Technology is irrelevant to Jewellery Design—or is it?

Dr. Christopher W. Corti
Director, International Technology
World Gold Council, London, U.K.

Introduction

Market research shows that today's women want innovation and quality in their lives, and this applies to the jewellery they wear—or want to wear. It should be of good quality and workmanship as a matter of course and, importantly, be of innovative design. It may even demonstrate exciting "new" effects. It should also be made in an environmentally friendly and safe manner. One thing is clear to all of us in the jewellery industry—we understand the importance of innovative design in our business. Without innovative design, we risk losing our competitiveness and our business.

Jewellery design is generally considered solely from an artistic standpoint, and the jewellery is viewed as an expression of a designer's artistic talent. How does technology fit into this scenario? Certainly design and technology are involved in making jewellery, but are they linked? What is the relationship between design and technology? In this presentation, I will try to explore this relationship in terms of jewellery manufacture, with some emphasis on technology's role in innovative design. I hope to show that technology is not irrelevant to creative design, and that each feeds off the other.

The Link Between Design and Technology

As many of you here will know, I am a metallurgist by training—a technologist whose job it is to disseminate the technology and best practice of the materials and processes used in manufacturing jewellery. I am not primarily concerned with jewellery design and my artistic talents are very modest to say the least!

However, I cannot help but notice "good design" in the jewellery that I see at jewellery fairs and design contests around the world. It is the artistic aspects that catch the eye. It is not often that I admire a piece of jewellery from a technology viewpoint. That said, World Gold Council held an international gold jewellery design competition last year, "Gold Virtuosi II," with the winning designs announced at the Vicenza Fair last June. This is the first occasion that I know of where prizes for good use of technology in the winning designs have been given. So that fact alone would suggest that there is a link between design and

technology. John Wright and Valerio Faccenda, who are well known to participants at the *Santa Fe Symposia*, were involved with me in judging the technology prizes. We were a little disappointed that none of the winning designs really stretched jewellery technology to its limits and beyond.

As a technologist, the link between design and technology has interested me for some while, and I have tried to determine what this might be. In this context, I use the term "technology" to embrace both machine-based processes and the top-class handcraft skills of making jewellery in the traditional way. Both approaches require a good understanding of gold's properties and capabilities if we are to employ our manufacturing skills to good effect. Anticlastic raising is, perhaps, a particularly good example of hand skills in a technology sense. It can only be achieved through understanding the material and its mechanical behaviour.

There is a parallel here with artists in other fields—the painter, sculptor and potter, for example. A painter of pictures has to understand his materials and his tools—the canvas, the paints and the way they interact, the various painting techniques, the hand skills, the importance of light, perspective and combinations of colour and so on, if he or she is to express his/her ideas in the way desired. The same is true of a sculptor or a potter making ceramic wares. Thus, it is self evident, I hope, that to make a piece of jewellery to a good standard of workmanship requires the designer to have a good understanding of the materials, tools and techniques used to make that piece, i.e., to have a level of technical competence. This is an obvious and first link between design and technology—that execution of a design idea leans on technology to bring it to fruition.

To elaborate on this point, here are some additional points to note:

Firstly, I believe it is important for designers of jewellery to understand the various technologies and what opportunities and limitations they can offer in design terms. Many goldsmiths and jewellery companies will have experience of interesting "paper" designs from designers that cannot be made, in practice, economically. Likewise, many investment casters will have experience of pieces, designed to be investment cast, that are not castable.

I will also remark at this point that it is important that manufacturers attain a good physical quality in their jewellery product, i.e., good workmanship and finish if the design is to be considered successful. This, too, requires the use of technology, both materials and production technology, and it is a major reason why World Gold Council undertakes its various technology programmes, for example, publication of *Gold Technology* and the technical handbooks, as well as carrying out technical seminars around the world.

When we talk of jewellery design, we must remember that there are two aspects to design. We tend to think of jewellery design solely in terms of artistic design, and most computer-aided design (CAD) systems used for jewellery design work from this artistic approach.[1] The growing use of CAD by designers illustrates another aspect of the link, that is the use of technology to facilitate artistic design and speed up the process. Speed to market, is of course, facilitated by the complementary Rapid Prototyping technology.

