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International jewellery design and product development specialist, Biagi has collaborated with renowned companies and organisations, such as the World Gold Council, Design Group Italia, Degussa, Esprit. She teaches at the European Institute of Design and Turin Polytechnic in Alessandria, and is the author of various Trend Books and articles published in specialised magazines (L'Orafo Italiano, Retail Jeweller, Ottagono). She regularly holds seminars and conferences on Strategic Design, the development of innovation and Trends in technological symposia and specialised seminars. Winner of the Gold Virtuosi 2, Biagi has participated as jury member for several design competitions and is a Fellow Member of the Chartered Society of Designers, UK.

*The application of new technologies is one of the key elements of product innovation. In the jewellery sector today we are at the beginning of a new revolution, as it integrates cutting edge technical progress. The selective melting technology is already being used for production of non precious objects and has given the possibility to improve functional and aesthetical qualities of products. Now it is possible to create gold, silver and steel products taking advantage of PLM direct manufacturing. In this presentation new style trends are analysed focusing on the aesthetical characteristics, production parameters and the high potential of SLM jewellery pieces.*

# STYLE TRENDS AND DESIGN WITH THE ARRIVAL OF THE NEW PLM TECHNOLOGIES

The development of new production solutions that were even unconceivable was recently allowed through the application of avant-garde technologies and the development of high performance materials. During the last few decades new scenarios of design development have been made possible. Entire urban landscapes and our environment are being reshaped with a new aesthetical language. This is characterized by fluid lines and complex geometries that often become visible structures. A three-dimensional character is evidenced by a multilayered alternation of empty spaces with organic volumes. We can speak of a revolutionary technical and aesthetical progress that consolidates in our present times and is destined to convince even the most skeptical public.

In architecture, urban planning, transport and products in general terms, a completely new project process is evolving. The creative concept uses ever evolving computer programmes with the aim to recreate the self-generative capacities of complex life systems into new manufacturing technologies. Intelligent mechanisms, methods and systems are being developed following the laws of nature. Artifacts are constantly upgraded to better adapt to their environment. The scope is to enhance the qualities of spaces and things by transferring natural parameters into digital codes, using mathematical schemes derived from organic systems. There is an ongoing research regarding the use of algorithmic processes applied to digitally controlled manufacturing technologies. At the same time new solutions for sophisticated mechanisms and composite materials are integrated in order to give the right responses to the innovation quest. We are talking about a combined use of last generation plasters, ceramics, metallic alloys, resins, plastics, derivatives from glass and natural fibers.

Sustainability, energy saving and the harmonic coexistence within the living environment are main focuses of creativity and the development of innovation today. The aim is to find the best solutions compatible with our ecosystem and the demands of our society. The style character of objects is the result of the most suitable and convenient processes as the best answer to the project setting. As such, these processes correspond to even self-generating parameters and its outcome appears harmonious and balanced. Shapes and lines gained through this creative process normally become a part of their environment and are perceived as beautiful, but often they break with current conventional standards and traditions.

This evolutionary approach leads to the construction of structures and mechanisms that are interactive, differentiated, intelligent, transformable, organic. These are logics of systems that find new solutions in all manufacturing sectors. This leads to the emergence of an inedited style language that is taking place in all sectors, from medical to transport and architectural. In fact, an emblematic example is the innovation process taking place in architecture during the last three decades. Before this the architectural design was rather static based on plane surfaces arranged by 90° compositions, using straight lines.

The creative minds of some specialists have pushed boundaries to find new solutions and managed to find an innovative response to the demand for a better ergonomics, eco-system adaptability, and together being. Jan Kaplicky, Amanda Levette and the work of the Future Systems studio, Frank Gehry, Zaha Hadid are some of the architects, that even in the controversy, provoked progress and moved technology forward to find innovative technical solutions to previously unthinkable structures and shapes.

