Optimization of scheduling flexible manufacturing systems by using multi-objective Genetic algorithm

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Abstract
Due to grow changing world around, flexible is the way to stay ahead in business. Flexibility has many aspects, one of the fundamental dimension of flexibility in production. Timing covers a wide range of most industrial systems issue. Scheduling issues have many different features that are why these modeling of issues are very difficult. Optimization is an important activity in determining the structural design. In many engineering optimization problem, which are solved by meta-heuristic methods, among these methods, a genetic algorithm has been used a lot. In this paper, used MUGA algorithm for optimization, that is a genetic algorithm for multi-objective. Due to choose this method, the power of the multi-objective optimization toward other similar algorithms. Among the most important issues in the field of optimizing is optimization of scheduling that has many economic benefits for organizations. There are several goals to optimize the scheduling of the research literature. The four goals: Operation time, operation costs, and workload imbalance on both machines at the same time have been crucial and common goals. In this work, first MATLAB code was prepared that calculate the objective function value of these four and make it understandable for MUGA algorithm then this code connected to the MUGA algorithm and was introduced by optimizing the four target areas that include. To this Sort Order, a method came into existence that has the ability to Schedule Optimization production system flexible take with every amount complexity and every number and objective function.

Keywords: Optimization, scheduling, multi-objective genetic algorithm for flexible manufacturing systems

1. Introduction

Today, manufacturing plants, with respect to role of competition in the competitive market environment, see them self in changed environment. Examples of these changes can be found in consumer and capital goods industries such as automotive, electronics and appliances. Manager, who is faced with rapid change, should adopt new strategies to cope with the new competitive environment. The old strategy based on economic theory of mass production (economies of scale) that stressed on increase production in order to break down the overhead lost its credibility and instead, the new flexible approach is alternative and economic largely replaced with economic diversification. Economic diversity is realized when the same equipment can be combined together and not separately, to produce several products with cheaper prices. These practices have been developed during these practices have been developed during the time of the release (for new products) and customers (new product) the time of the release (for new products) and customers (new product).
2. Some of the main characteristics of the new environment are:

Increased variety of goods 2 - 3 sharp decline in product life cycle - to increase understanding and awareness of the environmental impact of their production systems 4 - Changing patterns of spending 5 - difficult to estimate the costs and benefits of integrating IT 6 - Change social expectations (Motaghi, hayedeh, 2008)

At the present time due to the complexity and intensity of environmental changes, the market competition is increasing, and those institutions that seek to gain and maintain their competitive advantage in the market, they are forced to turn to modern technology. FMS, is designed as one of the most productive techniques to gain and maintain competitive advantage in terms of flexibility. And using such a system can be in many manufacturing industries due to the advantages such as greater use of machinery, lower delay time, lower cost per unit, superior quality and quick response to market changes has been welcomed by people. Obviously, such attributes on profit institution that has been effective in ensuring their survival and the survival of them and can be positioned in a competitive market to extending the institution.

3. Background Investigations

Each review of articles about FMS is classification issues base on various criteria that Based on one of the papers ((Shouman and et al 2002 questions are divided into four categories. That one of these categories is FMS scheduling. Articles in FMS scheduling optimization are presented as follows:

1. Flexible Manufacturing System

1 - Scheduling FMS systems by using knowledge-based algorithm
A. Prakash, Felix T.S. Chan, S.G. Deshmukh
That introduces a meta-heuristic algorithm that is a combination of genetic algorithms and knowledge systems to minimize down time and maximize workflow efficiency

**Multi-objective planning process in FMS systems by using the algorithm depends**
Kyoung seok shin, Jong-ohpark Yaokeunkim that introducea multi-objective evolutionary dependent algorithm, with the aim of minimizing the displacement components at the change machine tools and workload balancing

3 - The use of distribution search for written FMS systems
R. Tavakkoli Moghadam, N. Javadian A. khorrani, Y. Gholipour kanani
That introduces a meta-heuristic algorithm based on scatter search process with the goal of minimizing the time, at least to an intracellular shift, delay minimization, and delay minimization of cost deals

4 - Improve FMS Scheduling systems by using parallel genetic algorithm
Ghada Abazal, Iman Badr, Peter Goehner and Sabina Jeschke
That introduced parallel genetic algorithm with the objective of minimizing processing time, minimizing setup time and maximum pay off the balance between the elements.

