II International Conference on Industrial Engineering and Industrial Management
XII Congreso de Ingeniería de Organización
September 3-5, 2008, Burgos, Spain

ELSP Variants: A review

Pilar I. Vidal Carreras[1], José P. García-Sabater[1], Juan A. Marín-García[1], Julio J. García-Sabater[1]

[1] ROGLE. Departamento de de Organización de Empresas. Universidad Politécnica de Valencia. Camino de Vera, s/n 46022. Valencia. pivicar@omp.upv.es , jpgarcia@omp.upv.es, jamarin@omp.upv.es, jugarsa@omp.upv.es

Keywords: Economic Lot Scheduling Problems, Variants, Classification Scheme

1. Introduction

The Economic Lot Scheduling Problem (ELSP) is defined as the problem of finding the production sequence, production times and idles times of several products in a single facility on a repetitive basis. So that, the demands are made without stockouts and average inventory holding and setup cost are minimized. This problem has been studied in the literature for around 50 years (Eilon (1957) and Rogers (1958)). A comprehensive review on the ELSP until the late seventies can be found in Elmaghraby (1978) who divides approaches into two categories; analytical approaches that achieve the optimum for a restricted version of the original problem; and heuristic approaches that achieve ‘‘good’’ solutions for the original problem.. Because of its nonlinearity, combinatorial characteristics, and complexity, the ELSP is generally known as a NP-hard problem (Hsu 1983, Gallego and Shaw 1997). According to Boctor (1987) the problem could occur in many situations, such as molding and stamping operations, bottling, metal forming, and plastic production lines (press lines, plastic and metal extrusion machines), weaving production lines (for textiles, carpets), , paper production, etc. However, in practical situations is common that some characteristics of the classical ELSP, appears modified. For that, some researchers investigated around the years, different variants of this problem. In this paper we pretend to review these ELSP variants, and classify them according to the ELSP characteristic which is modified. The motivation of this work is to identify ELSP researched variants to provide the reader a complete vision of them, and a starting point for distinguish other variants, in despite of being common in practice, are not addressed in the literature. So, the objective of this paper is to (i) review the literature, (ii) classify the literature based on the modifications of the classical ELSP characteristics.

2. Classification scheme for ELSP variants

Table 1 illustrates a classification scheme for literature review on ELSP variants. This classification is based in three aspects: (i) the classical ELSP characteristic which is violated (ii) the research topic related to it and (iii) the concrete variants which are treated. Due to restrictions in the number of pages of the complete article, most relevant variants are extended, leaving these for posterior articles research topics as the number of stages, the number of machines, the characteristics of planning horizon and the stock.

Table 3. Classification scheme for ELSP variants

ELSP Characteristics	Research Topic	Variants Investigated
1. Product production rates are deterministic and constant	Production Rates	Rigid Approach Flexible Approach
2. Product setup costs and times are independent of production order	Setup Estructure	Simple Complex
3. Product demand rates are deterministic and constant	Demand type	Static demand: deterministic and dynamic Stochastich demand: deterministic and dynamic
4. Demand must be met in the periods in which occur.	Inventory shortage	BackOrders Lost sales
5. Production capacity is sufficient to meet total demand	Capacity Restrictions	Insufficient capacity Capacited System
6. Items Standard	Items Characteristics	MTO - MTS Imperfect quality

3. Production Rates

In this section we analyzed situations in which, production rates are not deterministic and constant, specifically they are a variable which can be chose in the problem. Traditionally, the speed of processing (production rate) was chosen according to the capacity (ability) of the machine (we will denote this rate by the term “nominal rate”). However, acording to Eynan (2003) in recent years it was suggested that when machines are underutilized further cost reductions can be obtained by slowing down the production rate and taking up the idle time (slack). Two approaches to reduce the production rate are available: (i) the “rigid” approach in which a slower production rate (than the nominal rate) can be used, but once such a rate has been selected it cannot be altered during an item’s production run; or (ii) the “flexible” approach which allows firms to modify the production rate during a run.

