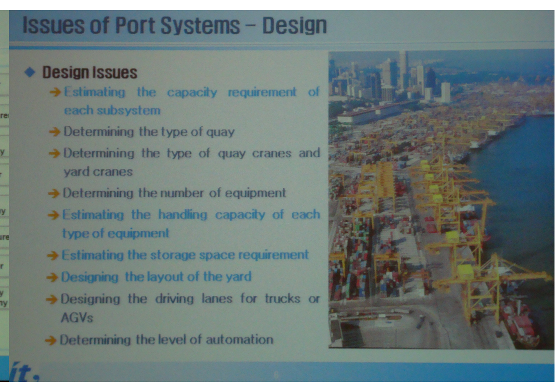
第40屆電腦與工業工程國際研討會（圖一）主要活動為期07/26～07/29四天，地點在日本淡路島（如圖二）上的國際會議場。由日本本州進入，須經由明石大橋（如圖三），明石大橋連接日本本州和淡路島，也是全世界最高最長的海上吊橋。07/26日首先登場的是來自台灣清華大學的主講員簡禎富教授，進行大會主題報告，其演講題目為：工業工程以產業為整體考量的概念方法（A Conceptual Methodology of "Industrial Engineering" for "the Industry as a whole" Semiconductor Industry as Illustration）。演講內容主要談論工業工程學科的內容，隨著整體大環境的演變，所遭遇的挑戰與可能擴充發展的方向。工業工程是結合技術和管理的學科，尤其重視實踐與力行，在企業生產運營中的作用是無可替代的，具備工程的性質、與其他學科交叉重疊的性質、應用並創新的性質。其目標

向來是為企業謀求高效益，高效率、低成本。長期以來工業工程充作管理與工程、技術的介面，也是人與人間、部門與部門間、企業內部與外部環境間交互作用的介面。其目的在消除介面的間隙，克服脫節或摩擦，使系統整體達成協調，發揮系統的優勢。隨著整體大環境的演變，工業工程的內容逐漸受到挑戰。簡禎富教授專長於決策分析，是台灣積體電路公司第一位從國內借調的學者，並屢獲重要獎項，包括98年度的「大學產業經濟貢獻獎」，主講員以個人在高科技電子產業任職的經歷，提出以垂直整合的系統化概念取代水平分工。其精闢的論點剖析，使後學獲益良多，能夠見到台灣的學者作為一個大型國際研討會的主講員，對於台灣的學術環境屢屢在重量不重質的批評聲浪之下，不啻為一項重大的激勵。

圖一、研討會會場　　　　圖二、淡路島　　　　　　圖三、明石大橋

接著由來自南韓的學者就海運物流的相關議題提出報告（圖四、圖五），南韓政府對韓國港口的轉型目標是以全球物流網路策略和交易為主的航運中心，長期的海運發展傳統和聚集的人才力量。南韓海運物流產業成功轉變，更是高雄港排名屢屢下降的國人有目共睹。兩位輪番上陣演講的學者則就南韓港口目前營運所遭遇的現況與亟待解決的問題，提出了詳盡的說明。





圖四、海運物流範疇　　　　　圖五、碼頭系統的問題

後學個人的口頭報告被安排於研討會會議的最後一天7月28日，與會的學者已經陸續離開，因此略顯孤單。不過還是非常感謝與會學者的提問，讓後學對於即將投稿的主題更具信心。

2.　會後心得

由於後學所訂的旅館位於大阪市，雖然交通便利四通八達，卻離研討會會場兩個小時以上的行程，大會晚宴安排於7月27日晚間，基於時間考量未能參加。每天早晨六點左右離開旅館，經過三趟的車班轉換後，才能於九點之前抵達會場，確實感到有些壓力。看到日本上班族、通勤族起早趕晚，親身體驗站在地鐵裡，雙手根本不必抓住任何支撐物也不會倒下的場景，非常震撼。

非常感謝國科會所提供之補助，使個人得以出席本次學術會議，從中獲得與來自國內、外學者討論的機會，深感不虛此行。

3. 考察參觀活動(無是項活動者省略)

