科技部補助專題研究計畫成果報告
期末報告

國軍空勤人員適應空間迷向模擬機訓練之性別差異與能力量測 (K02)

計 畫 主 持 人 ： 王仁宏
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報 告 附 件 ： 出席國際學術會議心得報告

中 華 民 國 107 年 10 月 25 日

中 文 摘 要 ： 空間迷向是軍機飛行過程中重大失事最主要的原因之一，當飛行員
在飛行中定向訊息錯誤或狀態失察時，可能產生空間迷向，飛行員
根據其錯誤感官訊息操作飛機，導致飛安事件發生。空間迷向是經
由複雜交錯的因素產生，各先進國家無不致力於相關研究。本計畫
旨在探討空勤人員克服空間迷向的能力，分析有效提昇學員能力的
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
理訓練中心的空間迷向模擬機訓練記錄，分析比較一般生理參數
（性別）與施訓結果間的關係，以連結性別與空間迷向模擬機訓練
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
人員在空間迷向模擬機訓練時空間迷向的誘發來源，進行受測者克
服空間迷向的能力量測。應用因素分析，將影響空勤人員於模擬機
訓練的空間迷向誘發來源分解成數個構面，以此作為進一步訓練規
劃管理的依據。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，估算個別誘發源的難度參數、與受測
者克服空間迷向模擬機訓練的能力參數，以供航生教官作為訓練方
案設計與修訂的依據。本計畫針對性別規範出空間迷向模擬機不同
的測驗裝備與教育訓練項目，有效精進不同性別學員的空間迷向訓
練品質，確保飛安。

中文關鍵詞 ： 空間迷向、項目反應理論、性別差異

英 文 摘 要 ： Spatial disorientation is aviation's top pilot-killer and
remains a serious drain on military air force resources.
Spatial disorientation is a condition in which an aircraft
pilot's perception of direction does not agree with reality
or loss of situational awareness. Pilots operate the
aircraft based on wrong sense lead to incorrect information
sent to the brain may jeopardize flight safety. Each
developed country has been devoted to recognize the complex
and confound factors which cause spatial disorientation.
This proposal investigates the military aircrews' ability
to overcome the spatial disorientation with gender and
analyzes whether the differences between genders has an
impact on the definition of an effective training
facilities and items. Regarding the analysis of physical
ability, this proposal will use the retrospective survey to
analyze the training records of spatial disorientation
trainer (DISO) in Aviation Physiology Research Laboratory,
Gangshan Armed Forces Hospital. General physiological
parameter (gender) and training results are analyzed and
compared using dichotomous Item response theory models, so
as to connect the gender and the physical ability
measurement of spatial disorientation trainer. Regarding
the analysis of physiological ability, questionnaires will
be used to assess the source of spatial disorientation for
aircrews in taking DISO training and measure the trainees'
ability to overcome spatial disorientation. Factors that

impact aircrews' DISO training will be decomposed into several constructs by factor analysis and these constructs is further taken as basis for implementing improvement. The polytomous partial credit model of Item response theory is the kernel with the joint maximum likelihood estimation adopted as procedures paradigm for estimating the difficulty of particular triggering source and trainee ability in overcoming spatial disorientation training. The results of this proposal is to regulate efficient training equipment and program of DISO in accordance with genders and effectively reinforce the trainees' ability to improve training quality and ensure flight safety.

英文關鍵詞： Spatial disorientation; Item response theory; Gender difference

科技部補助專題研究計畫成果報告
（■期末報告）

國軍空勤人員適應空間迷向模擬機訓練之性別差異與能力量測(K02)

計畫類別：■個別型計畫　　□整合型計畫
計畫編號：MOST 106－ 2629 － E － 327 －001
執行期間： 106 年 08 月 01 日至 107 年 07 月 31 日

執行機構及系所：國立高雄科技大學運籌管理系

計畫主持人：王仁宏
共同主持人：林珮珺
計畫參與人員：史盈欣

本計畫除繳交成果報告外，另含下列出國報告，共 _1_ 份：
□執行國際合作與移地研究心得報告
■出席國際學術會議心得報告

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　　　　　中　華　民　國 107 年 10 月　31 日

行政院科技部專題研究計畫成果報告

國軍空勤人員適應空間迷向模擬機訓練之性別差異與能力量測 (K02)