5 - Use schedule for the allocation of limited tools, FMS production scheduling systems, written by L. J. Zeballoy introduced with the aim of minimizing the time That CP process, at least moving parts, minimizing the total process time, minimizing delays in delivery deals.
4. Statement of Problem

FMS recent decades, consist considerable attention to itself. FMS is a manufacturing system automatically includes all transport vehicles and automated storage is undergoing a comprehensive computer control system, working together. The system is capable of producing different parts without much to reconsider the tools; the ability to quickly change the program or change the piece is able to carry several pieces. (Nagarjunaa and et al, 2006)

This system has the following advantages:

1 - Lower speed and cost of replacement one piece to another that develop it main use.
2 - Reduce the inventory As a result of discussion design and planning;
3 - Stability and better quality in the automatic control;
4 - Reduce labor costs;
5 - Increase flexibility and type of product;
6 - Improving productivity and increasing efficiency of machines. (Nagarjunaa and et al, 2006)

In decision making to install a FMS, strategic considerations may be important to its economy, Needs of the market system, needs constant flexibility and performance. Key decisions about system design can be divided into design can be long-term planning, preparation and timing control short to medium term.

In general, the issues of FMS are divided into four categories:

1 - Designing Issues
2 - Planning Issues
3 - Scheduling Issues
4 - Control issues (Shauman and et al, 2002)

First, system design, The relative lack of industrial experience with complex matters refer to coordinate system that At least initially, a cautious approach should be implemented In a small system, Systems are adjustable and can be implemented with a little foresight should be designed to develop them. From an economic perspective, All components can be allocated on the basis of potential benefit they ranked FMS. MS can be load with pieces that show the system’s superiority. The second major problem is bunch of parts for cogeneration system and this system. Tools should be assigned to devices and components along with the appropriate tools to flow devices. Tools should be allocated so that the flexibility of the system will be possible in time to occurrence the disability. The third issue is the timing of the actual system. To choose the means of transport available and suitable packing machine tool, when the device should be transmitting is required rule. Vehicles to avoid collisions and deadlocks should be controlled. With regard to the issues raised above, it is clear how coordinate different parts of an FMS is difficult. Here Schedule of These systems are considered. Scheduling is a decision-making activity that has as goal to optimize one or several objectives. But the scheduling in these systems, because of their inherent complexity and the existence of different scenarios is very difficult. So there is a need to optimize to different parts of the FMS can efficiently work together (Maccarthy and et al, 1993). There are several methods for optimization, that each of these methods is applied to a number of issues. Whatever the complexity of the problem increases, the need will be feel more powerful method, especially if several objectives are optimized simultaneously. Among the various methods, meta-heuristic methods for solving such problems have many potential. Genetic algorithms, including innovative learning methods that have been used in the literature a scheduling problem. This algorithm is part of
an evolutionary algorithm that used to optimize the principally (MotiGhader and et al, 2010). The basic problem here is that we're faced with, isscheduling optimization of flexible manufacturing systems. Since there are different purposes for these systems, it is important that can use different method that different and sometimes conflicting goals can be optimized with each other. This paper examines the four objectives that include: Operation time, operation costs, unbalance and maximum workload on any machine. This goal helps each other system to act in the best part of its job and the economic advantages accrue to organizations.