略

4. 建議

無

五、攜回資料名稱及內容

大會議程、本次研討會錄取之文章電子檔CD。

六、其他

無

出席國際學術會議心得報告

計畫編號	NSC 98-2629-E-006 -001 -
計畫名稱	國軍空勤人員適應人體離心機之性別差異與能力量測
出國人員姓名 服務機關及職稱	黃亦萱 國立成功大學交通管理系
會議時間地點	99 年 6 月 2 日~99 年 6 月 5 日 新加坡
會議名稱	(中文)第五屆 IEEE 科技創新管理國際研討會 (英文)The 5th IEEE international conference on management of innovation and technology
發表論文題目	(中文)應用消費價值理論探討綠色產品之選擇行為 (英文)Applying the theory of consumption values to choice behavior toward green products

Abstract

This study applies the theory of consumption values as a theoretical basis to verify consumer choice behavior toward green products. This study investigates consumers' consumption values and choice behaviors toward green products to provide promotion/sales advice for governments, green groups, and the green industry. The study result will help producers decrease the risk of green product development, and strengthen its marketing competition, and eliminate the gap between consumption values of green products and consumers' choice behavior.

一、 參加會議經過

本次的新加坡行的目的是為了參加IEEE主辦的科技創新管理國際研討會，並於其中的分組討論時段進行一段口頭簡報，除了這項主要的任務外，也希望能藉著此機會與國外同領域的朋友進行交流，相互切磋。學生於2010年6月1號搭乘長榮BR225班機12點40分抵達樟宜機場，樟宜機場一直被評比為國際最佳機場(圖1、圖2和圖3)，去到那兒發現它其不枉盛名，環境綠化、造景清新幽美，旅客等待空間舒適並提供無線上網，機場內部路線標示清楚明瞭，並有捷運可連接市中心之交通運輸。入境後，搭乘機場內單軌列車到第二航廈轉乘捷運，在歐南園站下車，到1929旅館check in。該旅館的房間設計簡約，有充足的陽光灑入室內，唯房間空間小，行李必須收納整齊。


圖1 機場旅客休息區　　圖2 入境大廳　　圖3 機場綠化維護工作

6月3日早上做口頭報告的最後準備，搭計程車前往研討會，此次研討會舉辦於Furama Riverfront Hotel，顧名思義此飯店位於新加坡河畔旁邊。圖4為飯店外觀，圖5為飯店門口，圖6為本次研討會之大型看版。到達後先至報到區領取相關資料(圖7)，圖8為學生本次口頭報告的會議室。



圖4 飯店外觀　　圖5 飯店門口　　圖6 研討會大型刊版


圖7 報到處　　圖8 會議廳

學生報告次序為Sustainable Development and Environmental Management組的第二位，但由於第一位報告者缺席，所以學生變成第一個報告。報告結束後有兩位會議參與者針對本研究提出問題與建議。第一個問題是關於本研究蒐集的樣本偏少，建議以後可以蒐集更多樣本。另一建議則是應該找更多的數據、資料支持本研究提出的結論之一「綠色產品之價格和品質並非影響消費者選擇行為之關鍵因素」。下一位報告者是自泰國的研究人員，其研究內容是「影響公司採用生物塑料的因素」，使用訪談和問卷資料蒐集進行分析。第三位報告者來自

Slovenia，其報告內容為「Corporate Environmentalism in Emerging Markets: Lessons from a Country in Transition」，以Slovenia的製造公司為調查對象，進行群集分析。雖然整個研討會是用英語進行，但是詳細的圖表與生動的解說，讓學生對各演講者專長領域，增加了一些認識。

