THE SANTA FE SYMPOSIUM ON JEWELRY MANUFACTURING TECHNOLOGY 2005

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Eddie Bell

Proceedings of the Nineteenth Santa Fe Symposium Albuquerque, New Mexico
THE REVOLUTION OF CAD/CAM IN THE CASTING OF FINE JEWELRY

Steven Adler and Teresa Fryé

In recent years CAD/CAM has seen tremendous growth as an accepted technology in the jewelry industry. As jewelry manufacturers increasingly bring these new methods of design and materials into the daily production arena, the specific relationship between the various CAD/CAM technologies and the casting process has been an area of great challenge.

This paper compares the advantages of additive fabrication manufacturing methods, generally termed Rapid Prototyping (RP), and focuses on the new machine technologies available for producing jewelry quality models in this quickly changing field.

Finally, the materials and techniques used in the casting process specific to RP models are explored. Shrinkage rates, thermal expansion, burnout parameters and surface treatments must all be considered differently from traditional wax model casting.

Mr. Adler is the founder and president of Automated 3D Modeling, Inc. a leading supplier of precision patterns for aerospace, telecommunications, as well as fine jewelry applications. He has more than 25 years of experience in fine jewelry development and has affiliations with the Rapid Prototype Association of the Society of Manufacturing Engineers and the Global Alliance of Rapid Prototype Associations.

PHOTOGRAphIC IMAGES ON METAL SUBSTRATES—TAKING THE MYSTERY OUT OF SUBLIMINAL JEWELRY

Steven Alviti

Sublimation is a chemical term that is used to describe a specific method of printing. For many years this process has been used to imprint all types of fabric articles ranging from clothing to pillowcases. Until recently, equipment and preproduction costs limited this technology to use in high-volume manufacturing.

The advent of new photo processing equipment and supplies brought the technology into the personalized products industry. The most common items produced using sublimation technology are T-shirts and mugs. In a marketplace where consumers constantly demand new products, many other personalized gifts are coming on stream.

Mr. Alviti has 33 years of experience finishing jewelry and holds three mechanical patents related to jewelry manufacturing. He has conducted various seminars for MJSA and SME. His work has been published by AJM and the World Gold Council. This is his fourth year presenting at the Symposium.
PUTTING QUALITY MANAGEMENT AT WORK
IN JEWELLERY WORKSHOPS .................... 37–52

Alexandre Auberson

Quality management systems such as ISO 9001 are now quite common in many industrial sectors and have even become compulsory in some. Although the jewellery world discovered quality management quite late, some medium to large companies already possessed an organisation that made it possible to install a system without too many constraints or investments. For smaller structures, however, the apparent administrative drawbacks of a quality system can put off many a manager. This is not taking into account the fact that many tools can be activated in workshops with often spectacular results and without complicating things. This presentation will highlight some proven methods to improve the quality of products, thanks to the tools used by the quality management systems.

Mr. Auberson, a jewelry goldsmith trained and educated in Switzerland, has been in business with jewelry and watchmaking firms in Switzerland, France and Thailand. He is experienced as a prototypist, workshop manager, production manager, quality manager and, most recently, plant director. As a quality manager, he carried out many audits of suppliers, which contributed to improvements in the quality of both the products manufactured and the organisations in which he worked.

UNDERSTANDING MICROALLOYS ............... 53–64

John E. Bernardin

The introduction of microalloys for gold, silver and platinum has made it possible to produce jewelry with the color and most of the properties of the pure metals. The addition of very small amounts of alloying elements can harden the pure metals so they can be used in jewelry production with minor changes in manufacturing protocols. This presentation will discuss the structure and composition of microalloys of gold, silver and platinum and the changes in structure that arise through deformation and temperature change. It will also show that these microalloys can increase in hardness by cold work and by age hardening and how every step in the production process has the potential to impart a change in the microalloy, even finishing. Techniques for finishing a piece without altering the hardened microalloy are also given.

