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Demand And Supply: College Faculty's Perceptions Of Computer Aided Design (cad) And Computer Aided Manufacture (cam) In Jewelry Design And Production

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DEMAND AND SUPPLY: COLLEGE FACULTY'S PERCEPTIONS OF COMPUTER AIDED DESIGN (CAD) AND COMPUTER AIDED MANUFACTURE (CAM) IN JEWELRY DESIGN AND PRODUCTION

by

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APPROVAL

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Patrick Awotwe
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ABSTRACT

The purpose of this research study was to explore perceptions of university faculty and jewelry industry professionals regarding the teaching of Computer Aided Design (CAD) and Computer Aided Manufacture (CAM) in a visual arts classroom. At the time of this study, there were mixed opinions about the teaching of CAD/CAM in the production of jewelry products, and there was limited literature available on this topic. With the use of CAD/CAM technologies, a jeweler emerges as potentially an artist and a design engineer who can apply creative and innovative principles to industrial design and manufacturing processes. Considering the impact of CAD/CAM on disciplines such as Engineering, Medicine, Industrial Designing, and Architecture, and the potential effect that CAD/CAM may have on visual arts, particularly on the production of jewelry, it is surprising how little research has been directed towards this area.

This study examined how fine arts professors have been using CAD/CAM technology and traditional methods of design and fabrication of jewelry as a teaching aid in the pedagogy of jewelry training. The research findings showed a gap between art and design educational institutions and businesses in the jewelry design and manufacturing industry. CAD/CAM technology is a tool to aid jewelers and one of a number of means to an end. CAD/CAM has added an enhanced creative dimension to jewelry design and manufacturing and this inventive technology has allowed jewelry design and manufacturing to push beyond creative and innovative boundaries. This study shows that

faculty members with knowledge in CAD/CAM are prepared to use the technology to teach jewelry design and manufacturing, but very few educational institutions had incorporated CAD/CAM into their teaching curricula at the time of this study. The jewelry design and manufacturing industry, on the other hand, has already been taking advantage of CAD/CAM technologies and has used these technologies to be competitive and also to maximize profit.

CHAPTER I

INTRODUCTION

Need for Study

The purpose of this quantitative study was to ascertain why Computer Aided Design (CAD) and Computer Aided Manufacture (CAM) technology are not included in most metal/jewelry curricula in the United States of America's arts and design institutions. Given the advantages that CAD/CAM technology provides, knowledge of CAD/CAM technology is gradually becoming part of the job requirement for a position in art and design (jewelry) institutions as well as in the jewelry industry. It is surprising that most jewelry designers and manufacturers are learning this technology from software developers of CAD/CAM technology rather than from academy or art institutions (Ghag & Dange, 2013). This is evidenced by the numerous CAD training and workshop advertisements in most jewelry associations' journals and websites such as the "Manufacturing Jewelers & Suppliers of America" journal (*MJSA Journal: Professional Excellence in Jewelry Making and Design*), and the Society of North American Goldsmiths (SNAG; *Metalsmith* magazine).

There are numerous characteristics of CAD/CAM technology which may allow students to be creative and innovative while stimulating idea development. CAD/CAM technology enables flexibility in drawing and learning environments that engage students. The characteristics of CAD technology make it relatively easier for designing 3D virtual

images, compared to 3D images using the traditional method of drawing and sketching, which is mostly associated with 2D imagery. Three-dimensional CAD drawings create a virtual image, which can be viewed from different perspectives on a computer interface. This allows clients and other interested parties to view three dimensional virtual images, which can later be fabricated using a variety of means. Though complex organic shapes are difficult to model using CAD programs designed primarily for engineering and product design applications, there are standard programs for the jewelry design and manufacturing industry; most have steep learning curves; and some individuals, without proper training, may struggle using these programs. While some limitations of CAD programs are attributable to the experiences of the artists, much of the limitations could be due to a lack of training in these specialized software packages. Computer Aided Design technology provides students the freedom and ability to design extremely intricate patterns that they might find difficult to do when using traditional drawing utensils. However, students need to be versatile and knowledgeable about the use of CAD technology as different types of CAD software perform for different kinds of special applications and design features.

Strengths and Weaknesses of CAD/CAM Technologies

Computer Aided Design software has evolved to meet the needs of numerous industries since it was first introduced. Those programs designed specifically for the jewelry industry, just like CAD programs designed for engineering applications, have strengths and weaknesses and some are better suited for specific tasks. Table 1 illustrates tasks CAD programs are used for and strengths and weaknesses of specific CAD programs.

Table 1. Strengths and Weaknesses of Different CAD/CAM Technologies.

Fast Modifications and Reworking of Existing Models

- **Fastest . . . :** 3Design, Countersketch, Firestorm CAD
- **Fast (with limited history features or a quick interface):** JewelCAD, Matrix
- **Reasonably Quick:** Any of the others

Making a Size Range From a Single Ring

- **Best:** 3Design, Firestorm, Matrix
- **Good:** ArtCAM Jewelsmith, JewelCAD
- **Can do it, but not really designed for it:** Rhino

. . .

Relief Sculpting (such as coins, medallions, or family crests):

- **Best:** ArtCAM Jewelsmith
- **Good:** Mudbox, ZBrush, Matrix, 3Design
- **Can do it, but not really designed for it:** Rhino, JewelCAD, Firestorm

. . .

Applying Texture or Inlay With Shapes Onto a 3D Surface

- **Best:** Geomagic Sculpt, Mudbox, Zbrush
- **Good (due to parametric history):** 3Design, Firestorm
- **Okay:** Rhino, Matrix

. . .

Rendering Images

- **Best:** 3Design with DeepImage, Firestorm CAD with Keyshot, Matrix, Rhino (with a good rendering plug-in like Brazil, Keyshot, V-Ray)
- **Good:** 3Design without DeepImage, ArtCAM Jewelsmith with Keyshot, Geomagic Sculpt with Keyshot, JewelCAD, ZBrush
- **Can do it, but not really designed for it:** ArtCAM Jewelsmith without Keyshot, Rhino without a rendering plug-in

(Meyer, 2012, Section 5, paras. 1, 2, 5, 7, 9)

Note: Author of information in Table 1 wrote, "All content provided on this blog is for informational purposes only. . . . every effort has been made to ensure all information provided is accurate as of the date of printing" (Meyer, 2012, p. "last paragraph on web page").

The traditional methods of drawing and sketching for designing jewelry have their own limitations. CAD/CAM technology provides users an option to use creative and innovative features of the technology and assist jewelers in designing and manufacturing original and inventive virtual images. It has been observed in the last two decades that CAD/CAM technology has been incorporated into the jewelry manufacturing industry (Meyer, 2013). This integration provides creative and innovative processes of designing and manufacturing jewelry. However, CAD/CAM technology has not been used extensively in the pedagogy of jewelry making processes in higher education. Perhaps this is because the adoption of CAD/CAM technology has not always been welcomed by professionals and art professors.

Given all the advantages CAD/CAM technology provides, it is interesting that this innovative, effective, and efficient technology is not being discussed in most jewelry arts programs. Computer Aided Design and Computer Assisted Manufacture are subjects that deserve attention and need to be addressed, especially when a perception exists that institutions of higher education are not current with trends in the working world.

Historically, the jewelry industry has often adopted new technology, which is seen in the following processes: the tracing, or carbon paper, and scratching of metal to transfer images onto metals and other materials for fabrication; the use of different methods of casting; the use of enameling processes; the use of hydraulic presses; milling of wire and flat sheet gauge sizes; the different ways of using polishing machines; electroforming and electroplating; and the use of ultrasonic devices to clean intricate designs. Automated machines, for example, have been employed in various stages of jewelry making or fabrication (Wannarumon & Bohez, 2004). All of these technologies

have been adopted by the jewelry industry over time; it is therefore time for art and design professors to integrate newer CAD/CAM technologies into their curriculum as well.

Expectations From Jewelry Workforce

The use of CAD/CAM technology, which is becoming a vital technology in designing and manufacturing of jewelry, is not being discussed in most jewelry arts teaching communities. Therefore, bringing the idea of using CAD/CAM technology up for discussion enriches the knowledge base of the jewelry industry and art schools. However, it becomes a concern when institutions of higher education do not also keep pace with current trends in their respective industries. It is for this reason that the relative lack of CAD/CAM implementation in academia needs to be examined. The research findings of this study will contribute to the knowledge of the jewelry discipline. It is hoped that the study will draw attention to standards and requirements of the workforce – especially the use of CAD/CAM technology, which the industry is beginning to incorporate.

The questions which this paper will attempt to examine are:

- What are faculty and industry perceptions regarding the use of Computer Aided Design (CAD) and Computer Assisted Manufacture (CAM) in jewelry design curricula?
- What level of satisfaction do jewelry manufacturers have about the technical knowledge of employees on CAD/CAM?
- What are the artist perceptions on the use of CAD/CAM technology?

New academic graduates in jewelry design and manufacturing with technology qualifications and hands-on experience safeguard the future of the jewelry industry. Technology is gradually shaping the direction of the jewelry industry, and graduates with technological know-how, competency, and capabilities may be the key to an ever-growing competitive business environment.

