Study the Performance of Hybrid Machining Process

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Abstract- **the Machining might be a an element of the manufacture of the numerous products, but it's used on materials like wood, plastic, ceramic and composites. Advanced engineering materials, including inter alia fiber-reinforced composites, super alloys, and ceramics, including various properties like physical, chemical and mechanical properties a la mode of strengthening, corrosion resistance and strength to weight ratio. These properties have permitted the planning of products with better properties, but the advanced material is extremely difficult to machine by the normal machining process so we use hybrid machining process. the basic idea behind the hybrid machining process is that the synergistic combination of constituent machining processes so on cut back their individual deficiency and achieve effective material removal rate. This article has summarized some important view of the literature on hybrid machining processes. The Machining processes generally are supported the mechanical, thermal, and electrochemical processes supported their material removal property. The various Working principles and mechanisms of cloth removal of existing hybrid processes and their capabilities are discussed.**

I. INTRODUCTION

Hybrid machining is combine different-2 machining processes for manufacturing components with a better machining performance & efficiently. The objective of hybridizing the machining processes is the positive effect of the hybrid process is more than double advantages of the single processes [12]. Hybrid processes developing because of the arrival of novel materials with extreme properties, requirements of enhanced machining precision and sophisticated shaped parts which earlier difficult or impracticable to machine with existing conventional and non-conventional machining technologies. The term "hybrid process" in machining is related to the combination of different process energies or assisting a specific process by using process energy. A hybrid process is often employed in different terms:

1. the mix of several active energy sources which work that time in the processing or working zone (laser electrochemical machining).
2. Processes which combine the strategy steps that are usually performed in two or more way (grind hardening).
3. The Hybrid machines, integrating different processes within one machining platform (sequential milling and electric arc machining).

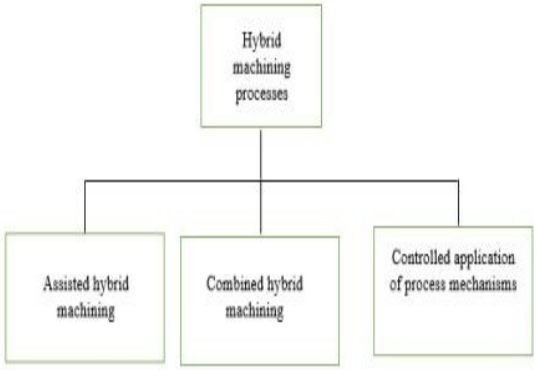

Figure 1: Classification of Hybrid Machining

II. PRINCIPLE

Fig.2 shows the hybrid processes that improve the assembly in terms of shortening of process chain or improvement of product qualities. In hybrid machining processes, it can shorten the present process chains by combining two or more processes on the identical machine platform by minimizing problems of referencing, clamping, alignment at different workstations. it can combine the method capabilities of various processes into one hybrid process so on realize complex product and evaluate machining performance like high material removal rate (MRR) and high surface finish simultaneously. Conventional mechanical machining technologies are limited by the strength of the tool and mechanism of chip removal which mainly involves plastic deformation. These technologies don't seem to be suitable for machining hard-to-machine materials, including highly brittle materials. Similarly nonconventional machining processes even have limitations, especially thanks to their process physics and material removal mechanisms. as an example, laser machining is proscribed to certain aspect ratios, EDM and electrochemical machining (ECM) are limited to machining of conductive materials, and also the precision of water jet machining is proscribed by hydraulic jump of the jet. Therefore, so as to satisfy challenging machining needs, two or more hybrid processes is combined to satisfy one or more machining objectives. Advanced machining capabilities are realized through hybridization of two or more machining processes.