However, we should not forget that there is also an engineering dimension to jewellery design. Like motor cars and aeroplanes and other engineered products, jewellery needs to be serviceable and fit for the purpose for which it is intended. Jewellery needs to be engineered! It needs to be sufficiently strong to withstand the handling it receives. Some jewellery such as herringbone chain needs to be flexible and not kink during use. Spring catches need to be durable and operate reliably. John Wright has discussed this aspect here earlier at the *Santa Fe Symposium* in 1997 for those of you wanting more depth.[2] Designing jewellery for ease of manufacture is another dimension to this. So engineering design is another link between design and technology. This is an aspect largely ignored in the industry, as John and Timo Santala have discussed.[2]

Innovative Design and Technology

Let me further develop the link. Take the concept of innovative design and the desire for products with attractive shapes and effects, and its link with technology. We should understand that technology can play an essential part in achieving innovation in design.

The classic tension ring, developed by Neissing in Germany, was a major design innovation some years ago, since copied and adapted by many others. Its production is only possible by a detailed understanding of the mechanical properties of gold, and how they can be controlled to hold an unmounted stone safely in place without any support apart from the compressive force exerted on it by the ends of the ring. Thus, this innovative design depends heavily on the use of technology. I will develop this theme shortly.

We have already noted the first link between design and technology, namely:

Link 1 The practical realisation of a design requires the use and understanding of technology—both in materials and manufacturing processes.

However, in discussing the link in terms of innovative design, I would suggest the following additional links are also valid:

Link 2 New technology can open up new design opportunities, and;

Link 3 Design demands can stimulate the development of improved technology.

These are particularly important points for designers of jewellery, and I shall focus on them in the rest of my presentation. A simple illustration of link 2 is the combination of colour to achieve novel effects. The slide, Figure 1, shows mass-produced jewellery in the striated multi-coloured golds produced by Mitsubishi, tradenamed "Diagold." Other, more elaborate effects are possible, based on this simple concept, known as mokume gane, Japanese for wood grain. Some are shown in sheets in the next slide, Figure 2. It depends on the ability to bond layers of different coloured golds (and other metal combinations) together, and further working them after sectioning and rebonding in complex ways. It is clearly useful in making hollow jewellery by stamping. However, it is difficult to envisage how one might utilize it in investment cast pieces, for example, suggesting a limitation of the technology. However, one could contemplate its use in wire for chain making, for instance.

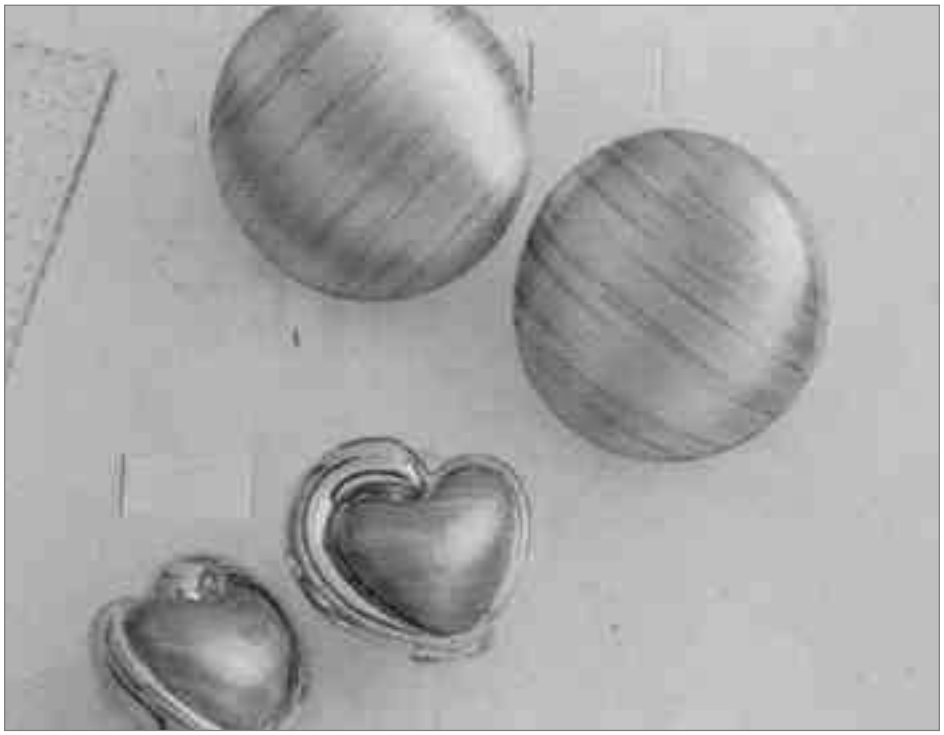


Figure 1 *Jewellery in "Diagold" multicoloured materials (Mitsubishi Materials Corporation, Japan)*