Manufacturing Job Outlook

The importance of CAD/CAM technology is underscored by the increasing international labor market for the jewelry industry, where the need for knowledge of CAD/CAM may increase competition for job seekers. According to labor statistics, the number of workers in the jewelry and metal industries is estimated to decrease by ten (10) percent from 2012 to 2022 (Bureau of Labor Statistics, 2015). The Bureau of Labor Statistics has also projected that workers in low skilled or labor intensive manufacturing jobs will experience higher competition from the computerized workforce. Jewelry manufacturing companies outside the USA produce jewelry at a relatively lower cost than U.S. companies. At the time of this report, there was a supply of well-trained jewelry professionals being paid less than United States professionals and living outside the USA. This supply of foreign professionals has made it economically viable for investors in the USA to take advantage of the lower cost of jewelry production outside the country. The demand for inexpensive jewelry will gradually increase, at the same time that the demand for locally produced jewelry will decrease due to the relative high cost of production in the United States. The fall in demand for locally manufactured jewelry is likely to adversely affect the demand for jewelry workers in the USA. Jewelry employers in the United States inadvertently reduce demand for jewelry workers by freezing employment.

The jewelry entrepreneurs may perhaps be engaged in more of a restructuring rather than just laying workers off largely as a way to cut their cost of production as projected by the Bureau of Labor Statistics (2015).

CAD/CAM Training

Integrating CAD/CAM technology into metal and jewelry design curriculums can result in qualified personnel bringing into the metal and jewelry design industry additional skills and technology, which will sustain and keep a constant workforce supply for the jewelry industry. With recruiters from the metal/jewelry industry (e.g. Indeed, ZipRecruiter, HigherEdJobs, Monster, etc.) gradually including knowledge of CAD/CAM technology as a requirement for jewelry job applications, it has become imperative that academia and metal/jewelry institutions collaborate with each other to incorporate CAD/CAM technology in metal/jewelry curricula. This partnership offers academia the knowledge and the standards demanded by recruiters of employees in the jewelry industry.

Traditional Jewelry Workforce

Jewelry fabrication is one of the oldest professions, and it has relied on traditional processes of making jewelry over time. Traditional methods of jewelry fabrication are more labor intensive and require the hands and ingenuity of a jeweler. At the time of this study, the past two decades had seen the integration and adoption of technology into the general visual arts field. An introduction and integration of automated or computerized methods of technologies in designing and manufacturing was considered extraneous in the art academic community (Mayo, 2007). However, the growth of CAD/CAM technology can be attributed to variables such as level of teacher commitment,

institutional direction and policy, a steep learning curve, and financial factors. Technology, in one way or another, has always been part of the jewelry manufacturing process from the time when jewelry was created and first adorned by the Stone Age people up to the current generation; the same cannot be said about CAD/CAM in an art jewelry classroom.

Artists who work using their hands rather than machines can create unique works of art with an individual flair. This sometimes increases the value of jewelry products while expressing the creativity and personality of a jeweler. In addition, there is a general agreement in two areas: first, working by hand is still needed even if the jewelry product was designed in CAD and produced in CAM; and second, that experience as a traditional or hands-on jeweler is an asset when working in a CAD environment. On the other hand, there are CAD/CAM professionals who consider themselves "jewelers" because they have knowledge about how to use software to design jewelry. An artist who knows how to use CAD/CAM technology to design virtual images but has not been trained in jewelry-making techniques is a designer rather than a jeweler. Becoming a full-fledged CAD/CAM jeweler with knowledge and skill in jewelry entails training in jewelry fabrication and knowledge of CAD/CAM technology.

Future Jewelry Workforce

Development of a future labor force is very important to the survival of industry and the socioeconomic stability of every country. Employers in the jewelry industry expect art and design jewelry graduates to be knowledgeable about current trends of designing and manufacturing technologies of jewelry which benefit industry (Laurillard, 2011). Stakeholders in the jewelry industry expect institutions of higher learning to meet

the vigorous and modern design and manufacturing processes of current jewelry making and operational methods. The strong skill set, knowledge, performance, and competence of a new graduate serves as a perfect fit for the jewelry industry. This will ensure that the industry employs individuals with knowledge and competence needed for the industry's survival in an ever-growing competitive business environment.

In the past, different technologies have provided artists with innovative tools for expression of talents in both the visual and performing arts. However, art and technology are interwoven now more than ever, and technology is becoming the essential force in the advancement and evolution of art. Disciplines such as ceramics, fibers, architecture, and metal designing are some art industries which incorporate technology in their fields. Engineers, software developers, entrepreneurs, visual artists, musicians, filmmakers, and professionals in many other professions are not only creating innovative art works, devices, machines, and movie productions but employing technology to push beyond the limits of art to create new forms. The use of technology has made jewelry making less inert. In the past, the jewelry industry, like most visual arts disciplines, found it difficult to accept change and adapt to innovative technologies both in designing and fabrication. However, this trend is gradually changing, and the following are some of the developmental changes which have occurred within the jewelry industry within the last three decades:

- Japan's economic growth in the 1970s led to the creation of JM Gem Microscope (How technology revolutionized the jewelry industry, 1999). This device was used to detect fake diamonds which were introduced into the jewelry industry. In

the 1900s, jewelry stores had no devices to identify natural gemstones such as diamonds, emeralds, and rubies.

- Jewelers, especially large scale manufacturers of jewelry products, now produce chains with accuracy with reduced level of error by using automated chain making machines.
- "[The] . . . electroforming process is suitable for metal, such as nickel, being electrodeposited onto the surface of a conical mandrel (the term mandrel is used to describe the former onto which an electroform is grown). When the deposit has attained a sufficient thickness it is then separated from the mandrel to become a metallic product with a totally independent existence" (Hart & Watson, 2002).

The last two decades has also shown the jewelry industry's use of technology such as CAD/CAM as a tool to design and manufacture jewelry products.

Computer Aided Design and CAM technology has been a revelation and an evolution in the jewelry industry in the last 20 years (Meyer, 2013). This technology, however, is gradually becoming a required skill for those entering the jewelry manufacturing trades. The jewelry industry accelerated growth and development by taking advantage of the creativity and innovation of CAD/CAM technological features; jewelers are responding positively to CAD/CAM software by integrating the technology into the designing and manufacturing process. Nevertheless, most jewelry designers and manufacturers are learning this technology not from academia or art schools, but from the manufacturers of CAD/CAM software. The question is: Can academia play a leading role in the development and adoption of technologies in the visual arts?

Purpose of Study

The purpose of this quantitative research study is to investigate why computer-aided design (CAD) and computer- aided manufacture (CAM) are not included in the metal/jewelry curricula of fine arts institutions in the United State of America for the development of the future jewelry workforce.

Significance of Study

This study examined the relationship between CAD/CAM technology and traditional methods of making jewelry. Though artists working by hand make art products that are unique compared to art products created using machines, and the introduction of the hand adds an individualistic touch to jewelry being designed, there are limitations to what can be created by hand. It is difficult to use the hand to design products that require a consistent design such as coins, monograms, and logos; and machines can create more complex intricate designs in jewelry products more quickly than those created by hand. In addition, the study attempted to find out how CAD/CAM technologies have been adopted by the jewelry industry and jewelry professors in the teaching and learning environment. A would-be-graduate jeweler who has knowledge in both hands-on methods and CAD/CAM methods of fabricating jewelry is at an advantage, as these methods of making jewelry are mutually beneficial. There is general agreement in two areas:

1. Jewelers' hands are still needed in correcting and finishing even if jewelry has been designed and manufactured in CAD/CAM.

2. Designing and printing in CAD/CAM as well as having experience making traditional jewelry are added advantages when working in the automated environment.

Definitions

Jewelry

A piece of jewelry is an object worn on the human body as a decorative and symbolic addition to the appearance (Unger, 2013)

Computer Aided Design (CAD)

CAD software is used to increase the productivity of a designer, improve the quality of a design, improve communications through documentation, and to create a database for manufacturing. “Integration of design and manufacturing into a system under direct control of digital computers. CAD systems use a computer with terminals featuring video monitors and interactive graphics-input devices to design such things as machine parts, patterns for clothing, or integrated circuits” (CAD/CAM, 2000, p. 263).

Computer Aided Manufacture (CAM)

Computer aided manufacture (CAM) is an application technology that uses computer software and machinery to turn a virtual design into a real product through the manufacturing processes. CAM brings a design to life with a virtual wax production. When the design is confirmed as “good enough,” it is then cast in any required metals (Janssen, 2016).

Bauhaus

Bauhaus is a school of design established by Walter Gropius in Weimar in 1919, best known for its designs of objects based on functionalism and simplicity (Bauhaus, 2016).

Art Nouveau

Art Nouveau is a style of fine and applied art current in the late 19th and early 20th centuries, characterized chiefly by curvilinear motifs often derived from natural forms (Art nouveau, 2016).

Electroplating

Electroplating is to cover the surface of a metal object with a thin layer of a different metal, often silver, using electrolysis (a method that uses electric current) (Electroplate, 2016).

Technology

Technology often refers to the essential qualities of a person's or society's tools, machines, or other apparati used to achieve a mechanical end; Technology is used in the creation, exhibition, conservation, or study of art, such as potter's wheels, presses, cameras, projectors, computers, lasers, and video equipment (Delahunt, 2010).