Measurement of military aircrews' ability to adapt to simulator based spatial disorientation training and the effect of gender differences

計畫編號：MOST 106－2629－E－327－001

執行期限：106 年 8 月 1 日至 107 年 7 月 31 日

主持人：王仁宏　　國立高雄第一科技大學運籌管理系

一、中文摘要

　　空間迷向是軍機飛行過程中重大失事最主要的原因之一，當飛行員在飛行中定向訊息錯誤或狀態失察時，可能產生空間迷向，飛行員根據其錯誤感官訊息操作飛機，導致飛安事件發生。空間迷向是經由複雜交錯的因素產生，各先進國家無不致力於相關研究。本計畫旨在探討空勤人員克服空間迷向的能力，分析有效提昇學員能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空間迷向模擬機訓練記錄，分析比較一般生理參數（性別）與施訓結果間的關係，以連結性別與空間迷向模擬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空間迷向模擬機訓練時空間迷向的誘發來源，進行受測者克服空間迷向的能力量測。應用因素分析，將影響空勤人員於模擬機訓練的空間迷向誘發來源分解成數個構面，以此作為進一步訓練規劃管理的依據。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，估算個別誘發源的難度參數、與受測者克服空間迷向模擬機訓練的能力參數，以供航生教官作為訓練方案設計與修訂的依據。本計畫針對性別規範出空間迷向模擬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空間迷向訓練品質，確保飛安。

關鍵詞：空間迷向、項目反應理論、性別差異

Abstract

Spatial disorientation is aviation's top pilot-killer and remains a serious drain on military air force resources. Spatial disorientation is a condition in which an aircraft pilot's perception of direction does not agree with reality or loss of situational awareness. Pilots operate the aircraft based on wrong sense lead to incorrect information sent to the brain may jeopardize flight safety. Each developed country has been devoted to recognize the complex and confound factors which cause spatial disorientation. This proposal investigates the military aircrews' ability to overcome the spatial disorientation with gender and analyzes whether the differences between genders has an impact on the definition of an effective training facilities and items. Regarding the analysis of physical ability, this proposal will use the retrospective survey to analyze the training records of spatial disorientation trainer (DISO) in Aviation Physiology Research Laboratory, Gangshan Armed Forces Hospital. General physiological parameter (gender) and

training results are analyzed and compared using dichotomous Item response theory models, so as to connect the gender and the physical ability measurement of spatial disorientation trainer. Regarding the analysis of physiological ability, questionnaires will be used to assess the source of spatial disorientation for aircrews in taking DISO training and measure the trainees' ability to overcome spatial disorientation. Factors that impact aircrews' DISO training will be decomposed into several constructs by factor analysis and these constructs is further taken as basis for implementing improvement. The polytomous partial credit model of Item response theory is the kernel with the joint maximum likelihood estimation adopted as procedures paradigm for estimating the difficulty of particular triggering source and trainee ability in overcoming spatial disorientation training. The results of this proposal is to regulate efficient training equipment and program of DISO in accordance with genders and effectively reinforce the trainees' ability to improve training quality and ensure flight safety.

Keywords: Spatial disorientation; Item response theory; Gender difference.

二、緣由與目的

The Taiwan's Defense Ministry announced on November 7, 2017 that a Mirage-2000 combat jet had lost contact during a drill off the island's northeast coast. The missing pilot may have experienced spatial disorientation (SD) when the aircraft entered dense low clouds. SD is the inability to correctly interpret aircraft attitude, altitude or airspeed in relation to the earth or other points of reference (McGraph, Rupert & Guedry, 2003; Newman & Faicd, 2007). On April 25, 2014, an AH-64E helicopter of the Taiwanese Army crashed and the cause judged to be the Coriolis illusion, an apparent deflection of an object's path that moves within a rotating coordinate system. The Coriolis illusion caused by making a quick head movement during a constant rate turn that has ceased stimulating the inner ear leads to SD (Martinussen & Hunter, 2017).

