# 以零件模組化進行產品變異之研究


## 楊鈺銓、曾懷恩

E-mail: 9221565@mail.dyu.edu.tw



**摘 要**

為了解決產品變異頻繁下零件增殖造成的問題，透過模組化的方式，讓設計者、生產者乃至於使用者擁有較大的彈性，以提升創新效率。擺脫以往憑藉著對產品知識經驗，以主觀的方式決定組裝網路圖上零件組合的先後順序。 本研究透過Das[4]所提出的因素評分標準，針對組裝上的工程特性加以評比，形成零件關係矩陣，並利用距離公式將不同度量單位的工程資訊加以合併，最終以最小展開樹(MinimalSpanning Tree)演算法的執行，形成組裝網路關係圖，提供設計初期之先行圖參考。 當零件的組合關係確定後，組裝網路也隨之固定；進一步地，透過基礎元件(Base Part)的選擇，作為模組分群的基準；當群組個數經由基礎元件選定後，分群即告完成，並藉由質量中心與相對距離的觀點來評估模組間的差異顯著性。 本研究以零件間組合關係為考量，改良Das 的評分標準，針對一般性產品(如：釘書機、隨身聽)，擬定評分標準；並利用距離關係來表示零件組合關係上的差異性；再者，利用距離遠近分別由重新使用(Reuse)、重新設計(Redesign)及零件合併(Merge)的觀點，來探究零件間的組合關係及可變的情形。



關鍵詞 : 產品變異 ; 零件增殖 ; 模組 ; 最小展開樹 ; 組裝網路關係圖 ; 基礎元件 ; 質量中心


**目錄**


目錄 封面內頁 簽名頁 授權書..... iii 中文摘要..... v
Abstract..... vi 誌謝..... vii 目錄..... viii 圖目錄..... x 表目錄..... xii 第一章緒論..... 1 1.1 研究動機與目的..... 1 1.2 研究範圍與假設..... 6 1.3 研究方法..... 9 1.4 研究流程及架構.....11 第二章文獻探討..... 13 2.1 組裝規劃之演進..... 13 2.2 模組化形成之探究..... 19 2.2.1 功能樹表達法..... 21 2.2.2 功能觀點之模組化研究..... 23 2.3 文獻回顧結論..... 25 第三章組裝網路演算法..... 28 3.1 Component 資料結構..... 28 3.1.1 Component 之接觸方式..... 33 3.1.2 Component 之使用工具..... 34 3.1.3 Component 之結合方向..... 35 3.2 Arc 權重計算..... 35 3.3 最小展開樹演算法..... 36 3.4 組裝網路關係範例—釘書機..... 38 第四章模組化分群演算法..... 49 4.1 基礎元件(Base Part)..... 51 4.2 距離指標(Distance Index, DI)..... 52 4.3 功能性模組(Functional Modular, FM) ..... 56 4.4 質量中心..... 57 4.5 分群範例—釘書機(續) ..... 59 第五章實例探究..... 66 5.1 演算法之執行步驟..... 66 5.2 系統說明..... 68 5.3 實例探討—CD 隨身聽..... 72 第六章結論與建議..... 86 6.1 結論..... 86 6.2 後續研究..... 86 參考文獻..... 88


**參考文獻**


[1] Akagi, F., H. Osaki, and S. Kikuchi, “The method of analysis of assembly work based on the fastener method,” Bulletin of the JSME, Vol.23, No.184, pp.1670-1675 (1980).

[2] Boothroyd, G., Design for Assembly — A Designer’s Handbook. University of Massachusetts, Amherst, MA (1980).

[3] Cohen, L., Quality Function Deployment: How to make QFD work for you, Addison-Wesley Publishing Company, New York (1995).