Summary of Chapter I and Preview of Chapter II

The first chapter of this quantitative study introduced the concept of CAD/CAM technology in the designing and manufacturing of jewelry in most metal/jewelry curricula in the United States of America’s arts and design institutions. Chapter I also discussed characteristics of CAD/CAM technology and how the technology allows students to be creative and innovative while stimulating idea development. It also addressed the

strengths and weaknesses of some CAD/CAM technologies. The second chapter, which is the literature review, will address the concept of CAD/CAM technology from a historical perspective and review other literature about the pedagogy of CAD/CAM technology in an art and design classroom environment. The second chapter also opens the debate on “Man versus Machine” and addresses why some jewelry training educators have been reluctant to include CAD/CAM technology in visual arts schools.

CHAPTER II

LITERATURE REVIEW

Research Framework

This investigative research contributes a conceptual framework for jewelry professors to instruct students about the use of CAD/CAM technologies for the design and manufacture of jewelry. The objective of this conceptual framework is to make the pedagogy of CAD/CAM technology more suitable for teachers and to encourage and motivate the use of CAD/CAM technologies in the classroom. This approach will provide more motivation to jewelry design faculty and other art and design professionals to teach CAD/CAM, individuals who are sometimes resistant to the idea of using CAD/CAM technologies to create art works.

The conceptual framework of this study is important because it will give teachers a better understanding of the significance of the pedagogy of CAD/CAM technologies in an art and design classroom environment. The appreciation of the use of CAD/CAM technologies will eventually assist the jewelry industry to create new jewelry forms, help assist jewelers to show jewelry pieces to customers before the jewelry are physically produced, and allow designers to manipulate existing unique and intricate prototype copies, which is difficult to do when a design must be created from the beginning.

This research will also show a gap between art and design institutions and jewelry design and manufacturing industries. This will offer faculty an opportunity to know the

requirements of the jewelry design and manufacturing industries, and tailor or create syllabi which will take into account the needs of eventual employers of graduates from the jewelry design and manufacturing teaching institutions.

Historical Overview

Technology has always been part of the jewelry manufacturing process, since jewelry was first created and adorned human bodies during the Stone Age. Jewelry products were made of different materials, which depended upon geographical location of the jeweler and the natural materials available to him there. Plants and other creeping foliage were some of the early materials used to adorn the body; these plants served as early forms of jewelry. Bacchiocchi (1995) gave an example of the use of leaves by Adam and Eve in his book, *Christian Dress & Adornment*. Basic materials used by early jewelers to make jewelry included beads, seeds, shells, and bones of animals, stones, teeth of animals, leaves, and later, metals. During the Stone Age, people wore body adornments as a means to show strength, prove one's "survival of the fittest capabilities" and status in society. However, history shows (Kuntzsch, 1981) that in the early stages of the Paleolithic Age (c. 50,000 – 10,000 BC), organic objects such as stones, mammals' bones, horns, fish, and mollusk shells were also used to create jewelry such as amulets and chains. These body adornments were worn to show strength and protect the wearer; they were used to exhibit the important things in the life of the wearer. In society, hunters especially used some of these adornments to signify birth, marriage, death, and the killing of strong and wild animals. The body adornments were believed to possess magic powers, which brought good luck and also indicated ones' status in society.

Through necessity and accidents, hard substances such as stones, hardwood, and bones of animals were used as sharp tools. These hard and sharp objects were used as the basic tools to create jewelry. Different jewelry-making methods and techniques were developed, and these processes went through different progressions depending on the generation, available materials, and methods used. The resulting evolution among different traditions and cultures in Europe and the Mediterranean areas had an impact on the jewelry designs of the era and corresponding location (Untracht, 1985). Today, body adornments are now commonly used as accessories (Dalrymple, 2010), and also to exhibit one's traditions and culture.

With advancements in technology, jewelers started to integrate metals and precious gems into jewelry products being produced. At the time of this report, jewelry was fashionable, but the jewelry being produced also continued to be influenced by cultural traditions and by contemporary jewelry designs. The jewelry industry has seen many technological developments since the introduction of metals and gemstones into the jewelry making process. Though there has been a progression in the making of jewelry, the reasons for wearing jewelry continue to be the same. People today, as in times past, wear jewelry to show off their wealth and status in society, as well as their political and religious affiliations. Jewelry has been worn to commemorate an important event or a ceremony such as a marriage, a funeral, a puberty rite, a naming ceremony, a graduation or an athletic team winning a championship. Though the purpose of wearing jewelry has not entirely changed, archeological findings, such as a study done by Phillips (1996), show that around 3000 B.C., people in different parts of Europe began to wear pendants made from materials which are peculiar to certain geographical locations.

Artist Versus Machines in Jewelry Development

There is a question of who the artist is. If "an artist" uses machine/computer technology to design and create an artwork, should the artist or the machine/computer be entitled to claim the compliments? This is the subject of the debate over "artist versus machine" within the art community. The fine arts world perceives visual arts products as those that are made using an artist's hands. Dalrymple (2010) explained that the art community finds it difficult to accept art products made with the aid of a machine or computer as art works. There are differences in opinion among artists and professors of the fine arts who are in the visual arts community. Computer aided design manufacturers, software developers, and the science/technological disciplines, on the other hand, see the availability of CAD/CAM as an opportunity to be creative and innovative in designing and manufacturing. The age old rift between the arts and advocates for new technologies continues with the integration and adoption of CAD/CAM technology into the jewelry industry. This artist versus machine debate may partially explain why some jewelry training professionals have been reluctant to incorporate CAD/CAM technology in visual arts schools.

Does taking the hand of the jeweler out of the fabrication of jewelry devalue or appreciate the value of jewelry products? Are wholesale jewelry manufacturing companies, which use machines and other creative and innovative technologies to produce jewelry products, different from traditional jewelers? The inception of the industrial age led to mass production of popular styles of jewelry products. This increase in the volume of jewelry production can be attributed to the emergence of machines/manufacturing technologies. Methods such as casting and stamping/cutting

were used to increase jewelry products mostly for commercial purposes. The industrial era brought competition into the jewelry industry between jewelry companies and independent traditional jewelers. The independent traditional jewelers used the "artist's hand" to fabricate custom made jewelry, and sold them to a consuming public; wholesale manufacturers mostly produced volumes of identical copies of jewelry pieces and often sold them to retailers at a discount. The increase in production keep cost of production down and, all other things being the same, profit margins increase.

Traditionally, works of art of all media made by the creative and innovative skills of an artist show the style/signature of the artist who made the artwork. One-of-a-kind jewelry is often based on an artist's concepts or customers' specifications. The making of more than one copy of a particular jewelry design takes away the value and uniqueness of a specific jewelry design. Therefore, using CAD/CAM to increase production is often required by industries who are looking for technology to assist them in producing large and identical quantities of jewelry.

Impact of Industrial Revolution on the Jewelry Industry

The Industrial Revolution was a period of transformation from predominantly agricultural economies to manufacturing, which started in Britain and later spread throughout the world. This period witnessed artisans losing out in the manufacturing industries. Many artistic movements were formed during the 18^{th} to 19^{th} centuries when artists revolted against the over-reliance on machinery in the manufacturing process. These artistic movements were formed as a reaction to what was happening during this era as well as during the preceding years. Some artists felt that manufacturing industries had taken over the position of the artist in the manufacturing process and had discounted

the importance of the creative labor intensive profession. Machinery was employed in the manufacturing process, which increased the volume of production. Manufacturing was faster than it was when services of artists were used to produce products. New and numerous manufacturing processes also meant that fewer artists were employed in the industry. Artists were no longer preferred employees in production processes. Textiles, printing, and other arts media were among the other industries which stopped employing artists. Loss of employment was one of the influencing factors which resulted in the formation of the Arts and Crafts movements (Obniski, 2008).

These Arts and Crafts movements were set up also to nurture back the skill and knowledge of artists into hand-craft industries, which had been taken over by industrial manufacturing processes. Arts and Crafts movements also encouraged individual artists to become more innovative and creative. The Bauhaus (Building House) is one of the movements which benefited from the innovation and creativity of artists as a result of the uproar over introduction of machines into the manufacturing industry (Stock-Allen, 2011).

This transformation was also evident in the jewelry industry. The Industrial Revolution had an impact on jewelers and subsequently affected jewelry production negatively. There were societal and cultural beliefs that hands were required in the process of marking art works. The backlash against the Industrial Revolution helped to fuel the Arts and Crafts movements. These resulted in the unification (Codina, 2000) of labor in the arts and crafts. These eras culminated in the formation of moments such as Art Noveau, and Modernism. These movements influenced design and manufacture of

jewelry throughout the 20th century (A short history of twentieth century jewellery, 2008).

It is ironic that the main reasons for the formation of the Arts and Crafts movements are now being used in reverse position to support the current jewelry manufacturing processes. Some artists or jewelers have adopted and integrated technologies to assist in designing and manufacturing of jewelry. Computer Aided Design (CAD) and Computer Aided Manufacture (CAM) are two such technologies which jewelers include in the jewelry design and making process.

