

**Beatriz Biagi**  
Beatriz Biagi Design

International jewellery specialist, Biagi has collaborated with renowned companies and organizations, such as the World Gold Council, Design Group Italia, Degussa, Esprit. Production manager for high-end jewellery and design consultant, she is author of various international Jewellery Trend Books and articles published on specialized magazines. She has been visiting Professor for Jewelry Engineering Master Course at Politecnico di Torino in Alessandria and has held numerous seminars and conferences on Strategic Design, development of innovation and Trends in universities and organizations, as well as in technological symposia. Winner of the Gold Virtuosi 2, Biagi has participated as jury member of diverse international competitions and is Fellow Member of the Chartered Society of Designers, UK as well as of the Istituto Gemmologico Italiano.

*The digital revolution is evolving quickly, changing the rules of the game for production, communication and commercialization of goods at an international level.*

*Jewellery has become the focus in the new maker scenario, as experimental products feature spectacular shapes, rich openwork patterns, algorithms able to create forms that weave together into convoluted, complex shapes and structures that could never have been made before. These objects have been engineered down to the finest details and reflect the immense potential for innovation, but often fail to become genuine pieces of jewellery.*

*In this presentation, Beatriz Biagi explores the potential of new technologies for the design and production of jewellery that can be a valid answer to the needs and expectations of the end customer. Analysing the product and commercial trends, Biagi looks into the design parameters and critical elements to be considered in Jewellery Design.*

# “Design and production of digital jewellery: the parameters for innovation”

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## INTRODUCTION

The question today is no longer whether digital technologies are right for the jewellery industry, but rather how they can be used to enhance production capacity and satisfy the client's expectations.

When I say digital jewellery, I mean jewellery that is partly or entirely designed, modelled, prototyped and/or assembled using CAD/CAM technologies (integrated computer-aided design and manufacturing systems) and which is the result of merging physical and computerised processes. Because it represents a revolutionary innovation, digital jewellery deserves an in-depth analysis. In my abstract, I dared to describe it as: “objects that have been engineered down to the finest details and reflect the immense potential for innovation, but often fail to become genuine pieces of jewellery.” To explain this statement, I need to look at two aspects: First, the expectations and trends of the contemporary customer and second, the evolutionary state of the product itself. These two analyses contribute to defining the short- to medium-term trends and allow explaining the design parameters needed for a correct creative process in jewellery innovation.

## EXPECTATIONS AND TRENDS OF THE CONTEMPORARY CLIENT

In the last decade, we have seen the globalisation process consolidating and the popularisation process of digital technologies accelerated. In fact, technological devices have now become protagonists in everybody's lives. Contemporary lifestyles are extremely dynamic, increasingly intercultural, and boosted by the widespread presence of technological equipment. On the other hand, lifestyles are now increasingly dispersive and superficial. The democratisation of luxury, the polarisation of the markets and the fragmentation of client segments, together with a rising awareness of environmental problems are characteristics now widely consolidated everywhere in the world.

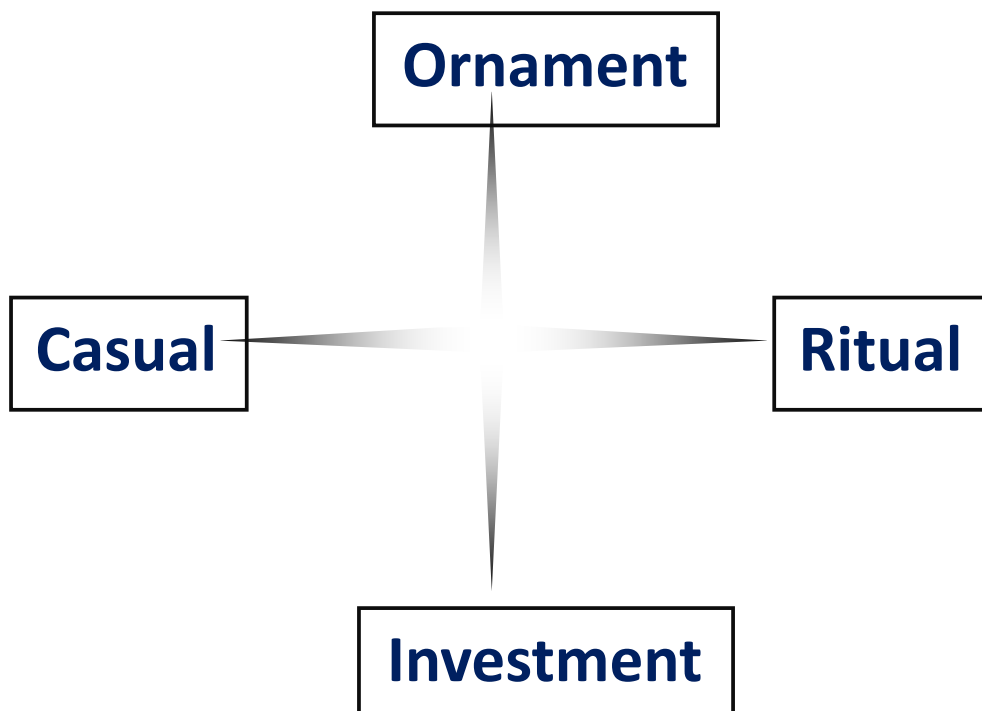
In general terms, we can say that nowadays innovation bursts into society and is integrated into the community's collective habits more rapidly and with greater permeability, even in the most unthinkable environments and places.

