An Approach of Combination for Cell Forming and Open Shop Scheduling Problem

張緯強、駱景堯

E-mail: 9808033@mail.dyu.edu.tw

ABSTRACT

Recently, the method that how to be superior in the competitive manufacturing industry environments obsiously focuses on the processes of "Customization" and "Low Cost". The concept of "Group Technology" is also more the production procedures and more important in modern productive demands, because it can simplify and reduce cost in the manufacturing industry. On the other hand, the whole framework must be gradually completed by combing the result of "Group Technology" to the thinking logic of "Product Scheduling". But until now, the present research doesn't combine or apply these issues yet, because they just study in every single realm. Therefore, this research is to explore a series of problem form cell forming and its corresponding productive procedures. I solute some related problems from taking advantage of genetic algorithm and heuristic algorithm; especially improve its quality and get good result of the exceptant cell formation problem in the realm of group effect and open shop scheduling.

Keywords: group technology; open shop scheduling; grouping efficacy; genetic algorithm

Table of Contents

封面內頁 簽名頁 授權書 iii 中文摘要 vi ABSTRACT vi 誌 謝 vii 目 錄 viii 圖目錄 xi 表目錄 xiii 第一章 緒論 1 1.1 研究動機與目的 1 1.2 研究範圍及假設 4 1.3 研究方法及流程 6 第二章 文獻探討 9 2.1 單元製造系統問題方面 9 2.1.1 早期文獻探討 9 2.1.2 近期文獻探討 11 2.1.3 單元製造系統 16 2.2 開放型排程問題方面 23 2.2.1 早期文獻探討 23 2.2.2 近期文獻探討 24 2.3 基因演算法(Genetic Algorithms) 25 第三章 標準單元形成問題之求解 32 3.1 標準單元形成問題演算法介紹 32 3.1.1 標準單元形成問題演算法之建立 33 3.2 零件分派問題起始解 35 3.3 自動切割群組觀念 38 3.4 機器分派問題的啟發式解 39 3.5 區域搜尋改善階段(零件移步法) 44 第四章 開放型排程問題之求解 47 4.1 考量開放型排程問題之演算法介紹 47 4.2 OSP問題之編碼方式 48 4.3 處理OSP之基因演算法 49 4.3.1 編碼(Encoding) 50 4.3.2 初始族群 (Initial Population) 51 4.3.3 適合度函數(Fitness Function) 52 4.3.4 複製(Reproduction) 53 4.3.5 交配(Crossover) 54 4.3.6 突變(Mutation) 56 4.4 例外加工元素的處理 57 4.5 單元形成後之開放型排程演算範例說明 58 4.5.1 產生初始母體 60 4.5.2 主架構基因演算法結果 61 第五章 演算結果與分析 64 5.1 標準單元形成問題測試例題 64 5.2 標準單元形成問題演算法參數選擇、結果和比較 66 5.3 開放型排程問題測試例題 69 5.3.1 開放型排程資料之產生與選擇參數之說明 69 5.3.2 演算結果分析 70 5.3.3 各種問題規模下之分析 71 第六章 結論與建議 79 6.1 結論 79 6.2 建議 80 參考文獻 82 附錄一 各開放型排程問題規模下之ANOVA求解品質分析表 90 附錄二 各問題模式下與各因子水準間之延遲時間求解品質關係圖 106 附錄三 各問題模式下與各因子水準間之延遲時間求解品質關係圖 106 附錄三 各問題模式下與各因子水準間之延遲時間求解品質關係圖 114