History of the CAD Software Program

Dr. Patrick J. Hanratty developed Computer Aided Design and Drafting (CADD) software technology in 1957, and the device was named PRONT in 1957. Cohn (2010) believed that Dr. Hanratty was the first person to create commercial computer numerical control technology. He has, therefore, often been called "the father of CAD CAM" (CAD software - History of CAD CAM, 2004, pp. 1, para. 4). This has been due to his creative, innovative, and pioneering role in the computer industry.

In the 1960s, Computer Aided Design (CAD) software was developed. It was not until the early part of the 1970s that CAD software was adopted by industry for commercial use (Danso, 2012). The discovery and introduction of the computer into the industrial manufacturing world found some of the designing disciplines integrating CAD/CAM technology into design and manufacturing processes. Among those who have adopted and integrated CAD/CAM technology are the automobile industry, aviation, the architectural industry, civil engineers, and industrial and product designers. Some of

these disciplines have also included CAD/CAM technologies in the training of students of these professions.

The introduction of CAD/CAM technology creates efficiency, effectiveness, and flexibility in a teaching and learning environment of jewelry making processes. The hardware and software available for the jewelry teaching environment, if accepted by faculty, students, and art design institutions, will add to the current knowledge base of teaching methods for traditional jewelry in an arts classroom.

CAD/CAM in the Classroom

The attempt of people involved in Arts and Crafts movements to compete with industry to justify why jewelers need to be employed explains why apprenticeship was the main mode of teaching and learning jewelry making in the past (Phillips, 1996). Though apprenticeship training was still being practiced at the time of this report, formal jewelry training has gradually become more prominent in the jewelry profession. The introduction of technology to education has resulted in CAD/CAM technology being included by some art and design teachers into their curricula. Technology in education aids faculty in the teaching and learning environment only if it is used appropriately. The introduction of technology into an art and design classroom, if well managed, assists a teacher in introducing efficiency and flexibility into design projects, and enhances learning experiences. Technology offers faculty the opportunity to push beyond the boundaries of the normal traditional classroom pedagogies (Cuban, 1986). Though the introduction of technology into art and design programs or arts institutions has been an issue, the inclusion of computers in the pedagogy of visual art programs is a bold and pragmatic initiative.

The computer was first adopted by professors of graphic design classrooms of art and design institutions. The Tyler School of Art of Temple University was one of the pioneering institutions to introduce the training of CAD/CAM technology in a jewelry classroom (Strzelec & Vavreck, 2005). The integration of CAD/CAM into art and design institutions has been gradually changing design and manufacturing methods.

Stanley Lechtzin, a metal/jewelry professor of the Tyler School of Art in Philadelphia, is a crusader for the use of CAD/CAM technology as a teaching and learning aid in an art classroom. Lechtzin's pioneering role led to the art program at the Tyler School of Art incorporating CAD/CAM into the institutions' metal/jewelry curricula. Integrating computers into a jewelry design program brings together technology and art. This incorporation allows the expression of artistic ideas with the use of computers to the benefit of students. Lechtzin's contributions (Hollern, 2009) to teaching and the adoption of CAD/CAM in a classroom are supported by Hodgson's (2005) study. Hodgson demonstrated that CAD/CAM technology can have a greater impact on the teaching of metal/jewelry pedagogy than jewelry programs taught solely using traditional design and fabrication methods. Hodgson's study also found that professors teaching CAD/CAM technology had little knowledge about the application of CAD/CAM technology, and other jewelry teaching instructors were also not using the technology appropriately in the teaching of jewelry design and manufacture.

Holloway (1984) was of the opinion that too much emphasis was being placed on technological devices faculty were using to teach. Many disciplines encourage the use of the latest technology to improve their graduates' skills. However, the pedagogy of using technology should benefit both faculty and students. Nevertheless, the knowledge level of

faculty on technologies and how technological devices are applied in classrooms needs to be supported and given attention. Use of CAD technology to design jewelry should save time and offer flexibility to faculty. These advantages are understandably lacking in traditional methods of using drawing utensils to design and manufacture jewelry.

Computer Aided Design and CAM technology has become a significant component of curricula and educational pedagogy in some disciplines, such as engineering fields, product design, automobile, and architecture (mostly CAD). A review of the literature on institutions using CAD/CAM technology showed both faculty and students at institutions in the United Kingdom and other European countries (Hodgson & Fraser, 2005) have accepted CAD/CAM technology. When the questionnaire for this research study was being developed, some art and design institutions were reviewed, and the result was: Twenty-five metal/jewelry arts and design institutions in the U.S., which include CAD/CAM technology as part of their jewelry program's curriculum, showed eight out of the 25 institutions integrated CAD/CAM into their educational program as part of the program content.

Computer Aided Design and CAM technology allows flexibility in drawing and encourages learning environments that captivate students. The technology gives students the freedom to design challenging and intricate patterns, which is difficult to do with traditional drawing tools. CAD/CAM technology tends to allow students to be creative and innovative and stimulates idea development. In the traditional pedagogy of drawing and sketching, three dimensional objects cannot easily be expressed, but CAD/CAM features allow students to successfully produce 3D designs. Artists are therefore capable of designing a virtual image of a piece of jewelry, which can be viewed from all angles.

Matthew H. Gross of MHG Jewelry in Berkley, Michigan, in a speech to art students of Kendall College in Grand Rapids, Michigan, was of the opinion that CAD should be taught the last semester of a student's senior year of college. Matthew believed that students pursuing jewelry programs need to first learn the fundamentals of jewelry making skills before CAD software is introduced into a program at a later time (Gross, 2005). For Gross, an emphasis on CAD/CAM should be prioritized during the period of jewelry training.

Modern Era of CAD/CAM Technology

The twenty-first century is experiencing integration of CAD/CAM technology into the designing and manufacturing of jewelry. Jewelers now have a technology which allows them to freely express themselves through different design and manufacturing methods. This level of creativity was lacking in times past due to technical deficiencies in certain design and manufacturing processes.

During the 1960s, the jewelry industry changed as more jewelers received formal training in a traditional classroom environment instead of learning their craft on their own or in an apprenticeship. This transition period ushered in the introduction of new technologies and methods of jewelry production. The last three decades have gradually seen the introduction of CAD/CAM technologies into the jewelry industry. The jewelry artist applies creative and innovative principles to industrial design and manufacturing processes. The jeweler, in an attempt to use these technologies, has emerged as both an artist and a design engineer. CAD/CAM technology makes it possible for some jewelry manufacturers to increase their volume of production. This technology allows greater

control over intricate and complicated designs (Untracht, 1985), which are difficult to achieve when the traditional methods of drawing and sketching are employed.

Faculty's Attitude on the Use of CAD/CAM Technology to Make Jewelry

According to Hodgson and Fraser (2005), CAD/CAM has been accepted and incorporated into the designing and manufacturing of jewelry outside traditional methods of fabrication. Hodgson and Fraser also showed that respondents who were professors had little or no knowledge of the application of CAD/CAM technology in an art classroom. However, the study of CAD/CAM pedagogy shows a positive attitude by learners in the classroom as indicated by Abdulrasool and Mishra (2010). Instructors who were knowledgeable about CAD/CAM also exhibited a better grasp of the use CAD/CAM in the jewelry making industry and created a better learning environment.

However, Attaway and Attaway (2010) stated that using CAD/CAM to design and produce jewelry does not necessarily mean that a jeweler is no longer important or not needed in the making of jewelry. They are of the opinion that as much as CAD/CAM technology is revolutionizing the jewelry industry, jewelers' traditional methods of making jewelry still need artists' signatures to customize jewelry products. Attaway and Attaway pointed out that CAD/CAM features are made to specialize in one or two areas of designing and manufacturing, and therefore cannot be used for every design.

CAD/CAM and Clients

According to Lewton-Brain (1996), a researcher, innovator, publisher, and a jewelry professor at Alberta College of Art and Design, incorporating CAD/CAM, a useful technology tool, into jewelry design and manufacturing fosters good business relationships between jewelers and clients. Computer Aided Design and CAM

technology offers clients the opportunity to see a virtual image or a prototype copy of a piece of jewelry to be purchased. Computer Aided Design and CAM also allows a jeweler to show prospective clients a likely end-product – a virtual image - of an expected jewelry. This helps clients to have an idea of how the jewelry they are ordering might appear. Pollack (2002) also made similar observations that CAD technology is a good sales tool. Pollack stated that a computer rendering gives a realistic image of a potential piece of jewelry, which makes it easier for customers to make a decision when buying jewelry. CAD/CAM technology, therefore, brings certainty, trust, and confidence into clients' and jewelers' business transactions.

Materials Commonly Used in the Jewelry Industry

An artist or a jeweler uses CAD to create innovative images which, after conversion to an STL (Stereolithographic) file format, can be printed using 3D printing technologies. Though most 3D printers utilize materials such as photopolymers, or ABS (Acrylonitrile butadiene styrene) plastics, newer technologies are allowing prints to be made of other materials such as ferrous and nonferrous alloys. Though 3D printing technologies using metals are in their infancy, in the future, jewelers may start utilizing 3D printing technology to print their designs directly into precious metals.