SD in flight wastes hundreds of millions of dollars worth of defense capability annually and continues to kill aircrew (Gillingham, 1992). 44% of Canadian Forces' pilots have reported experiencing SD, of whom 10% have experienced more than three episodes (Cheung et al., 1995). A survey of U.S. Army rotary-wing operations found that 78% of aircrews had been disoriented and 8% to the extent that flight safety was threatened (Braithwaite et al., 1998). SD has been blamed for 20% of all fatal mishaps in military aviation (Previc & Ercoline, 2004). SD cost the U.S. Army $308,887,000 and 78 lives between 1987 - 1992 (Durnford et al., 1995). Gaydos et al. (2012) reported that 100 aviation accidents, ranging from A to C class in the U.S. Army between 2002 and 2011, were related to SD. SD was also the cause of 31% of deaths in helicopter accidents. Between 1990 and 2000, SD causing share of Class A aviation accidents (involving total cost of property damage over US$2 million, death, full incapacitation for a

lifetime, or destroyed, missing, or abandoned aircrafts) increased from 20% to 33%, with the mortality rate approaching 100% (Gibb et al., 2011).

A significant factor in a large percentage of military Class A aviation mishaps, erroneous orientation messaging or the loss of grip during flight cause pilots to operate their aircrafts using erroneous sensual messages. Disorientation presents to a pilot in two ways: either there is a sense of confusion about the attitude of the aircraft on account of deteriorating visual information and an awareness of conflicting sensations, or everything feels as expected until there is a sudden realization that the aircraft is not in the attitude or position that was intended to be (Stott, 2013). Spatial orientation is the result of complex compound factors and has been a major subject of study in industrially developed nations (Nascimento, Majumdar & Jarvis, 2012). SD occurrence may be influenced by several factors, including aircraft type, time of day, flight conditions and mission profiles (Takada et al., 2009). Poisson and Miller (2014) found 72 U.S. Air Force accidents due to SD caused 101 deaths and the loss of 65 aircraft at a total cost of US $ 2.32 billion. Mishap rates for F-16 fighter/attack aircraft were marginally higher than for other fighter/attack aircraft, and casualty rates for F-16 fighter/attack aircrafts were higher than for other models. Holland & Freeman (1995) and Gillingham (1992) attributed the higher SD rate for F-16 pilots than other models' pilots to the design of the F-16's cockpit canopy and its head-up display (HUD).

The study probed the contribution of cockpit layout and design to Taiwanese air force jet pilots' SD in order to reduce the risk of triggering SD. The study took into account differences in subjects' ability to cope with SD triggers, resorting to the Rasch model for measurements. The study objective was to measure combat jet pilots' ability to cope with SD triggered by cockpit layout and design in order to improve pilots' SD training quality and skills to anticipate and assess SD risk factors and thereby ensure flight safety. The study first interviewed aviation physiologists, medical and medical-engineering experts, and pilots to identify possible factors contributing to pilots' SD before formulating the study questionnaire. The Rasch model was subsequently employed to measure pilots' ability to cope with mechanical designs triggering SD. Conclusions were drawn from the study findings and future areas of research proposed.

三、研究方法

Approach to assessing ability

In this study, we employed a polytomous Rasch model to estimate combat jet pilots' ability to cope with SD triggered by cockpit layout and design using data obtained from their responses to a questionnaire. The purpose of employing the model was to obtain measurements from

categorical response data. The study first identified possible factors for pilots' SD via interviews with aviation physiologists, pilots, and medical-engineering experts, and then reviewed the literature on SD-trigger items to formulate the questionnaire, which was distributed to pilots of mainstay combat jets in Taiwan.

Rating scales and Likert scales are popular psychological measurement scales that depend on human judgment (Nunnally and Bernstein, 1994). Likert scales, which use a standard set of response options representing the degree of agreement instead of descriptive terms, do not differ fundamentally from rating scales. Both Likert scales and rating scales assume that the human observer is capable of quantitative observation and assigning numbers to reflect the degree of agreement/disagreement with the statements being measured (Hopkins, Stanley and Hopkins, 1990). The merits of rating scales include conciseness, time efficiency, scope of application, and ease of use. However, they are criticized for being too simplistic. First, the raw scores of a rating scale fail to meaningfully measure objects. To obtain objective and meaningful measurements, raw scores must be transformed into linear measures to enable subsequent analysis and inference (Wright and Masters, 1982). Second, without clear and mutually exclusive distinctions, the options provided by rating scales can be viewed as linguistic variables. Without clear definitions of the variables, performing arithmetic on linguistic variables exceeds the capability of traditional binary crisp logic. The Rasch model was therefore the preferred method of measurement.

