1. Introduction and Scope

Though new manufacturing processes that revolutionize the landscape regarding the rapid manufacture of parts have recently emerged, the machining process remains alive and up-to-date in this context, always presenting itself as a manufacturing process with several variants and allowing for high dimensional accuracy and high levels of surface finish [1–3]. Indeed, machining has numerous aspects that constantly need to be investigated due to the constant evolution of materials to be machined, the materials and geometry of tools, and the evolution of coatings normally applied to the tools’ surfaces [4–6]. In view of this evolution, the parameters used in machining also need to be optimized, thus contributing to increased attention by researchers in this area of manufacturing [7–10]. In fact, metal alloys have significantly evolved in terms of properties, which poses additional challenges for research [11–13]. The market’s demand for new alloys that need to meet increasingly demanding requirements is a constant, thus creating a greater diversity of alloys in the market and new challenges in their processing in order to achieve the characteristics required by customers. When the requirements are truly challenging, it becomes necessary to make polymeric or metallic matrix composite materials, creating even more demanding challenges in their processing that have further expanded the research field in the machining area [14–16]. Composite materials still have a huge margin of progression in terms of research, which will also allow the scientific community linked to the manufacturing processes to continue to have a lot of available topics to explore. For example, the chip that can be formed during the machining processes has been the subject of several studies because chip formation provides valuable and useful information about the way the machining process is being conducted and can provide information on the problems related to its removal from equipment and occupied space [17–19].

Dry machining has always been a great challenge [20] because lubrication causes environmental problems [21] and, in some cases, is not even allowed. Thus, aspects related to lubrication in machining have also been widely explored by using techniques that seek to minimize the use of lubrication (minimum quantity lubrication) [22, 23]. On the other hand, the need to increase productivity levels has not only resorted to the science of materials and technological processes to offer the industry the necessary means to produce with the necessary quality at increasingly competitive costs but also captured the attention of the industrial engineering field [24, 25]. This has led to numerous research projects aimed at the development of models and procedures that allow for the optimization of all operations involving machining processes, as well as some tools used in the process itself, such as more advanced jigs [26].

Recently, new research opportunities have opened up because machining operations are largely linked to the concepts of Industry 4.0. In fact, the operations traditionally developed between equipment can be integrated by using computer systems with greater decision power, making the whole production process much more agile [27, 28]. The concepts of Industry 4.0 have also made it possible to develop other areas around machining, namely the concept of “machine learning,” which allows for the creation of standard figures...
that can be recognized by equipment and thus allowing for greater integration between CAD (Computer-Aided Design) and CAM (Computer-Aided Manufacturing) [29,30]. Similarly, the measurement operations of tools and machined parts bring new challenges that are also being scientifically explored [31]. The vibration index and cutting forces developed in tools, which naturally evolve with wear, can also be properly monitored to bring added information to the process and allow for the automation of tool change decisions or maintenance interventions for equipment [32,33].

Bearing in mind all the previously mentioned factors, it is easy to realize that there is innumerable research to be continuously developed in this field of investigation. Thus, this Special Issue intended to gather contributions from different authors in the field of machining, allowing for its easy dissemination and thus contributing to an increase of knowledge of the scientific community that works hard in this area.