Historical Use of Metals in Jewelry

Metals have long been part of civilization. The jewelry trade dates back to 6000 B.C. Gold, copper, steel, and silver were used by ancient peoples of the Mediterranean and some parts of Europe to construct bridges, residential buildings, and industrial buildings; precious metals were also used in light manufacturing industries (Freeman, 2014). In addition to these disciplines, jewelry making became one of the disciplines

using metals as a form of raw material in the fabrication of jewelry products. This period witnessed the evolution and advancement of the jewelry industry with the introduction of metals into jewelry making (Kuntzsch, 1981). Gold was discovered in 6000 B.C., followed by copper, which was discovered in 4200 B.C., and finally silver, which was discovered and introduced into the jewelry industry around 4000 B.C.

Gold was commonly found in Egypt, Nubia, Arabia, and west of the Balkans (Phillips, 1996)**.** According to Phillips, archeological discoveries of gold products supported a high level of craftsmanship exhibited by artisans who created gold collections found in most tombs during those eras. In the period between 3000 B.C. and 1284 A.D., gold was the main material used to make unique jewelry products. In 1200 B.C., Egyptians' artisans hammered gold into sheets as thin as a leaf. The thin metal sheets were used to form and fabricate most jewelry products during that period. It was also during this period that experimentation of alloy metallurgy began. Other metals were added to gold to create elegant and fashionable jewelry products.

Archaeological findings show that gold was among objects discovered and used during early civilization in the Middle East (Tait, 1987). The use of gold was evidenced and supported by the discovery of this precious metal in the tomb of Puabi of Sumeria (Phillips, 1996). The tomb of Queen Puabi housed an elaborate crown of gold leaves, gold ribbons, necklaces, and a tall comb of gold, chokers, and a large pair of crescent-shaped earrings. The upper part of the Queen's body was also decorated with strings of gold beads and semi-precious stones.

As the centuries passed there was a continual progression of materials used in making jewelry in the 5th to 12th centuries. Archeologists learned from the findings in the

era between the 5th to 12th centuries that religion, politics, and socio-cultural conditions had a significant effect on jewelry that was produced. Jewelry held symbolic status and has also been embedded in religion as shown within the Anglo-Saxon communities in the United Kingdom (Anglo-Saxon art, & architecture, n.d.) (Kuntzsch, 1981). Jewelry also existed during the transition from the Gothic style of architecture to the Renaissance era between the 15th and 16th centuries; this transitional period saw naturalistic and figurative jewelry pieces mostly made of gold. These impacted the form and style of designs, materials, and methods of fabrication of jewelry. This trend design characterized most periods throughout modern history (Phillips, 1996).

The introduction of metals into jewelry making catalyzed the evolution of the jewelry industry. Gold has long been considered as one of the more desirable metals used in jewelry making. This is due to both the physical and chemical properties of gold which include its rarity, perceived beauty, and the malleability and ductility of this precious metal. In addition, gold is also resistant to tarnish and corrosion. These properties have made gold jewelry valuable; and gold has become one of the most sought after commodities for exchange.

By the Neolithic era, jewelry products became one part of available commodities used for trading (Dalrymple, 2010). Precious metals including silver and gold were among materials used as a form of currency created in areas which stretched from Iraq and Egypt to China and Britain (Ferguson, 2008). Evolution of the barter system and the introduction of metal led to jewelry being used as a medium of exchange. Most jewelry products were small in size and had practical value, which made it easier for merchants to transport the commodity from one town to another. Jewelry, therefore, become the

preferred choice over animals such as cows and horses for barter trade; jewelry does not die like animals.

Though there were changes in processes of manufacturing from labor intensive or hand made to the use of machines or automated processes after the industrial revolution, most basic methods of the traditional jewelry making process of production are still in use. Basic traditional methods of fabrication such as forging, casting, repousse, and granulation have been maintained and, at the time of this report, were being used in most jewelry making processes (Thompson, 2010). Methods of jewelry fabrication have culminated in a blending of new technologies and old traditional processes of jewelry-making. The blend of new technologies such as CAD/CAM and old traditional processes enhance creativity and innovation among jewelers.

Summary of Chapter II and an Introduction to Methodology

This literature review shows that the jewelry industry in the 21st Century has been experiencing integration of CAD/CAM technology into the designing and manufacturing of jewelry. Though there were changes in the processes of manufacturing jewelry from labor intensive or handmade practices to the use of machines or automated processes after the industrial revolution, the literature review shows that basic traditional methods of fabrication are currently being used in most jewelry making processes. In the literature review, professors with knowledge in CAD/CAM are willing to include the technology in their pedagogy of jewelry, and learners exhibit positive attitudes towards CAD/CAM in jewelry classroom environments. However, there is a need to integrate CAD/CAM technology into the teaching of jewelry making. In going forward, Chapter III will address the methodology used to collect data for this study, to find out why CAD/CAM is

not being used in the pedagogy of jewelry training in most art and design classrooms in the USA. In Chapter III, the researcher will discuss a questionnaire that was developed to determine what faculty's perceptions and jewelry professionals' perceptions are regarding the use of CAD/CAM technology in the designing and manufacturing of jewelry in arts and designs programs. The objective of Chapter III was to address how permission or approval was obtained from the University of North Dakota's (UND's) Institutional Review Board (IRB) to conduct the study, to describe the procedure for conducting the study, to describe the process used to collect data, and to describe how data was analyzed.

CHAPTER III

METHODOLOGY

Introduction

The author's inquiry into pedagogies of metals/jewelry training led him to believe that CAD/CAM technology, due to its flexible nature and functionality, could enhance and assist in design and manufacture of jewelry products and could allow users to be more creative and innovative. CAD/CAM technology allows flexibility in sketching and drawing in a learning environment, which engages designers. The characteristics of CAD technology makes it relatively easy to design 3D virtual images compared to traditional methods which are mostly associated with 2D imagery. CAD technology gives jewelry designers freedom to design very intricate patterns as the technology offers flexibility in drawing, which may be difficult and sometimes challenging to do using traditional drawing utensils. This allows clients and other interested parties to view prototype copies of jewelry images before they are produced. CAD technology is also capable of storing copies of designs, and this makes it convenient to retrieve old copies for redesigns or for production.

Despite the numerous features of CAD/CAM technology, its adoption has not always been entirely welcomed by some art and design administrators, as well as art professors in academia. The researcher became curious and set out to determine how CAD/CAM technology has been incorporated into the metals/jewelry pedagogy in arts

and design institutions in the United States of America. Permission was obtained from the National Association of Schools of Art and Design (NASAD) to obtain a list of accredited art and design institutions from the NASAD website. A list of 50 institutions was selected from the association's website. A preliminary review conducted showed that out of the fifty arts and design institutions selected, seven institutions have adopted and integrated CAD/CAM in their course curriculum. The process of reviewing the fifty arts and design institutions increased the interest of this researcher and raised significant questions about CAD/CAM pedagogy.

Quantitative Method

Quantitative research methods provide data which can validate or refute a research hypothesis. A quantitative procedure was adopted for this study because it provided statistical interpretation of the occurrence of data collected. This approach eliminates the subjectivity of conclusions, which tend to create uncertainty in research findings (Western, 2014).

A quantitative research method was also selected to eliminate bias in collecting, analyzing, and presenting research findings. A statistical program (SPSS), was used because it gives efficient and effective options in data management: It takes less time to complete a data analysis using SPSS than if you had to do the analysis by hand. The program can be used to store data and retrieve information when needed. It was adopted because the SPSS program provides good results when used for statistical data analysis. It also offers a variety of options for displaying results such as graphs and charts. Recorded data may include errors due to omissions and inclusions of statistical figures. To avoid continuance or recurrence of miscalculations, and to reduce errors and ensure reliable

values, SPSS was used to analyze and compute data collected. However, to avoid the typical problem of "Garbage In, Garbage Out" (GIGO), additional review was done to eliminate other mistakes which were missed at the time of data input.

In this quantitative research, the interval and ratio level of measurement in percentages, mean, and standard deviation were used to analyze the information collected. These were selected as the most authoritative available methods. The researcher collected and compiled data. However, not all participants who were sent the research questionnaire participated in the survey. The response rate was between 15 to 30 percent. This made it difficult to conclude results were a true reflection or representation of the population.

This quantitative research study examined the effectiveness and efficiency of Computer Aided Design (CAD) and Computer Aided Manufacture (CAM) technology features involved in the pedagogy of metal and jewelry design and manufacturing education. It also examined the relationship between CAD/CAM technology and traditional methods of making jewelry. The study also examined the impact of adoption of CAD/CAM technology into the metal/jewelry curriculum of fine arts institutions in the United State of America. CAD/CAM research findings will contribute to the knowledge base of the jewelry industry and arts and design training institutions. Arts and design administrators generally formulate policies to initiate and implement reforms, and it is hoped that the data analyzed will offer insights that will enable faculty to prepare graduates with knowledge needed by the jewelry industry.

Research Questions

The following questions were used as a basis of understanding:

- What are faculty and industries' perceptions regarding the use of Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) in jewelry design curriculums?
- What level of satisfaction do jewelry manufacturers have in regards to the technical knowledge of employees on CAD/CAM?
- What are the perceptions of the use of CAD/CAM technology from an artist's perspective?