4 - Terms and concepts and implemented methods
Definitions, concepts and features of FMS
FMS is:
* A series of CNC machines and stations that support the work of a transportation system connected by a central computer to be controlled;
* One or more produce cells (or chamber or small room) which are beside together And in each of these cells, with work stations that produce a specific set of components;
* A group of NC and CNC machines that are connected to a central control computer
* System Integrated, computer-controlled include automated material handling equipment and CNC machinery
* automatic System of manufacturing components with the average amount of diversity and its components are driven by a central computer (Nagarjunaa and et al, 2006).
FMS is a fully automated production system, along with transportation machine and automatically storage that under a comprehensive computer control system are working together. The system is capable of producing different components without much to reconsider the tools, the ability to quickly change the application process to change a piece or several pieces of Transportation. FMS technology is a gradual process with superior transmission lines that can be changed according to customer demand and customer-friendly products, with high-speed deliver. This system is a technology and an alternative arrangement, some components are loaded into the system simultaneously and some machines are able to process the information and necessary tools to work on any device. So the components can be fabricated in a machine by a series of successive operations. By reading code fragment, the fragment will be detected and appropriate processes for the manufacture of its memory segment will be considered. Two important features of FMS include:

1 - of flexibility
2 - self-employment

The necessity for the use of the FMS includes:

  1. Computer Numerical Control
  
A: Make the most of flexibility in order to produce competitive and a variety of products
B - Increase productivity
C - Reduce production costs (Bedross and et al, 1995)

5. Competitive Advantage of FMS:

Research has shown that proper policies and operating technology principles, determines the competitiveness of an organization's future. A policy that is based on flexible manufacturing technology, enabling organizations to make the best of success in the upcoming battle plans.
production is a relatively new policy that by the Successful Company, use to develop and increase competition in the labor market. A company with the use of flexible manufacturing allowing that provides a wide variety of products to suit the requirement of clients. Flexible manufacturing enables companies to manufacturing multiple products that alter the production process and quickly and effectively reporting to customers’ needs quickly. However, applying this approach is not feasible in some industries, but most successful companies, including the auto industry have attempted to implement it. (Iran-Zadeh et al 2000)

6. The structure of FMS

Flexible single machine 1
Flexible Manufacturing Cell 2
Flexible manufacturing system, multi machine-3
Multi-cell flexible manufacturing system4
1 – Single Flexible machine (SFM)
2 – Flexible manufacturing cell (FMS)
3 – Multi-machine Flexible manufacturing system (MMFMS)
4 – Multi-Cell flexible manufacturing system (MCFMS)

The concept of flexibility
Flexibility is the ability to adapt to a wide range of possible conditions
There is flexibility in FMS 8 types include:

1 - Machine: Ease of making changes required to manufacturing series of family components
2 - Process: Ability to perform mix of works
3 - Product: Ability to change to produce new products quickly and economically
4 - Path: Ability to control, remove stop and continued to produce a family of components
5 - Volume of production: Ability to advantageously use the FMS to generate different volume
6 – Development: facilitate Ability development of an FMS, as needed
7 - Operation: Ability to exchange a variety of operations in any part of component
8 - Production: All parts that FMS can produce no new investment.

7. Types of FMS

1 - Sequential: This type of system will initially produce a family of components and then produce a family of component
2 - Proprietary: different family’s components are produced, but the quantity is limited.
3 - Random: the ability to produce different families of components and has the capacity to change production schedules.
4 - Engineering: have the ability to produce different families of parts but there is no possibility of changing production plans over time
5- Modular: the ability to produce different families of components and can be converted by the user to any of the previous Types of (Shivanand, 2006)
The main components of FMS

1 - Integrated Computer Control System

Use of computer technology is for the integration of design, production and marketing and product delivery system.

2 - The workstation: In respect of equipment, including CNC or NC machine tools that has interchangeable parts and machining operations are performed on families. This component allows FMS to process different parts of products simultaneously and actually setting the stage for flexibility of the system component.

3 - Material Handling Systems and Storage (Shinvanand, 2006)

Auto transport segment, is an important component of the FMS. Transport system is designed for transferring parts between stations. Transportation system of the FMS makes up AGV. AGV means equipment designed under the guidance of AGV’s are lift or transport that run by a central computer. This computer sends and follow them and will lead their actions on rings. AGV can be replacing with complex in transport lines, to carry out an inventory storage location and movement of inventory in the warehouse to the crane. They can act as a production platform, carry out production support.