2. Contributions

The contributions received for this Special Issue are high-quality and show how active the research around machining processes is. Three of the studies contained in this Special Issue are related to the chip formation and cutting behavior that are registered during the machining process. In the work “Assessment of Chip Breakability during Turning of Stainless Steels Based on Weight Distributions of Chips” developed by Du et al. [34], the breakability of the stainless-steel chip is studied in the turning of these alloys by using a new methodology: the weight distribution of chips. This methodology was shown to present very consistent results in the evaluation of the way a part is trimmed, thus allowing one to perceive the machinability of a given alloy and allowing for a comparison with similar ones. The study was developed on an AISI 316L alloy, using one without treatment and another with treatment and showing that the treatment drastically modified the breakability of the chip. Even though the chip looked very similar for both cases, the developed method showed that the obtained results were significantly different, showing how this methodology can be useful in other analyses. On the other hand, the work entitled “Predicting Continuous Chip to Segmented Chip Transition in Orthogonal Cutting of C45E Steel through Damage Modeling” performed by Devotta et al. [35] integrated dynamic strain aging in the Johnson–Cook model, which is usually used to modelling machining processes, while also using the Voyiadjis–Abed–Rusinek approach. In this way, it became possible to predict the transition from a continuous chip to a discontinuous chip regarding the widely used C45E steel, depending on the rake angle and feed rate while keeping the cutting speed constant. The main outcome of the study was to discover that chip segmentation intensity and frequency are sensitive to fracture initiation strain models. Additionally, using the finite element method, but now based on an AA2024 T351 aluminum alloy, Muhammad Asad [36] studied the influence of the tool’s geometry, namely hone and chamfer, on chip segmentation and burr formation. The study demonstrated an increasing trend in the degree of chip segmentation and end burr as hone edge tool radius or chamfer tool geometry macro parameters concerning chamfer length and angle increased. With the development of this work, a model that helps in the definition of the best tool geometry and the optimization of the cutting parameters was obtained, with the aim to increase productivity, minimize the formation of burr, and avoid the formation of a continuous chip. The quality of a machined surface is also present in this Special Issue. In order to minimize the problems reported in the quality of finishing of aluminum parts, Rubio-Mateos et al. [37] studied the introduction of elastomeric systems to support parts to be machined, with a view to dampening any vibrations during the finishing process of soft materials. For this, nitrile butadiene rubber (NBR) was used. A suitable flexible vacuum fixture was also developed, allowing for the easy implementation of the system in the manufacturing process. Different sets of parameters that varied the degree of compression imposed on the flexible system were tested, verifying that it perfectly accommodated these variations. Thus, the main outcome of this work was the establishment that the milling operations of the AA2024 alloy can benefit from more flexible fixations to the
detriment of very rigid jigs. Del Sol and Rivero [38] also investigated the parameters that could give rise to skin panel and thin plate components obtained by machining, thus eliminating the need to use chemical milling in the manufacture of parts for the aeronautical industry because the rigidity presented for this type of parts is quite low. The study was essentially conducted by using the experimental pathway, measuring the cutting forces that developed during the process and keeping the surface roughness within the imposed limits. The correct selection of the cutting parameters led to a 40% reduction in the thickness variation of the components and a 20% decrease in the cutting forces, which makes the clamping process of parts easier. The study also resulted in the creation of a model capable of monitoring the quality of the process based on the measurement of equipment power consumption. The work of Berzosa et al. [39], entitled “Feasibility Study of Hole Repair and Maintenance Operations by Dry Drilling of Magnesium Alloy UNS M11917 for Aeronautical Components,” also investigated the best set of parameters to be used for drilling holes in magnesium alloys, which are increasingly used in the aeronautical, aerospace, and even automotive industries. The study of the parameters allowed for an improvement of the surface quality obtained in holes made in that alloy, mainly in repair or maintenance operations. Additionally, based on the aeronautical industry, Martín Béjar et al. [40] investigated the macro-geometric deviations reported in the turning of a UNS A97075 alloy, verifying that the parts provided with a lower stiffness presented a greater sensitivity to macro dimensional deviations when adjusting parameters. It was once again verified that feed speed is the parameter with the greatest influence on the deviations recorded during the turning process. Based on the obtained results, models that allow for the prediction of macro dimensional deviations as a function of machining parameters were presented. Bañon et al. [41] carried out a quality study of the cut surface in structures composed of different materials. In that case, the abrasive waterjet cutting of a mixed structure of CFRTP (carbon fiber-reinforced thermo-plastic) with steel was studied, which presented quite different behaviors under the same cutting conditions. Two different stacking configurations were studied to investigate different sets of parameters that would lead to lower levels of roughness in waterjet cutting when using abrasives. The experimental work made it possible to draw several diagrams that enabled the correlation of the cutting parameters with the cut surfaces’ quality. The sustainability related to the machining processes is also represented in this Special Issue. Indeed, sustainability can be explored in its most diverse aspects because productivity is fundamental but environmental impact—with important factors such as power consumption, the minimum use of lubricants/coolants, and social issues in which health conditions at work and ergonomics must be respected—cannot be ignored. Iqbal et al. [42] investigated the use of cryogenic coolants in the machining of the Ti6Al4V alloy, which is widely used in aeronautics. At the same time, they tried to optimize the parameters with a view to minimizing the consumption of tools by acting on the parameters of the milling process. As main outcomes, it was found that micro-lubrication was more effective than cryogenic cooling with CO₂ or liquid nitrogen; it could increase tool life while also improving the surface quality of machined parts, reducing energy consumption, and reducing the overall cost of process. These authors also verified that the high levels of cutter’s helix angle and cutting speed clearly contributed to an increase in process sustainability. Diaz-Álvarez et al. [43] also investigated new cutting parameters in the turning of the Haynes 282 nickel alloy while avoiding the use of lubricants/coolants. The used coated tools allowed them to optimize the cutting parameters, making it possible to obtain roughness values in the machined parts as low as those obtained using lubricants/coolants. The proper selection of parameters also kept the cutting forces as low as those obtained with lubrication, as well as extending the tools’ life. In this way, the process can become more environmentally sustainable without jeopardizing product quality or economic sustainability.

In addition to the aforementioned works, this Special Issue also presents two wide-revision works [5,8], one on the use of coated tools in turning and another that performs an in-depth study of the literature on TiAlN-based coatings for both the turning and
milling processes, focusing on coatings developed around that same coating, providing information on recent uses of these coatings and what elements are used in the fabrication of these types of coatings, showing their mechanical properties, and providing information on their machining performance and application. Each of the reviews is based on more than one hundred references, thus allowing for the deepening and discussing of innumerable ideas taken from a wide range of works. These works constitute a great base of work for MSc and PhD students who are starting in the area by providing (in a concentrated way) a wide range of knowledge in these areas, from the cutting performance of various coated tools in machining processes to the study of the different wear patterns and mechanisms that these tools suffer during the machining process.

3. Conclusions and Outlook

Through the research collected in this Special Issue, it can be noted that there is much work regarding the machining process, in its most diverse aspects, to be continuously carried out because there is still a huge margin of progression in almost all aspects of machining. In this Special Issue, some excellent examples of the most recent developments in this area are shown, with special emphasis given to optimizing parameters, increasing the quality of machined surfaces, and improving the sustainability of the process. Very important information is also provided regarding tool coatings, with a view to extending cutting tools’ working life, which will certainly be useful for those who conduct research in this area or for young students who want to start their studies in this field of knowledge.

The continuous search for greater productivity in machining and for increases of tools’ working life (always based on the improvement of the global sustainability) will lead to more and more research in this area that will continue to be collected and disseminated, thus allowing this process to continue to be competitive and capable of producing high-quality parts. Thus, the research around machining processes will surely remain challenging.

Conflicts of Interest: The author declares no conflict of interests.

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