這次到新加坡給我最大個印象是它們的觀光推廣得很成功，除了當地的四大民族(華人、馬來人、印度人、歐亞混血)，在各景點皆可看到來很多自世界各地的旅客。在搭乘計程車時，問及司機為什麼新加坡那麼多種族，但卻不會有治安安全問題，他回答因為政府對待每個種族都是公平的，而且新加坡國土小，容易掌控，所以新加坡才如此安全，這部分使我佩服新加坡政府對於多種族的管理。另一方面，新加坡對於環境保護也很有遠見，在路上很少看見人們騎乘摩托車，所以道路和人行道很整齊空曠，不像台灣的道路和人行道總是被機車停放佔滿，而且在新加坡要擁有一台車輛必須付出高額的費用，避免整個國家的車輛過多，也保持空氣乾淨。因此，新加坡的大眾交通工具的費用很便宜，政府以此鼓勵民眾多使用大眾運輸工具。在觀光景點方面，新加坡令我印象深刻的是魚尾獅公園(圖9)和其對面的金沙酒店(圖10)的夜景，很美麗！

圖9 魚尾獅公園

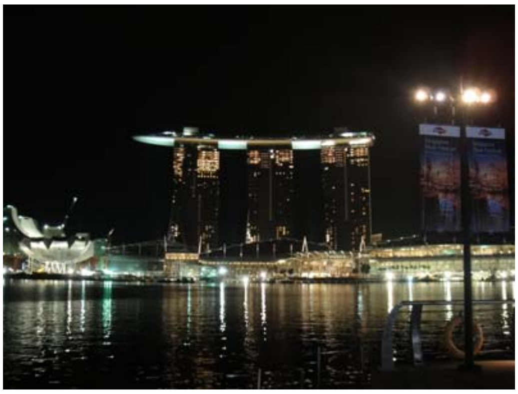


圖10 金沙酒店

三、會後心得

這是學生第一次參加國際研討會的口頭報告，心情難免緊張，面對台下聽眾提出的問題，回答得不夠完整。希望以後學生能把握上台的機會，訓練自己的膽量和台風。透過此次國際研討會，發現自己的英文口說能力仍不足夠，必須多加練習口說。同場次的中國人和泰國人的英語說得很流利，相信學生勤加練習也可達到這樣的程度。另外，台下聽眾很踴躍的提出問題，也不吝嗇給予建議，感謝他們的問題與建議，使本研究將能更盡善盡美。這次的研討會將會是學生生涯中難忘的一次經驗。

這次新加坡行也是學生第一次出國，體驗了不同國家的文化與飲食。雖然有些東西不習慣，但是嘗試新鮮的事物是很有趣的，而且親身經歷得到的印象總比書上看到的深刻許多，不禁令我開始期待我下一次的出國經驗。感謝國家科學委

員會提供本次經費，以及指導老師能夠將出國經費撥予學生使用，。

四、建議

無

五、攜回資料名稱及內容

大會議程、本次研討會錄取之文章電子檔案

六、其他

無

出席國際學術會議心得報告

計畫編號	NSC 98-2629-E-006 -001 -
計畫名稱	國軍空勤人員適應人體離心機之性別差異與能力量測
出國人員姓名 服務機關及職稱	王豪山 國立成功大學交通管理系
會議時間地點	98 年 12 月 28 日~98 年 12 月 30 日 香港
會議名稱	(中文)第一屆生產與作業管理—香港研討會：變遷中經濟的生產與作業管理 (英文)The First POMS-HK International Conference-Production and Operations Management in a Changing Economy
發表論文題目	(中文)運用類免疫演算法求解都市交通限制下的貨物運輸問題 (英文)Applying the immune algorithm to solve an urban freight transport problem under traffic control

