6

Conclusions and Further Research

6.1 Conclusions

We propose a robust supply chain design using an integrated hierarchical planning approach. This hierarchical planning approach is adopted because most supply chains make their decisions based on the natural hierarchy existing within their managerial systems. There are typically three levels of planning in a supply chain: strategic, tactical and operational levels. It is therefore necessary to translate plans from the strategic level into the tactical level, and from the tactical level into the operational level while maintaining a prescribed service level. This PhD work attempts to explore and develop new approaches in integrating the various plans in supply chains in order to resolve the complex issue of uncertainty inherent in these supply chains.

Three models are formulated -one for each level- addressing problems that most commonly occur in a supply chain. At the strategic level, the safety stock placement problem is formulated for a capacitated supply chain. The effect of capacity limitation is to increase the quantity of required safety stock by a certain correction factor. Even when the net replenishment time is non positive, a capacitated stage must place safety stocks in order to maintain the prescribed service level. At the tactical level, the aggregate production planning is formulated addressing two types of uncertainty: demand and capacity uncertainty. Some capacity cushion levels are used to deal with demand uncertainty and a preventive maintenance planning is used to deal with capacity uncertainty. We propose a general preventive maintenance policy where maintenance periods do not necessarily fall at equally distant epochs. At the operational level, a family production is disaggregated into finished products taking into account machine breakdowns. The operational level planning, aims at producing the planned production decided at the tactical level as accurately as possible, in addition to synchronizing production across the production line. In summary, we attempt to solve one of the most important problems in a supply chain, namely meeting uncertain demand using a machinery which is subject to failures.

Considering the results from each planning level, an integrated hierarchical approach is proposed in this research. Two phases of integration are considered: [1] the integration of strategic and tactical level planning and [2] the integration between tactical and operational level planning.

This collection of models can serve as a basis for further elaborated models to solve more complex problems in a supply chain. It is worth noting that the complexity in a supply chain is partly reduced by the use of safety stock at the strategic level, the formulation of inventory movement constraints at the tactical level and the formulation of runout deviations at the operational level. At the strategic level, the guaranteed service time of a stage (along with the safety stock) decouples it from other stages in the supply chain which allows it to generate its own tactical plan. At the tactical level, the inventory movement constraints also decouple a machine from others in the production line. Finally, the formulation of runout deviations synchronizes the production of finished products across the production line even though the planning is executed independently for each machine. At the tactical level, partitions of planning horizon for both demand realization and preventive maintenance actions are used. Such partitions bring about a deterministic formulation while maintaining the prescribed service level. The computational complexity of such a robust deterministic formulation stays within a reasonable amount of time and space.

We have tested these models at the strategic, tactical and operational levels using some test sets which are designed to reflect real problems. Because we want to put emphasizes on understanding uncertainty at all levels in a supply chain, we evaluate the models using small size test sets. Our findings suggest that this proposed hierarchical planning approach is promising, particularly when dealing with uncertainty and complexity issues in the supply chain.

6.2 Further research

Further research may be directed towards the evaluation of this hierarchical planning approach on large scale problems. Such an evaluation will probably provide a good assessment for the real implementation of the approach in a supply chain.

It is also necessary to investigate the integration of transportation in this approach because transportation is a critical factor in supply chains. Moreover, a general structure for supply chains is an important issue and it needs to be addressed accordingly. Although the safety stock placement problem in a general network has been studied by Graves and Willems (2000) and Lesnaia et al. (2004), capacity limitation issues have not been adequately addressed in the literature. We believe that some of our findings can be extended into a general network safety stock placement problem (i.e. the correction factors needed to adjust the amount of safety stock in a capacitated stage). An analytical study of the correction factor or a simulation study for any value of stock out probability α, would be very valuable for practical reasons.

Future research should also be directed towards the investigation of a 'safety' capacity strategy which deals with the progressive deterioration of machines. We believe that 'safety' capacity will be able to dampen some of the variability of machine capacity at the tactical level. For this reason, we need to further study the capacity cushion levels needed at the tactical level so that the realization of machine breakdowns can be resolved efficiently at the operational level. The relationship between this 'safety' capacity and the capacity cushion levels for demand uncertainty also needs to be examined. We believe that there is a shared risk between demand uncertainty and machine uncertainty that can be dealt with 'safety' capacity or system slack (see also Webster, 2008). Such research will lead to new ways of resolving other types of uncertainty. The development of new models that include other sources of uncertainty, such as supply lead times, delivery lead times and quality uncertainty can advance the study on uncertainty in supply chains as well as practical values for supply chain practitioners.