It is well known that some innovations are taken up easily, while others are harder to adopt, being slowly accepted over the course of one or more generational changes. At this point, we should consider two things that I feel to be crucial to our sector: on one hand, the fact that jewellery has strong ties to century-old traditions, and on the other, the fact that today we are facing a generational turnover of workers and consumers.

It is important to understand that from now on and for the coming decade, there is a window of new opportunities, given the generational changeover. In the next decade, the generation of “Millennials”, represented by people born between 1980 and 2000, will be in employment age. People who are currently between 15 and 35 represent an army of new consumers of videogames, films, music and accessories. A genuine wave of hedonism, strongly hinged around social networks and with a strong propensity towards building virtual relationships. Youngsters shaping their self-esteem through online popularity (which is measured with “likes” and view numbers), who develop an idea of privacy that is completely different to that of previous generations. And on top of this, with an uncontested predisposition for everything that can be done with an internet connection: studies, entertainment, business, etc... In fact, the demand is for everything to happen in a virtual environment, immediately and flawless. It is a fast-moving, elusive world that encourages users to feel powerful when it comes to decision-making, creating, and exerting influence over a public audience. Figuratively speaking, I like to see “tablets” as silver platters offering everything one could possibly desire. And behind these silver platters there are expert teams, research and implementation projects from big enterprises working non stop to make all this happen. Researchers, programmers, engineers, designers, lawyers, doctors, philosophers, teachers, and sociologists: all working in the development new possibilities and new knowledge applications.

The jewellery sector remains anchored in tradition, requiring long time to adopt innovation. This is both, its strength and its limitation; it is simply its intrinsic feature, specially when talking about precious jewellery. In any case, we have come to the historic moment in which the jewellery industry is opening its doors to the new opportunities that digital technologies offer for innovation in every field, from product development to marketing scenarios.

After this brief introduction, I would like to analyse the expectations of the contemporary jewellery customer, who is undergoing a strong evolution with the arrival of the “Millennials”, but who still maintains close ties with his/her own cultural traditions. This analysis involves mapping out the main segments of the jewellery sector, based on the motivations customers have to buy and use jewellery.



On the horizontal axis we see the different attitudes of use: on the right end of the axis ritual jewellery pieces are positioned, while on the left end, we find the casual jewellery. By ritual jewellery pieces I mean jewellery conditioned by specific cultural traditions and following given social rules, hence worn on special occasions, such as marriages or births. Casual jewellery is driven by individual, even spontaneous choices without any traditional limits and often worn simply as a fashion accessory to complement the personal look.

The vertical axis shows the role of jewellery as an economic asset/investment, or purely as an ornament/ style expression.

The area of traditional jewellery seeks precious items as store of value and investment meant for special occasions, (birth, dowry, engagement, marriage, anniversary or graduation) and is present in the most important markets, such as India and China, which together represent more than 50% of the world’s gold and diamond markets.

The area of popular jewellery is represented by items with low added value and not necessarily used as traditional or religious symbols. This kind of jewellery meets the need to preserve the intrinsic value of the materials it is made of, but it represents something more spontaneous and easy to wear.

Prestigious jewellery has a higher added value due to the story it brings with it. Typically, it is a piece made by a renowned brand and a special asset is attributed to its creator, on top of the appreciation it has for both, its intrinsic and its aesthetic values.

The area of jewellery that is sought after purely for aesthetic and ornamental value detached from any traditional conditioning, becomes an expression of the character and style of the wearer, whose attitude is the most innovative.

Up to a decade ago, these areas were quite delimited, both in terms of product and geography. Today these four main areas of the market overlap one another and the boundaries between them are blurred. In the same communities and territories we can find two, three or even all types of purchasing attitudes and the one person may reveal all four types of expectations towards a product, not just in the course of his or her lifetime, but also simultaneously, at a given point of time.

This means that it is no longer possible to group clients in categories divided by geographical zone, income, age, or education level, as once was. Today, segmentation must take in consideration the attitudes to the buying experience and the use of products, being aware of the fact that the same person may fall into more than one category even at the same time. This also means that lifestyles have become globalised and transversal and client segments or niches are formed by people making similar choices while having similar habits and interests, rather than formed by clients just living in the same geographical area or with the same age or purchasing power.

