# Improvement of Passive Safety of Two－Wheels Commuting Vehicles － Based on Industrial Design Solutions


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**ABSTRACT**

This research aims to find an improvement of passive safety for scooter drivers in Taiwan. The number of motorcycles is growing fast over here, and so does the numbers of safety problems. It is worthy to look for a possible solution on this field, especially focusing on Ordinary Heavy-Duty Motorcyclists. This thesis indicates active safety and passive safety. In the moment, ‘ active safety ’ applied on vehicles is difficult to match market requests, because it will rise the costs for motorcycling essentially. So we concentrated on passive safety for both, vehicles and also driver ’ s gear. This research uses questionnaires to analyze the acceptance of a big number of Taiwan motorcycle users, there it shows that users have low acceptance for existing protective products, especially for changes on the vehicles, because of high costs and inconvenience in usage. So for us it turned out more meaningful to focus our design improvements on the driver ’ s body. During the design improvement part, the author chose professional specialists from Taiwan ’ s motorcycle market as interviewees. We used an in-depth interview method and compared existing products with prepared ideas for improvement, collecting opinions and suggestions. Finally, the professionals came to a positive conclusion on the offered design work. According to their general impression, the design improvement shows possibilities for a safety enhancement.



Keywords : passive safety、traffic accident、Ordinary Heavy-Duty Motorcycle、design improvement


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**REFERENCES**

一. 中文部份 1.白家榮，十字路口行人的偵測及追蹤，國立台灣師範大學資訊教育研究所碩士論文，民國九十一年。 2.石心寧，市中心商業步行空間領域標示物機能之研究－以台中市繼光街行人徒步區為例，東海大學工業設計學系，民國九十一年。 3.吳正宇，「機車氣囊防護衣之防護效益評估和機車車禍之電腦模擬」，國立陽明大學醫學工程研究所碩士倫文，民國九十二年。 4.李自浩，市中心區購物商街人潮遊逛空間阻礙因子之研究，中國文化大學事證暨環境規劃研究所碩士論文，民國九十五年。 5.李明聰，地區性道路人車共存設施風險評估模式建立與應用，國立台灣大學土木工程學研究所碩士論文，民國八十九年。 6.林立，「機車事故之受傷部位及傷亡程度探討」，國立嘉義大學運輸與物流工程研究所碩士論文，民國九十六年。p5-8，p39-56 7.侯斌元，手機發展趨勢與零組件產品設計之關係探討—以手機連接器為例，大同大學工業設計研究所碩士論文，民國九十八年。 8.許瓊方，「停車導引資訊服務接受度研究」，國立成功大學電信管理研究所碩士論文，民國九十八年。p46-72 9.陳立欣，嗅覺氣味刺激對工作績效之影響-以電腦文書工作者為例，大同大學工業設計研究所碩士論文，民國九十六年。 10.陳怡君，利用軌跡特徵分析行人異常行為，國立中央大學資訊工程研究所碩士論文，民國九十五年。 11.曾建民，終身吊銷駕駛執照制度之實施成效評估－被吊照人吊照前後開車實證分析，國立交通大學運輸科技與管理系，民國九十五年。p34 12.黃嵐鈴，數位臥室的生活需求調查與產品設計，雲林科技大學工業設計系碩士班碩士論文，民國九十六年。p105-109 13.劉希麟，數位生活形態下電腦桌的使用需求與產品設計，大同大學工業設計研究所碩士論文，民國九十八年。p101-138 二. 英文部分 1.Alexandra Millonig, Katja Schechtner, 2005. Developing Landmark-based Pedestrian Navigation Systems. IEEE Conference on Intelligent Transportation Systems. 2.Annika Larsson, 2005. PEDESTRIAN DETECTION AND DRIVER ATTENTION, Cues needed to determine risky pedestrian behavior in traffic, p.2-9 3.Annika Larsson, 2005. Pedestrian Detection and Driver Attention-Cues needed to determine risky pedestrian behavior in traffic. Department of Computer and Information Science, Linkoping University, Sweden. 4.Bogozzi, R. P., Yi, Y., 1988. On the evaluation of structural equation models. Academic of Marketing Science. p16, 437-454. 5.Choo, S, Mokhtarian, Patricia L, UC Davis, 2004. What type of vehicle do people drive? The role of attitude and lifestyle in influencing vehicle type choice. University of California.