The Rasch model

Rasch (1960) developed the dichotomous Rasch measurement model, which is frequently considered an item response theory (IRT) model with a one item parameter. Rasch models are built on two basic concepts: 1) a person with greater ability than another person should have a greater probability of solving any item in a tes; and 2) one item being more difficult than another item means that for any person the probability of solving the second item is greater. Rasch models are used for analyzing data from assessments that measure items such as ability, attitude, and personality traits. Rasch models are employed frequently in psychometrics, the field concerned with the theory and technique of psychological and educational measurement. Application of Rasch models can also provide information as to how well assessment questions or items measure a specific ability or trait. The IRT and Rasch models are frameworks commonly adopted to examine and evaluate the measurement quality of pilot training or crew resource management (Veldhuis et al., 2012).

In the Rasch model, the probability of a specified response (e.g. right/wrong answer) is modeled as a function of the person and item parameters. Specifically, in the dichotomous Rasch model, the probability of a correct response is modeled as a logistic function of the difference between person ability and item difficulty. In this study, each combat jet pilot g had a unique

ability, θ_g, that represented their capability to cope with the SD trigger associated with cockpit layout and design. Each item i had a difficulty level, β_i, that represented the difficulty combat jet pilots had in coping with the SD trigger caused by item i. In the Rasch model, the combat jet pilot's ability, θ_g, and the item difficulty, β_i, were calibrated on the same scale. If the ability of aircrew g was greater than the difficulty of item i ($\theta_g - \beta_i > 0$), then the probability of correct response is greater than 0.5. If $\theta_g - \beta_i < 0$, then the probability of correct response was less than 0.5. If $\theta_g - \beta_i = 0$, then the probability of correct response was equal to 0.5.

The polytomous Rasch model

The polytomous Rasch model (Andrich 1978; 1979) is a generalization of the dichotomous model, where successively higher integer scores represent the increasing level or magnitude of a latent trait (Ostini and Nering, 2006). Under the polytomous Rasch model, the relative difficulty of the steps within an item are assumed to be constant across all items in the instrument, and the items are believed to differ only in their location on the ability scale. The Partial Credit Model (Masters, 1982) has an identical mathematical structure, but is expressed in a form that allows various thresholds for different items. If an item has five response choices (e.g. 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree), it is modeled as having four thresholds. Each set of threshold estimates is unique to the individual item (i.e. threshold k for item i). β_{ik} is the location parameter of the boundary curve between the kth and $k+1$th response categories. The probability of a person choosing any category on any item as a function of the agreeability of subject g (θ_g) and the endorsement of item i at the given threshold k (β_{ik}) (Wright and Masters, 1982) is as follows:

$$P_{ik}(\theta_g) = \frac{\exp(\theta_g - \beta_{ik})}{1 + \exp(\theta_g - \beta_{ik})}.$$

This study measured combat jet pilots' ability to cope with SD triggered by cockpit layout and design by considering item difficulties and ability differences among combat jet pilots. The study result would contribute an initial but significant insight into the psychometric properties of the scale used to measure the combat jet pilots' perceived SD triggers.

四、成果與討論

After transforming ordinal raw data into an interval scale using the Rasch model, item difficulty and combat jet pilots' ability to cope with SD triggers were calibrated on the same scale for subsequent interpretations. When a pilot agreed that an equipment item might trigger SD, the negatively-keyed item would represent a relatively low level of the attribute. Table 3, displaying WINSTEPS (version 3.92.1) summary statistics, shows that the mean scores for person

reliability and item reliability were 0.87 and 0.97, respectively. Both person reliability and item reliability are interpreted as a measure of reliability of the psychometric instrument. The widely accepted social science cut-off is 0.70 for an item set. In this study, both infit $Zstd$ and outfit $Zstd$ ranged between ±2, indicating that observational responses fitted the model well (Wright et al., 1994). All items could therefore be used to measure the latent construct of combat jet pilots' ability to cope with SD-triggers during centrifuge training. The person ability estimate mean of -0.88 provided the first indication that the sample found the SD triggers comparatively hard to cope with because the combat jet pilots' ability was relatively lower than the item difficulty (0.0).