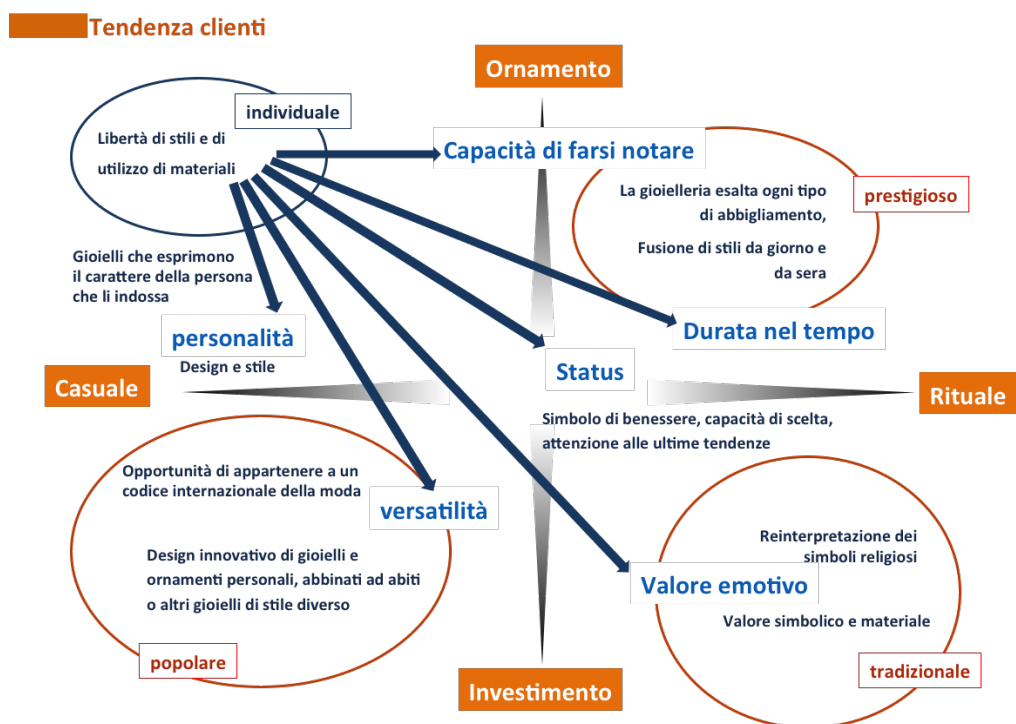
Without having to look deeply into the further customer segmentations in each one of the previously described international macro

areas, clear general trends emerge in our sector, following the general trends of many other product markets: the consumer wants to express his/her individual character and has both the ability and the means to interpret cultural traditions, status symbols, prestige and popular taste, in his/her own, unique fashion. Today's jewellery clients are able to choose without limits, interpreting use and customs in their own, personal way. We should remember that in any case, it is a matter of choices guided by the search for the intrinsic value of the materials, the versatile use of popular jewellery, of brand and designer jewellery, but always giving more importance to the emotional value of one's own choices. The expression of the individual character has also been found previously in the choice of jewellery reflecting membership of a specific group, a social class, which will last over time or which is part of a marriage dowry or even of jewellery of religious value.

The result is that today we have much more freedom when it comes to using synthetic materials in luxury products with high added value. We can see fusions of casual and formal ware, the development of precious jewellery in precious materials in designs that have been freed from their archetypal and ritual symbols. The result is a genuine mix of cultures, attitudes, values and styles that no longer correspond to the schematic layout of the still prevalent production chain in the sector. Finally, there is the desire (and the capacity) of end customers to play an active role in the creative and production processes, to mould their own feelings, and give a shape to their individual expression.

This changing process is not immediate, in spite of 3D printers, and more in general, digital technologies are rapidly shaping a whole new reality: the digital revolution.

However, very soon, a new business scenario will be developed for customised products. This no longer means just a phenomenon of "masstige" (mass prestige) or a process of the democratisation of luxury items, which we first saw establish itself in the 90s. It is also the capacity to offer and sell single products on a wide scale. A scenario that has become crucial specially when referring to products that are not consumed, which are worn and which are full of emotional value: jewellery. A commercial scenario with significant numbers, where anyone can have a customised range of unique, exclusive products.



It is important to point out that digital technologies allow us not only to customise the output, and develop a wide range of models that communicate directly with the client, but also input, or in other words, the information as needed to process individual requirements. Thus, with the right tools, from a customer contact channel, it is possible to obtain and store personal, morphological, and ergonomic data as well as information on individual preferences. With the implementation of the required systems and tools, we can process this information and immediately commence production "on demand". And this means that, supported by synchronised systems to manage logistics and customer services, we can systematically sell one-of-a-kind products.

We are faced with a profound transformation of the production and sales system, which is happening in every sector and which requires the renewal of whole company frameworks in order to make the most of the competitive advantages involved and even more importantly, to meet customer expectations.