REFERENCES

- [1] 許惇旭,民國86年,結合禁忌搜尋法(TS)與模擬退火法(SA)在彈性製造系統(FMS)排程之應用,大葉大學碩士學位論文。
- [2] 吳佳璋,民國86年,禁忌搜尋法在彈性製造系統排程問題之應用,大葉大學碩士學位論文。
- [3] 呂紹煌,民國88年,以塔布搜尋法求解開放工廠排程問題,朝陽大學碩士學位論文。
- [4] 吳文田, 民國89年, 製造單元形成問題解法之研究, 大葉大學碩士學位論文。
- [5] 賴彥銘,民國89年,應用群聚技術求解製造單元形成問題,大葉大學碩士學位論文。
- [6] 林安祥,民國89年,開放工廠加權延遲最小化排程問題之研究,朝陽大學碩士學位論文。
- [7] 賴崇瑋,民國90, 二機開放工廠具有工作連接性限制之排程演算法效率比較, 東海大學碩士學位論文。
- [8] 駱芳梧,民國91年,以考量整備及拆卸時間之開放型工廠排程問題研究,大葉大學碩士學位論文。
- [9] 李師尹,民國91年,應用基因演算法於求解模糊環境下之單元製造系統問題,大葉大學碩士學位論文。
- [10] 尤冠斌,民國92年,混合基因演算法於開放型排程問題探討,大葉大學碩士學位論文。
- [11] 楊鎰銘,「製造單元形成之啟發式求解研究」,大葉大學碩士學位論文,民國93年。
- [12] Achugbue, J.O., and Chin, F.Y., 1982, "Scheduling the open shop to minimize mean flow time," SIAMJ. Comput., 11, pp.709-720.
- [13] Adam, S., 2006, " Evolutionary strategy for manufacturing cell design," Omega., 34, pp.1-18.
- [14] Ankerst, M., Breuning M., Kriegel H.P., and Sander J., 1999, "OPTICS:Ordering point to identify the clustering structure," In Proc. 1999

- ACM-SIGMOD Int. Conf. Management of Data(SIGMOD '99), pp.49-66, Philadelphia, PA.
- [15] Askin, R.G., Cresswell, S.H., Goldberg, J.B., and Vakharia, A.J., 1991, "A Hamiltonian path approach to reordering the part-machine matrix for cellular manufacturing," International Journal of Production Research, 29, pp.1081-1100.
- [16] Askin, R.G., and Subramanian, S., 1987, "A cost-based heuristic for group technology configuration." International Journal of Production Research, 25, pp.101 113.
- [17] Asoo, J.Vakharia., and Urban, Wemmerl?v., 1995, "A comparative investigation of hierarchical clustering techniques and dissimilarity measures applied to the cell formation problem," Journal of Operations Management 13, pp.117-138.
- [18] Balakrishnan, J., and Jog, P.D., 1995, "Manufacturing cell formation using similarity coefficients and a parallel genetic TSP algorithm formulation and comparison," Mathematical & Computer Modeling, 21, pp.61-73.
- [19] Boctor, F., 1991, "A linear formulation of the machine-part cell formation problem." International Journal of Production Research, 29(2), pp.343-356.
- [20] Boe, W., and Cheng, C.H., 1991, "A close neighbor algorithm for designing cellular manufacturing systems." International Journal of Production Research, 29(10), pp.2097 2116.
- [21] Chan, F.T.S., Mak, K.L., Luong, L.H.S., and Ming, X.G., 1998, "Machine-component grouping using genetic algorithm," Robotics & Computer-Integrated Manufacturing, 14, pp.339-346.
- [22] Chan, H.M., and Milner, D.A., 1982, "Direct clustering algorithm for group formation in cellular manufacture." Journal of Manufacturing System, 1, pp.65 75.
- [23] Carrie, S., 1973, "Numerical taxonomy applied to group technology and plant layout." International Journal of Production Research, 11, pp.399 416.
- [24] Chandrashekharan, M.P., and Rajagopalan, R., 1986a, "An ideal seed non-hierarchical clustering algorithm for cellular manufacturing." International Journal of Production Research, 24(2), pp.451 464.
- [25] Chandrashekharan, M.P., and Rajagopalan, R., 1986b, "MODROC: An extension of rank order clustering for group technology." International Journal of Production Research, 24(5), 1221 1233.