A similar evolution is evident also in other sectors, including home and personal products, such as telephones, furniture, sports, fashion and inevitably, also in jewellery. As example we can observe it in the polyfaceted Crystal Palace collection of Swarovski developed in collaboration with designers and architects or in the illumination solutions proposed by Corian from Du Pont and in the furniture collections from Magis or Moroso using polycarbonate, polypropylene and 100% recyclable materials.

The end client is exposed to these aesthetical developments going on in all areas and products that are part of his/her life. If we talk about socio-cultural and style trends we realize that it is only natural that the public seeks the emerging aesthetical language also in personal ornamentation. It is only a matter of time that fluid shapes, open worked volumes and three-dimensional solutions become popular also in the world of jewellery.

Design scenarios change in the jewellery sector while technological innovation is being integrated in the manufacturing cycle. The arrival of direct manufacturing with Powder Laser Melting (PLM) in the jewellery sector represents a deep and revolutionary change. The production of fine jewellery pieces through this selective laser melting process offer a great development potential. Today we are at a fascinating turning point of progress that requires a change of thought. It requires a shift in the way we conceive objects and challenges our technical and creative skills.

An important advantage of the direct Powder Laser Melting technology is the simplification of the manufacturing process. If compared to other manufacturing techniques and specifically with the casting technique, the process stages needed are significantly reduced (Fig. 1).

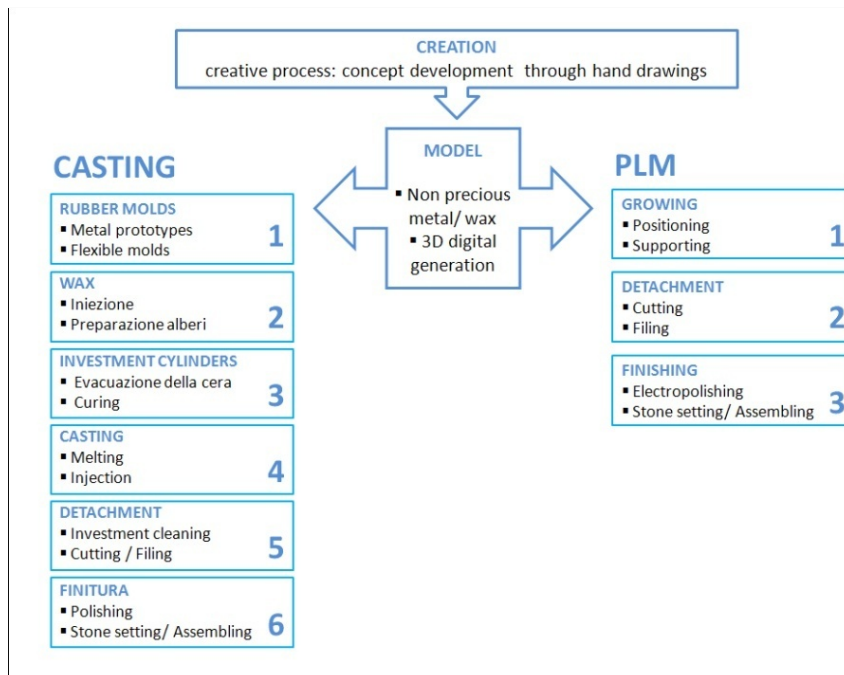


Fig. 1 Comparative scheme of production phases in casting and PLM techniques

Concerning the required abilities of professionals to implement the PLM technology we can also see some significant variations when compared to production made with casting (Fig. 2). This change of skills corresponds to the general scenario of our times, in which innovation is based on digital technologies. Today, the creative designer has to be able to develop innovation using 3D digital instruments and the machine operator is not a traditional jewellery technician or jeweller any more, but an informatic technician. Jewellers and stone-setters are required only in the final assembling, polishing and stone-setting phases.