WINSTEPS summary statistics

325 comabt jet pilots					
Score Mean (SD)	**Ability**	Infit		Outfit	
		MNSQ	Zstd	MNSQ	Zstd
21.1 (0.57)	**-0.88**	0.98	-0.4	0.98	-.04
Reliability 0.87					
8 items					
Score Mean (SD)	**Difficulty**	Infit		Outfit	
		MNSQ	Zstd	MNSQ	Zstd
855.6 (0.09)	**0.00**	0.99	-0.2	0.98	-0.4
Reliability 0.97					

This study results indicated that unfamiliarity with instruments on aircraft was most likely to trigger SD and was the most difficult item for combat jet pilots to cope with. We therefore suggest that physiology instructors clearly explain in a classroom lecture the design differences between different combat aircraft models in order to prevent SD. Special attention should be paid to the range of features of instrument displays on different fighter aircraft since these may contribute to SD. Ground-based and inflight training programs should be developed to improve pilots' awareness of possible SD-triggers and enhance their skills and ability to cope with them.

A significant difference was found between with-SD experience and without-SD experience subjects for SD triggered by "the helmet-mounted display (HMD)". Without-SD experience subjects rated "the helmet-mounted display (HMD)" significantly more likely to trigger SD than with-SD experience subjects. Further, DIF results for aircraft groups were prone to variation regarding "the helmet-mounted display (HMD)" item. The helmet-mounted display (HMD) of the F16 was more likely to trigger SD than that of the Mirage 2000 and IDF combat jets. The study's findings thus provide a useful reference for the military when considering procurement of new aircraft models in the future. The air force can establish more effective

training programs by quantifying and prioritizing ergonomics issues in SD training
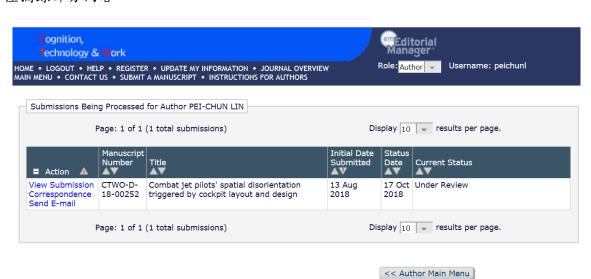
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五、成果自評

　　本研究成果與計畫書之相符，由於本專題計畫補助的經費補助，計畫內容已執行完成，並獲致完整結果。2018 年 8 月 13 日完成英文編修完成，共同主持人以回應作者身份投稿至主題相符期刊 Cognition, Technology & Work (SCI 索引源)，目前狀態審查中，本結案報告僅摘錄部分內容。

Cognition, Technology & Work

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科技部補助專題研究計畫出席國際學術會議心得報告

日期：<u>2018</u> 年 <u>07</u> 月 <u>13</u> 日

計畫編號	MOST　106－2629－E－327－001		
計畫名稱	國軍空勤人員適應空間迷向模擬機訓練之性別差異與能力量測(K02)		
出國人員姓名	林珮珺	服務機構及職稱	國立成功大學交通管理系教授
會議時間	2018 年 07 月 10 日至 2018 年 07 月 12 日	會議地點	日本東京
會議名稱	(中文) 管理與社會科學年度論壇 (英文) Annual Symposium on Management and Social Sciences (ASMSS)		
發表題目	(中文) 量測台灣戰鬥機飛行員座艙佈置與設計誘發之空間迷向的因應能力 (英文) Measuring Taiwanese Combat Jet Pilots' Ability to Cope with Spatial Disorientation Triggered by Cockpit Layout and Design		

一、 參加會議經過

2018 第五屆管理與社會科學年度論壇（Annual Symposium on Management and Social Sciences，ASMSS）為期三天，主辦單位是高等教育論壇（HEF），該組織全名為高等教育術論壇（the Higher Education Forum，HEF）， HEF 是一個國際學術會議組織者。自 2010 年起，持續深耕國際學術會議，每年在全球主要城市約舉辦 20 場學術研討會，以舉辦高質量的國際學術會議、加強高等教育的發展、促進知識的傳播與國際學術交流。所主辦研討會多以跨領域形式，本年度與教育、心理與社會國際研討會（The International Conference on Education, Psychology and Society，ICEPS）同步舉行，以達規模經濟。本次研討會在日本東京新宿區舉辦，東京泛指東京都及周邊衛星都市群相連而成的「首都圈」。目前首都圈的人口數約 3 千 6 百萬，是全球規模最大的都會區，亦為亞洲最重要的世界級城市。東京都人口密集，也是各種物資與各類資訊的巨大集