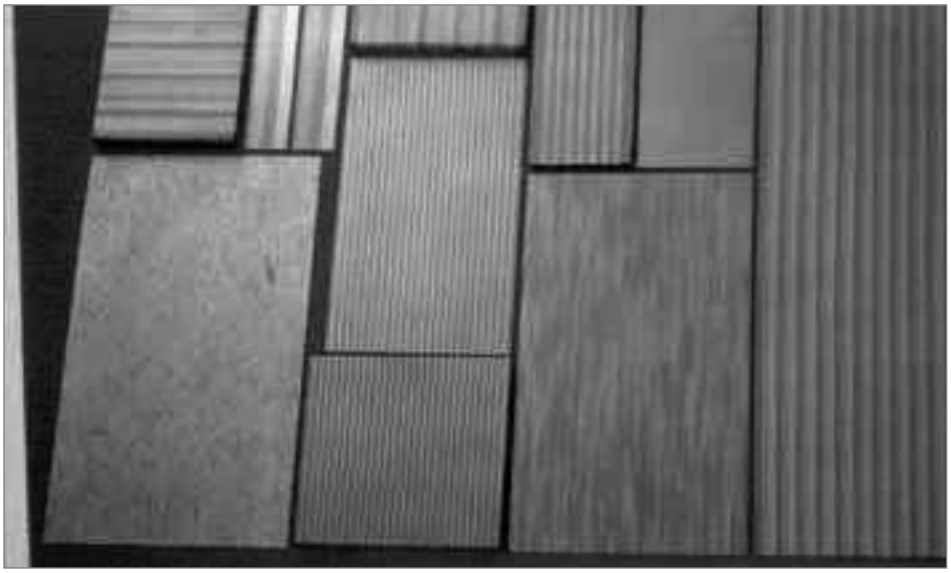
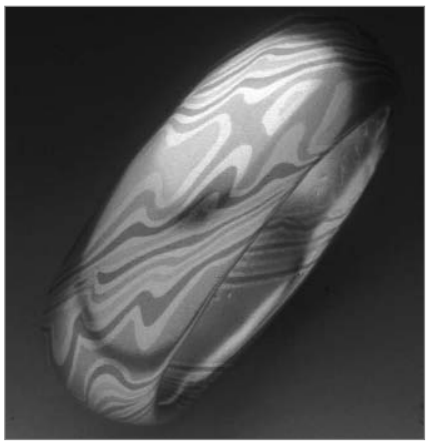


Figure 2 *Carat gold sheet materials in various wood grain patterns (Mitsubishi Materials Corporation)*

The handcrafted equivalent of these machine-produced materials is the old Japanese technique of mokume gane. I show some modern jewellery using this technique in the next two slides (Figures 3, 4), which are by James Binnion in California, who spoke on his work at Santa Fe last year.[3] The rings are in 14- and 18- carat golds and silver. Each pattern is unique and is individually crafted by the jeweller. The design opportunity this technique affords the designer is very obvious.



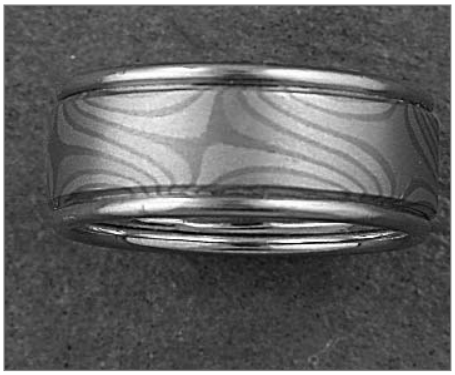


Figure 3 and Figure 4 *Mokume Gane rings in 18 karatyellow/14 karat red and palladium white golds and silver by James Binnion*

Technology Enabling New Design Opportunities

In this section, I will look at some new (and not so new) technologies, both materials and process technologies, and show how they also afford design opportunities. I will use several of these to demonstrate how they might also be used to create mokume gane type colour combinations.

