Role of Artificial Intelligence in Flexible Manufacturing Process - A Review

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Abstract - *Despite of evidence that information technology (IT) has recently become a productive investment for a large cross-section of firms, a number of questions remain. Some of these issues can be addressed by extending the basic production function approach that was applied in earlier work. Such activities involve part design, process design and process execution, as IT plays such an important role in various sectors and industries. Artificial Intelligence (AI) has the potential to enhance and extend the capabilities of humans, and help businesses achieve more, faster and more efficiently. AI in smart machines currently manages the more traditional repetitive tasks; however, this is advancing very quickly. The ability of AI to adapt to continuously changing tasks will move quickly into the mainstream. In the case of production, we will see sensors spotting defects on the production line. The data is then fed to the cloud to verify, which will immediately remove the defective part from the line and order a replacement all while calculating in real-time just-in-time schedules. Each one of these intelligent insights will turn information into tangible outcomes. This paper reports different scope of AI implemented in manufacturing process.*

Keywords: Artificial Intelligence, sensors, flexible manufacturing, real time.

1. INTRODUCTION

Manufacturing has evolved and become more automated, computerised and complex. In this paper, the origin, current status and the future developments in manufacturing are disused. Smart manufacturing is an emerging form of production integrating manufacturing assets of today and tomorrow with sensors, computing platforms, communication technology, control, simulation, data intensive modelling and predictive engineering. It utilises the concepts of cyber-physical systems spearheaded by the internet of things, cloud computing, service-oriented computing, artificial intelligence and data science. Once implemented, these concepts and technologies would make smart manufacturing the hallmark of the next industrial revolution. The essence of smart manufacturing is captured in six pillars, manufacturing technology and processes, materials, data, predictive engineering, sustainability and resource sharing and networking.

The concept of flexible production has been applied to the following three basic manufacturing subsystems: (1) fabrication, (2) machining, (3) assembly (Kusiak [12]). Flexible machining systems have received great attention among practitioners (measured by number of systems developed) and researchers (measured by number of papers published). This might be due to the importance of machining in manufacturing industries and to progress in technology of machine tools. Although initially flexible assembly systems have drawn rather little attention, interest has been increasing rapidly in the last few years. Flexible fabrication systems have attracted the least interest, but they represent a great potential for applications of flexible technology. One of the most difficult problems generated by these three subsystems is the scheduling problem. Readers interested in FMS planning and scheduling frame.

2. MATHEMATICAL MODELLING

Manufacturing comes in many shapes and sizes. Two major categories are continuous manufacturing are and discrete manufacturing. Continuous manufacturing of the sort found, for example, in a chemical factory will not be further discussed. Of the many subcategories of discrete manufacturing, only one is used for the purposes of discussion. The area of choice is the manufacture of mechanical products, i.e., those products made primarily of three dimensional rigid parts. A bicycle is a good example, as is an automobile, as is an airplane. So are a refrigerator and a washing machine.

Processes such as the discrete manufacture of electrical/electronic products or the continuous Manufacture of chemical products cannot be viewed as application areas for computational Techniques. It simply means that discrete mechanical manufacturing has been selected as a rich source of examples, most of which are within the experience of the intended audience.

To discuss discrete mechanical manufacturing and associated engineering functions as computational problems, a simple (but not overly simplified) model is proposed. This model consists of three stages of activity including the Part Design Stage, the Process Design Stage, and the Process Execution Stage.

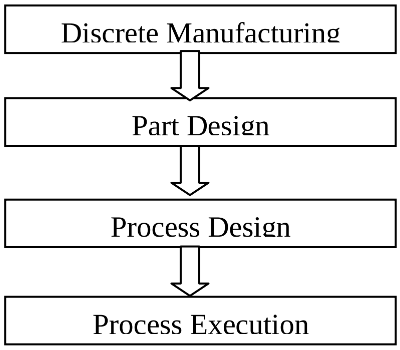

Fig 1 Flow chart of Flexible Manufacturing

2.1. Part Design Stage of Manufacturing

The first step in part design is a conceptual one dealing with both synthesis and analysis. Here the basic ideas of the product from the design standpoint are generated and tested. There are many constraints on this step. From the product planning function comes the request for a product with a particular set of functions, a performance level for each, and a packaged selling price in the marketplace. From the management function come design and development budgets which should not be exceeded while responding .The goal of concept synthesis is to consider these various constraints, and those constraints imposed product planning.