3.1. Rigid Approach

Buzacott and Ozkarahan (1983) and Silver (1990) used the rigid approach to demonstrate the cost savings associated with reduced production rates. They showed that the production rate of only one item should be reduced while all other items should be produced at their nominal rates. Moon and Christy (1998) studied the rigid approach where production rates also have lower limits (in addition to their upper limits). They also considered a mold cost that increases with increasing production rates. Khouja (1999) analyzed the rigid approach with imperfect quality where the quality level deteriorates with increased lot size and product rates. In Khouja (1997) is provided a similar extension for systems with high utilization. Eiamkanchanalai and Banerjee (1999) suggest that the production cost per unit is a quadratic function of the production rate, in an effort to capture the effect of.

3.2. Flexible Approach

Volume flexibility in Sheti and Sheti (1990) is defined as the capability to operate profitably at different output levels. Allen (1990) modified the ELSP to allow production rates to be decision variables. He developed a graphical method for finding the production rates and cycle times for a two-product problem. Moon et al. (1991) analyzed the flexible approach using Karush-Kuhn-Tucker conditions and presented an iterative solution procedure. Gallego (1993) developed a simple algorithm based on a sharp lower bound, has derived procedures for solving the ELSP with reduced production rates for rigid and flexible case to a single item. In works of Moon et al. (1991), Gallego (1993) and Elhafsi and Bai (1997), they ignore any production cost and therefore, when manufacturing of an item one should start producing synchronously with the demand rate an then at a certain moment increase the production rate to its maximum level. In Eynan (2003) the flexible approach using a cyclic schedule is investigated. Employing marginal analysis generates new insight and properties regarding the optimal solution as well as a simple procedure for its isolation. The cost associated with the flexible approach is compared to the rigid approach and the traditional approach (where all items are produced at their nominal rates), to demonstrate the potential savings. Khouja and Mehrez (1994) have considered variable production rates they extended the classical production model to the case where the production rate is a decision variable and the production process is imperfect, assuming that a demand is continuous. AlFawzan and AlSultan (1997) extended the model of Jamal and Sarker (1993) to the case the production rate is a decision variable. They developed two mathematical models considering allowance or not of shortages, and supposing the demand is discrete. In Giri et al. (2005) the economic production quantity problem (EPQ) of Khouja and Mehrez (1994) has been put forth from a different point of view. It is considered as an EMQ problem with stochastic machine breakdown and repair.

4. Setup Structure

Setup structure is another important characteristic that directly affects problem complexity. Setup costs and/or setup times, are usually modelled by introducing zero–one variables in the mathematical model of the problem and cause problem solving to be more difficult. Usually, production changeover between different products can incur setup time and setup cost. There are two types of setup structure according to Karimi et al. (2003), simple setup structure and complex setup structure. If the setup time and cost in a period are independent of the sequence and the decisions in previous periods, it is termed a simple setup structure, but when it is dependent on the sequence or previous periods, it is termed a complex setup. In classical ELSP, simple setup cost structure is supposed, so in the next section important references for complex setup structure are provided.