[4] Das, S. K., P. YEDLARAJIAH, and R. NARENDRA, “ An approach for estimating the end-of-life product disassembly effort and cost, ” International Journal of Production Research, Vol.38, No.3, pp.657-673 (2000).
[5] Das, S. K. and S. NAIK, “ Process planning for product disassembly, ” International Journal of Production Research, Vol.40, No.6, pp.1335-1355 (2002).
[6] De Fazio, L. T. and D. E. Whitney, “ Simplified generation of all mechanical assembly sequences, ” IEEE Journal of Robotics and Automations, Vol.3, No.6, pp.640-658 (1987).
[7] De Fazio, L. T., A. C. Edsall, R. E. Gustavson, J. Hernandez, P. M. Hutchins, H.-W. Leung, S. C. Luby, R. W. Metzinger, J. L. Nevins, K. Tung and D. E. Whitney, “ A prototype of feature-based design for assembly, ” Transcription of the ASME Journal of Mechanical Design, Vol.115, December, pp.723-734 (1993).
[8] HE D. W. and A. Kusiak, “ Performance analysis of modular products, ” International Journal of Production Research, Vol.34, No.1, pp.253-272 (1996).
[9] Henrioud, J. M. and A. Bourjault, “ Computer-aided generation of assembly plans, ” International Journal of Systems Automation: Research and Applications (SARA) Vol.2, pp.127-138 (1992).
[10] Lin, A. C. and T. C. Chang, “ An integrated approach to automated assembly planning for three-dimensional mechanical products, ” International Journal of Production Research, Vol.35, No.5, pp.1201-1227 (1993).
[11] Kroll, E., B. Beardsley and A. Parulian, “ A methedology to evaluate ease of disassembly for product recycling, ” IIE Transaction, Vol.28, pp.837-845 (1996).
[12] Kuo, T. C., “ Disassembly sequence and cost analysis for electromechanical products, ” Robotics and Computer Integrated Manufacturing. Vol.16, pp.43-54 (2000).
[13] Kuo, T. C., H. C. Zhang and S. H. Huang, “ Disassembly analysis for electromechanical products: a graph-based heuristic approach, ” International Journal of Production Research, Vol.38, No.5, pp.993-1007(2000).
[14] Kusiak, A., Intelligent manufacturing systems, Prentice-Hall International Editions (1990).
[15] Kusiak, A. and C. C. Huang, “ Develop component of Modular Products, ” IEEE Transactions on Components Packing and Manufacturing Technology, part A, Vol.19, No.4, December (1996).
[16] Kusiak, A., “ Computational Intelligence in Design and Manufacturing, ” John Wiley & Sons, Inc, pp.294-346 (2000).
[17] Martin, M. and K. Ishii, “ Design for variety: A methodology for understanding the costs of product proliferation, ” 1996 ASME Design Engineering Technical Conference, Irvine, CA, USA. ASME New York NY USA (1996).
[18] Martin, M. and K. Ishii, “ Design for variety: Development of complexity indices and design charts, ” 1997 ASME Design Engineering Technical Conference, Sacramento, CA, USA. ASME New York NY USA (1997).
[19] Martin, M. V. Design for variety: A methodology for developing product platform architectures, PHD dissertation, Stanford University in Mechanical Engineering (2000).
[20] Nevins and Whitney, ” A strategy for the next generation in manufacturing, ” Concurrent design of products & process, New York: McGraw-Hill (1989).
[21] Ong, N. S. and Y. C. Wong, “ Automatic subassembly detection from a product model for disassembly sequence generation, ” International Journal of Advance Manufacturing Technology, Vol.15, pp.425-431 (1999).
[22] Otto, K. and Wood, K., Product Design, Prentice Hall. (2001) [23] Pahl,G. and W. Beitz, Engineering Design-A Systematic Approach, 2nd edn., Spring-Verlag, London (1996).
[24] Pugh, S. Total Design: Integrated methods for successful product engineering, Addison-Wesley Pub (1991).
[25] Pugh, S. Creating Innovative Products Using Total Design, Addison-Wesley Pub (1996).
[26] Swaminathan, A. and K. S. Barber, “ An experience-based assembly sequence planner for mechanical assemblies, ” IEEE Transactions on Robotics and Automation, Vol.12, No.2, APRIL, (1996).
[27] Tonshoff, H. K., E. Menzel and H. S. Park, “ A Knowledge-based System for Automated Assembly Planning ” , Annals of the CIRP, Vol.41, FEB, (1992).
[28] Tseng, M. and M. J. Jiao, “ Design for mass customization ” , Annals of the CIRP, Vol.45, No.1, pp.153-156 (1996).
[29] Tseng, H. E. and R. K. Li, “ A novel means of generating assembly sequences using the connector concept, ” Journal of Intelligent Manufacturing. (Accepted in 1998) [30] Tseng, H. E., T. S. Chang. and Y. U. Yang, “ A connector-based approach to modular formulation problem for mechanical products, ” International Journal of Advance Manufacturing Technology, (Accepted in 2003) [31] Yin, Z. P., H. Ding, H. X. Li, and Y. L. Xiong, “ A connector-based hierarchical approach to assembly sequence planning for mechanical assemblies, ” Computer-Aided Design, Vol.35, pp.37-56 (2003). 中文部分: [32] 張堂聖, 「Connector 為基之模組化研究—以機械產品為例」, 私立大葉大學工業工程系碩士論文, (2002)。
[33] 劉立晟, 「方形組件之組裝次序與加工次序之整合分析與評 估」, 私立元智工學院工業工程系碩士論文, (1997)。
[34] 黎文龍, 工程設計與分析, 東華書局, (2000)。
[35] 谷口勝洋著, 陳坤賞譯, 研究開發的群組思考, 中衛發展中心, (2001)。

[36] 黃國瑜、葉乃菁編著，資料結構，文魁資訊股份有限公司，(2001)。