散地，長期作為亞洲金融、貿易等經濟活動的要地。交通工具多元，市區內除了有多條東日本旅客鐵路株式會社（JR）路線、以及四通八達的地鐵。本次研討會會場位在新宿燦路都廣場大酒店（Hotel Sunroute Plaza Shinjuku，建築外觀如下圖所示）。

2018/07/10 星期二下午首先登場的是研討會的歡迎接待與註冊報到（入口地點如下圖），與兩場平行的口語分場會議報告與海報展示。2018/07/11 星期三開始進行全日大會安排的專題演講、展演、海報展示、平行的分場會議。後學被安排口頭報告場次於 2018/07/12 日星期四。後學曾於 2017 年參與高等教育論壇（HEF）在北海道主辦的一場研討會，該次大會主辦單位於一個月前，先將該場次所有論文寄給主持人，供主持人閱讀事先瞭解每位講者的報告內容，相當用心。

　　大會所安排的第一場報告，主講人 Dr. Thanh Pham 任職於澳洲 Monash University，從事高等教育工作已超過 10 年，主要研究領域是跨文化教育，全球化，國際化，持續在越南和其他亞洲國家從事高等教育國際化研究。將以學生為中心的教學法引入亞洲教室，並將非西方文化的知識素質融入西方課程和教學法。本次大會演講討論國際學生如何利用資本管理他們在留學國和祖國的職業生涯，越來越多的國際學生返回祖國，此趨勢顯示留學國的高等教育需要為國際學生在各種勞動力市場中的就業能力做好準備，以便國際學生能在職涯發展上找到適用、有用的海外學習成果。該研究使用澳洲和越南進行研究的實證數據，說明國際畢業移民和返鄉者在不同背景下如何使用其資本。研究結果顯示國際學生需要有明確的意圖，將在哪裡開展自己的職業生涯，以便投資開發其未來職業發展所需的資本類型。對於留學國的高等教育，技能議程是必要的，但仍不夠，管理，教學和專業人員應該更密切地合作，制定更全面的計劃，為國際學生提供多維度的資源。第二場報告，主講人 Dr. Karen Miranda-Fernandez 博士是菲律賓伊姆斯科學技術學院之酒店，餐廳和旅遊管理學院、國際事務副校長兼院長，也是台灣中華大學和銘傳大學的客座教授，相當活躍，本次以國際視角探討永續旅遊和事件管理。

　　後學所分配的場次共安排六位講者報告，首先是彰化師範大學工業教育與技術學系博士生，發表「工作中的福祉是否會改善審計績效？— 激情的調節作用」，該博士由於長期任職於勤業眾信會計師事務所，此主題與其工作職場直接相關。接著由高雄第一科技大學會計資訊系陳育仁教授報告「利用股東信函預測企業財務危機」，陳教

授的家人並在場聆聽，有小學生參與相當有趣。第三位講者是淡江大學國際企業系曾忠蕙副教授，講述「使用大型銷售數據重新審視禮品促銷，價格促銷活動和消費產品每日銷售的關係」，該研究的資料來源是在促銷手段下，實際的快速消費品實際銷售數萬筆數據，非常難得。接著由中央大學產業經濟研究所鄒孟文教授，報告「企業異質性，市場選擇和生產率：來自中國外資企業的證據」，資料來源來自中國兩項資料庫，使用比對手法分析，前述兩項研究的數據量都大到令後學印象非常深刻。後學的報告主要以 Rasch 模式，測量台灣空軍戰鬥機飛行員因應駕駛艙佈局和設計引發的空間迷位的能力。最後則由輔仁大學博士生以計劃行為理論（TPB）探索台灣家庭住宿加早餐旅館（B＆B）。上述六篇研究主題的差異性頗大，但有此機緣聆聽商管學院學者先進的研究主題，獲益匪淺。非常巧合的是作者都來自台灣，但在台灣卻不必然有此吸引力舉辦國際研討會，讓學者們齊聚一堂，分享各項研究主題與成果。