4.1. Complex setup structure

According Lopez and Kingsman (1991) in basic period and extended basic period ELSP approaches, the only possible option to incorporate sequence dependent setups is to use an average value for each product in the beginning to decide on the production frequencies. These production frequencies are then used to create an initial production schedule which is then modified using the sequence dependent setup time data. This problem is a Travelling Salesman Problem with sub-tours. However in the common cycle approach (method which results in a solution where the cycle times for each product are the same and each product is produced exactly once during the cycle), no constraint on the order in which products are produced is imposed. We can thus first attempt to produce a sequence of products that minimises the total setup time required in the cycle. These values can then be used in the calculation of the optimal cycle time. Maxwell (1964) considered the ELSP with sequence-dependent setups having setup costs proportional to the setup time. He further restricted the problem to cyclical schedules with no idle time. With these assumptions he showed that setup cost per unit time was a constant and could be ignored in determining a schedule. Adding the zero-switch rule (requiring the inventory of a product to be zero before production starts), he developed the best-product-in- best-position heuristic. Dobson (1992) considered the ELSP model with sequence-dependent setups. Through transformations and relaxations of the problem, Dobson developed a model that could solve for production frequencies. With the production frequencies determined, a sequencing and timing heuristic procedure was used to determine the production sequence, production cycle time and production and idle times. In Oh and Karimi (2001) a methodology for solving the single machine ELSP with sequence-dependent setups and a given planning horizon are presented. It's important to note that it works equally well on problems with sequence-independent setups. Wagner and Davis (2002) propose a heuristic procedure to solve the sequence-dependent ELSP problem using the cyclic schedule (CS) approach Hanssmann, (1962) to build up the production sequence similar to Delporte and Thomas (1977) and Maxwell (1964). They use a search procedure to determine the production sequence and evaluate the sequences using a nonlinear program to exactly determine the optimal schedule given a production sequence, solving for production quantities, inventory levels, production starting and ending times and the cycle time. In Alle et al. (2004) are proposed a mathematical programming model for the economic lot scheduling problem (ELSP) with performance decay.

5. Demand Type

Demand type is considered as an input to the model of the problem. Static demand means that its value does not change over time, it is stationary or even constant, while dynamic or variable demand means that its value changes over time. If the value of demand is known in advance (static or dynamic), it is termed deterministic, but if it is not known exactly and the demand values occurring are based on some probabilities, then it is termed probabilistic or stochastic.

5.1. Static demand

Classical models for ELSP are based on an assumption of deterministic static demands. In this section we consider references which demand different than this.

Static demand dynamic

We appear heuristic solution techniques for this kind of demand in Dixon and Silver (1982), Dogramaci et al. (1981), Newson (1975b), Newson (1975a), and Vannunen and Wessels (1978) among others. An optimal dynamic programming solution technique for the case when holding cost are a function of aggregate inventory and there are changeover costs in lieu of setup costs was developed by Leachman et al. (1991), building on the work of Glassey (1968).

5.2. Stochastic demand

Most of the existing models for ELSP are based on an assumption of deterministic demands. In many practical applications uncertainty of demand is a complicating factor, since demand rates for goods and services can vary greatly. Sox et al. (1999) investigate the research literature on the stochastic lot scheduling problem (SELSP), defined as the problem of scheduling production of multiple items, each with random demand, on a single facility that has limited production capacity and significant setups between items. They conclude that the deterministic version of the problem is investigated extensively within the literature, whereas the stochastic problem is not as investigated.

Stationary stochastic demand

Vergin and Lee (1978) were the first to propose and test dynamic scheduling policies based on feedback of inventory levels. They considered the case of stationary demands and simulated the performance of six different policies. The simulations performed by Vergin and Lee demonstrated that policies which consider current inventory levels in making scheduling decisions outperform policies whose schedules are based solely on the solutions of an ELSP (deterministic model). Graves (1980) also developed a dynamic scheduling policy for the case of stationary, stochastic demands. In Grave's approach, $2^n - n - 1$ one-item Markov decision problems must be solved to establish the control parameters for n items. Other references are, Gallego (1990), Bourland and Yano (1997) , and Gascon et al. (1994) and Kelle et al. (1994). Most recently, in paper of Brander et al. (2005) is examined if a deterministic model can be used if demand is stationary stochastic. Their conclusion is that a deterministic model of this kind can be used in a practical situation where the demand rate is stationary stochastic, but the models must be complemented by a decision rule; which item to produce and when to produce it. This study indicates that the model used for determination of lot sizes is of less importance than the decision rule used for identification of the item to produce and when to produce it.