References

Aghezzaf, E. H., 2005. Capacity planning and warehouse location in supply chains with uncertain demands. Journal of the Operational Research Society 56 (4), 453–462.

Aghezzaf, E. H., 2008. Robust distribution planning for supplier-managed inventory agreements when demand rates and travel times are stationary. Journal of the Operational Research Society 59, 1055–1065.

Aghezzaf, E. H., Jamali, M., Ait-Kadi, D., 2007. An integrated production and preventive maintenance planning model. European Journal of Operational Research 181 (2), 679 – 685.

Aghezzaf, E. H., Najid, N., 2008. Integrated production planning and preventive maintenance in deteriorating production systems. Information Sciences 178, 679–685.

Aghezzaf, E. H., Sitompul, C., Najid, N., 2008. Integrated production and preventive maintenance in production systems subject to random failures. In: 7eme Conference Francophone de Modelisation et Simulation. Paris (France), pp. 1–8.

Aghezzaf, E. H., Sitompul, C., Najid, N., 2010. Models for robust tactical planning in multi stage production systems with uncertain demands. Computers and Operations Research 37 (5), 880–889.

Albers, S., Schmidt, G., 2001. Scheduling with unexpected machine breakdowns. Discrete Applied Mathematics 110, 85–99.

Alcaide, D., Rodriguez-Gonzales, A., Sicilia, J., 2002. An approach to solve the minimum expected makespan flow-shop problem subject to breakdowns. European Journal of Operational Research 140, 384–398.

Alcaide, D., Rodriguez-Gonzales, A., Sicilia, J., 2006. A heuristic approach to minimize expected makespan in open shops subject to stochastic processing times and failures. International Journal of Flexible Manfacturing Systems 17, 201–226.

Allaoui, H., Artiba, A., 2006. Scheduling two-stage hybrid flow shop with availability constraints. Computers and Operations Research 33, 1399–1419.

Anily, S., Federgruen, A., 1991. Capacitated two-stage multi-item production/inventory model with joint setup costs. Operations Research 39, 443 – 455.

Azaron, A., Brown, K. N., Tarim, S. A., Modarres, M., 2008. A multi-objective stochastic programming approach for supply chain design considering risk. International Journal of Production Economics 116, 129–138.

Bai, D., Carpenter, T., Mulvey, J. M., 1997. Making a case for robust optimization models. Management Science 43 (7), 895–907.

Barahona, F., Bermon, S., Gunluk, O., Hood, S., 2005. Robust capacity planning in semiconductor manufacturing. Naval Research Logistics 52, 459–468.

Barbarosoglu, G., Ozgur, D., 1999. A tabu search algorithm for the vehicle routing problem. COmputers and Operations Research 26, 255–270.

Barlow, R. E., Hunter, L. C., 1960. Optimum preventive maintenance policies. Operations Research 8, 90–100.

Bhagwat, R., Sharma, M., 2007. Performance measurement of supply chain management: a balanced scorecard approach. Computers and Industrial Engineering 53, 43–62.

Bitran, G. R., Haas, E., Hax, A. C., 1981. Hierarchical production planning: a single stage system. Operations Research 29 (4), 717–743.

Bitran, G. R., Haas, E., Hax, A. C., 1982. Hierarchical production planning: a two-stage system. Operations Research 30 (2), 232–251.

Bitran, G. R., Tirupati, D., 1993. Hierarchical production planning. In: Graves, S. C., Rinnooy Kan, A. H. G., Zipkin, P. (Eds.), Handbooks on Operations Research and Management Science. Vol. 4. North-Holland, Amsterdam, pp. 523–568.

Bonfill, A., Espuna, A., Puigjaner, L., 2008. Proactive approach to address the uncertainty in short-term scheduling. Computers and Chemical Engineering 32, 1689–1706.

Cakir, O., 2009. Benders decomposition applied to multi-commodity, multi-mode distribution planning. Expert Systems with Applications 36, 8212–8217.

Chakraborty, T., Giri, B. C., Chaudhuri, K. S., 2008. Production lot sizing with process deterioration and machine breakdown. European Journal of Operational Research 185, 606–618.

Chelby, A., Ait-Kadi, D., Radhoui, M., 2008. An integrated production and maintenance model for one failure prone machine-finite capacity buffer system for perishable products with constant demand. International Journal of Production Research 46 (19), 5427–5440.