Electroforming

I will start with a process technology—electroforming. This is a technology that has been around for a long time, although greatly improved in recent years, as I discussed in a recent *AJM* magazine article.[4] It is important to visualize electroforming as a unique process, and not simply an alternative to other processes such as stamping or lost-wax casting. Each technique has its strengths from a design viewpoint. Electroforming offers unique opportunities for creative designers, and some jewellery manufacturers, such as Charles Garnier in

Paris, France, have built a reputation for quality electroformed jewellery. For thin, hollow, lightweight, voluminous and complex three-dimensional shapes, electroforming is unsurpassed. It can enable designs to be realized at affordable prices that are not possible by other techniques.

For the individual craft designer, it also allows unique jewellery to be made. One can replicate natural objects—leaves, flowers, shells, nuts, cobwebs, for example—as well as create interesting shapes from manmade objects. Some examples of creative design by Marianne Ridge in the U.K., illustrate this capability. The example in Figure 5 shows one of the prize-winning designs from the recent WGC international gold jewelry design competition, Gold Virtuosi, a suite of electroformed jewellery, based on replication of leaves, by Ewa Rudowska of Poland.

Figure 5 *Gold Virtuosi prize-winning design made by electroforming*

Typical applications for electroformed jewelry include earrings, pendants, brooches, chains and necklaces, charms, clasps and bangles, as well as decorative artefacts and statues.

From the designer's standpoint, it is also possible to consider combining electroforms with other techniques—stamping, lost-wax casting and enamelling, for example, as well as gem stones, corals and pearls. It is possible to set gem stones during electroforming, either by setting them into the wax mandrel, or by using a two-stage technique. Colour, as a design feature, could be encompassed by electroplating the electroform in selected areas with metals such as copper, silver, platinum or rhodium. In this context, the use of the red and white gold

clays with electroforming also raises exciting possibilities, and could enable interesting colour combinations to be produced in gold. The possibilities for creative design using electroforming technology are unique and endless, as I have tried to suggest!

Cable-making

A process technology that is relatively new to jewellery is cable-making which involves spinning many wires together in a helical manner. A recent trend is the use of gold cables in place of chain for neckwear, particularly for supporting pendants. This is an opportunity for designers to break away from the conventional chain neckwear design philosophy. Cable-making technology from the electrical cable industry has been adapted to the requirements of the jewellery industry. Think how the use of different colour carat gold wires in cable-making offers an interesting design option. Maybe, use of wires in Spangold shape memory material could create an interesting surface texture!

Knitting and weaving

Another process technology new to jewellery is knitting of precious metal wires to create knitted metal fabrics. Chain-making technology is also used to create similar chain-mail type fabrics. Several examples of knitting were to be found among the Gold Virtuosi design competition prize-winners. These illustrate the design opportunities available. Furthermore, these technologies, like knitting in wool, could be used to knit coloured gold and other precious metal wire combinations into unique patterns, and thus extend the design opportunities.

On the individual designer front, weaving of wires to produce stunning jewellery has been pioneered by Barbara Berk, Figure 6.