Survey Trial Test

A questionnaire was developed and tested to limit errors and to find possible technical challenges associated with the use of a Likert scale style of questionnaire. The choice of the Likert scale format permitted respondents to choose from a range of possible responses. A trial test was conducted using five participants. The individuals who participated in the pilot test were selected from both the jewellery design and manufacturing industries, and jewellery instructors in art and design institutions. These five participants who responded in the pilot test were not considered part of this study. The pilot was conducted to test the validity of the questionnaire developed, and also to assess any technical deficiencies. The pilot test respondents were also requested to give their opinion about how to improve the questionnaire to make it simple and easy to complete. The responses of respondents were not included in the actual survey, but were collected for testing and validating purposes only. The pilot test respondents' opinion and survey responses were used to improve the validity of the questionnaire. An issue such as the

compatibility of using computer tablets and cell phone devices was identified as problematic and was addressed as a result of the pilot test.

Collection of the Data

Qualtrics, an online survey website, was used to distribute the questionnaire to randomly selected participants. Two reminder e-mails were sent to each participant in the study. The jewelry industry participants were sent reminders, which were posted on the Society of North American Goldsmith's (SNAG) website. SPSS software was used to analyze the data received from respondents. Output resulting from the analysis of data formed a basis for organization and interpretation of research findings.

The Institutional Review Board's (IRB) permission and approval was sought to conduct the study, and a questionnaire was developed based on the following parameters**:**

- Demographic distribution: The demographic data comprised gender, number of years' respondents had either been using or teaching jewelry making or manufacturing of jewelry, and the location of the institution each participant worked in.
- Knowledge and Experience: The second section of the findings focused on faculty's levels of knowledge and experience on adoption and integration of CAD/CAM to teach jewelry making.
- CAD/CAM versus traditional methods of design and manufacture of jewelry.
- Collaboration between art and design educational institutions and jewelry design and manufacturing industries. The fourth section of the results focused on collaboration between art and design educational institutions and

jewelry design and manufacturing industries on the integration of CAD/CAM technology.

- Types of CAD/CAM software.

An incentive program, a lottery or drawing, was developed to attract potential participants. Awards to respondents were initially three 25 dollar rewards. This was later increased to four 25 dollar rewards, and two African signet rings were also added to the rewards given to respondents. Participants who wanted to win an award for participating in the survey were asked to include their email in their responses for the purpose of including them in the drawing and also to inform them about the outcome of the drawing. The Institutional Review Board (IRB) was contacted at two separate times to seek permission to increase the number of prizes for respondents who participated in the survey, and also to change the duration needed to complete the survey. The completion time was changed from fifteen minutes to five minutes. Regardless of the difficulties encountered during this research, this research should form the basis of information for further research and the expansion of a broader appreciation of the effect and impact of CAD/CAM technology to teach the design and manufacture of jewelry making.

Survey Questionnaire

A questionnaire was developed to determine academic faculties' and jewelry industry professionals' perceptions regarding the use of CAD/CAM technology to design and manufacture jewelry. The survey questionnaire developed was used as the procedure for collecting data for this research study. The questionnaire was made of two parts: demographics and the main survey using a Likert scale of measurement to measure perceptions of faculty and industry professionals on the adoption and integration of

CAD/CAM technology into their systems. Demographics was made up of: gender, location, years CAD/CAM had been used in either teaching or designing jewelry, number of jewelry companies in the locality, and occupation of the participant. The main survey questionnaire explored faculty and jewelry industry professionals' perceptions of CAD/CAM pedagogy. The questionnaire also covered investment required to integrate CAD/CAM technology into training of jewellers and the steep learning curve of the technology. The question on location was to explore the relationship between art and design institutions and jewelry labour distribution in each state as shown in Figure 1.

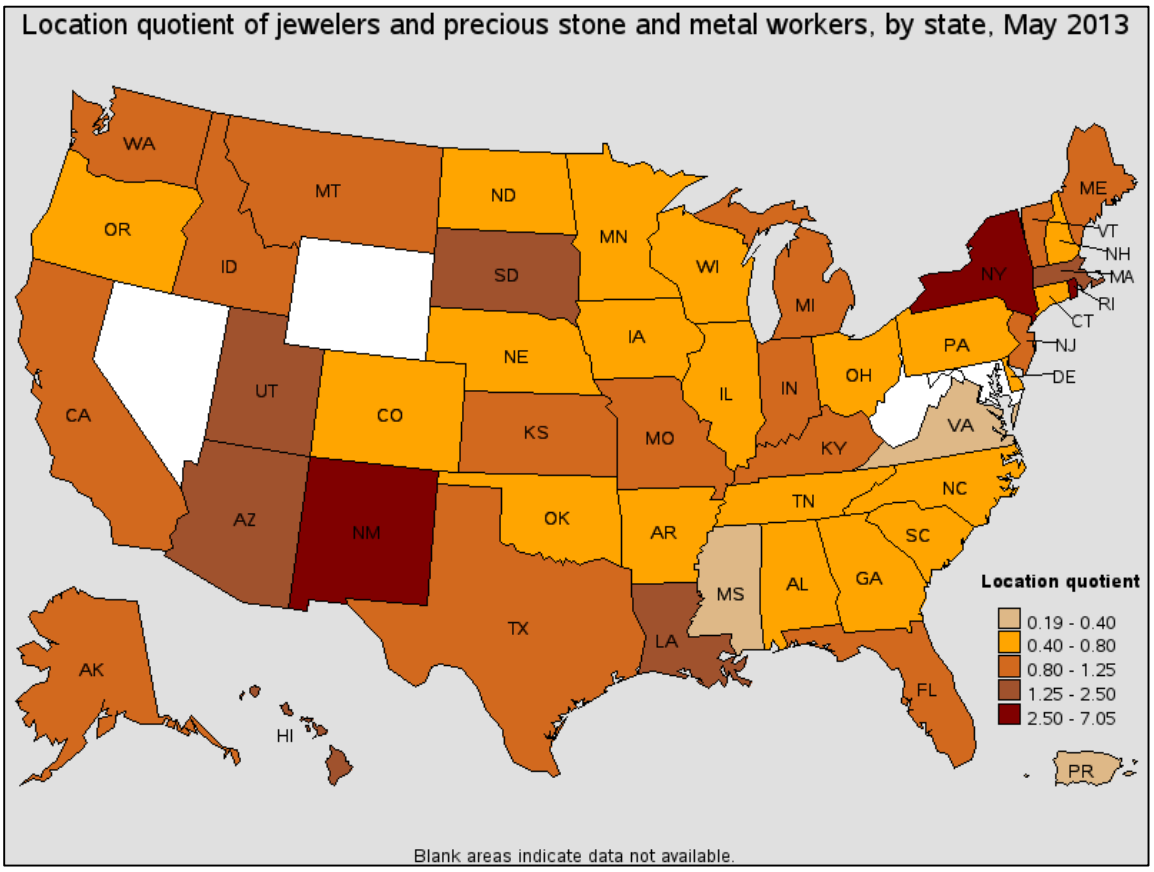

Figure 1. Distribution of Jewelers, Precious Stone Workers, and Metal Workers.

A correlation relationship between art and design institutions and number of jewelry industries in the locality perhaps explains why and how some art and design institutions have adopted and integrated CAD/CAM technology.

The developed questionnaire was sent to randomly selected instructors or professors, and metal/jewelry industry professionals. A questionnaire was also randomly sent to selected visual arts institutions electronically to invite the participation of both instructors/professors of art departments and individuals from jewelry industries.

Likert Scale of Measurement

A Likert scale of measurement was adopted for this CAD/CAM research study. A Likert scale of measurement offers a participant a range of possibilities when answering, which allows flexibility, and shows a degree of opinion (strength of opinion) of survey participants (Uebersax, 2006). Data was collected using a Likert scale of measurement to assist in determining the range of perceptions of faculty and professionals working in the jewelry industry. For this survey, five possible choices were provided to participants for each answer using the Likert scale shown below:

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

The five possible choices of this Likert scale epitomized the degree of perception respondents expressed on each of the given questions.

The research population was taken from professionals working in the jewelry industry and faculty working in arts and design institutions. Research participants were selected from and invited to participate from 50 metal/jewelry instructors or professors, and 50 design and manufacture professionals in the jewelry manufacturing field. A total of 100 participants were invited to participate from each of the states (two from each state) in the USA, representing both industry and academia. A letter (Appendix A) was sent to the National Association of Schools of Art and Design (NASAD) asking for information on accredited metal/jewelry visual arts programs in the United States of America. The NASAD responded (Appendix B) to the information request by giving the researcher a link on their website to where a list of accredited art and design institutions could be found. Another letter (Appendix C) was sent to the Society of North American Goldsmiths (SNAG) inviting the association's members to participate in the research survey. After uploading the research questionnaire onto SNAG's website, a letter from SNAG confirmed the survey was available (Appendix D). The choice of involving SNAG in this research was based on the association's nationwide appeal, as members of the association are from different states in the United States. Also, most of the association's members were made up of individuals from jewelry art institutions and manufacturing industries.