Chen, C. L., Yuan, T. W., Lee, W. C., 2007. Multi-criteria fuzzy optimization for locating warehouses and distribution centers in a supply chain network. Journal of the Chinese Institute of Chemical Engineers 38, 393–407.

Chen, J., Chen, F., 2003. Adaptive scheduling in random flexible manufacturing systems subject to machine breakdowns. International Journal of PRoduction Research 41 (9), 1927–1951.

Cheng, L., Subrahmanian, E., Westerberg, A. W., 2004. Multi-objective decisions on capacity planning and production-inventory control under uncertainty. Industrial and Engineering Chemistry Research 43 (9), 2192–2208.

Cheung, R. K.-M., Powell, W. B., 1996. Models and algorithms for distribution problems with uncertain demands. Transportation Science 30 (1), 43–59.

Clark, A. J., Scarf, H., 1960. Optimal policies for a multi-echelon inventory problem. Management Science 6, 475 – 490.

Cochran, J., Ramanujam, B., 2006. Carrier-mode logistics optimization of inbound supply chains for electronics manufacturing. International Journal of Production Economics 103, 826–840.

Cohen, M.-A., Lee, H. L., 1988. Strategic analysis of integrated production-distribution systems: model and methods. Operations Research 36 (2), 216–228.

Crespo Marguez, A., Gupta, J. N. D., Sanchez Heguedas, A., 2003. Maintenance policies for a production system with constrained production rate and buffer capacity. International Journal of Production Research 41 (9), 1909–1926.

Dauzère-Péres, S., Lasserre, J. B., 1994. An integrated approach in production planning and scheduling. Lecture Notes in Economics and Mathematical Systems.

Dempster, M. A. H., 1982. A stochastic approach to hierarchical planning and scheduling. In: Dempster, M. A. H., Lenstra, J. K., Rinnooy Kan, A. H. G. (Eds.), Deterministic and Stochastic Scheduling. Reidel, Dordrecht, pp. 271–296.

Dempster, M. A. H., L., F. M., Jansen, L., Lageweg, B. J., Lenstra, J. K., Rinnooy Kan, A. H. G., 1983. Analysis of heuristics for stochastic programming: results for hierarchical scheduling problems. Mathematics of Operations Research 8, 525–537.

Dolgui, A., Levin, G., Louly, M.-A., 2005. Decomposition approach for a problem of lot-sizing and sequencing under uncertainties. International Journal of Computer Integrated Manufacturing 18 (5), 376–385.

Dolgui, A., Prodhon, C., 2007. Supply planning under uncertainties in mrp environments: a state of the art. Annual Reviews in Control 31, 269–279.

Dullaert, W., Vernimmen, B., Aghezzaf, E. H., Raa, B., 2007. Revisiting service-level measurement for an inventory system with different transport modes. Transport Review 27 (3), 273–283.

Federgruen, A., Zipkin, P., 1986a. An inventory model with limited production capacity and uncertain demand i: the average costs criterion. Mathematics of Operations Research 11, 193 – 207.

Federgruen, A., Zipkin, P., 1986b. An inventory model with limited production capacity and uncertain demand ii : the discounted costs criterion. Mathematics of Operations Research 1986 (11), 208 – 215.

Francas, D., Minner, S., 2009. Manufacturing network configuration in supply chains with product recovery. Omega 37, 757–769.

Frenk, J. B. G., Rinnooy Kan, A. H. G., Stougie, L., 1984. A hierarchical scheduling problem with a well-solvable second stage. Annals of Operations Research 1, 43–58.

Fukasawa, R., Longo, H., Lysgaard, J., Reis, M., Werneck, R., 2006. Robust branch-and-cut-and-price for the capacitated vehicle routing problem. Mathematical Programming 106, 491–511.

Galbraith, J., 1973. Designing complex organizations. Addison-Wesley, Reading, MA.

Geary, S., Childerhouse, P., Towill, D., 2002. Uncertainty and the seamless supply chain. Supply Chain Management Review 6 (4), 52–60.

Geng, N., Jiang, Z., Chen, F., 2009. Stochastic programming based capacity planning for semiconductor wafer fab with uncertain demand and capacity. European Journal of Operational Research 198, 899–908.

Gfrerer, H., Zäpfel, G., 1995. Hierarchical model for production planning in the case of uncertain demand. European Journal of Operational Research 86 (1), 142–161.