二、與會心得

後學在完成投稿後有相當寬裕的時間安排行程，感謝大會系統性、有組織地安排。舉辦地點國家日本因治安良好、交通便捷，旅遊相當安全，加上國內各大學積極補助國內研究生出席國際學術會議，本次大會有機會聆聽來自台灣的博士生進行口頭報告。

三、發表論文全文或摘要

Measuring Taiwanese Combat Jet Pilots' Ability to Cope with Spatial Disorientation Triggered by Cockpit Layout and Design

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1.   Background

Taiwan's Defense Ministry announced on November 7, 2017 that a Mirage-2000 combat jet had lost contact during a drill off the island's northeast coast. The missing pilot may have experienced spatial disorientation (SD) when the aircraft entered dense low clouds. SD is the inability to correctly interpret aircraft attitude, altitude or airspeed in relation to the earth or other points of reference (McGraph, Rupert & Guedry, 2003; Newman, 2007). On April 25, 2014, an AH-64E helicopter of the Taiwanese Army crashed and the cause judged to be the Coriolis illusion, an apparent deflection of an object's path that moves within a rotating coordinate system. The Coriolis illusion is caused by making a quick head movement during a constant rate turn that has ceased stimulating the inner ear. This leads to SD (Martinussen & Hunter, 2017)

SD in flight wastes hundreds of millions of dollars worth of defense capability annually and continues to kill aircrew (Gillingham, 1992). 44% of Canadian Forces' pilots have reported experiencing SD, of whom 10% have experienced more than three episodes (Cheung et al., 1995). A survey of U.S. Army rotary-wing operations found that 78% of aircrews had been disoriented and 8% to the extent that flight safety was threatened (Braithwaite et al., 1998). SD has been blamed for 20% of all fatal mishaps in military aviation (Previc & Ercoline, 2004). SD cost the U.S. Army $308,887,000 and 78 lives between 1987 - 1992 (Durnford et al., 1995). Gaydos et al. (2012) reported that 100 aviation accidents, ranging from A to C class in the U.S. Army between 2002 and 2011, were related to SD. SD was also the cause of 31% of deaths in helicopter accidents. Between 1990 and 2000, SD causing share of Class A aviation accidents (involving total cost of property damage over US$2 million, death, full incapacitation for a lifetime, or destroyed, missing, or abandoned aircrafts) increased from 20% to 33%, with the mortality rate approaching 100% (Gibb et al., 2011).

The study probed the contribution of cockpit layout and design to Taiwanese air force jet pilots' SD in order to reduce the risk of triggering SD. The study took into account differences in subjects' ability to cope with SD triggers, resorting to the Rasch model for measurements. The study objective was to measure combat jet pilots' ability to cope with SD triggered by cockpit layout and design in order to improve pilots' SD training quality and skills to anticipate and assess SD risk factors and

thereby ensure flight safety.

2. Methods

In this study, we employed a polytomous Rasch model to estimate combat jet pilots' ability to cope with SD triggered by cockpit layout and design using data obtained from their responses to a questionnaire (Ostini and Nering, 2006; Veldhuis et al., 2012). The purpose of employing the model was to obtain measurements from categorical response data. The study first identified possible factors for pilots' SD via interviews with aviation physiologists, pilots, and medical-engineering experts, and then reviewed the literature on SD-trigger items to formulate the questionnaire, which was distributed to pilots of mainstay combat jets in Taiwan between October 2016 and January 2017. The questionnaire contained 8 SD-trigger items developed by military instructors and aviation physiology experts。

3. Expected Results/ Conclusion/ Contribution

The study assessed combat jet pilots' ability to cope with SD triggers associated with cockpit layout and design. The study found that SD was most likely to be triggered by unfamiliarity with instruments on the aircraft in flight training, followed by shape of the aircraft's cockpit canopy, layout of instrument display in the cockpit of the aircraft, and the helmet-mounted display (HMD). The study's findings point to the importance of improving overall cockpit layout and design in order to reduce the SD problem as well as intensify SD training to focus more on pilot skills to anticipate and assess SD risk factors and thereby ensure flight safety

Keywords: Ability; Rasch model; Spatial disorientation; Combat jet pilots.