## THE PRODUCTION-COMMERCIAL SCENARIO FOR THE JEWELLERY INDUSTRY

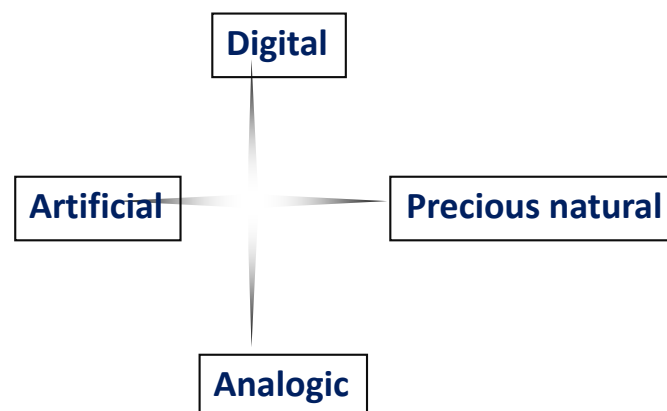
We find ourselves in a historical period of transition, in which there is a combination of analogue and digital experiences and knowhow are combined, and which, in my opinion, is one of the richest, most fertile moments in the history of applied art. The fascinating dimension of the so-called maker culture is now born: it is an area that has taken shape and revolutionised the product world, applying digital innovative methods and instruments that are now accessible to everybody. Materials and technologies continue to evolve and the production – business scenario is undergoing a profound transformation.

Contact with clients becomes increasingly direct and companies can establish one-to-one dialogue with consumers, independently of their geographical location in the world. With digital information technologies and communication, businesses can and must transmit stories built around each product line, promoting it through the many different routes online. The client or end consumer can interact with businesses and with a high number of other customers or potential consumers, becoming communicators of messages and potential opinion leaders. The spontaneous choice and customisation of a product by a client may turn into a capillary sale of goods and services, immediately and without limits to geography. Production is increasingly “on demand”, requiring notable organisation in terms of logistics during the production and assembly stages, as in the distribution of the goods, whereas waste and storage costs can be drastically reduced.

The general public can and wants to be a part of the design and construction process, becoming at the same time the co-creators of the goods and services they use and consume and, being users and producers, or “producers”.

Our sector is in an embryonic stage. It has already adopted digital technologies in some production areas, but the modus operandi of many companies in the the supply chain as well as the selling channels are still based on the framework developed in the analogue world. Cutting-edge technologies, such as scanning and direct production are already available to the industry, but there is no sales support that uses their full potential. Recently, processes have been developed to improve some essential aspects for the jewellery trade, such as the quality of the finishes and surface treatments, although there is still a need for research and very much room for improvement.

To analyse the current jewellery scenario, the following map was used to outline the product through its material and production processes. The horizontal axis represents the materials used; at the far right we find natural precious metals and stones from high-end jewellery (gold, platinum, diamonds), and at the far left, artificial materials, including plastics and synthetics. The vertical axis shows the type of manufacturing technique used, starting from the bottom, with analogue techniques and getting to the digital technologies at the top. We have the items made entirely by hand, using traditional crafting techniques (openwork, embossing, filigree, granulation). Then there are jewellery items made using technology - now widely used for production (such as moulding, electroforming, and micro fusion), arriving to the application of the most recent technologies (laser engraving and cutting, CNC milling, protofusion, 3D modelling) and to cutting-edge direct manufacturing technologies (stereolithography and sintering).



By positioning some examples of well-known brands and designers into this map, we can identify the different specialisations in our sector and explain the vast difference in products that form the great “jewellery” family. In other words, we can define jewellery itself, which presents itself in profoundly different ways, from the aesthetic and formal viewpoints, as well as in terms of materials, finishing quality and price.

Analyzing the configuration of this map we can observe the macro areas that stand out for the types of materials used (precious and non precious) and which have clearly different characteristics in terms of security and manufacturing process: gold and diamond jewellery and fashion jewellery.



The high-end jewellery pieces are made exclusively in precious materials and using traditional artisan techniques, such as, for example, the jewellery of Buccellati, or with some technological input, but always with an extremely high contribution of artisan workmanship, as in the cases of Scavia or Palmiero. The majority of jewellery brands and high-end jewellery concerns, such as Bulgari, Cartier, Tiffany, Damiani or Van Cleef & Arpels has integrated digital technologies into their production processes, improving quality and optimising working times. However, they continue to maintain the hand-crafted processes, that are essential to obtain the extremely high quality that high-end jewellery requires, such as assembling, setting, finishing and in some cases, modelling and prototyping (especially when dealing with figurative subjects).

The production chain for precious jewellery now mainly integrates 3D modelling and laser engraving, cutting and welding; prototypes are directly grown using mainly stereolithography and DLP (Digital Light Processing) technologies and protofusion (direct prototype casting).

Mechanised working methods are fully in use for mass-produced jewellery. In this area, the technological input in the production process is essential to maintain high quality standards at lower prices, as for example, in some collections by Damiani, Pomellato or Marco Bicego, and by the majority of companies that have made Italian jewellery a worldwide success from the the post-war period onwards.

The mass-produced jewellery category also includes synthetic materials in combination with gold and silver, as done for example, by Pandora.