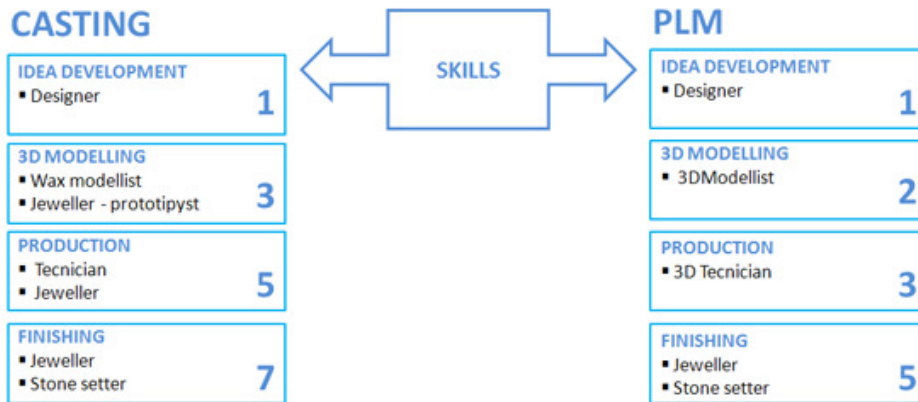


Fig. 2: Required professional profiles

During the creative process it is fundamental to have an in-depth understanding of the object construction dynamics. The PLM technology does not impose the usual limitations as opposed to the processes that require metal stamps or rubber moulds, such as in the pressing and casting techniques. Without the presence of any kind of stamps there are no restrictions regarding free shapes and three-dimensional solutions. In fact, this technique, which is based on powder melting, opens the possibility to produce complex volumes with intersected, intertwined and interlinked elements. PLM allows the production of inedited jewellery pieces with a highly innovative aesthetical character(Fig. 3) .

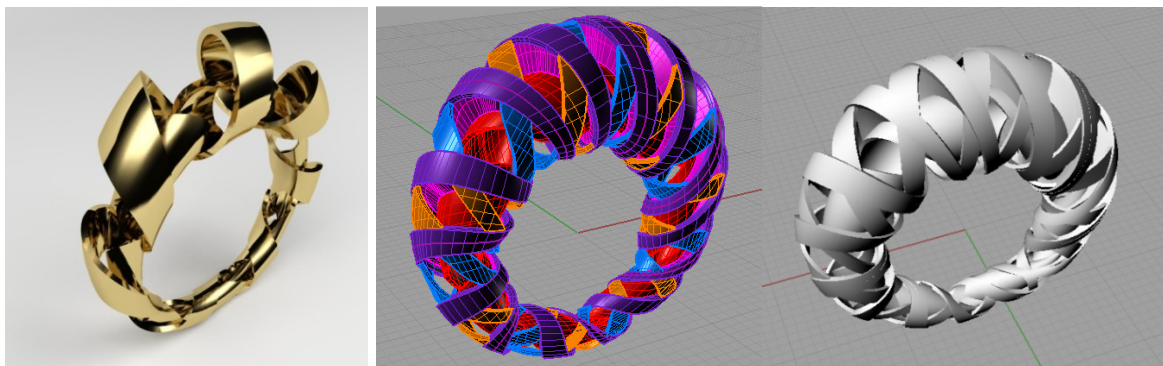


Fig 3. Jewellery pieces with complex shapes

Designers and new product developers always have to keep in mind that the PLM direct manufacturing process is possible through the sequential layering of a melted alloy powder. The “growth” of the melted object takes place within the remaining non-melted powder.

The model to be produced requires an accurate positioning into the area in which it will be grown as well as a supporting structure. These procedures are prepared in 3D digital format and are comparable to the preliminary supporting phase in rapid prototyping. Optimization during these stages is very important to get best quality results within the minimum time and cost of production. The positioning of the 3D model and the good distribution of its supporting structures have to take in consideration also the time it takes to build the shape. It is in fact a 4D reasoning, as it has to take in consideration the 3 spatial dimensions and the 4<sup>th</sup> dimension of time.