Benefits of FMS

1 - higher performance of cars
2 - less production time,
3 - greater flexibility in the timing of
4 - to 30% reduction in space needed
5 - most significant profit despite high initial costs
6 - The need for less cars
7 - 8 direct labor costs
8 - reducing the amount of waste produced
9 - inventory reduction


8. Disadvantages of FMS

1 - Company in all aspects related to each other
2 - Number of decision options is a lot
3 - There are multiple objectives, and in some cases, incompatible in systems.
4 - The low number of available manpower during the adjustment process of change is problematic

8.1-Automatic Guided Vehicle

Scheduling allocation of resources over time is to perform a set of tasks. Scheduling is a kind of decision making process which during it schedule is set. Scheduling is a theoretical discussion of the principles, models, methods and logical results which provides us with a deep insight about the timing operation (Baker and others, 2008).

Scheduling include planning and prioritization of activities that need to be done in order.

9. Types of scheduling

Scheduling issues can be divided into two main groups: 1 - of deterministic models
2 - probabilistic models

In the definitive model, all parameters are assumed to be deterministic model and probabilistic models are some of the parameters uncertain.
10. Optimization

Optimization is a process that is looking for something better. Thought, idea or proposal considered by a scientist or an engineer, during the optimization procedure becomes better. In optimization we talk about finding the best solution for a problem. Optimization changing the inputs and characteristics of a device is a mathematical or experiment process in a way that achieved best output or outcome. Input is variables of a process or function that called the function. The purpose of Optimization is finding the best acceptable answer, given the constraints and needs of the problem.

11. Genetic Algorithms

One of the meta-heuristic methods based on the nature, range of genetic algorithms is very broad. Each day, the progress of science and technology are increasingly using this method in solving optimization issues has greatly expanded. Genetic algorithms, is One of the best subset of evolutionary computation that directly related to Artificial intelligence topic. Actually genetic algorithm is one of the subsets artificial intelligence. Genetic algorithms can be generally described as a search method that mimics natural biological evolution laws. Genetic algorithm on a set of answers the question, hoping to get better answers apply best law of conservation. In every generation, to help with the selection process and the response of selected reproductive response to emulate natural genetic operators better approximation is obtained of the final solution (Alborzi et al, 2006).

This algorithm for the first time presented in 1960 by Mr. Rychnragr whose research on the development strategies. His theory was later studied by many researchers. So the genetic algorithms by John Holland in 1975 and was presented in University of Michigan.

12. Multi-objective optimization

As previously mentioned in multi-objective optimization multiple objective functions have to be optimized simultaneously. In such problems, in contrast to single-objective issues that there is only one extreme point. Set of vector design as an answer, obtained that called Pareto points. And problem designer picks based on your needs one of these points as the optimum solution.

13. MUGA algorithm

This algorithm was presented for the first time by Nariman Zadeh and Jamali. In 2005, due to the problems in the program of CDA algorithm NSGAII, Nariman-Zadeh offered Modified NSGAII algorithm on the ε-elimination program (K. Atshkari and others, 2005, Kosinski and others 2005). In 2008 MUGA algorithm that was modified of NSGAII algorithm was present. Subprogram ε-elimination algorithm works based on E-elimination sub-program. Subprogram of the ε-elimination is a measure of the chromosomes in the front. This following program uses a value of ε near the two chromosomes in space of design variables and the measure of objective. If all values of ε bottleneck are smaller than the value of two chromosomes, one of the chromosomes will delete. By using this criterion, chromosomes that are close together in front of a community have to be removed. As a result, the total Pareto curve points are evenly distributed in whole area.

14. Summary and conclusions

1-Metaheuristic  2-MUGA: Multi-objective uniform-diversity Genetic Algorithm
In this paper a study of FMS production system fully automated with car transportation and storage is automatically used. The system is capable of producing different parts without much to reconsider the utility's ability to rapidly changing manufacturing process plan for the part or transport several pieces or one piece. There are several issues in these systems and there is a lot of research on various sectors. One of the crucial issues is the Scheduling. For manufacturing operations, there are several possible actions by different machines. This flexibility greatly increases the space of possible solutions, and the Scheduling is more complex. MUGA Scheduling algorithm is used to optimize the multi-objective algorithm and has been used for a wide variety of optimization problems. Due to this method is the power of the multi-objective optimization than other similar algorithms.
References