Mr. Bernardin holds a PhD. in Physical Chemistry from the University of Oregon. He founded the company Pure Gold seven years ago and has had articles relating to micro-alloy gold published in both Gold Technology and AJM magazines.
DESIGNING, BUILDING AND TESTING A THERMAL EXPANSION MISMATCH TORQUE PLATE (TEMTP) SYSTEM FOR DIFFUSION BONDING MOKUMÉ GANE BILLETS: "THE POOR MAN'S HOT PRESS". 65-101

James Binnion,

Mokumé gane, the traditional Japanese metalworking technique, is the art of diffusion bonding multiple layers of dissimilar alloy sheets into a billet that is then processed and patterned to the desired effect. The current torque plate and bolt technology for creating mokumé gane billets, although effective, has some inherent limitations including the inability to maintain pressure throughout the diffusion bonding process. This paper documents a new thermal expansion mismatch torque plate (TEMPT) system for creating mokumé gane that incorporates multiple innovative features. The paper will also discuss the design of the system and both quantitative and qualitative testing performed while using it.

Mr. Binnion founded his company in 1991 and developed his own technique for making mokumé gane using an electric kiln. He produces a line of mokumé gane wedding rings and other jewelry. He has taught metalsmithing and goldsmithing techniques and has conducted many workshops on mokumé gane. Several pieces of his work have been exhibited by invitation.

WHAT IS A WHITE GOLD? PROGRESS ON THE ISSUES! 103-119

Dr. Chris W. Corti

The popularity of white gold jewellery, particularly among younger consumers, and the impact of the E.U. directive on nickel has led to a number of issues concerning white gold to be raised within the industry. Prime among these is the issue of what is 'white'. Associated with this is the use of rhodium plating. For good technical and economic reasons, many white golds are not a good white colour and need to be rhodium plated, a fact the jewellery purchaser is generally not made aware of. The validity of the nickel-release test procedure as a basis for the E.U. legislation is also questioned, as conformance does not necessarily prevent the appearance of a skin rash on sensitised people. These issues and some of the marketing and legal implications are discussed.

The need to address these issues has resulted in the establishment of the White Gold Task Force being established in the U.S.A. under the auspices of the MJSA and World Gold Council. Progress in the work of the task force and that of a U.K. initiative are discussed in terms of proposed recommendations regarding the technical issues in this paper as part of a worldwide consultation to reach an agreed international industry consensus.

The Santa Fe Symposium on Jewelry Manufacturing Technology
CONTINUOUS CASTING OF JEWELLERY ALLOYS

Dr. Chris W. Corti

Continuous casting of precious metals and their alloys is used widely in the jewellery industry for producing semi-finished mill products such as strip, rod and tubing. In addition to the economic advantages, there can also be technical benefits to this process. This presentation reviews the principles and the practices of continuous casting in the jewellery industry, highlighting the different equipment commercially available for casting silver, gold and other jewellery alloys and some of the problems that may arise.

Dr. Corti holds a PhD. in Metallurgy from the University of Surrey (UK) and is currently a consultant for the World Gold Council and the Worshipful Company of Goldsmiths in London. He served as editor of Gold Technology magazine and currently edits Gold Bulletin journal, the Goldsmiths’ Company Technical Bulletin and the magazine, Technology. A recipient of the Santa Fe Symposium® Research Award, Technology Award and Ambassador Award, he is a frequent presenter at the Symposium.

JEWELRY ALLOY HARDENING AND HARDNESS TESTING

Gary Dawson with Andrew Nyce and Stewart Grice

Through the use of hardness and abrasion testing, an attempt was made to determine the optimum time and temperature conditions for hardening selected commercially available gold and silver alloys. The test was performed with gold and silver alloys in a cold-worked, fully annealed state and precipitation-hardened alloys. The test procedures were then used to establish the optimum times and temperatures for precipitation hardening of gold and silver alloys. It is hoped that by developing simple, in-shop procedures for assessing hardness and showing the effectiveness of hardening, jewelers will embrace the practice of hardening gold and silver alloys by thermal treatments and improve the quality of handcrafted jewelry.

