Chapter

Introductory Chapter: Drilling Technology

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1. Introduction

Drilling technology has been widely used in many industries such as manufacturing, mining, oil and gas, and construction. In manufacturing industries, drilling processes are not limited to conventional methods where a physical contact is made between the cutting tool and the solid material. Non-conventional drilling processes use forms of energy such as electrical, chemical, electrochemical, thermal and heat, to generate holes on the hard materials.

Among all drilling processes, conventional drilling with twist drill bits is the first operation attracting extensive attention of researchers. Therefore, the fact that majority of today's products incorporate holes generated by drilling operations cannot be ignored. In various industries, drilling is one of the essential operations, where the joint's life can be critically affected by the quality of the drilled holes. Drilling is often considered the final machining operation during assembly of components, where an efficient drilling process provides superior quality of drilled holes to ensure high strength and high efficiency [1]. A low-quality drilled hole can result in cracks within the structure, which ultimately reduce their service lifetime and add extra costs for maintenance [2]. This is why the drilling process is acknowledged as a more challenging issue during assembly and is the most common, frequent and necessary processing craft in various industries. Therefore, both academia and industries are highly motivated for research on the applications of drilling operations.

However, the drilling process required the use of right cutting tools together with appropriate cutting parameters, such as cutting speed or spindle speed, feed rate, and a reliable machine tool setup, to ensure high quality holes in terms of low surface roughness, cylindricity, circularity, perpendicularity and less formation of burrs [3]. Therefore, the drilling process can be explicitly understood by proper selection and optimization of process parameters without compromising productivity and hole quality [4, 5].

Drilling operations form the largest portion of machining operations in manufacturing industries; therefore, conventional and CNC machines do not give a high production rate where production volumes are huge. In contrast, special purpose machines can provide very high production rates for performing drilling and drilling-related operations including tapping and reaming. The production rates of these machines are many times higher than conventional and CNC machines. In addition, the quality and uniformity of production are superior compared to conventional methods. **Figure 1** shows a two-station special-purpose machine used to perform drilling and tapping operations. The production rate increases as the number of workstations increases, since the machine can perform multiple operations simultaneously. Special purpose machines with 8, 10, and 12 workstations are very common.

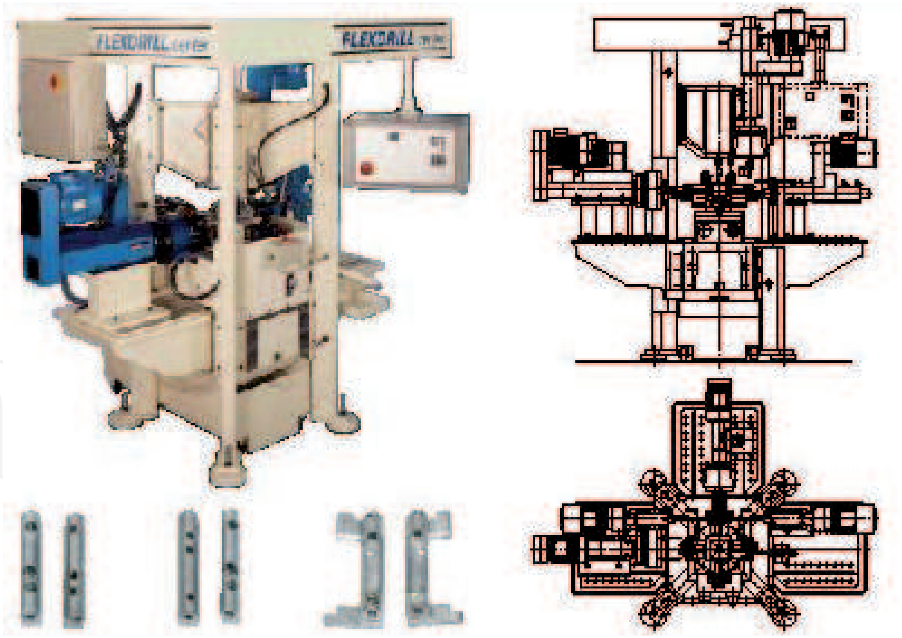

Figure 1.
Flex drill: A special purpose machine used for performing drilling and tapping operations [6].

Figure 2.
A poly-drill head with three adjustable spindles mounted on conventional milling machine.

A significant 59% cost reduction is reported in the literature when a special-purpose machine is used in place of a CNC machine, and the cost reduction is an impressive 95.5% when compared to a conventional machine [6]. Although these machines are capable of improving the quality and quantity of the parts produced compared to conventional machines, the utilization of this technology is not proportional to its benefits [6]. This, to a large extent, is attributed to the lack of a solid foundation for feasibility analysis of utilization of these machines. To tackle this, extensive research has been performed by contemporary researchers and models are developed for feasibility analysis of the utilization of such machines; both technically and economically [7–9]. The models developed can assist engineers and manufacturing firms in deciding when this technology gives superior results compared to other alternatives.

Another essential accessory for the drilling operation is the poly-drill head, which can increase production by creating many holes simultaneously [10]. Poly-drill heads are used for drilling and drilling-related operations. As these can perform multiple operations simultaneously, then the overall machining time is reduced significantly, resulting in a huge improved productivity [11, 12]. Poly-drill heads are of fixed and adjustable types, and the number of spindles could vary from two to more than 10. In the adjustable type, the position of the spindles can change providing varied center-to-center distances of the holes within a range. Poly-drills could be used on the conventional drill presses, milling machines, CNC machines, and special-purpose machines. **Figure 2** shows a three-spindle poly-drill head mounted on a conventional milling machine for drilling three holes simultaneously.

Poly drill head also ensures advantages like less rejection of parts by providing better accuracy, less operator fatigue and time saved in the operation. A poly drill head or multi-spindle drill head performed better than the one-shot drilling process by giving a better hole quality, less tool wear, and producing small and fragmented chips [13].

Conflict of interest

The authors declare no conflict of interest.

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