Vibration Assisted Machining (VAM)

Vibration-assisted machining (VAM) aids the cutting motion of the tool by adding small-amplitude,

High-frequency tool displacement to the tool during cutting [7]. The tool tip is driven in a small reciprocating whose centroid moves in the direction of the cutting velocity. For appropriate Combinations of cutting velocity, tool amplitude and frequency, the tool periodically loses contact with the chip. As a consequence, machining forces can be reduced and thinner chips can be Generated. This leads to improved surface finishes, better form accuracy, and near-zero burr Vibration-assisted machining (VAM) aids the cutting motion of the tool by adding small-amplitude, High-frequency tool displacement to the tool during cutting [7]. The tool tip is driven in a small reciprocating whose centroid moves in the direction of the cutting velocity. For appropriate combinations of cutting velocity, tool amplitude and frequency, the tool periodically loses contact with the chip. As a consequence, machining forces can be reduced and thinner chips can be generated. This leads to improved surface finishes, better form accuracy, and near-zero burr

III. DESIGN PRINCIPLE AND METHODOLOGY FOR HYBRID MACHINING PROCESSES

The objective of designing hybrid machining processes and related technologies is twofold. First it can vary the established process chains by adding two or more processes on the identical machine so minimizing the issues of referencing, clamping, alignment at different work platform. Next it can companioning the method capabilities of different processes into single hybrid machining process so on realize complex products and/or obtain contradictory machining performance like high material removal rate (MRR) and high surface finish simultaneously. Mainly the involvement of the plastic deformation, the Conventional mechanical machining technologies is limited by the strength of the tool and mechanism of metal removal. These technologies aren't suitable for machining hard-to-machine materials, including highly brittle materials. Similarly nonconventional machining processes even have limitations, especially because of their process of material removal mechanisms. As an example, laser machining is restricted to certain aspect ratios, EDM and electrochemical machining (ECM) are limited to machining of conductive materials, and also the precision of water jet machining is restricted by hydraulic jump of the jet. Therefore, so as to satisfy challenging machining needs, two or more hybrid processes are often combined to fulfill one or more machining objectives. The Advanced machining abilities are often realized through hybridization of two or more of machining processes. Fig.2 shows the opportunities where hybrid processes can improve the assembly in terms of shortening of process chain or improvement of product qualities [4]. to attain the above aims design of a hybrid machining process will must follow a minimum of one in all the subsequent principles: 1. Broadening existing material processing window of processes (i.e. machinable materials). 2. Improving existing process capabilities (i.e. attainable surface finish, surface integrity, tool life, etc.). Additionally, being cost-effective and not causing hazard and waste material also are important design principles for a hybrid machining process. Design for hybrid machining may be a multidisciplinary field because it requires the planning of a mix of processes, considering their process physics in addition because the design of dedicated machine tools. as an example, LECM processes need a design for optics in addition as ECM peripherals. Furthermore, these two processes can even influence one another through mutual interaction of process energies. On the opposite hand, combined mechanical milling and EDM process needs dedicated machine tools since milling may be a contact-based process, experiencing machining forces, whereas EDM may be a noncontact machining process, experiencing no machining force. Fig. 2 shows the most elements for design of hybrid machining processes.

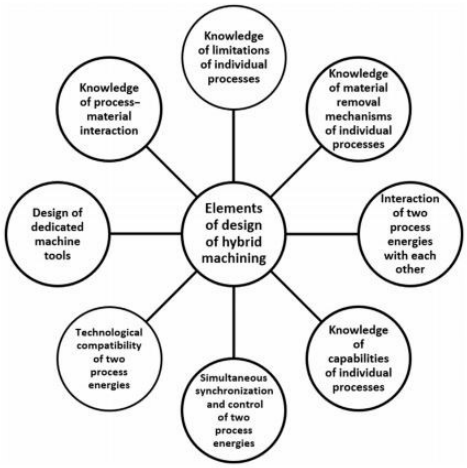

Figure 2: Elements of Hybrid Machining

IV. ASSISTED HYBRID MACHINING

For assisted hybrid machining, the main machining process is superimposed with input from one or several kind of energy such as ultrasonic vibration, laser, fluid, magnetic field, etc. so as to improve the constituent machining process.