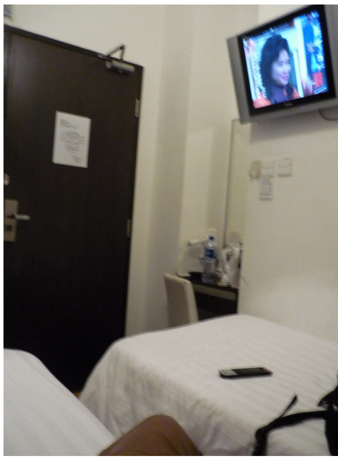
Abstract

This study investigates the routing of the distribution system for convenience stores located in high-density areas and required high service levels. During the partitioning phase, this study incorporates the anti-change, experience-oriented mind-set of planners in the industry. It accounts for the potential changing cost by using the memory property of an immune algorithm to construct a partition model that is based on past experience of planners and makes minor modifications to the existing plan rather than completely re-scheduling. During the routing phase, this study formulates the actual road network as an asymmetric, multi-traveling salesman problem by adding urban traffic restrictions, especially turn restrictions that may necessitate a detour. This purpose of this study is to demonstrate a model and with a solution that is designed to improve the efficiency of daily urban logistics and can be readily accepted by planners in the industry.

一、 參加會議經過

本次的香港行的目的是為了參加香港理工大學主辦的The POMS-HK International Conference，並於其中的分組討論時段進行一段口頭簡報，除了這項主要的任務外，也希望能藉著此機會與國外同領域的朋友進行交流，相互切磋。學生於2009年12月28號搭乘華航CI0917班機1730點抵達香港機場，由於學生是今年第二度前往香港，對香港機場的入境十分熟悉且為了趕赴香港朋友所辦的接風

宴，所以出關後即馬不停蹄得依照朋友所教的轉乘方式搭上機場快線前往青衣，再換乘東涌線和荃灣線到深水涉站，前往下榻的紅茶館酒店(如圖一、圖二、圖三)。紅茶館是香港連鎖的三星級酒店，然而學生對它的唯一感想就是「小」，香港地小人稠，除了高級的酒店外，位於市中心的平價酒店都頗狹小，學生住的房間雖然設備一應俱全，但是包括廁所不還三坪大小，酒店裡沒有游泳池、沒有健身房、甚至沒有大廳，這樣的酒店還有三星級且開到全港11間分店，讓學生非常訝異。



圖一、紅茶館雙人房　　圖二、紅茶館內景　　圖三、紅茶館外景

29 號除了出門測試前往研討會會場香港理工大學需花費的時間外，足不出戶的都在準備隔日報告。香港理工大學的外觀就像一座城堡，整座學校是由數棟建築連結而成，與綠草如茵成大校園大大不同，沒有大樹，更不用說大片草地與湖了，一從正門進入學校即走在兩層樓高的屋頂上，一棟棟細長的高樓像極了歐式城堡的高塔，大部分的高樓都以捐贈者的人名命名，位居中央最高的建築即為李嘉誠樓，富麗堂皇的名符其「樓」(如圖四、圖五、圖六)。

圖四、香港理工大學正門　圖五、李嘉誠樓　圖六、香港理工大學模型

30號的研討會在細雨中開幕，歡迎的茶會由草坪移到了蔡繼有樓前的長廊(如圖七、圖八)，報到時意外的遇到會議的主席Chung-Lun Li，他爽朗的笑聲及輕切的問候緩和了學生不少緊張情緒，大會報告主講者為來自Stanford University的Hau L. Lee教授(如圖九)，這次主講的題目為Building Supply Chain Excellence in Emerging Economies，他於其中點出幾項在現今變遷的經濟型態中產生的新供應鏈管理議題，並以中國及其他市場為例進行解說。之後開始進行分組報告，學生的報告次序是**Routing and Delivery Planning**組的第二位，第一位是廣州中山大學與當地政府合作的出租車排程計畫，第三位是韓國海事大學的教授，他提出使用“de-cranking heuristic”求解VRP問題的理論，第四位是香港大學的博士生代表其教授發表一家醫院使用其設計的portering system後產生的結果，第五位則是來自分組主席相同的東北大學，其探討旅行社進行機場接送的車輛排程與等候模式，這篇文章研究的主題很新奇，也引起了全部參與人的熱切討論，雖然整個研討會是用英語進行，但是詳細的圖表與生動的解說，讓學生對各演講者專長領域，增加了不少認識。