It is of crucial importance to give enough attention to the initial phases of concept development and design of objects. During these project phases the relation cost/quality of the produced items can be significantly improved,

and its added value can be therefore risen . The more jewellery items will be conceived following the PLM production parameters, the more commercial success they will have.

The constructive logic of production through sequential layering is best performing when shapes follow the growing principle. Ideally the object's base is more robust and the structure of the object is self-standing, so that the melting process becomes homogeneous. From the creative point of view it is evident that inspiration is to be taken from nature transferring parameters and patterns from organisms (Fig. 4) into the new designs. This is true for what the shape of jewelry items is concerned and also its way of growing, as well as the way these new objects get related with their function and their environment.

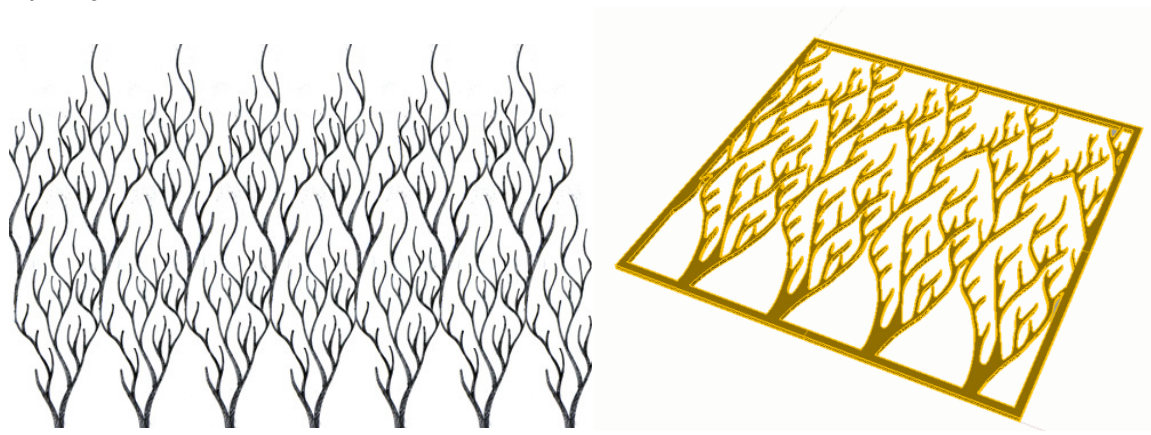


Fig. 4: Pattern vegetale

In this context we analyze how a design can be modified in order to optimize production. The example bellow shows a ring that takes advantage of the possibilities of PLM manufacturing. The ring shank is formed by 3 stems joint together in the lower area and then flowing separately and intertwined towards the upper part of the ring. Stems finish in bold leaves that hold a central gem. In this first proposal two of the six leaves lean on the ring shank and needed to be supported by an additional lateral structure (Fig. 5).

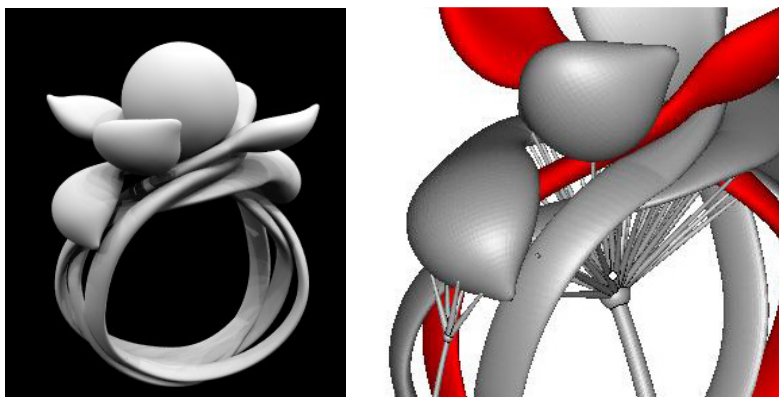


Fig. 5: Ring with additional supportino structures

The design of this jewellery piece was modified without changing its creative concept with the aim of eliminating supplementary supporting structures, optimizing its growing process and production costs. In the final ring (Fig.6) all leaves are turned towards the top creating a self standing shape. This ring 3D model offers the possibility to use different gems and presents several variations on the colours an materials.