A two-pronged approach was used to distribute the questionnaire (Appendix E) to participants. First, a link to an online questionnaire was sent to SNAG and was also posted on SNAG's website. Secondly, a random selection of 100 participants from both academia and the jewelry industry were selected. Fifty accredited art and design institutions were picked from the website of NASAD. Participants selected from NASAD

represented academia. Another 50 participants representing the jewelry industries were randomly selected to cover almost all of the states in the U.S. The survey questionnaire links were sent to all participants using Qualtrics, an online research survey software. This process of choosing participants enabled the researcher to select participants who were accredited and knowledgeable to provide data for the research.

The survey results were grouped into the following sections: (a) demographic distribution, (b) types of CAD/CAM Software, (c) knowledge and experience, (d) CAD/CAM and traditional methods of design and manufacture of jewelry, and (e) collaboration between art and design institutions and jewelry design and manufacturing industries. The analysis was conducted on data collected from the research questionnaire. Results of the data analysis are provided in Chapter IV.

Summary of Chapter III and Introduction to Chapter IV

Chapter III addressed how permission was obtained from IRB to conduct the study, described the procedure used to conduct the study, and described the processes used to collect and analyze data. Chapter IV includes reports on data collected. Responses obtained are graphically represented in tables. Responses to Likert scale questions are represented in one table for each question to show each question and its corresponding responses and to describe the information which has been tabulated.

CHAPTER IV

REPORTING ON SURVEY RESULTS

The objective of this study was to examine perceptions of: (a) teachers of metals/jewelry design and manufacturing in higher education, and (b) jewelers in the jewelry industry about CAD/CAM technology. A total of 18 respondents comprised of jewelry design and manufacturing institutions and accredited art and design institutions which offer metals/jewelry programs responded to the survey. The website of SNAG was used to invite individuals who were employed in the jewelry design and manufacturing industry and/or teaching jewelry design and manufacturing to participate in the survey. All participants were sent an online link to the survey questionnaire; the same questionnaire was sent to faculty and industry participants. Data obtained was used for survey analysis using SPSS. The researcher analyzed the information collected by dividing the data into two sections, namely Faculty and Industry. The data was subsequently classified into the following sub-categories:

- Survey demographic distribution,
- Survey on types of CAD/CAM software,
- Survey on knowledge and experience,
- Survey on CAD/CAM versus traditional methods of making jewelry,
- Survey on collaboration between art and design institutions and jewelry design and manufacturing industries.

Descriptive statistics were used to analyze the data in categories and subsections. The descriptive statistics used frequencies and percentages. To analyze the data, a variety of statistical tests were performed. These included calculations of standard deviation, variance, mean, and frequencies for art and design institutions, and the number of jewelry design and manufacturing institutions.

Faculty Survey – Demographic Distribution

The demographic data comprised gender, number of years respondents either taught jewelry or designed and manufactured jewelry, location of participants, and occupation. Table 2 shows the gender of respondents who teach jewelry design and/or manufacturing.

Table 2. Gender of Faculty Respondents, Participants Who Teach.

Answer Options		Frequency	Response (%)
Male		7	58
Female		5	42
Total Responses		**12**	**100**
Mean	1.42		
Variance	0.27		
Standard Deviation	0.51		

Table 3 shows responses relating to the number of years individual participants either taught jewelry design/manufacturing classes or actually worked as professionals designing and manufacturing jewelry. Only 11 people responded to this question.

Table 3. Responses to Survey Question: *I Have Been Using/Teaching Jewelry Design and Manufacturing for . . .*

Answer Options		Responses	Frequency (%)
0 -10 yrs		2	18
11-21 yrs		5	45
22-32 yrs		2	18
33-44 yrs		2	18
45-55 yrs		0	0
Total Responses		**11**	**100**
Mean	2.36		
Variance	1.05		
Standard Deviation	1.03		

Table 4 shows responses to the question on demographics relating to the location of participants. Only 11 people responded to this question.

Table 4. Answers to Location (City and State) of Participants.

City	State	Responses
Grand Rapids	Michigan (MI)	2
Oxford	Ohio (OH)	1
Kent	Ohio (OH)	1
New York	New York (NY)	1
Lafayette	Louisiana	1
Richmond	Virginia (VA)	1
Arcata	California (CA)	1
Denton	Texas (TX)	1
Bloomington	New Jersey (NJ)	1
Grand Forks	North Dakota (ND)	1
Total Responses		**11**

Table 5 examines the relationship, if any, between the number of art and design institutions offering instruction in metals/jewelry design and/or manufacturing and the number of jewelry companies commercially designing/manufacturing jewelry in the same locality. Twelve (N = 12) individuals responded to this question. Eight (n = 8) individuals, which represent 67% of participants who answered this question, indicated they have 1 to 10 jewelry industries in their locality as shown in Table 5. The table shows the number of jewelry industries operating in and around communities where educational art and design institutions are located.

Table 5. Responses to Survey Question: *How Many Jewelry Manufacturing Industries are in Your Communities?*

Answer Options		Responses	Frequency (%)
None		1	8
1-10		8	67
11-21		2	17
22-32		0	0
33 or more		1	8
Total Responses		**12**	**100**
Mean	2.33		
Variance	0.97		
Standard Deviation	0.98		

Table 6 shows the distribution of responses to the survey question regarding occupation. Twelve (N = 12) participants responded to the question on occupation with eight (n = 8) respondents, representing 67%, indicating they design and manufacture jewelry and also teach jewelry. The remaining four (n = 4) respondents taught jewelry

design/manufacturing only, and thus represented 33% of the total number of those who responded to the question.

Table 6. Occupation of Faculty Participants.

Answer Options		Responses	Frequency (%)
Designs/Manufactures Jewelry		0	0
Teaches Jewelry		4	33
Designs/Manufactures and Teaches Jewelry		8	67
Total Responses		**12**	**100**
Mean	2.67		
Variance	0.24		
Standard Deviation	0.49		

Faculty Survey – Types of CAD/CAM Software

Four questions from the survey were designed to elicit responses relative to the variety of CAD/CAM software available, which faculty and industry adopted and used to teach, design, and manufacture jewelry. Participants were asked, "*What is the name of the CAD/CAM software you are using to teach/produce jewelry design and manufacturing now?*" The next question asked, "*Have you used any different CAD/CAM software in the past for teaching? (If Yes please list all in order of preference).*" Another question asked, "*What is the name of the CAD/CAM software you are now using to produce jewelry design and manufacturing now?*" And, another question asked, "*Have you used any different CAD/CAM software in the past for jewelry design and manufacturing? (If Yes please list all in order of preference).*"

The responses to questions on types of CAD/CAM programs participants have used are shown in Table 7 below. These responses show the frequency of use of various CAD/CAM programs, which faculty and industry use when teaching, designing, and manufacturing jewelry.

Table 7. Types of CAD/CAM Programs Faculty Respondents Have Used.

Type of CAD/CAM	**Number of times mentioned**	**Type of CAD/CAM**	**Number of times mentioned**
Rhino	12	Maya	1
Matrix 8	1	Illustrator	2
Netfabb	1	Solidworks	1
Meshlabs	1	Autocad inventor	1
Solidthinking	1	Artcam	1
Scultrips	1	Zbrush	1
FormZ	1	Sketchup	2

Faculty Survey – Knowledge and Experience

The third section of the findings focuses on faculty's level of knowledge and experience on the adoption and use of CAD/CAM to teach jewelry. In this section of the survey, twelve (N = 12) individuals responded to the question, "*I have CAD/CAM teaching experience*," and the details are shown in Table 8.

Twelve individuals responded to the question on whether or not they include CAD/CAM in their jewelry curriculum and the breakdown is shown in Table 9.

Table 8. Faculty Responses to: *I Have CAD/CAM Teaching Experience*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		3	25
Disagree		4	33
Neither Agree nor Disagree		0	0
Agree		2	17
Strongly Agree		3	25
Total Responses		**12**	**100**
Mean	2.83		
Variance	2.70		
Standard Deviation	1.64		

Table 9. Faculty Responses to: *I Include CAD/CAM in the Jewelry Curricula*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		4	33
Disagree		1	8
Neither Agree nor Disagree		2	17
Agree		0	0
Strongly Agree		5	42
Total Responses		**12**	**100**
Mean	2.92		
Variance	0.81		
Standard Deviation	0.90		

Table 10 shows responses to the survey question: "*It is simple to use the CAD/CAM technology to teach jewelry making methods*."

Table 10. Faculty Responses to: *It is Simple to Use the CAD/CAM Technology to Teach Jewelry Making Methods*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		1	8
Disagree		2	17
Neither Agree nor Disagree		6	50
Agree		3	25
Strongly Agree		0	0
Total Responses		**12**	**100**
Mean	2.92		
Variance	0.81		
Standard Deviation	0.90		

Faculty Survey – CAD/CAM Versus Traditional Methods

In this section on art and design, participants were asked to choose between CAD/CAM and traditional methods of making jewelry. Twelve (N = 12) individuals responded to this section of the survey. Table 11 shows a breakdown of data collected on the survey question: "*I prefer teaching using traditional jewelry making methods more than CAD/CAM jewelry methods*."