Dynamic stochastic demand

Stochastic demand also can be dynamic, in case its value changes over time. Wagner and Whitin (1958) were the first to deal with the single product, single machine case with dynamic demands. They used dynamic programming to find the optimal solution but they assumed that production is instantaneous and that machine capacity is unlimited. Leachman and Gascon (1988) developed a heuristic procedure based on ELSP using target cycles combined with a continuous adjustment of production cycles. Their goal was to adequately space inventory runout times in order to balance the effect of random demand changes. Goncalves et al. (1994) also addressed the single-stage problem but with several machines. They considered demands are stochastic and time-varying and they use a nonlinear integer optimization model to allocate items to machines and schedule production quantities for the next time period. Although several authors have dealt with the uncapacitated version of this multi-stage problem (see the review by Ouenniche and Boctor (1998) very few contributions deal with the capacitated version. Boctor and Poulin (2005) which solve multi-product, multi-stage dynamic-demand lot sizing and scheduling problem.

6. Inventory Shortage

Attending not to fulfil the classical condition of ELSP that demand must be met in the periods in which occur, inventory shortage is provided. When shortage is allowed it is possible to satisfy the demand of the current period in future periods (backlogging or backorder case), or it may be allowable for demand not to be satisfied at all (lost sales case). Gallego and Roundy (1992) extended the time-varying lot sizes approach to the ELSP which allows backorders. Gallego and Shaw (1997) showed that the ELSP is strongly NP-hard under the time-varying lot sizes approach, giving theoretical justification of the development of the heuristics. Some of the models that allow for backordering of unmet demand can be found in Dodin (1984), Dodin (1985), Altiok and Shiue (1994), Gupta (1992), and Gallego and Roundy (1992) extended the tyme-varying sizes approach with allows backorders.

7. Capacity Restrictions

We can state that classical ELSP is uncapacited because is supposed that is no restriction on resources, because production capacity is high enough to meet the demand of all items independently backorders are allowed or not. If capacity constraints are explicitly stated, the problem is named capacitated. A reference in this subject is Goyal and Gopalakrishnan (1996), they not only considered insufficient capacity, but that consumption begins only after a batch is completely produced. Consequently, demand cannot be fully met and shortages will occur. Unfortunately, their model deals with just a single product. Gallego and Moon (1996) analyze the ELSP when there is insufficient capacity over a finite planning horizon, which they refer to as a transition period. Transition periods are used to model temporarily overloaded facilities that will eventually catch up with demand. Khoury et al. (2001) study the two-product problem (facility that can produce two different products, but does not have sufficient capacity to meet demand of both products), using common cycle approach under deterministic conditions, and then discuss a special extension that treats any number of products. We can find a complete review of models and algorithms of capacitated lot sizing problem in Karimi et al. (2003).

8. Item Characteristics

8.1. Make to order or Make to Stock

In ELSP is supposed product is make to stock. However in many industries, like food processing industries, the product variety is very large and contains a mix of make-to-order (MTO) and make-to-stock (MTS) products (see Soman et al. (2004) We can find a first studies on combined MTO–MTS production system is in Williams (1984). In which the way of estimating the waiting time for the availability of the capacity for the individual products using approximation to M/G/m queue is provided, which aids in choosing the batch sizes for MTS and to determine the probability with which the orders for MTO products satisfy the quoted lead-time. Rajagopalan (2002) addresses a similar problem. He provides a heuristic procedure to solve a non-linear, integer programming formulation of the problem that determines the MTO–MTS partition and the batch sizes for the MTS items. He, unlike Williams (1984) allows low demand items to follow the MTS strategy. Federgruen and Katalan (1999) address a variety of strategic questions—the number and types of products that should be manufactured to stock or to order, the effects of adding low volume specialized items to a given product line on the stock system.

8.2. Imperfect quality

Owing to aging, many production processes deteriorate from “in-control” state to “out-of-control” state and produce defective items. Ben-Daya and Hariga (2000) studied the effects of imperfect production processes on the ELSP. They assumed negligible setup times for the products and developed a mathematical model under the common cycle approach taking into account the effect of imperfect quality and process restoration. If significant time is required to set up the machine, then their analysis is incomplete because the frequency of setup may impose time requirements which would exceed the time available. Giri et al. (2003) consider the ELSP with imperfect production processes, where the process shift distribution is normal and positive setup time is required for machine setup. The normal distribution has an increasing hazard function that begins to increase rapidly near but before the point of median life. Other important references are Moon et al. (2002) in where the mathematical models are developed for the ELSP using both the common cycle approach and the time-varying lot sizes approach, taking into account the effects of imperfect quality and process restoration. Ben-Daya and Hariga (2000) studied the effect of imperfect production processes. They developed mathematical models for the ELSP taking into account the effects of imperfect quality and process inspection during the production run so that the shift to an out-control.