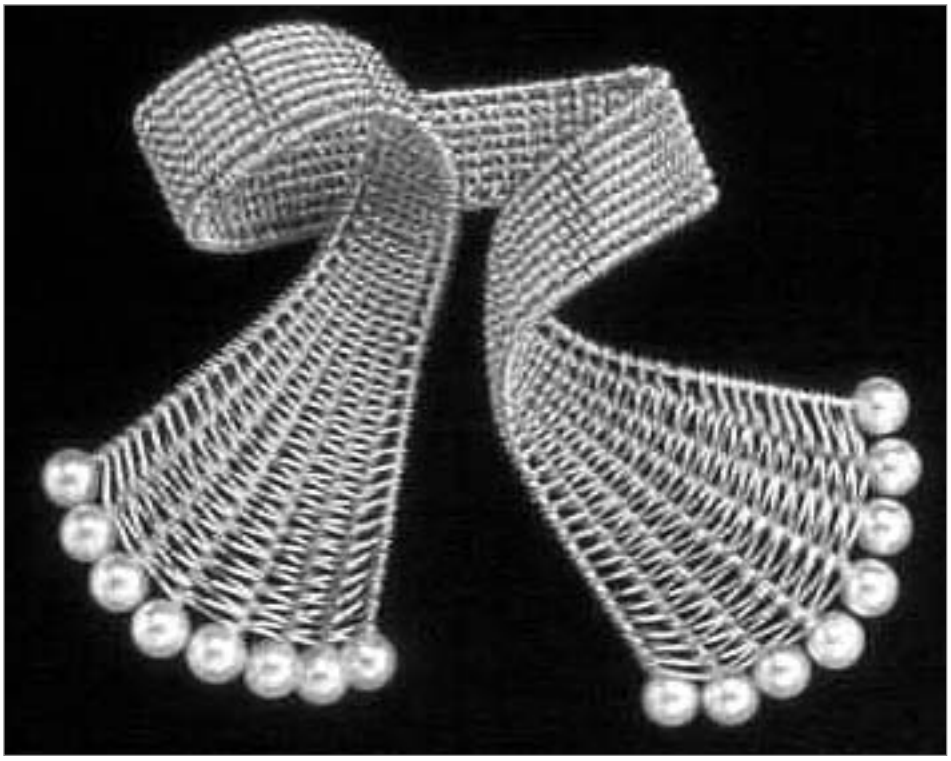


Figure 6 *Woven wire jewellery design (courtesy Barbara Berk Designs)*

Powder metallurgy

A very recent development is the production of wedding rings from precious metal powders.[5] The attributes of powder metallurgy processing to produce net-shaped components is ideally suited to precious metals in that scrap is reduced; scrap is costly in the precious metals industry. Engelhard UK have pioneered this technology using water-atomised powders of carat golds, silver and platinum in a "press and sinter" approach. The resulting rings are quicker and cheaper to produce, and have superior properties.

However, the point I want to make here is that this technology also offers interesting design opportunities. The careful combination of different coloured carat gold powders or combined in layers with platinum powders, for example, could lead to some interesting new design effects. Maybe, it could be possible to make mokume gane type patterns by this technique?

There is a demand to extend the capability of this technology to other less symmetrical shapes. Metal injection moulding (MIM) may be the appropriate technology route to achieve this. This is an example, perhaps, of link 3—design demands stimulating improved technology development. On this point, one

could also envisage the incorporation of conventionally fabricated components and findings into the die, prior to adding the powder, to produce other interesting "composite" products.

Laser technology

Laser technology is being used increasingly in jewellery production, not only for cutting and welding, but also for decoration by laser engraving. This slide, Figure 7, shows one of the technology prize-winners at the recent Gold Virtuosi design competition which illustrates well how lasers, in combination with CAD/CAM, can create interesting design opportunities. This technology opens up interesting design opportunities in mass production as well as for individual pieces. The concept of laser welding for mass producing jewellery with a granulation design has been demonstrated[6], although surprisingly not yet commercialised. This is an ancient technique bought into the 21st century! Again, I would draw to your attention the possibility of combining colours in a granulation design. Some examples of the use of lasers in jewellery manufacture were presented at the *WGC International Technology Symposium* in Vicenza, in 2002[6], and illustrate the opportunities this technology gives in creative design.