Ghezavati, V., Jabal-Ameli, M., Makui, A., 2009. A new heuristic method for distribution networks considering service level constraint and coverage radius. Expert Systems with Applications 36, 5620–5629.

Glasserman, P., Tayur, S., 1994. The stability of a capacitated, multi echelon production-inventory system under a base stock policy. Operations Research 42, 913 – 925.

Graves, S. C., 1982. Using lagrangian technique to solve hierarchical production planning problems. Management Science 28 (3), 260–275.

Graves, S. C., Willems, S. P., 2000. Optimizing strategic safety stock placement in supply chains. Manufacturing and Service Operations Management 2 (1), 68 – 83.

Groenevelt, H., Pintelon, L., Seidmann, A., 1992a. Production batching with machine breakdowns and safety stocks. Operations Research 40 (5), 959–971.

Groenevelt, H., Pintelon, L., Seidmann, A., 1992b. Production lot sizing with machine breakdowns. Management Science 38 (1), 104–123.

Guan, Y., Ahmed, S., Nemhauser, G. L., Miller, A. J., 2006. A branch and cut algorithm for the stochastic uncapacitated lot-sizing problem. Mathematical programming 105 (1), 55–84.

Gunasekaran, A., Kobu, B., 2007. Performance measures and metrics in logistics and supply chain management: a review of recent literature (1995-2004) for research and application. International Journal of Production Research 45 (12), 2819–2840.

Gupta, A., Maranas, C. D., 2003. Managing demand uncertainty in supply chain planning. Computers and Chemical Engineering 27, 1219–1227.

Haughton, M., 2002. Route reoptimization's impact on delivery efficiency. Transportation Research Part E 38, 52–63.

Hax, A. C., Meal, H. C., 1975. Hierarchical integration of production planning and scheduling. In: Geisler, M. A. (Ed.), Studies in Management Sciences. Vol. 1. Elsevier, New York, pp. 53–69.

Huchzermeier, A., Cohen, M. A., 1996. Valuing operational flexibility under exchange rate risk. Operations Research Letters 44 (1), 100–113.

Jia, C., 2001. Stochastic single machine scheduling with an exponentially distributed due date. Operations Research Letters 28, 199–203.

Kallrath, J., 2005. Solving planning and design problems in the process industry using mixed integer and global optimization. Annals of Operations Research 140, 339–373.

Kasap, N., Aytug, H., Paul, A., 2006. Minimizing makespan on a single machine subject to random breakdowns. Operations Research Letters 34, 29–36.

Kaut, M., Wallace, S. W., 2007. Evaluation of scenario-generation methods for stochastic programming. Pacific Journal of Optimization 3 (2), 257 – 271.

Kenne, J. P., Gharbi, A., Beit, M., 2007. Age-dependent production planning and maintenance strategies in unreliable manufacturing systems with lost sale. European Journal of Operational Research 178, 408–420.

Kira, D., Kusy, M., Rakita, I., 1997. A stochastic linear programming approach to hierarchical production planning. Journal of the Operational Research Society 48, 207–211.

Kubiak, W., Blazewicz, J., Formanowicz, P., Breit, J., Schmidt, G., 2002. Two-machine flow shops with limited machine availability. European Journal of Operational Research 136, 528–540.

Laguna, M., 1998. Applying robust optimization to capacity expansion for one location in telecommunications with demand uncertainty. Management Science 44 (11), 101–110.

Lasserre, J. B., Mercé, C., 1990. Robust hierarchical production planning under uncertainty. Annals of Operations Research 26, 73–87.

Lesnaia, E., Vasilescu, I., Graves, S. C., 2004. The complexity of safety stock placement in general-network supply chains. Tech. rep., Innovation in Manufacturing Systems and Technology (IMST), Massachussetts Insitute of Technology.

Leung, S. C. H., Tsang, S. O. S., Ng, W. L., Wu, Y., 2007. A robust optimization model for multi-site production planning problem in an uncertain environment. European Journal of Operational Research 181 (1), 224–238.

Leung, S. C. H., Wu, Y., 2004. A robust optimization model for stochastic aggregate planning. Production Planning and Control 15 (5), 502–514.

Leus, R., Herroelen, W., 2005. The complexity of machine scheduling for stability with a single disrupted job. Operations Research Letters 33, 151–156.

Li, W., Cao, J., 1995. Stochastic scheduling on a single machine subject to multiple breakdowns according to different probabilities. Operations Research Letters 18, 81–91.

Li, W., Glazebrook, K. D., 1998. On stochastic machine scheduling with general distributional assumptions. European Journal of Operational Research 105, 525–536.