If non-precious alloys are used, we then are in the field of mass-produced fashion jewellery, such as the Swarovski, Majorica or Swatch product ranges.

At this point, we should take a close look at the low end mass production, especially with regards to digital design, which is often used for the development of precious and fashion jewellery. Today we can use modelling software that is increasingly user friendly and filled with ready-made elements. Settings, links, hinges, gem cuts, predisposition of prongs and pavé drills, are just some examples of the variety of elements contained in today's powerful modelling programmes. Unfortunately, the potential of this highly sophisticated and specialised software is often not used to the full potential, so that new jewellery collections on the market are the result of repetitive and monotonous combinations of pre-shaped elements. This standardized, anonymous jewellery lacks beauty and charm except maybe for the gems fitted, but unfortunately, these are often also of low quality. This kind of new product development is neither innovative, nor based on design and for sure it's not the expression of a new maker culture, but it's just a rough way to cut costs and maximise profits by selling large amounts of low quality items. As a designer, I find it very important to point out the lack of value - in terms of style - of this type of productions.

If a fashion jewellery piece is not made using industrial techniques, but rather by hand, we have an endless number of crafters who make pieces with beads and low-cost findings, with more or less refined aesthetic qualities. This area includes ethnic productions by many populations of the world, which in some cases can become very fashionable, as currently are the works of the Huichol Indians of Mexico.

We also have the designer jewellery area, in which creators tend to work with materials of any type and experiment with their transformation, in order to obtain unique items with great artistic value, such as the creations of Barbara Uderzo, Annamaria Zanella or Michael Zobel.

With the arrival of direct manufacturing technologies and the recent consolidation of digital modelling, we now have a new category on the market scene: 3D jewellery.

The areas of 3D growing quickly are: digital craftsmanship, direct manufacturing and integrated craftsmanship.

Digital craftsmanship bases its creativity on CAD technologies and experimentally explores new means to conceive shapes. Digital artists propose limited editions of items in gold, silver, steel or other metals, focusing on the potential of digital design and exploring the various digital modelling tools. As far as production, new technologies already adopted in the gold industry are used (3D prototyping, protofusion, laser cutting) together with casting and the more traditional finishing processes, as in Stefania Lucchetta's proposals. The protagonists of this type of jewellery often come from traditional goldsmith backgrounds and have a highly developed sensitivity towards the objects they create, being able at the same time, to develop their own creative language through virtual modelling.

We should pay close attention to the work of Nervous System, which explores digital technologies in the fashion and accessories fields. They make and sell unique items, customised on request and with the direct contribution of the end client through web platforms.

For what direct manufacturing in metal is concerned, sintering technology is apt for both precious and non-precious alloys. In this area, I can use as example my own jewellery pieces grown and presented by Legorgroup at VicenzaOro three years ago, made with PLM (Powder Laser Melting) in gold and silver. Sintered fashion jewellery present in the market today is usually made of

thermoplastic polymers (polyamide-nylon) or polyamide/metal or silicon powder mixed materials using the SLS (Selective Laser Sintering) technology. Independent designers and digital artists in representing this area, such as Bethsheba and new brands like maison 203, .bijouettes or monomer, work mainly on the miniaturisation of digitally created shapes. An interesting example of work that is already more articulated is the recent collection proposed by Olimpia Aveta for Just99, using UV stamping on sintered nylon to improve the sensorial quality (visual and tactile) of the item itself and allow customizing collections through the applied 2D patterns.

Recently, proposals of what I call integrated handcrafted collaborations have started to appear. As an example, I can quote Ipnotix, using the application of crystal gems by hand on the sintered accessories, and the work of Silvia Weidenbach, who uses direct manufacturing techniques and traditional goldsmithing techniques on the same item. This area is destined to expand quickly, the more 3D designers will work together with goldsmiths and companies in the jewellery sector will implement suitable processes for the assembling and finishing production phases.