圖七、蔡繼有樓　　　圖八 報到處　　　圖九、大會主講員

中午的餐會是以自助餐的形式進行，同桌的是幾位是香港大學、理工大學與復旦大學的博士生，因為他們多是大陸來的學生，所以學生們都以中文來交談，他們介紹了香港四間重點學校的特色，也與學生交流了相異的學習制度，和幾位學生交換了msn，希望以後還能再見面，這是學生在香港吃得最開心的一頓飯，憋了兩天終於可以開口講中文。

飯後因為必須趕下午的班機，趕在當晚回到台南，所以提早離開研討會。在飛機的窗邊看著遠去的香港島的燈景，手上拿著明日的期末考講義，此趟香港行雖然來沖沖去沖沖，但收穫實在不少。

三、會後心得

與學生在台灣曾經參加過的中華民國運輸年會相比，這次的研討會規模小多了，參加人數僅200多人，比起總是全所出動的年會算是小而精美，而參與的角色由單純的台下聽眾換成報告者感受也大有不同，肅穆的心情雖取代了過去輕鬆的逛廟會心態，然而卻緊張的無法詳細聆聽別人的報告，直到放下麥克風、走下

講台的當刻才得緩和，學生的準備還是不足，白白浪費了大半的研討會。

另外學生對香港的大學裡收了如此多的中國碩博士生感到驚訝，同桌的學生家鄉近至廣州遠至河南省，香港大學的自由學風吸引了眾多中國學生報考，將來如果台灣開放陸生來台，勢必也會面臨如香港一般的情況，政府在增加競爭力與保護主義之中必須要訂出一個平衡，而學生更須提升自身能力與國際競爭。感謝國家科學委員會提供本次經費，以及指導老師能夠將出國經費撥予學生使用。

四、建議

有些系所的畢業要求是必須於任一研討會中報告過其論文，學生認為這項措施對研究生的自學生督促有良好的效果，不但可在兩年漫漫的撰寫時程中設立個中繼的里程碑，亦可拓展研究生的視野，看看同領域的人都在做什麼，且和初識者的應對進退，與台上的及時反應也都是在研究室難以獲取的珍貴經驗。但前提往往是教師能夠申請到經費補助，同時這項經費補助能夠讓學生使用。

五、攜回資料名稱及內容

大會議程

六、其他

無

無研發成果推廣資料

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■達成目標

□未達成目標（請說明，以 100 字為限）

□實驗失敗

□因故實驗中斷

□其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文：□已發表 □未發表之文稿 ■撰寫中 □無

專利：□已獲得 □申請中 ■無

技轉：□已技轉 □洽談中 ■無

其他：（以 100 字為限）

本研究成果與計畫書相符，初步成果已於 2010 年 7 月 28 日於日本淡路島第 40 屆電腦與工業工程國際研討會發表。

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以 500 字為限）

1. 本研究樣本的特殊性與專業性的資訊取得不同於一般研究，畢竟空勤人員身體健康檢查除較一般人嚴謹，在自我心理的調適度與一般職業抗壓性有差異外，所面臨的環境也不竟相同，因此本研究問卷樣本數的取得，除群體職業的特殊性外，也是即時性的資料，有別於一般研究珍貴；除此之外，能得到國內相關航空生理與工程專業人員的指導與意見，更可支持本研究完整性。

2. 過往的研究文獻較強調人體離心機抗 G 耐力訓練的成效，與相關抗 G 裝備及生理反應等研究，較少從訓練裝備設計的基礎與空勤人員心理狀況反應結合，無法針對不同群體實施有效訓練方案與問題改善。

3. 本研究針對裝備設置之議題，可提供於未來新一代人體離心機更新建案時，提供予航空生理與工程專業人員在該裝備設計時的人因工程考量之依據與重點。

4. 以往軍事發展著重以任務完成為導向，對於人員執行訓練時，因外在的因素導致壓力產生而影響能力展現較無研究，易發生非人員自發性問題的產生，而導致人才損失與傷害，希望本研究可延伸出更多相關性議題研究，對國軍的戰力發揚有所貢獻。