- [26] Chandrasekharan, M.P., and Rajagopalan, R., 1987, "ZODIAC-an algorithm for concurrent formation of part-families and machine-cells," International Journal of Production Research, 25, pp.835-850.
- [27] Chandrasekharan, M.P., and Rajagopalan, R., 1989, "GROUPABILITY:an analysis of the properties of binary data matrices for group technology," International Journal of Production Research, 27, pp.1035-1052.
- [28] Cheng, C.H., Gupta, Y.P., Lee, W.H., and Wong, K.F., 1998, "A TSP-based heuristic for forming machine groups and part families," International Journal of Production Research, 36, pp.1325-1337.
- [29] Cheng, C.H., Goh, C.H., and Lee, A., 2001, "Design group technology manufacturing systems using heuristics branching rules," Computers & Industrial Engineering, 40, pp.117-131.
- [30] Ester, M., Kriegle, H.P., Sander, J., and Xu., 1996, "Density-Based Algorithm for Discovering Clusters in Large Spatial Databases with Noise," In Proc. 1996 Int. conf. Knowledge Discovery and Data Mining(KDD '96), pp.226-231, Portland, OR, Aug.
- [31] Felix, T.S.Chan., Lau, K.W., Chan, P.L.Y., and Choy K.L., 2006, "Two-stage approach for machine-part grouping and cell layout problems," Robotics and Computer-Integrated Manufacturing, 22, pp.217-238.
- [32] Gonzalez, T., and Sahni, S., 1976, "Open shop scheduling to minimize finish time," Journal of The Association for Computing Machinery, 23(4), pp.665-679.
- [33] Gon?岬Ives, Jos??Fernando., Resende Mauricio.G.C., 2004, "An evolutionary algorithm for manufacturing cell formation," Compuers & Industrial Engineering, 47, pp.247-273.
- [34] Gursel, A.Suer., and Angel, A.Cede o., 1996, "A Configuration-Based Clustering Algorithm For Family Formation," Computers ind. Engen Vol. 31. No.1/2 pp.147-150.
- [35] Harhalakis, G., Nagi R., and Proth, J.M., 1990, "An efficient heuristic in manufacturing cell formation for group technology applications," Int J. Prod. Res., Vol. 28, no. 1, pp.185-198.
- [36] Han, J., and Kamber, M., 2000, "Data Mining:Concepts and Techniques," Morgan Kaufmann.
- [37] Hiroshi, Ohta., Masaeru, Nakamura., 2002, "Cell formation with reduction in setup time," Compuers & Industrial Engineering, 42, pp.317-327.
- [38] Kaufam, L., and Rousseeuw, P.J., 1990, "Finding Groups in Data:an Introduction to Cluster Analysis," John Wiley & Sons.
- [39] Kitaoka, M., Nakamura, R., Serizawa, S., and Usuki, J., 1999, "Multivariate analysis model for machine-part cell formation problem ingroup technology," International Journal of Production Economics, 60-61, pp.433-438.
- [40] King, J.R., 1980, "Machine-component grouping in production flow analysis: An approach using a rank order clustering algorithm." International Journal of Production Research, 18(2), pp.213 232.
- [41] King, J.R., and Nakornchai, V., 1982, "Machine-component group formation in group technology: Review and extension." International Journal of Production Research, 20(2), pp.117 133.