9. Conclusions

Through the review of the bibliography we intended to provide the reader a starting point for investigating possible variants of the ELSP, in despite of being common, in practice are not addressed in the literature.

References

AlFawzan, M.A.; AlSultan, K.S. (1997). "Economic production quantity for a manufacturing system with a controllable production rate". *Production Planning & Control*, 8(7):678-685.

Alle, A.; Pinto, J.M.; Papageorgiou, L.G. (2004). "The economic lot scheduling problem under performance decay". *Industrial & Engineering Chemistry Research*, 43(20):6463-6475.

Allen, S.J. (1990). "Production rate planning for two products sharing a single process facility: a real world case study". *Production and Inventory Management*, 31:24-29.

Altiok, T.; Shiue, G.A. (1994). "Single-Stage, Multiproduct Production Inventory Systems with Backorders". *IIE Transactions*, 26(2):52-61.

Ben-Daya, M.; Hariga, M. (2000). "Economic lot scheduling problem with imperfect production processes". *Journal of the Operational Research Society*, 51(7):875-881.

Boctor, F.F. (1987). "The G-Group Heuristic for Single-Machine Lot Scheduling". *International Journal of Production Research*, 25(3):363-379.

Boctor, F.F.; Poulin, P. (2005). "Heuristics for the N-product, M-stage, economic lot sizing and scheduling problem with dynamic demand". *International Journal of Production Research*, 43(13):2809-2828.

Bourland, K.E.; Yano, C.A. (1997). "A comparison of solution approaches for the fixed-sequence economic lot scheduling problem". *IIE Transactions*, 29(2):103-108.

Brander, P.; Leven, E.; Segerstedt, A. (2005). "Lot sizes in a capacity constrained facility - a simulation study of stationary stochastic demand". *International Journal of Production Economics*, 93-94:375-386.

Buzacott, J.A.; Ozkarahan, I.A. (1983). "One and two stage scheduling of two products with distributed inserted idle time: the benefits of a controllable production rate". *Naval Research Logistics Quarterly*, 30:675-696.

Delporte, C.M.; Thomas, L.J. (1977). "Lot Sizing and Sequencing for N-Products on One Facility". *Management Science*, 23(10):1070-1079.

Dixon, P.S.; Silver, E.A. (1982). "A heuristic for the multi-item, single-level, limited capacity, lot-sizing problem". *Journal of Operations Management*, 2:23-29.

Dodin, B. (1984). "Scheduling N-Products on A Single Facility with Back-Ordering and Fixed Terminal Inventory". *Infor*, 22(4):317-342.

Dodin, B. (1985). "Scheduling N-Products on A Single Facility with Allowed Backordering". *International Journal of Production Research*, 23(2):329-344.

Dogramaci, A.; Panayiotopoulos, J.C.; Adam, N.R. (1981). "The Dynamic Lot-Sizing Problem for Multiple Items Under Limited Capacity". *AIIE transactions*, 13(4):294-303.

Eiamkanchanalai, S.; Banerjee, A. (1999). "Production lot sizing with variable production rate and explicit idle capacity cost". *International Journal of Production Economics*, 59(1-3):251-259.

Eilon, S. (1957). "Scheduling for batch production". *Journal of Institute of Production Engineering*, 36:549-579.

Elhafsi, M.; Bai, S.X. (1997). "The common cycle economic lot scheduling problem with backorders: Benefits of controllable production rates". *Journal of Global Optimization*, 10(3):283-303.

Elmaghraby, S.E. (1978). "The economic lot scheduling problem (ELSP): Review and extensions". *Management Science*, 24(6):587-598.