Li, Y., Huang, G., Nie, X., Nie, S., 2008. A two-stage fuzzy robust integer programming approach for capacity planning of environmental management systems. European Journal of Operational Research 189, 399–420.

Li, Z., Ierapetritou, M. G., 2008. Robust optimization for process scheduling under uncertainty. Industrial and Engineering Chemistry Research 47, 4148–4157.

Liao, C., Chen, W., 2004. Scheduling under machine breakdown in a continuous process industry. Computers and Operations Research 31, 415–428.

Liberatore, M. J., Miller, T., 1985. A hierarchical production planning system. Interfaces 14, 1–11.

Lim, S. J., Jeong, S. J., Kim, K. S., Park, M. W., 2006. Hybrid approach to distribution planning reflecting a stochastic supply chain. International Journal of Advanced Manufacturing Technology 28 (5), 618–625.

Lin, G. C., Kroll, D. E., 2006. Economic lot sizing for an imperfect production system subject to random breakdowns. Engineering Optimization 38 (1), 73–92.

List, G. F., Wood, B., Nozick, L. K., Turnquist, M., Jones, D. A., Kjeldgaard, E. A., Lawton, C. R., 2003. Robust optimization for fleet planning under uncertainty. Transportation Research Part E 39, 209–227.

Liu, L., Gu, H.-Y., Xi, Y.-G., 2007. Robust and stable scheduling of a single machine with random machine breakdowns. International Journal of Advanced Manufacturing Technology 31, 645–654.

Lodree, E., Jang, W., Klein, C. M., 2004. Minimizing response time in a two-stage supply chain system with variable lead time and stochastic demand. International Journal of Production Research 42 (11), 2263–2279.

Lusa, A., Corominas, A., Munoz, N., 2008. A multistage scenario optimisation procedure to plan annualised working hours under demand uncertainty. International Journal of Production Economics 113, 957–968.

Magnanti, T. L., Shen, Z. J, M., Simchi-Levi, D., Teo, C. P., 2006. Inventory placement in acyclic supply chain. Operations Research Letters 34, 228–238.

Malcom, S. A., Zenios, S. A., 1994. Robust optimization of power systems capacity expansion under uncertainty. Journal of the Operational Research Society 45, 1040–1049.

Mapes, J., 1992. The effect of capacity limitations on safety stock. International Journal of Operations and Production Management 13, 26 – 33.

Mehta, S., Uzsoy, R., 1999. Predictable scheduling of a single machine subject to breakdowns. International Journal of Computer Integrated Manufacturing 12 (1), 15–38.

Melo, M. T., Nickel, S., Saldanha-da Gama, F., 2009. Facility location and supply chain management - a review. European Journal of Operational Research 196, 401–412.

Miller, E., Roorda, M., Carrasco, J., 2005. A tour-based model of travel mode choice. Transportation 32, 399–422.

Mula, J., Poler, R., Garcia-Sabater, J. P., Lario, F. C., 2006. Models for production planning under uncertainty. International Journal of Production Economics 103 (1), 271–285.

Mulvey, J. M., Vanderbei, R. J., Zenios, S. A., 1995. Robust optimization of large scale systems. Operations Research 43 (2), 264–281.

Raa, B., Aghezzaf, E. H., 2005. A robust dynamic planning strategy for lot-sizing problem with stochastic demands. Journal of Intelligent Manufacturing 16 (2), 207–247.

Raa, B., Aghezzaf, E. H., 2009. A practical solution approach for the cyclic inventory routing problem. European Journal of Operational Research 192, 429–441.

Rosenblatt, M. J., Lee, H. L., 1987. A robustness approach to facilities design. International Journal of Production Research 25 (4), 479–486.

Roundy, R. O., Muckstadt, J. A., 2000. Heuristic computation of periodic-review base stock inventory policies. Management Science 46, 104 – 109.

Roux, W., Dauzère-Péres, S., Lasserre, J. B., 1999. Planning and scheduling in a multi-site environment. Production Planning and Control 10, 19–28.

Schmidt, G., 2000. Scheduling with limited machine availability. European Journal of Operational Research 121, 1–15.

Sethi, S. P., Yan, H., Zang, Q., 2002. Optimal and hierarchical controls in dynamic stochastic manufacturing systems: a survey. Manufacturing and Service Operations Management 4, 133–170.

Shapiro, J. F., 2001. Modeling the supply chain. Duxbury, Pacific Grove, CA.