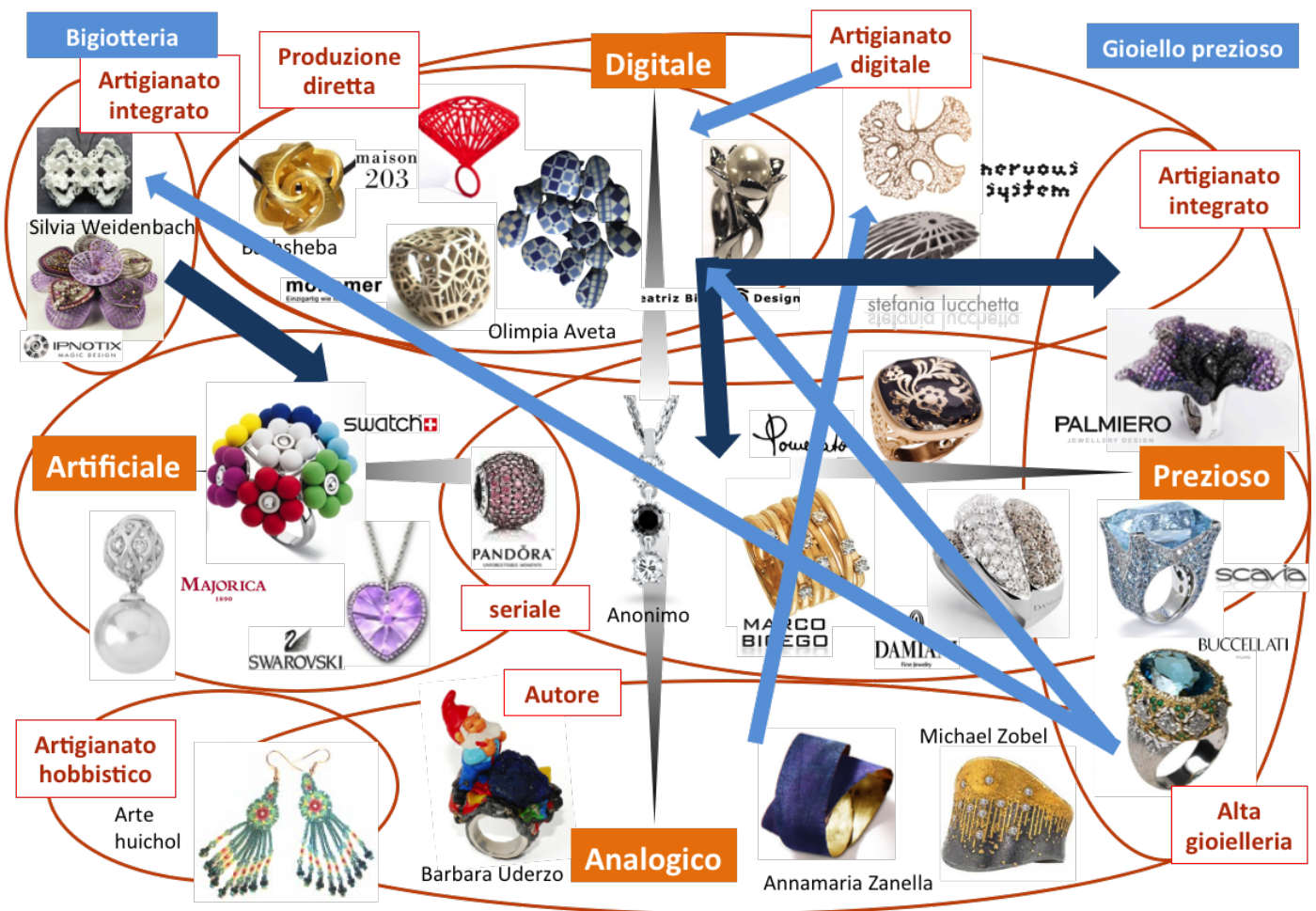
We are in fact in the initial stages of building a new production chain that involves dynamic professionals, able to dialogue innovatively with the end client.

Boundaries between the described product areas will become increasingly blurred and items will become more and more hybrid, as the jewellery industry becomes increasingly digitalised. Based on knowledge contaminations, which in part are already occurring, between analogue and digital craftsmanship, there will be an increasingly successful collaboration between highly specialised goldsmiths and digital experts with the direct manufacturing facilities. The area of 3D jewellery will continue to grow, expanding into every area of jewellery and mass-produced fashion jewellery, and even the exclusive area of high-end diamond jewellery and of designer jewellery.

Using the product mapping I illustrated earlier, it is possible to highlight flows of knowledge, technical and creative contaminations and the most immediate or ongoing market trends, which may not yet be known to the general public:

- a) The leading figures of high-end analogue jewellery will find more and more synergies using PLM or SLM direct manufacturing technologies in precious metals, which in turn will be taking up increasing amounts of space in mass produced jewellery and into the world of high end diamond jewellery combining digital technologies with traditional methods.
- b) Designer jewellery will expand into the digital area, dialoguing with the ever evolving software, and vastly enriching the style features of jewellery items designed in virtual environments. This new and more developed style expression will influence all areas of jewellery, starting with the direct manufactured objects. We will soon see the first analogue craftsman's proposals experimenting with the use of digital modelling software for the creation of unique items high-end jewellery, produced with direct manufacturing technologies and finished by hand.
- c) The integrated craftsmanship in fashion jewellery will expand into mass-produced collections, requiring the collaboration of craftsmen specialised in the traditional goldsmith techniques.

## Tendenze prodotto



### REDEFINED PARAMETERS OF DIGITAL JEWELLERY DESIGN

According to the previous analysis, trends show that jewellery is increasingly designed with the aid of 3D modelling software and/or made with additive and direct manufacturing technologies. It can be made of both, precious and non-precious materials. The design parameters for the creation of contemporary jewellery are determined by the following aspects: physical (material, weight, volume, malleability, resistance, form and colour), ergonomical (typology, size, wearability), social (function, symbolism, emotional value, economic value, durability), technological (production processes and their integration) and commercial (added value, selling channels, promotion, customer service, guarantees).