Eynan, A. (2003). "The benefits of flexible production rates in the economic lot scheduling problem". *IIE Transactions*, 35(11):1057-1064.

Federgruen, A.; Katalan, Z. (1999). "The impact of adding a make-to-order item to a make-to-stock production system". *Management Science*, 45(7):980-994.

Gallego, G. (1990). "Scheduling the Production of Several Items with Random Demands in A Single Facility". *Management Science*, 36(12):1579-1592.

Gallego, G. (1993). "Reduced Production-Rates in the Economic Lot Scheduling Problem". *International Journal of Production Research*, 31(5):1035-1046.

Gallego, G.; Moon, I. (1996). "How to avoid stockouts when producing several items on a single facility? What to do if you can't?" *Computers & Operations Research*, 23(1):1-12.

Gallego, G.; Roundy, R. (1992). "The Economic Lot Scheduling Problem with Finite Backorder Costs". *Naval Research Logistics*, 39(5):729-739.

Gallego, G.; Shaw, D.X. (1997). "Complexity of the ELSP with general cyclic schedules". *IIE Transactions*, 29(2):109-113.

Gascon, A.; Leachman, R.C.; Lefrancois, F. (1994). "Multi-item, single-machine scheduling problem with stochastic demands: a comparison of heuristics". *International Journal of Production Research*, 32(3):583-596.

Giri, B.C.; Moon, I.; Yun, W.Y. (2003). "Scheduling economic lot sizes in deteriorating production systems". *Naval Research Logistics*, 50(6):650-661.

Giri, B.C.; Yun, W.Y.; Dohi, T. (2005). "Optimal design of unreliable production-inventory systems with variable production rate". *European Journal of Operational Research*, 162(2):372-386.

Glassey, C.R. (1968). "Minimum Change-Over Scheduling of Several Products on 1 Machine". *Operations Research*, 16(2):342- .

Goncalves, J.F.; Leachman, R.C.; Gascon, A.; Xiong, Z.K. (1994). "A Heuristic Scheduling Policy for Multiitem, Multimachine Production Systems with Time-Varying, Stochastic Demands". *Management Science*, 40(11):1455-1468.

Goyal, S.K.; Gopalakrishnan, M. (1996). "Production lot sizing model with insufficient production capacity". *Production Planning & Control*, 7(2):222-224.

Graves, S.C. (1980). "The Multi-Product Production Cycling Problem". *AIIE transactions*, 12:233-240.

Gupta, D. (1992). "On the Economic Lot Scheduling Problem with Backlogging - the Common Cycle Approach". *Operations Research Letters*, 12(2):101-109.

Hanssmann, F., (1962). *Operations-Research in Production and Inventory Control*. Willey. New York

Jamal, A.M.M.; Sarker, B.R. (1993). "An Optimal Batch Size for A Production System Operating Under A Just-In-Time Delivery System". *International Journal of Production Economics*, 32(2):255-260.

Karimi, B.; Ghomi, S.M.T.F.; Wilson, J.M. (2003). "The capacitated lot sizing problem: a review of models and algorithms". *Omega-International Journal of Management Science*, 31(5):365-378.

Kelle, P.; Clendenen, G.; Dardeau, P. (1994). "Economic Lot Scheduling Heuristic for Random Demands". *International Journal of Production Economics*, 35(1-3):337-342.

Khouja, M. (1997). "The scheduling of economic lot sizes on volume flexible production systems". *International Journal of Production Economics*, 48(1):73-86.

Khouja, M. (1999). "A note on 'deliberately slowing down output in a family production context'". *International Journal of Production Research*, 37(17):4067-4077.

Khouja, M.; Mehrez, A. (1994). "Economic Production Lot-Size Model with Variable Production-Rate and Imperfect Quality". *Journal of the Operational Research Society*, 45(12):1405-1417.

Khoury, B.N.; Abboud, N.E.; Tannous, M.M. (2001). "The common cycle approach to the ELSP problem with insufficient capacity". *International Journal of Production Economics*, 73(2):189-199.