Part design also explained under the engineering microscope for detailed consideration. All of the same constraints input to the concept synthesis phase are passed along to the detail synthesis phase in expanded form. For example, the list of desired features and functions originally input from product planning for concept synthesis is now broken down, specified, documented, and examined at the level of an operations manual and a maintenance guide. Detail analysis deals with extended calculations simulating various expected operating conditions of the product in contrast to the coarse analysis of the conceptual step.

2.2 Process Design in Manufacturing

The Process Design Stage exhibits a high degree of similarity to the Part Design Stage, except that the focus of attention is on designing processes by which the manufacture parts have been produced. The first step in process involves designing a conceptual one where the basic ideas of the product from the production standpoint are generated and tested. A number of the constraints input to this step come from the Part Design Stage in the form of the detailed product specification. Other important constraints come from the production facilities actually available on the factory floor and the inventory of materials, tools, and parts. Once again, the management function provides constraints in the form of time and money budgets which should not be exceeded in the Process Design Stage. The goal of the conceptual synthesis phase is to consider these constraints, and those imposed by the rules of engineering and the laws of nature, to create a solution, i.e., a conceptual process design. The goal of the concept analysis phase is to test these concepts for feasibility.

During the Process Design Stage, a number of build or buy decisions are made. If it is possible to buy a part (or a tool), and its cost is reasonable in the context of the design of the process, then part (or tool) orders must be placed and deliveries entered as constraints. If, on the other hand, parts (or tools) are more effectively made in-house, orders for materials must be placed and the resulting constraints considered. Pre-requisite of the result of the Process Design Stage is a detailed production specification to pass to the Process Execution Stage.

2.3 Process Execution Stage in Manufacturing

After the product has been designed in detail and the manufacturing process planned in detail, the next obvious stage is the execution of the process to make the product. The first step in process execution is one in which raw materials and tooling are brought together with manufacturing equipment such as numerically controlled machine tools to produce parts. Such step might also include finishing the parts, inspecting and/or testing, and placing the parts in storage until required. The second step in Process Execution includes bringing together parts and tooling along with other manufacturing equipment such as sensor-based robots to assemble products. In addition to this, it requires finishing, inspecting, testing, and storing of the product.

In this model of manufacturing, the packaging function is included as a kind of generalized assembly and also assembling the product. The process encapsulated in both the detailed product specification and the detailed process specifications are used as inputs to process execution. From the management function come production time and cost budgets. The laws of nature come to the forefront in this stage of manufacturing.

3. A Simple Model of Artificial Intelligence

Artificial Intelligence as a Simple technique of manufacturing of a number of interesting computational problems in manufacturing sector. Many of the problems are numeric in nature, requiring what might be considered conventional computational techniques, but a significant subset of the problems involves combinatorial complexity. Although these latter problems are strongly implicated in adding expense to manufacturing functions, a little effort has been focused on computational solutions for them. From the beginning of computing as a discipline, a number of classes of problems have been fairly well understood. The major application of Computers today is solving the numerically difficult or calculationally tedious problems which fall into these classes. Computers have had a tremendous impact on our lives through the automated solution of problems in these classes, at least partly because humans are not very efficient in the face of numerical analysis. Solving equations, calculating payrolls, and generally keeping track of numbers is the obvious work of the computer, a role from which it derives its popular name.

In the context of this paper, the problems do not involve combinatorial complexity in their solution. They may be numerically difficult and require mathematical creativity and require programming skills. Second, there is usually a well known, relatively standard solution process for these problems. In some cases, the processes were commonly used by humans before computers and have evolved as they were transferred onto the machine. This realization marked the beginning of Artificial Intelligence (AI) as a branch of Computer Science. For the purposes of this discussion, AI can be thought of as the experimental branch of computer science which relates a natural phenomenon, human cognitive ability, with an artificial analogy, computer programs.

4. CONCLUSION

This paper aims the scope of Artificial Intelligence in manufacturing process and some substantiation of the belief that AI techniques can be useful in manufacturing. As combinatorial complexity of part design, process design, and process execution continues to increase, AI will become as indispensable in the factory of the future as conventional data processing. The data is then fed to the cloud to verify, which will immediately remove the defective part from the line and order a replacement all while calculating in real-time just-in-time schedules. Each one of these intelligent insights will turn information into tangible outcomes.

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