6.Diamantopoulos, A., Siguaw, J. A., 2000. Introducing LISREL: A guide for the uninitiated. Thousand Oaks, CA: Sage. 7.Dominique Lord, Alison Smiley & Antoine Haroun, 2001. Pedestrian Accidents with Left-Turning Traffic at Signalized Intersections: Characteristics, Human Factors, and Unconsidered Issues. Safety Studies Group, Department of Civil Engineering, University of Toronto. 8.FRED D. DAVIS, RICHARD P. BAGOZZI AND PAUL R. WARSHAW, 1989. USER ACCEPTANCE OF COMPUTER TECHNOLOGY: A COMPARISON OF TWO THEORETICAL MODELS. School of Business Administration, University of Michigan. , California Polytechnic State University. 9.Geetam Tiwari, Shrikant Bangdiwala, Arvind Saraswat, Sushant Gaurav, 2007. Survival analysis: Pedestrian risk exposure at signalized intersections. Indian Institute of Technology, Delhi Transportation Research and Injury Prevention Programme. 10.Ingo Kalliske, Christoph Albus, 1998. Safety Potential of Future Two-Wheel Concepts-A Challenge, Federal Highway Research Institute, Germany, p.2-9 11.KALU UDUMA, 2000. Innovations in Auto Safety Design, a Key to Quality Improvement. Vehicle Development-Impact Systems, DaimlerChrysler. 12.KALU UDUMA, 2000. Innovations in Auto Safety Design, a Key to Quality Improvement. Vehicle Development-Impact Systems, DaimlerChrysler. 13.Kandice Kreamer Fults, 2005. AN ANALYSIS OF PEDESTRIAN-VEHICULAR CRASHES NEAR PUBLIC SCHOOLS IN THE CITY OF BALTIMORE, MARYLAND. Master of Science. 14.Lars Hollmotz, Steffen Sohr, 2005. CLEVER – A Three Wheel Vehicle with a Passive Safety Comparable to Conventional Cars, TAKATA-PERTRI Aschaffenburg / Berlin / Ulm, Germany, p1-4 15.Leon G. Schiffman, Leslie Lazar Kanuk, 1997. Consumer behavior, Prentice Hall. 16.M. Suzanne Zeedyk, Laura Kelly, 2003. Behavioural observations of adult – child pairs at pedestrian crossings. Department of Psychology, University of Dundee. 17.Mariana Bayley, Barry Curtis, Ken Lupton, Chris Wright, 2004. Vehicle aesthetics and their impact on the pedestrian environment. Transport Management Research Centre, Middlesex University Business School. 18.Megan Bayly, Michael Regan and Simon Hosking, 2006. Intelligent Transport System and Motorcycle Safety, MONASH University, Accident Research Centre, p.43-51 19.Natasha Mack, Cynthia Woodsong, Kathleen M. Macqueen, Greg Guest, Emily Namey, 2005. Qualitative Research Methods: A data collector ' s field guide, Family Health International. p29-32 20.Schiffman, Leon G, & Kanuk, Leslie, 1994, Consumer Behavior (Fifth Edition), A Simon & Schuster Company, p.459-469 21.Yajun Fang, Student Member, IEEE, Keiichi Yamada, Member, IEEE, Yoshiki Ninomiya, Berthold K. P. Horn, and Ichiro Masaki, Senior Member, IEEE, 2004. A Shape-Independent Method for Pedestrian Detection with Far-Infrared Images. IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, VOL. 53, NO. 6, NOVEMBER 2004 22.Yasuhiro Matsui, 2005. Effects of vehicle bumper height and impact velocity on type of lower extremity injury in vehicle – pedestrian accidents. Japan Automobile Research Institute, 2530 Karima, Tsukuba, Ibaraki 305-0822, Japan.