Mr. Dawson established Goldworks Jewelry Arts Studio in 1975 and has been involved in every facet of its operation, including design, research and studio benchwork. He has been an instructor in jewelry and metalsmithing, conducted in-studio seminars and has been a frequent contributor to AJM magazine on various topics.
INNOVATIVE LOST WAX INVESTMENT CASTING TECHNIQUE ............................. 193–214

Dr. K. D. Desai

The lost wax investment casting method is widely used to cast jewellery products. In the jewellery industry there have been continuous efforts to increase the productivity, decrease the process loss and optimise the cost of production. The wax carbon produced starts reaction at low temperature, producing gases like CO and CO₂. The thermal decomposition of CaSO₄ generates SO₂, leading to gas porosity. To reduce porosity, it is important to remove carbon and its oxides at the appropriate time. The new lost-wax investment casting process has effectively removed the reasons of porosity at the early cycle of burnout. Innovative wax tree making techniques and burnout cycles have reduced the wax investment casting cycle time by 60%, with a 30% decrease in production loss with improved finish.

Dr. Desai has more than eight years of experience working with jewellery manufacturing and is currently the Director of Technology at the Livingstones Group in India. He is also a faculty member at Mumbai University teaching telecommunications, laser technology and bio-medical engineering. This is his first year presenting at the Santa Fe Symposium®.

QUALITY CONTROL: ACTUAL QUALITY AND PERCEIVED QUALITY ............................. 215–234

Dr. Valerio Faccenda and Michele Condò

The demand for high-quality jewelry products is steadily increasing and consumers have become ever more demanding. In response, jewelry producers have become more conscious of quality and make process and product quality control ever more accurate. But does the consumer realize this? Complaints made by customers in the last four years have been scrutinized by Pomellato and have found to be fairly low in numbers, sometimes due to incorrect use or from a natural or sometimes unusual phenomena. This presentation will describe the results of the most frequent quality complaints and will conclude that manufacturers should regularly spread information on the properties and correct use of jewelry products among consumers.

Dr. Valerio Faccenda, a metallurgical consultant for Pomellato, has served as a consultant to The World Gold Council. He is presenting for the eighth time at the Santa Fe Symposium®.
AN INTRODUCTION TO METALLURGY PART IV—ODDS AND ENDS AND DEFORMATION PROCESSES . . . . . .235–254

Mark Grimwade

The original intention was to have three presentations in the series “An Introduction to Metallurgy”. These have been “The Nature of Metals and Alloys,” “Solidification and Casting” and “Working, Annealing and Deformation Processes.” It is evident that some metallurgical topics of interest to silversmiths and jewellers do not fit readily under these three headings. Consequently, there were some omissions. The aim of this presentation is to redress that by highlighting the metallurgical principles and mechanisms underlying three such topics, namely, “Soldering and Brazing,” “Corrosion and Stress Corrosion” and “Tarnishing.” Papers have been given at past Symposia on practical aspects of these topics with respect to jewellery manufacturing technology. Here, the emphasis is in promoting an understanding of the theoretical background.

Mr. Grimwade is a metallurgical consultant to The Worshipful Company of Goldsmiths as well as to the World Gold Council. He is the recipient of the Santa Fe Symposium® Technology Award and Ambassador Award. This is his fifteenth year presenting at the Symposium.