4.1 Mechano-Electrochemical Machining

The process required a dedicated machine tool design and machine tool. The mechanic-electro chemical machining process exploits double benefits by a combination of mechanical and electrochemical material removal method. The process is analyzed by the design of a special electro chemical machine tool with a cutting edge. The process is especially very useful for machining hard and new metals such as Ti-6Al-4V, which suffer from surface roughness during the ECM process. The mechanical process facilitates

removal of the upper layer by a cutting edge, so improving the surface quality and process existence.

4.2 Electro discharge grinding and abrasive-EDM processes

In electro discharge grinding and abrasive-EDM processes, the fabric removal is assist by combination of spark ignition and abrasive action. The Fig. 3 shows the required principle of the hybrid machining processes during EDM grinding and abrasive-wire EDM. The mixture of EDM and grinding is especially useful in machining of electrically conductive cemented carbides with a metal bonded diamond grinding wheel. The material removed due to abrasive action and spark ignition depends on process parameters. The spark of electric discharge machining process results in thermally creates softening of the material in the grinding zone. Thus, the process is benefiting from reduced cutting forces and also the requirement of the low spindle power. This process is especially applicable for the aerospace industry because it generated machined surfaces.

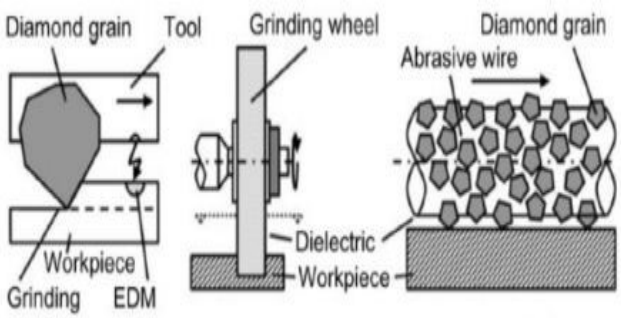

Figure 3: Electro discharge grinding and abrasive-EDM processes

4.3 Vibration-assisted machining

Vibration-assisted machining means the vibrations to provide material removal and enhance the performance. In this process, a very small vibration is mixed to the tool or work piece movement. The vibrations could even be in one or more directions. A small-amplitude high-frequency tool displacement is provided to the cutting motion of the tool in the case of old or conventional machining and to the tool-electrode, work piece and working fluid in the case of nonconventional machining processes. Fig.4 shows an ultrasonic-assisted ECM system in which the electrolyte flushing and removal of the by-products is enhanced or increased by the use of ultrasonic vibrations to the tool. The ultrasonic vibration to the tool also offers the probability to decrease electrode polarization. In most of the systems, the amplitudes are in the range between 1-16 mm and vibration is within a frequency range from 20 to 26 kHz and the starting of vibration are piezoelectric elements of the spindle, tool holder, and work piece holding system. The vibrations are of ultra-sonic frequency.

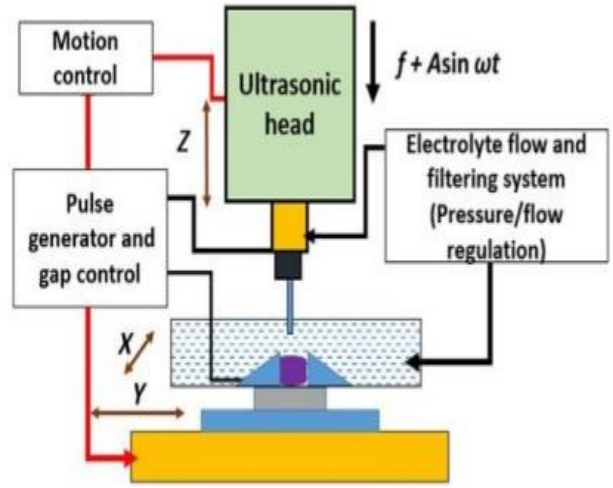

Figure 4: Vibration-assisted machining

The main advantages of vibration-assisted machining are as follows:

- Improvement in surface quality and machining time.
- Improved machining of brittle materials like ceramics and glass.