Leachman, R.C.; Gascon, A. (1988). "A Heuristic Scheduling Policy for Multi-Item, Single-Machine Production Systems with Time-Varying, Stochastic Demands". *Management Science*, 34(3):377-390.

Leachman, R.C.; Xiong, Z.K.; Gascon, A.; Park, K. (1991). "Note - An Improvement to the Dynamic Cycle Lengths Heuristic for Scheduling the Multiitem, Single-Machine". *Management Science*, 37(9):1201-1205.

Maxwell, W.L. (1964). "Scheduling of Economic Lot Sizes". *Naval Research Logistics Quarterly*, 11(2-3):89- .

Moon, D.H.; Christy, D.P. (1998). "Determination of optimal production rates on a single facility with dependent mold lifespan". *International Journal of Production Economics*, 54(1):29-40.

Moon, I.; Gallego, G.; Simchilevi, D. (1991). Controllable Production-Rates in A Family Production Context. International Journal of Production Research, Vol. 29, No.12, pp. 2459-2470.

Moon, I.; Giri, B.; Choi, K. (2002). Economic lot scheduling problem with imperfect production processes and setup times. Journal of the Operational Research Society, Vol. 53, No.6, pp. 620-629.

Newson, E.F.P. (1975a). Multi-Item Lot Size Scheduling by Heuristic .1. with Fixed Resources. Management Science Series B-Application, Vol. 21, No.10, pp. 1186-1193.

Newson, E.F.P. (1975b). Multi-Item Lot Size Scheduling by Heuristic .2. with Variable Resources. Management Science Series B-Application, Vol. 21, No.10, pp. 1194-1203.

Oh, H.C.; Karimi, I.A. (2001). Planning production on a single processor with sequence-dependent setups part 1: determination of campaigns. Computers & Chemical Engineering, Vol. 25, No.7-8, pp. 1021-1030.

Ouenniche, J.; Boctor, F. (1998). Sequencing, lot sizing and scheduling of several products in job shops: the common cycle approach. International Journal of Production Research, Vol. 36, No.4, pp. 1125-1140.

Rajagopalan, S. (2002). Make to order or make to stock: Model and application. Management Science, Vol. 48, No.2, pp. 241-256.

Rogers, J. (1958). A Computational Approach to the Economic Lot Scheduling Problem. Management Science, Vol. 4, No.3, pp. 264-291.

Sheti, A.K.; Sheti, S.P. (1990). Flexibility in Manufacturing: A survey. International Journal of Flexible Manufacturing Systems, Vol. 2, No.4, pp. 289-328.

Silver, E.A. (1990). Deliberately Slowing Down Output in A Family Production Context. International Journal of Production Research, Vol. 28, No.1, pp. 17-27.

Soman, C.A.; van Donk, D.P.; Gaalman, G. (2004). Combined make-to-order and make-to-stock in a food production system. International Journal of Production Economics, Vol. 90, No.2, pp. 223-235.

Sox, C.R.; Jackson, P.L.; Bowman, A.; Muckstadt, J.A. (1999). A review of the stochastic lot scheduling problem. International Journal of Production Economics, Vol. 62, No.3, pp. 181-200.

Vannunen, J.A.E.E.; Wessels, J. (1978). Multi-Item Lot Size Determination and Scheduling Under Capacity Constraints. European Journal of Operational Research, Vol. 2, No.1, pp. 36-41.

Vergin, R.C.; Lee, T.N. (1978). Scheduling Rules for Multiple Product Single Machine System with Stochastic Demand. Infor, Vol. 16, No.1, pp. 64-73.

Wagner, B.J.; Davis, D.J. (2002). A search heuristic for the sequence-dependent economic lot scheduling problem. European Journal of Operational Research, Vol. 141, No.1, pp. 133-146.

Williams, T.M. (1984). Special Products and Uncertainty in Production Inventory Systems. European Journal of Operational Research, Vol. 15, No.1, pp. 46-54.