THERMAL STABILITY AND CHEMICAL PHYSICAL FEATURES OF GYPSUM–BONDED INVESTMENT WITH REGARD TO BURNOUT CYCLE . . . . . . . . . . .255–274

G. M. Ingo, C. Riccucci, T. de Caro, G. Gusmano, P. Sbornicchia
G. Montesperelli

The micro-chemical features, the porosity and the thermal and mechanical properties of a commonly-used calcium sulphate-bonded investment have been studied as a function of the firing temperature and duration by means of the combined use of chemical/physical methods and electron microscopy. The results show a remarkable variation in the porosity, pore-size distribution, mechanical properties and thermal stability of the investment that are strictly related to the thermal expansion behaviour and structural modification of the investment components. From a technological point of view, the results show that it is possible to tailor the final chemical/physical properties of a calcium sulphate-bonded investment by properly selecting the burnout cycle parameters.

Dr. Ingo is a researcher at the National Research Council of Italy’s Institute of Materials Chemistry and a professor of Archaeometry at the University of Bologna. This will be his fifth time presenting at the Symposium.
ARTHRTIC FINGER JOINTS
AND ADJUSTABLE RINGS ............. .275–302

Fred Klotz
With baby boomers reaching the retirement years, the problems associated with ring fit and finger-joint swelling will become a major issue for jewelers. This paper addresses the medical causes of swollen finger joints due to rheumatoid and osteoarthritis and solutions for the jeweler. Since this has been a problem faced by many generations of jewelers, the historical methods of dealing with it will be explored. Today, there are several major manufacturers of products that effectively address this issue. Their solutions are all very creative and their products range from inexpensive to very high end. This paper will describe these devices, their method of manufacture and how they are installed.

Mr. Klotz is the Director of Findings at Hoover & Strong. He holds patents in palladium white gold findings and Tru-Seat™ settings and has been published in Gold Technology magazine. This is his second year presenting at the Santa Fe Symposium®.

PLATINUM ALLOYS: FEATURES AND BENEFITS

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Jurgen J. Maerz
In the recent past, Platinum Guild International has identified several issues relating to the use of improper platinum alloys for specific manufacturing methods. Rings made from soft alloys would scratch rapidly, some would deform, others would dent, etc. The underlying causes of these issues can be addressed by clarifying which alloy is best suited for which function. This paper will address the suitability of individual platinum alloys for different manufacturing methods, ranging from fabrication to casting, die-striking to machining. Comparing hardness, strength and durability, the ideal platinum is identified and recommended for the specific manufacturing method. Specialty alloys and their uses in manufacturing will also be discussed.

Mr. Maerz is Director of Technical Education for PGI, USA. His love for teaching and his 31 years of experience in the jewelry industry led him to teach classes and seminars all over the United States. He is a recipient of the Santa Fe Symposium® Ambassador Award and a familiar presenter.

The Santa Fe Symposium on Jewelry Manufacturing Technology
THE ROLE OF SILICON IN INVESTMENT CASTING—A STUDY OF THE REACTIVITY OF VARIOUS METALS WITH THE INVESTMENT

Daniele Maggian, Iader Milani, Silvano Bortolamei, Paolo Baretta, and Alessandro Zocca

It is well known that silicon improves the form-filling and deoxidation of castings. Up until now, it has been believed that silicon alone, and its reaction with oxygen and the formation of silica, could explain this improvement. This could be only partially true. Investigations suggest that silicon forms a high surface-tension compound in the molten alloy and, therefore, lets the liquid metal flow more easily, improving mould filling. This work aims to clarify the real mechanism of silicon’s effect in investment casting of gold alloys. It will also study the possibilities of obtaining a partial or total alternative to silicon.

Mr. Maggian is the R & D Manager at Pro Gold s.r.l. in Italy. His background is in materials engineering. This will be his second year presenting at the Santa Fe Symposium®.

CAD/CAM FOR MODELS AND MOULDS WITH CNC

Apollonius Nooten-Boom II

This paper is about the hands-on, practical aspects of making use of CAD/CAM, told from the experiences and observations of a user. Issues covered shall include the errors made due to large-screen images in relation to actual size and the considerations that need to be taken into account with on-screen measurements to achieve the desired measurements on the finished product. In addition, the paper will present a resumé of experiences and observations on using CNC matching of wax and the limitations of the machining process. Finally, the paper will look at comparative Rapid Prototyping systems and materials in relation to casting.