When developing a new product, all of these parameters need to be defined beforehand and complied with throughout the design process to achieve the required results, coherently with the social and economic context to be approached. In other words, to develop the product that features the quality requested according to the values it reflects.

We cannot conceive a piece of jewellery in electric blue nylon for the wedding dowry of a bride in Bangalore, just like there is no sense in selling a piece of diamond jewellery at a beach stall in Ibiza.

When we talk about "jewellery", people have a precise idea of what this must be and represent. This personal idea derives from the cultural notion of what jewellery represented throughout previous generations and is matured in each individual through his/her life and experience within the social context. In every cultural context, jewellery is synonymous with luxury, beauty, and durability, featuring religious symbols, magic attributes or representing love and personal memories. Precious jewellery remains the archetype of personal ornamentation, to which also fashion jewellery is associated. This is the reason why fashion jewellery, even if made of poor materials, is capable of evoking the same values and expectations as precious jewellery, especially to what its aesthetic value and finishing quality is concerned.

Of crucial importance for the success of any new product is the degree of client acceptance, which is in turn influenced by a brand's communication capability.

We can talk about a strategic design and marketing methodology, of an holistic approach to product development, able to position innovation in target markets through the efficient dialogue with the end client; a virtuous circle that leads to the success of the



product and its brand (whether this is a large company or an independent designer). The better informed a designer is with regard to all of these aspects, and the more involved he or she is in the processes, the more correct and convincing his design project will be. And this will mean better success for the company.

With the use of 3D modellers to conceptualise and materialise ideas, designers become modellers. Designing objects that are produced using digital technologies requires a complete different way of conceiving them. As well as having a good 3D modelling software knowledge, it is necessary to have a strong familiarity with virtual environments. This might seem obvious, but the first hurdle to overcome in CAD modelling is the development of good abstraction skills, along with the ability to project and evaluate the physical presence of a virtual item.

The most obvious characteristics to be aware of are the physical parameters of objects, meaning the characteristics of the materials they will be made of and all technical specifications concerning thicknesses to be kept to guarantee the necessary strength, item dimensions to be kept in order to suit its function and the ergonomics of the human body; weights and prices resulting from the volumes modelled, the functional properties of integrated mechanisms and links, the visual effect of surface treatments or texturing to be applied to the finished item.

Fundamental is the in-depth knowledge of production methods and the ability to integrate construction principles into the design itself, defining the position of the item within the environment in which it will be made, its supporting structures, considering the path the light beam will take, and foreseeing everything, as far as possible, in order to optimise the production process and simplify the successive cleaning, assembling and finishing stages.

A good ability to foresee the output of the digitally designed products regarding all technical issues, requires knowledge gained through research and working experience. For this purpose it is very useful to assess results through the evaluation of intermediate models.

FDM (Fused Deposition Modelling) printers, which have affordable prices and running costs, make these testing stages easy, offering the opportunity to create low-resolution intermediate models quickly and at low cost. Through this control process it is possible to verify an item's formal characteristics and to test its functions. It is an essential study for any digital modeller who, working in a virtual environment, will not instantly learn about the physical aspects of objects and materials, as the traditional craftsman actually does, working directly on the material through his "analogue" techniques.

It is true that digital tools are increasingly intuitive and user friendly, bringing the physical and sensorial experience closer during the creative process. This is the case of the haptic modelling, to say it in other words, the 3D modelling based on a virtual sense of touch. We can see the first results by craftsmen who have begun to use this modelling method, such as Silvia Weidenbach, whose results are very interesting and still within the field of the experimental ornamentation.

It is necessary to dedicate resources, time, and commitment to design and planning, from the initial research and conceptualisation stages, the development of proposals through testing prototypes, through to the conception of a large number of variations and customised products.

Previously, I pointed out the growing need of clients at every level, to own customised, bespoke products. This is probably the type of demand that emerged more recently, adding to the other, ever-present needs, such as the requirement of best quality, wonderful design, good price, reliability and durability.

We have tools with an enormous and not yet fully exploited potential. As I mentioned before, too often we use programmes to make modelling easier by copying and pasting ready-made elements for mass-produced, standardised collections with no soul. The result of this approach with no design strategy is the trivialisation of jewellery which often remains anonymous, far from the emotion that the client seeks, wants to experience and expects.

We already have the possibility to meet personal requirements and develop individualised proposals of substantial meaning and fascinating in terms of style, which however, find no positioning in the production and retail systems, to which the jewellery industry is still firmly anchored.

Innovation today come from independent creatives and visionaries, small entrepreneurs, new craftsmen, self-made and dynamic businesses, that are creating their own new communication paths, their own alternative selling and promotional channels, without having to succumb to the established organisational systems of the sector.