Fig. 6: Ring with self-standing structure.

As for all manufacturing technologies, the creative concept of objects grown with the PLM technology has to follow precise building parameters. The more these parameters are respected, the better the final quality will be. Wall thicknesses of the jewellery items can be very thin, but from the point of view of overall quality, it is recommended to use thicknesses between 0,3 mm and 10 mm. When wall thicknesses below this are used, the volume of the object does not correspond with the idea of weight that people have and the general public does not perceive the quality of the piece and preciousness of the metal any more. Furthermore, depending of its shape, the jewellery piece can become too fragile and in any case stones cannot be set.

Wall thicknesses from 0.2 mm in all precious alloys tested until now are compact and resistant. It is therefore possible to produce gold and silver jewellery with any desired alloy. These jewels present a rather rough surface and should be finished with electropolishing and further brush polishing. At 3D model generation it is necessary to take in consideration the superficial layer of material that will be removed during polishing.

In PLM each object is manufactured based on a digital programme and without any stamp or mold, so it is possible to produce jewellery pieces (i.e. necklaces and bracelets) with some or even all elements different one from each other (Fig. 7). Differences can be in terms of size, shape and/or the ornamental pattern. The fact that each element is different does not significantly affect the final cost of the piece.

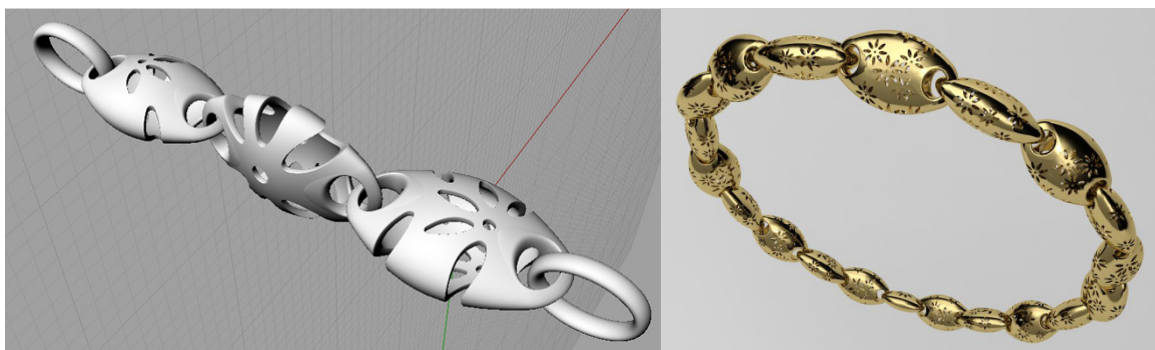


Fig. 7: Bracciale con elementi diversi

The variation versatility of objects and their elements is a characteristic of PLM technology, that multiplies the possibilities of formal solutions. The PLM technology not only opens up the space for creativity, but allows even the production of one-of-a-kind pieces on a large scale and to offer exclusivity for the general public. This means that with a slightly higher project cost we can offer a highly personalized service that corresponds with our clientele desires and the general market trends.

As mentioned before, direct manufacturing through alloy powder melting represents a deep innovation change of products. This new manufacturing process based on digital technologies gives jewellery companies the possibility to create new product lines in tune with current style trends and with the client's expectations. The great creative potential of PLM also in combination with traditional manufacturing technologies and handcrafted techniques is still to be explored and exploited leading fine jewellery to become a high quality, fascinating product; unique jewellery pieces capable of reflecting today's international taste.