4.4 Abrasive-Water jet Milling

Abrasive-water jet machining (AWJM) is generally used in the cutting of latest, hard and low mach inability materials like titanium alloys, ceramics, metal matrix composites, concrete, rocks, etc. the method makes use of the impact of a water jet moreover as the impact of abrasives for improving the mach inability of certain materials. Fig. 5 shows a setup for AWJM . The main parts of an abrasive-water jet setup are the reciprocating pump which is used to pump pure water at very high. The abrasive particles are introduced into the water jet from a hopper in the mixing chamber. The combined impact of water jet and abrasives is incredibly useful in machining of composites, toughened steels, and some ceramics. the most important job in abrasive-water jet machining lies in controlling the depth of cut.

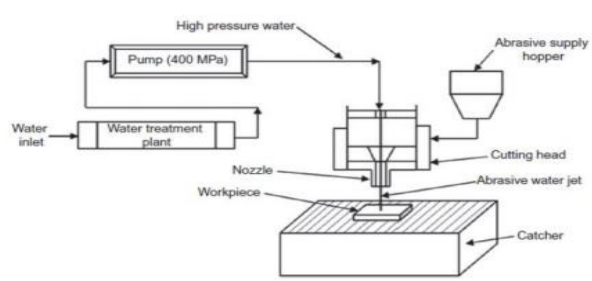

Figure 5: Abrasive-Water jet Milling

The advantages of abrasive-waterjet machining over conventional machining methods are listed below:

- The AWJM process produces very small stresses and negligible heat and is suitable for heat-sensitive materials such as plastics.
- The process is suitable for cutting complex contours on wide range of materials.
- The process has the capability to cut thin pieces with least bending.

4.5 Electrochemical Grinding

The development of combined electro chemical machining and grinding was to obtain a material removal process for difficult-to-cut aerospace alloys and other cemented carbides material. The combination of ECM and grinding is more beneficial than conventional grinding due to small residual stresses, great depths of cut, and increased life of wheel . The combined process also performs better than ECM process as it greater material removal rates can be realized by combined grinding and ECM. In ECG, a rotating grinding wheel is work as a cathode . When the wheel comes closer to the workpiece, its abrasive particle contact the workpiece surface and a gap is created between the workpiece and the wheel.

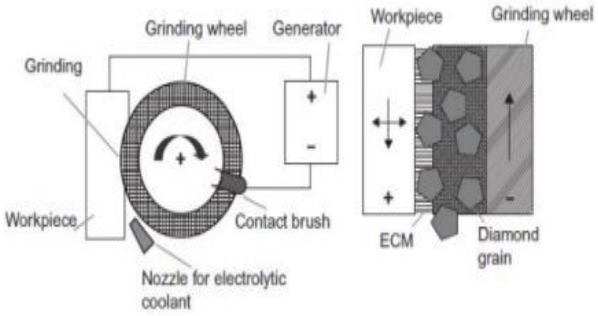

Figure 6: Electrochemical Grinding

V. CONCLUSION &FUTURE SCOPE

Aviation, aerospace, medical and military industry demand advanced materials like ceramics, sintered carbides, titanium alloys, nickel alloys etc. These materials are difficult to shape and difficult to achieve satisfactory efficiency and proper part surface quality that will be acceptable for practical applications. In finishing operations satisfactory results are often obtained by application of EDG and ECG. Smaller values of surface roughness are often reached by application of electrochemical grinding. Combination of allowance removal by discharge or electrochemical dissolution and abrasive grinding enables:

1. Increasing of machining efficiency in respect to classical EDM and mechanical grinding.
2. Reaching satisfactory properties of surface layer and geometrical structure of surface.
3. Decreasing abrasive grain wear and increasing of the wheel lifetime.
4. Wheel self-sharpening phenomena.

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