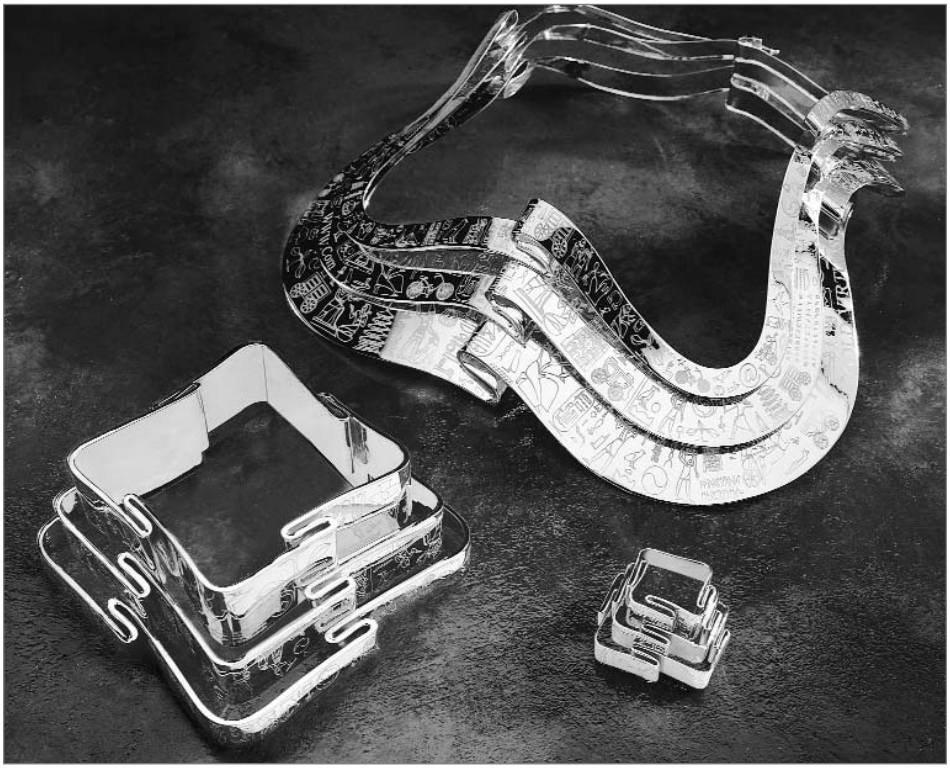


Figure 7 *Gold Virtuosi technology prize-winner showing laser engraved design*

I am now going to turn to some materials technologies:

Micro-alloyed 24-carat golds

Sometimes, we forget that technology imposes limitations on jewellery design. Pure 24-carat gold is an example of such a constraint in that it is soft and weak, and such properties prevent its use in the manufacture of certain products such as Venetian box chain and lobster claws. Typically, 24K chain necklaces and bracelets are connected together by a simple "S"-shaped hook. However, the recent advent of the stronger microalloyed 24-carat golds[7,8] has overcome many of these constraints. Maybe, this is also an example of link 3, albeit indirectly.

Spangold shape memory alloys

Let us look at another recent development that allows a novel surface texture effect—trade-named "Spangold." This is a family of special shape memory-effect alloys in 18 and 23 carat golds that, on heat treatment, give rise to a multi-coloured spangled surface. It is shown to best effect on large flat or curved surfaces. This spangle arises from a rumpling of the surface caused by a change in crystal structure, but is more than skin deep. It goes throughout the bulk alloy and is a reversible effect.

Available in yellow and pink shades in both wrought and cast forms, it offers an exciting new effect that cannot be simulated by conventional treatments to the jewellery surface. This next slide, Figure 8 shows a highly magnified picture of the effect—an array of needle-shaped surface rumples that give the spangle effect. Again, this material is only just being taken up by designers and manufacturers in a limited way. Remember, the jewellery design possibilities can be enhanced by selectively polishing away the spangle.

Figure 8 *Microstucture of Spangold alloy showing martensitic needle structure responsible for the spangle effect*

It is also theoretically possible to make use of the reversible shape memory effect in jewellery design. Maybe for easy gem-setting (and disassembly) or "dynamic" modern shapes that change shape with temperature changes? Interestingly, one Gold Virtuosi prize-winning design claimed use of shape memory gold wire, but its benefit in the design is not obvious to me.

Precious Metal Clays

The new gold and other precious metal clays developed by Mitsubishi Materials Corporation[9] are an exciting development. This material, comprising metal powders in a binder, is literally like potters clay and can be moulded by the same techniques. It can also be moulded in novel ways, and is potentially suitable for mass production of jewellery components and pieces using cheap, easily made tooling. It produces a novel surface finish, although this can be polished to a conventional bright reflective surface. Something of the material's potential in opening up new design opportunities that cannot be achieved by conventional goldsmithing can be seen in the slides, Figures 9 and 10. The beads are hollow and one can texture the surfaces individually by hand using simple tools.

The clays are available in 18K red, yellow and white golds as well as 24K, silver and platinum. You can see, with a little imagination, that it is possible to combine different colours of the gold clays in novel ways and also to combine fabricated components such as castings or wire pins into the clay prior to sintering to produce "composite" pieces. The parallel with powder metallurgy, to which it is related, is evident here. Truly, the design possibilities are endless.