- [42] Kumar, C.S., and Chandrasekharan, M.P., 1990, "Grouping efficacy: a quantitative criterion for goodness of block diagonal forms of binary matrices in group technology," International Journal of Production Research, 28, pp.233-243.
- [43] Kumar, K.R., Kusiak, A., and Vannelli, A., 1986, "Grouping of parts and components in flexible manufacturing systems." European Journal of Operations Research, 24, pp.387 397.
- [44] Kumar, K.R., and Vannelli, A., 1987, "Strategic subcontracting for efficient disaggregated manufacturing." International Journal of Production Research, 25(12), pp.1715 17281.
- [45] Kusiak, A., and Cho, M., 1992, "A sililarity coefficient algorithms for solving the group technology problem," International Journal of Production Research, 30, pp.2633-2646.
- [46] Kusiak, A., and Chow, W., 1987, "Efficient solving of the group technology problem." Journal of Manufacturing Systems, 6(2), pp.117 124.
- [47] Kyparisis, G.J., and Koulamas, C., 2000, "Open shop scheduling with makespan and total completion time criteria," Computers & Operations Research, 27(1), pp.15-27.
- [48] Liang, M., and Zolfaghri, S., 1999, "Machine cell formation considering processing times and machine capacities: an ortho-synapse Hopfield neural network approach," Journal of Intelligent Manufacturing, 10, pp.437-477.
- [49] Liaw, C., 1999, "An iterative improvement approach for the nonpreemptive open shop scheduling problem," European Journal of Operational Research, 111(3), pp.509-517.
- [50] Liaw, C., 1999, "A tabu search algorithm for the open shop scheduling problem," Computers & Operations Research, 262(2), pp.109-126.
- [51] Liaw, C., 2000, "A hybrid genetic algorithm for the open shop scheduling problem," European Journal of Operational Research, 124(1), pp.28-42.
- [52] Lin, H.F., Liu, C.Y., and Liu, P.Y., 1995, "A heuristics approach to the total tardiness in nonpreemptive open shop scheduling," International Journal of Industrial Engineering, 2(1), pp.25-33.
- [53] Lin, H.F., 1995, "A heuristics solution to the total tardiness and earliness penalties of an m-machine nonpreemptive scheduling," Journal of The Chinese Institute of Industrial Engineering, 15(2), pp.159-167.
- [54] Lin, H.F., 1995, "A heuristic solution to the total tardy cost of an machine non-preemptive open shop scheduling," Sun Yat Sen Management Review, 3(4), pp.122-143.
- [55] MacQueen, J., 1967, "Some Methods for Classification and Analysis of Multivariate Observation," In Proc. 5 Berkeley Symp. Math Stat. and Prob., Vol 1, pp.281-297.
- [56] Mak, K.L., Wong, Y.S., and Wang, X.X., 2000, "An adaptive genetic algorithm for manufacturing cell formation," International Journal of Advanced Manufacturing Technology, 16, pp.491-497.
- [57] Menouar, B., and Karim, A., 2006, "A new branch-&-bound-enhanced genetic algorithm for the manufacturing cell formation roblem," Computers & Operations Research, 33, pp.2219-2245.
- [58] Mosier, C.T., and Taube, L., 1985a, "The facets of group technology and their impact on implementation," OMEGA, 13(6), pp.381 391.
- [59] McCormick, W.T., Schweitzer, P.J., and White, T.W., 1972, "Problem decomposition and data reorganization by a clustering technique." Operations Research, 20, pp.993-1009.
- [60] Nair, G.J., and Narendran, T.T., 1997, "Cluster goodness: a new measure of performance for cluster formation in design of cellular manufacturing system," International Journal of Production Economics, 48, pp.49-61.
- [61] Onwubolu, G.C., and Songore, V., 2000, "A tabu search approach to cellular manufacturing systems," Production Planning & Control, 11, pp.153-164.
- [62] Onwubulo, G.C., and Mutingi, M., 2001, "A genetic algorithm approach to cellular manufacturing systems," Computers & Industrial Engineering, 39, pp.125-144.
- [63] Pinedo, M., 1995, Scheduling: Theory, Algorithm and Systems, Prentice-Hall, Englewood Cliffs, NJ.
- [64] Sarker, B.R., 2001, "Measure of grouping efficiency in cellular manufacturing systems," European Journal of Operational Research, 130, pp.588-611.
- [65] Seifoddini, H., and Wolfe, P.M., 1989, "Application of the similarity coefficient method in group technology." IIE Transactions, 18, 3, pp.266-270.
- [66] Seifoddini, H., 1989, "Single linkage versus average linkage clustering in machine cells formation applications." Computers and Industrial Engineering, 16(3), pp.419 426.
- [67] Srinivasan, G., Narendran, T., and Mahadevan, B., 1990, "An assignment model for the part-families problem in group technology." International Journal of Production Research, 28, pp.145 152.
- [68] Stanfel, L., 1985, "Machine clustering for economic production." Engineering Costs and Production Economics, pp.73-89.
- [69] Vila, Gon?岬Ives.Filho., Eduard?? Jos??Tiberti., Alexandre., 2006, "A group genetic algorithm for the machine cell formation problem," International Journal of Production Economics, 102, pp.1 21.
- [70] Waghodekar, P.H., and Sahu, S., 1984, " Machine-component cell formation in group technology MACE." International Journal of

Production Research 22, pp.937-948.

- [71] Wemmerlov, U., and Hyer, N.L., 1987, "Research issues in Cellular Manufacturing," International Journal of Production Research, 25, pp.413-431.
- [72] Yasuda, K., and Yin, Y., 2001, "A dissimilarity measure for solving the cell formation problem in cellular manufacturing," Computer & Industrial Engineering, 39, pp.1-17.
- [73] Zahir, A., Hamdi, A., and Mingyuan, C., 2005, "A mathematical approach for the formation of manufacturing cells," Computer & Industrial Engineering, 48, pp.3-12.