The direct manufacturing collections on the market today are not yet represented by gold jewellery nor made by traditional companies. These proposals have been created by architects, industrial designers and digital artists; "makers" (new artisans), who dare and self-produce, often using manufacturing services, collective selling platforms and social networks, in order to get notoriety. We currently find simple products that often present no integrated mechanisms or hinging systems, have no sophisticated finishes and are not articulated with the complexity with which jewellery is normally made. Often they are not even conceived as real pieces of jewellery with their entailed ergonomic aspects and social roles, but they become pure formal exercises in the search for new expressions of artificial intelligence. So we can find stupendous patterns and structures created by self-generating algorithms, which miniaturised are placed around the wrist or hung from a chain to form pendants or charms. Mini sculptures that explore the infinite possibilities offered by the digital language, but which hardly become something more than experimental explorations. The

sensitivity of the goldsmith, the experience of the craftsman and the skills of the expert is needed to confer a sense of jewellery to these digital constructions. Therefore it is fundamental to promote the collaboration, dedication and creative synergy generated by interdisciplinary teams, capable of integrating traditional aspects with the potential of the digital innovation.

The design parameters of 3D jewellery are both subjective and objective, as the parameters of traditional jewellery. It is very important that the designer is given the possibility to approach digital modelling with the same patience and dedication as in the traditional craftsmanship.

The designer / modeller needs to be able to understand the sensorial characteristics of the item being created: colour, weight, tactile quality of its surfaces. He or she needs to be familiar with the resistance of the materials, mechanisms and the way in which the different parts can be assembled. He/she needs to know all specifications regarding gem setting, ergonomical and wearability aspects, the types of embellishment that can or should be applied during the finishing stages, working time and costs, the targeted client segment. It will be even better if he/she is able to underline the intrinsic characteristics of the production process in his or her designs.

The designer / modeller must also be able to convey into his or her idea, the dimension of preciousness that jewellery evokes, due to its intrinsic nature. Therefore, it is essential for the designer / modeller to be aware of the emotions that the materials, shapes, symbols and finishes convey. And not only this; he or she needs increasingly to be skilled in dialoguing with the clients and interpreting their needs into new objects, as they increasingly take part in the creative process of the items they desire.

The characteristics of the identity and potential of 3D products differ from what the client is used to, risking not to be appreciated if not properly explained. The digital industrial revolution is a total cultural revolution in which not just the designer, but also the technical engineer, sales expert and public in general are confronted with new languages, new possibilities to explore, new risks to assess. There is the need of creating synergies of interdisciplinary collaboration aiming at further development materials, improving precision, dedicating resources and time to all of the stages of production and commercialization processes: from modelling to production, assembling and finishing, from logistics to the communication with the end client.

Everything still rotates around a perception of quality in relation to its price and the function of the product. Digital technologies make it possible to achieve perfection in reasonable time and at reasonable costs. In certain cases, the construction of the object is so perfect that it becomes too mechanical and therefore it is less appreciated as it has lost its "human touch", the sensitivity and artistic expression that the "analogue" craftsman transmits through his hands. In its perfection, Nature is able to express individuality through tiny imperfections while implementing its generative principles. The "perfect imperfection" is the great beauty of nature and the excellence of traditional craftsmanship, which can be missed in 3D design. Corners, wall thicknesses, volumes, and mechanisms need to be rethought throughout, looking at every detail in terms of style and construction. We face a new aesthetic language which is profoundly different from the known. The "perfect imperfection" of items made with additive technologies is different in its nature and is often not understood or appreciated; 3D objects are still widely perceived as items made with low quality materials and finishes, with poor functionality, and above all, with a high price, which definitely does not correspond to its poor performance. The most obvious feature is the porosity of surfaces in sintered items, which is not acceptable to the majority of trade operators and the end user.

Finishes are often one of the main features to make the difference between a successful piece of jewellery or fashion jewellery and one that is badly placed. Alternative and poor materials are accepted if the finishes are good. Finishes and material assembling have always been the subject of study and research. Over time, all of the mechanical processes, such as stamping, soldering or casting, have achieved extremely high levels of sophistication, notably improving the quality of the finished product. Mechanisms have become increasingly refined, achieving high operating precision. We should remember that the technologies of direct manufacturing and the alloys used are very recent and constantly developing, meaning that their potential for development and improvement is enormous.

Today we are in a unique point of time, rich of evolving expertise and in profound transformation; a fascinating moment from the design perspective. It is an historic occasion, in which digital innovation lives alongside the "analogue" excellence, and where the experience of traditional techniques, forged over thousands of years, meets digital innovation.

Training schools should not provide only basic notions of some modelling programs, but they do have the task of teaching the vast richness of all complex, articulated notions that have been achieved over the thousands of years of jewellery making history. It is essential to awaken the student's interest in research and in looking deeper at his/her own path, which will lead him or her to evolve throughout their profession.

We are observers and artificers of the integration process between physical and virtual realities. A window of a decade (or more, if we are capable of preserving traditional knowhow), in which production will become increasingly hybrid to reach a highly performing level of sophistication never seen before, while still using the skills of old-school master craftsmen. Combining traditional techniques with digital technologies will bring in new contents and revolutionise the world of jewellery.