Mr. Nooten-Boom II and his company, Hean Studio, have always been at the industry’s leading edge with new technologies, having many custom-built pieces of machinery. The latest direction has been the development of a CAD/CAM department to benefit their customers. Mr. Nooten-Boom is the recipient of the 1992 Caster of the Year award, the 1999 and 2001 Top Performing Company in Herefordshire awards, and the 2002 Santa Fe Symposium® Industry Leader Award. He was recently made a Fellow of the Institute of Professional Goldsmiths under the category of Master Caster. This is his third year presenting at the Symposium.
THE PREPARATION OF THE MASTER MOULD—THE KEY POINT OF STONE-IN-PLACE CASTING 399-408

Dr. Hubert Schuster

The proper preparation of the master model is the first, but most of all, the key point in the complete process of successful stone-in-place casting. The quality of the final cast depends primarily on this first step in the process, a step that requires a lot of experience and know-how. This paper shares both knowledge of, and experience with what types of settings are best done in wax, what model-making systems are available (wax, metal, CAD/CAM) and the preparation of the master model for wax setting. In addition, the paper will discuss the convenience and reliability of stone-in-place casting compared to traditional setting techniques and the risks involved in damaging the stones.

Dr. Schuster, Director of the Jewelry Technology Institute in Creazzo, Italy, has more than 30 years of experience in jewelry production. He has four patents for jewelry applications and has served as a technical consultant for more than 110 major companies worldwide. He is a recipient of the Santa Fe Symposium® Ambassador Award. This is his fourth year presenting at the Symposium.

CAD SOFTWARE FOR JEWELRY DESIGN: A COMPREHENSIVE SURVEY 409-422

Scott Patrick

The purpose of this presentation is to provide a comprehensive survey of CAD software and its growing use and impact in jewelry design. It will discuss the enormous benefits that CAD technology offers with both solid and surface jewelry modeling and define much of the terminology relating to CAD. It will also review some of the CAD programs available on the market today and compare their cost, learning ease, user friendliness, compatibility with other programs and CAM machines.

Scott Patrick, a Rio Grande jewelry designer and expert in manufacturing R & D, has over 30 years of jewelry-making experience including design, custom work, jewelry masters, model-making, consulting and training. He holds several computer certifications, which combined with his jewelry-making knowledge and experience, allow him to do most of his designing and modeling today using CAD/CAM software. In addition, he is dedicated to manufacturing R & D, teaches jewelry classes, has presented at jeweler’s conferences and seminars across the country, adds his expertise to judging jewelry competitions and maintains his own shop in his home.
LASER BENDING SILVER .......................... 423–469

Dr. S. Silve and H. Zhao

Using a laser to locally heat a metal sample, thus inducing metal stresses which can cause the material to bend, has been an established process for the past 20 years. Laser forming has had potential applications in silversmithing and the creations of designed objects. Defined edges can be fabricated and sharp folds generated when there is a temperature gradient through the material’s thickness. But, this is difficult to achieve with silver due to its high thermal diffusivity. This investigation utilizes experimental data, derived with thermocouples employed to determine the presence of a temperature gradient, to obtain the operating window for bending silver. Through these methods, a more accurate selection of parameters for bending silver is possible, which lends credence to the future use of laser forming in the production of silver objects.

Dr. Silve, a research fellow at Brunel University in Middlesex, England, studied laser forming under a collaborative project between Buckinghamshire Chilterns University College and The Laser Group at the University of Liverpool from 1997–2000. Since joining Brunel University, she has been involved in setting up a CO₂ laser facility for continuing her research in laser forming and laser material processing techniques for silversmithing and jewellery applications.