四、建議

後學非常感謝科技部所提供之補助,由於科技部計畫主持人王仁宏老師行程衝突,後學以共同主持人、共同作者出席本次學術會議進行口頭報告,從中獲得與其他國內、外學者討論的機會,深感不虛此行,若能持續積極補助、鼓勵研究人員或學者參與國際研討會,營造研究人員更佳的研究環境,並與國際學術交流、接軌,作專業上交流,必能提升研究水準與國際能見度。

五、攜回資料名稱及內容

大會議程、摘要手冊、隨身碟。

六、其他

無。

106年度專題研究計畫成果彙整表

計畫主持人：王仁宏				計畫編號：106-2629-E-992-301-		
計畫名稱：國軍空勤人員適應空間迷向模擬機訓練之性別差異與能力量測(K02)						

成果項目				量化	單位	質化（說明：各成果項目請附佐證資料或細項說明，如期刊名稱、年份、卷期、起訖頁數、證號...等）
國內	學術性論文	期刊論文		1	篇	本研究成果與計畫書之相符，由於本專題計畫補助的經費補助，計畫內容已執行完成，並獲致完整結果。2018年8月13日完成英文編修完成，共同主持人以回應作者身份投稿至主題相符期刊 Cognition, Technology & Work（SCI索引源），目前狀態審查中
		研討會論文		1		2018 Annual Symposium on Management and Social Sciences (ASMSS 2018), Tokyo, Japan. July 10 - 12, 2018.
		專書		0	本	
		專書論文		0	章	
		技術報告		0	篇	
		其他		0	篇	
	智慧財產權及成果	專利權	發明專利 申請中	0	件	
			發明專利 已獲得	0		
			新型/設計專利	0		
		商標權		0		
		營業秘密		0		
		積體電路電路布局權		0		
		著作權		0		
		品種權		0		
		其他		0		
	技術移轉	件數		0	件	
		收入		0	千元	
國外	學術性論文	期刊論文		0	篇	
		研討會論文		0		
		專書		0	本	
		專書論文		1	章	應用Rasch模式探索空軍二代主力戰機空勤人員適應空間迷向能力之量測
		技術報告		0	篇	
		其他		0	篇	
	智慧財產權及成果	專利權	發明專利 申請中	0	件	
			已獲得	0		

		新型/設計專利	0		
		商標權	0		
		營業秘密	0		
		積體電路電路布局權	0		
		著作權	0		
		品種權	0		
		其他	0		
	技術移轉	件數	0	件	
		收入	0	千元	
參與計畫人力	本國籍	大專生	1	人次	史盈欣
		碩士生	1		李世欽
		博士生	0		
		博士後研究員	0		
		專任助理	0		
	非本國籍	大專生	0		
		碩士生	0		
		博士生	0		
		博士後研究員	0		
		專任助理	0		
其他成果 （無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。）					

科技部補助專題研究計畫成果自評表

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（簡要敘述成果是否具有政策應用參考價值及具影響公共利益之重大發現）或其他有關價值等，作一綜合評估。

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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：

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2. 研究成果在學術期刊發表或申請專利等情形（請於其他欄註明專利及技轉之證號、合約、申請及洽談等詳細資訊）
   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200字為限）
   本研究成果與計畫書之相符，由於本專題計畫補助的經費補助，計畫內容已執行完成，並獲致完整結果。2018年8月13日完成英文編修完成，共同主持人以回應作者身份投稿至主題相符期刊Cognition, Technology & Work（SCI索引源），目前狀態審查中

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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）
   在女性比例遠少於男性的軍事環境下，長久以來累積的管理經驗與規則，無可避免地是由男性觀點主導，設備的發展也以男性操作使用為主。當女性空勤人員愈來愈多時，忽略女性空勤人員的需求，將無法達成有效訓練的目的，同時影響女性空勤人員的表現。根據研究結果，使儀表飛行訓練教官瞭解，如何針對性別規範空間迷向模擬機有效的訓練裝備與教育科目，有效精進不同性別學員的儀表飛行訓練。瞭解女性是否適合駕駛慢速機以外的機種，同時作為國軍擴充女性飛行員招收人數的參考。

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4. 主要發現
   本研究具有政策應用參考價值：□否　■是，建議提供機關國防部,
   （勾選「是」者，請列舉建議可提供施政參考之業務主管機關）
   本研究具影響公共利益之重大發現：■否　□是
   說明：（以150字為限）