Figure 9 *Hollow bead necklace in gold PMC clay*

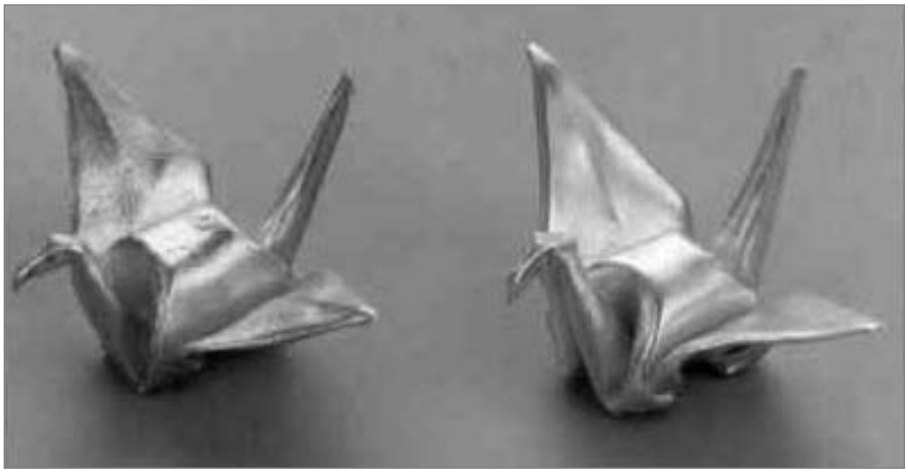


Figure 10 *Origami birds from gold and silver PMC clay sheet*

Concluding Remarks

As I conclude my remarks on technology and design opportunities, I will remind you that the limitations of technology can limit design options, although Philip Poirier, at this symposium last year, did illustrate how some limitations can be used advantageously to create innovative jewellery designs.[10]

I hope that I have demonstrated that design and technology are interdependent in several ways. There is a strong link. Innovative design leans strongly on innovative materials and process technology—as I am sure you will agree. I have particularly focused on how new technology can open up the design options. I have only given you a glimpse of some new materials and process technologies, and how they can be used creatively. The challenge for designers is to look at these and use their imagination to stretch the capabilities of the technology to create innovative designs. From a commercial viewpoint, such creative designs can give a competitive advantage!

Acknowledgements

I would like to thank many people in the industry, too numerous to mention individually, for their assistance and co-operation in providing me with information and allowing use of their illustrations, without which I could not have made this presentation. However, I must thank World Gold Council for their support and permission, and Eddie Bell and the *Santa Fe Symposium* team for inviting me yet again to present at this outstanding Symposium.

References

1 Molinari, L.C., Megazzini, M.C. and Bemporad, E., "The role of CAD/CAM in the modern jewellery business," *Gold Technology* No 23, April 1998, p3-7

2 Wright, J.C. and Corti, C.W., "Manufacturability of gold jewellery related to composition & properties," *Proceedings, Santa Fe Symposium on Jewelry Manufacturing Technology 1997*, p155-172; also *Gold Technology* No 23, April 1998, p27-34

See also Santala, Timo, "The Weakest Link," *Proceedings, Santa Fe Symposium on Jewelry Manufacturing Technology 1996*, p165-186

3 Binnion, James, "Mokume Gane: An ancient technique brought into the new millennium," *Proceedings, Santa Fe Symposium on Jewelry Manufacturing Technology 2002*, p97-110

4 Corti, C.W., "Electroforming by design," *American Jewelry Manufacturer*, March, 2003

5 Raw, Peter, "Gold wedding rings from powder—tomorrow's technology today," *Gold Technology* No 27, November 1999, p2-8; also: *Proceedings, Santa Fe Symposium on Jewelry Manufacturing Technology 2000*, p251-270

6 Valenti, Santi, "Laser applications in gold jewellery manufacture," *Gold Technology* No 34, Spring 2001, p14-20

7 Corti, C.W., "Metallurgy of microalloyed 24 carat golds," *Proceedings, Santa Fe Symposium on Jewelry Manufacturing Technology 1999*, p379- 402; also: *Gold Bulletin*, 32(2), 1999, p39-47 and *Gold Technology* No 33, Winter 2001, 27-35

8 Bernadin, John, "Jewellery manufacturing with the new high carat golds," *Gold Technology*, No 30, Winter 2000, p17-21

9 Takahashi, S., Uchiyama, N., and Nishio, A., "Design opportunities through innovative materials," *Gold Technology*, No 23, April 1998, p12-17

10 Poirier, G. Philip, "Deep-drawing techniques for the small studio/manufacturer," *Proceedings, Santa Fe Symposium on Jewelry Manufacturing Technology 2002*, p451-476

Note: copies of articles in *Gold Technology* can be viewed on the World Gold Council website, www.gold.org in the Jewellery Professional—Technology subdomain.