STANDARDIZING THE DESIGNATION
OF KARATED GOLD SOLDERS .......................... 471–487

Gregg Todd

For years, the bench jeweler has been poorly informed about the melting characteristics of the solders and the karat gold alloys they use. Little effort has thus far been made to correct this and create a reliable system of definitions. Manufacturers have all along designated their products dependent on their individual production system. This creates problems for the bench jeweler who uses solders from different manufacturers or uses different karat or color combinations while step soldering. These problems were usually solved using costly trial and error. This paper will explore a system to establish defined temperature ranges for the various solder grade designations for each color and karatage of gold jewelry alloys with the objective of standardizing the designation of karat gold solders within the industry.

Mr. Todd has more than 25 years of jewelry manufacturing experience as a bench jeweler, designer, diamond setter, mold cutter, model maker, wax carver, instructor and more. He is currently the Industrial Training and Project Administrator for Stuller, Inc.
USING SURFACE TO AREA RATIO TO DETERMINE QUALITY OF CASTINGS—PART II ..........................489–500

Tino Volpe

As some may recall from last year’s experiment, attempts at using Volume/Surface Area (V/A) via Chirnov’s equation to predict a good casting was clouded by the chosen system temperatures being too high. This resulted in almost all castings being poor regardless of what the V/A was. This year, I will use much lower temperatures so the effects of the V/A will be measurable. I will also look at several gating shapes and sizes to see if certain myths are true or just that, myths. Finally, I will explore earlier results that seemed to show that the gate becomes more of a factor as the volume-to-surface area ratio increases. The end result will attempt to determine if Chirnov’s equation has any use for us in the manufacture of precious metal components.

Mr. Volpe received both his Bachelors and Masters in metallurgy and material science from Columbia University in New York City. He has been with Tiffany & Co. for the past 10 years, performing R&D work on new technologies and processes for gold, silver and platinum jewelry. He has presented papers at the Santa Fe Symposium® and at Platinum Days East and West. He has also given presentations at local ASM chapters.

SINTERING TECHNOLOGY FOR JEWELLERY AND MULTICOLOUR RINGS .....................501–520

Klaus Wiesner

Sintering technology, the use of heat (without melting) to create a coherent mass that results in welding and permanent connections, has always been a common industrial process. In the past 15 years, sintering has made its way into the jewellery industry and has made the manufacture of wedding rings and multi-coloured rings easier and more profitable. But, although it is a relatively simple technology, there can be problems with the process and it is vital that one have a good metallurgical and jewellery production background to succeed with it. This paper describes the sintering process for jewellery and offers some tips and tricks on how you can take advantage of it.

Mr. Wiesner has more than 20 years of experience with precious metals. He is responsible for the development and technical support to customers and for production of semi-finished products at C. Hafner GmbH Gold and Silver Refining in Pforzheim, Germany. He is a recipient of the Santa Fe Symposium® Ambassador Award; this is his fifth year presenting at the Symposium.
Simulation, or modelling, is a powerful technique for conducting much research, exploring designs and developing production prototypes. The jewellery industry has begun to adopt CAD/CAM in design and limited production of plastic models but does not yet use simulation as an analytical design tool. This paper explores the current limitations, in relation to the small-scale accurate casting process at relatively high temperatures, and shows that the data fed into the computer and the formulae it applies must be accurate to an adequate degree or errors will be replicated. Simulation is already a very powerful training technique, particularly for casting, but extending its accuracy requires more accurate knowledge and data. Sensitivity analysis and calibration against real-life casting data can help provide this kind of information. Using both techniques together would be mutually reinforcing but this is research, not direct tailor-made problem solving for jewellery casters. However, with good collaboration on building the database, an agency advisory service for jewellery casters is a possibility within a few years.

Dr. Wright holds a BS in metallurgy, a PhD. in gas turbine technology and became an FGA in 1990. He has worked as a consultant with several assay offices, Johnson Matthey, Platinum Guild International, World Gold Council and several jewelry and equipment manufacturers. He is a recipient of the Santa Fe Symposium® Applied Engineering Award and Ambassador Award. This is his ninth time presenting at the Symposium.