Shu, J., Karimi, I. A., 2009. Efficient heuristics for inventory placement in acyclic networks. Computers and Operations Research 36, 2899–2904.

Simpson, K. F., 1958. In-process inventory. Operations Research 6, 863 – 873.

Sitompul, C., Aghezzaf, E. H., 2008. Robust production planning: an alternative to scenario based optimization model. In: Le Thi, H. A., Bouvry, P., Pham, D. (Eds.), Modelling, Computation and Optimization in Information Systems and Management Sciences. Vol. 14 of Communications in Computer and Information Science. Springer, Metz, France, pp. 328–337.

Sitompul, C., Aghezzaf, E. H., Van Landeghem, H., Dullaert, W., 2008. Safety stock placement problems in capacitated suply chains. International Journal of Production Research 46, 4709–4727.

Sounderpandian, J., Prasad, S., Madan, M., 2008. Supplies from developing countries: optimal order quantitites under loss risks. Omega 36, 122–130.

Srinivasan, K., Bhargavi, P., 2007. Longer-term changes in mode choice decisions in chennai: a comparison between cross-sectional and dynamic models. Transportation 34, 355–374.

Sungur, I., Ordonez, F., Dessouky, M., 2008. A robust optimization approach for the capacitated vehicle routing problem with demand uncertainty. IIE Transactions 70, 509–523.

Tan, K. C., Cheong, C., Goh, C., 2007. Solving multiobjective vehicle routing problem with stochastic demand via evolutionary computation. European Journal of Operational Research 177, 819–839.

Tayur, S., Ganeshan, R., Magazine, M. (Eds.), 1999. Quantitative models for supply chain management. Kluwer Academic, Norwell, Massachussets.

Thompson, S. D., Davis, W. J., 1990. An integrated approach for modeling uncertainty in aggregate production planning. IEEE Transactions on Systems, Man and Cybernetics 20, 1000–1012.

Thompson, S. D., Watanabe, D. T., Davis, W. J., 1993. A comparative study of aggregate production planning strategies under conditions of uncertainty and cyclic product demands. International Journal of Production Research 31, 1957–1979.

Van den broecke, F., Aghezzaf, E. H., Van Landeghem, H., 2008. Cyclical volume planning and fair share mix decisions, delivery a more robust service level. Production Planning and Control 19 (7), 668–676.

Van Landeghem, H., Vanmaele, H., 2002. Robust planning: a new paradigm for demand chain planning. Journal of Operations Management 20, 769–783.

Vidal, C. J., Goetschalckx, M., 2000. Modeling the effect of uncertainties on global logistic systems. Journal of Business Logistics 21 (1), 95–120.

Wang, G., Huang, S., Dismukes, J., 2005. Manufacturing supply chain design and evaluation. International Journal of Advanced Manufacturing Technology 25, 93–100.

Wang, J., Shu, Y. F., 2007. A probabilistic decision model for new product supply chain design. European Journal Of Operational Research 177, 1044–1061.

Webster, S., 2008. Principles and tools for supply chain management. McGraw-Hill/Irwin, Boston (Massachusetts).

Weinstein, L., Chung, C. H., 1999. Integrating maintenance and production decisions in a hierarchical production planning environment. Computers and Operations Research 26, 1059–1074.

Wu, D., Olson, D., 2008. Supply chain risk, simulation, and vendor selection. International Journal of Production Economics 114, 646–655.

Xia, Y., Chen, B., Yue, J., 2008. Job sequencing and due date assignment in a single machine shop with uncertain processing times. European Journal of Operational Research 184, 63–75.

Yano, C. A., Lee, H. L., 1995. Lot sizing with random yields: a review. Operations Research 43, 311–334.

You, F., Grosmann, I. E., 2008. Mixed-integer nonlinear programming models and algorithms for large-scale supply chain design with stochastic inventory management. Industrial and Engineering Chemistry Research 47, 7802–7817.

You, F., Grossmann, I. E., 2008. Design of responsive supply chains under demand uncertainty. Computers and Chemical Engineering 32, 3090–3111.

Yu, C. S., Li, H.-L., 2000. A robust optimization model for stochastic logistic problems. International Journal of Production Economics 64 (385-397).

Yu, G., 1997. Robust economic order quantity models. European Journal of Operational Research 100, 482–493.

Zäpfel, G., 1998. Customer-order-driven production: an economical concept for responding to demand uncertainty? International Journal of Production Economics 56-57, 699–709.