Table 11. Faculty Responses to: *I Prefer Teaching Using Traditional Jewelry Making Methods More Than CAD/CAM Jewelry Methods.*

Answer Options		Responses	Frequency (%)
Strongly Disagree		0	0
Disagree		3	25
Neither Agree nor Disagree		4	33
Agree		4	33
Strongly Agree		1	8
Total Responses		**12**	**100**
Mean	3.25		
Variance	0.93		
Standard Deviation	0.97		

Faculty Survey – Collaboration Between Art and Design Institutions, and Jewelry Industry

Table 12 shows responses of faculty participants to the question on collaboration between educational institutions and the jewelry design and manufacturing industry.

Table 12. Faculty Responses to: *My Institution Collaborates With the Jewelry Design and Manufacturing Industry on the Adoption of CAD/CAM Technology*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		2	17
Disagree		2	17
Neither Agree nor Disagree		5	42
Agree		2	17
Strongly Agree		1	8
Total Responses		**12**	**100**
Mean	2.83		
Variance	1.42		
Standard Deviation	1.19		

On the issue of adoption of CAD/CAM technology in the making of jewelry, 12 individuals responded to the question as shown in Table 13.

Table 13. Faculty Responses to: *The adoption of CAD/CAM Technology in Jewelry Making Increases Production*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		0	0
Disagree		2	1
Neither Agree nor Disagree		4	33
Agree		6	50
Strongly Agree		0	0
Total Responses		**12**	**100**
Mean	3.33		
Variance	0.61		
Standard Deviation	0.78		

The researcher designed the next question on the survey to discover whether or not it is difficult to learn CAD software, and whether the steep learning curve might account for the relative low number of individuals who have adopted CAD/CAM technology in the jewelry industry. Table 14 shows detailed responses to the question: "*The steep learning curve required does not encourage CAD/CAM to be incorporated in jewelry design and manufacturing*."

Table 14. Faculty Responses to: *The steep learning curve required does not encourage CAD/CAM to be incorporated in jewelry design and manufacturing*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		0	0
Disagree		7	58
Neither Agree nor Disagree		2	17
Agree		3	25
Strongly Agree		0	0
Total Responses		**12**	**100**
Mean	2.67		
Variance	0.79		
Standard Deviation	0.89		

Table 15 shows the replies from 12 individuals who responded to the survey question relating to how cost of CAD/CAM affects its use.

Table 15. Faculty Responses to: *The investment required does not encourage CAD/CAM to be incorporated in jewelry design and manufacturing*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		2	17
Disagree		4	33
Neither Agree nor Disagree		2	17
Agree		3	25
Strongly Agree		1	8
Total Responses		**12**	**100**
Mean	2.75		
Variance	1.66		
Standard Deviation	1.29		

Table 16 shows responses to the survey question asking if respondents would recommend using CAD/CAM technology to design and manufacture jewelry. Twelve (*N* = 12) individuals responded to the question.

Table 16. Faculty Responses to: "*I Recommend Using CAD/CAM Technology in Designing and Manufacturing of Jewelry*."

Answer Options		Responses	Frequency (%)
Strongly Disagree		0	0
Disagree		0	0
Neither Agree nor Disagree		3	25
Agree		6	50
Strongly Agree		3	25
Total Responses		**12**	**100**
Mean	4.00		
Variance	0.55		
Standard Deviation	0.74		

Table 17 shows responses from 12 individuals to a question on training.

Table 17. Faculty Responses to: *I Recommend Training in Using CAD/CAM Technology in Designing and Manufacturing of Jewelry*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		0	0
Disagree		0	0
Neither Agree nor Disagree		1	8
Agree		4	33
Strongly Agree		7	58
Total Responses		**12**	**100**
Mean	5.08		
Variance	1.36		
Standard Deviation	1.16		

On one survey question, participants were asked to show how much they had accepted and incorporated CAD/CAM technology in making jewelry. Twelve (N = 12) individuals responded to the question. Table 18 shows the breakdown of the data collected on this question**.**

Table 18. Faculty Responses to: *I am Prepared to Pay to Acquire CAD/CAM Technology Software to Teach Jewelry*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		0	0
Disagree		0	0
Neither Agree nor Disagree		3	25
Agree		4	33
Strongly Agree		5	42
Total responses		**12**	**100**
Mean	4.92		
Variance	1.54		
Standard Deviation	1.24		

Industry Survey – Demographic Distribution

The data on demographics for the industry consist of gender, the number of years individual jewelers have worked in the jewelry industry, location, and occupation. There were two sets of respondents: Jewelers in the industry and individuals who teach jewelry as well as work in the jewelry industry. Six (N = 6) individuals responded to the question regarding gender as shown in Table 19.

Table 19. *Gender* – Jewelers in the Industry.

Answer Options		Frequency	Response (%)
Male		3	50
Female		3	50
Total Responses		**6**	**100**
Mean	1.50		
Variance	0.30		
Standard Deviation	0.55		

In this section of the demographics data from the industry, a total of six ($N = 6$) individuals responded to the survey question on years of service. Respondents indicated the number of years they have either taught or designed and manufactured jewelry. Table 20 shows the distribution of responses participants from the industry gave on the question. Table 20 also shows details of responses to the question.

Table 20. Industry Responses to: *I Have Being Using/Teaching Jewelry Design and Manufacturing for . . .*

Answer Options		Responses	Frequency (%)
0 -10yrs		1	17
11-21yrs		3	50
22-32yrs		0	0
33-44yrs		1	17
45-55yrs		1	17
Total Responses		**6**	**100**
Mean	2.67		
Variance	2.27		
Standard Deviation	1.51		

Table 21 below shows the replies to the demographic question on "location."

Table 21. Answers to Location (City and State) of Industry Professionals.

City	State	Responses
Baton Rouge	Louisiana (LA)	1
Glasgow	Texas (TX)	1
Denton	Ohio (OH)	1
Champaign	Illinois (IL)	1
Zanesville	Ohio (OH)	1
Spokane	Washington (WA)	1
Total Responses		**6**

The purpose of asking industry professionals the question: "*How many Jewelry manufacturing industry(s) are in your communities?*" was to investigate the relationship between the number of art and design educational institutions offering metals/jewelry design and/or manufacturing classes and jewelry industries in the same communities. Because the section of the survey addressing industry did not count the number of educational institutions in the location of the industry participant, we had no way to correlate industry with number of educational institutions in the locations of industry participants, and so this question was not addressed in the industry section of the survey.

Table 22 shows a distribution of respondents on occupation. Six ($N = 6$) participants responded to the question on occupation.

Table 22. Occupation of Industry Participants.

Answer Options		Responses	Frequency (%)
Designs/Manufactures Jewelry		2	330
Teaches Jewelry		0	
Designs/Manufactures and Teaches Jewelry		4	67
Total responses		**6**	**100**
Mean	2.33		
Variance	1.07		
Standard Deviation	1.03		

Industry Survey – Types of CAD/CAM Software

Industry responses to the question on types of CAD/CAM software participants have used was included in faculty responses in Table 7.

Industry Survey – Knowledge and Experience

The third section of the findings on industry focuses on the level of "Knowledge and Experience" industry professionals had in the usage of CAD/CAM technology to design and manufacture jewelry. The researcher used the following survey questions – *I have CAD/CAM experience*; *I include CAD/CAM in the jewelry design and manufacturing processes*; *It is simple to use the CAD/CAM technology in jewelry making processes* – to investigate how knowledgeable and experienced interviewed jewelers were, and to find out who had acquired CAD/CAM and incorporated the technology into their jewelry making. Tables 23, 24, and 25 show the distribution of participants' responses to "Knowledge and Experience" questions on the survey.

Table 23. Industry Responses to: *I have CAD/CAM experience*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		0	0
Disagree		0	0
Neither Agree nor Disagree		0	0
Agree		2	100
Strongly Agree		0	0
Total Responses		**2**	**100**
Mean	4.00		
Variance	0.00		
Standard Deviation	0.00		

Table 24. Industry Responses to: *I include CAD/CAM in the jewelry design and manufacturing processes*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		0	0
Disagree		0	0
Neither Agree nor Disagree		0	0
Agree		1	50
Strongly Agree		1	50
Total Responses		**2**	**100**
Mean	4.40		
Variance	0.50		
Standard Deviation	0.71		

Table 25. Industry Responses to: *It is Simple To Use the CAD/CAM Technology in Jewelry Making Processes*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		0	0
Disagree		0	0
Neither Agree nor Disagree		1	50
Agree		1	50
Strongly Agree		0	0
Total Responses		**2**	**100**
Mean	3.50		
Variance	0.50		
Standard Deviation	0.71		

Industry Survey – CAD/CAM Versus Traditional Methods

On the question on using CAD/CAM versus traditional methods of designing and manufacturing jewelry, participants were asked about their choice of methods for designing and fabricating jewelry. Table 26 shows the details of the responses to the survey question, "*I prefer using traditional jewelry making methods more than CAD/CAM jewelry*."

Table 27 shows responses from individuals in industry to the survey question: "*I am prepared to pay to acquire CAD/CAM technology software to design and manufacture jewelry*."

Table 26. Industry Responses to: *I Prefer Using Traditional Jewelry Making Methods More Than CAD/CAM Jewelry*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		0	0
Disagree		0	0
Neither Agree nor Disagree		1	50
Agree		1	50
Strongly Agree		0	0
Total Responses		**2**	**100**
Mean	3.50		
Variance	0.50		
Standard Deviation	0.71		

Table 27. Industry Responses to: *I Am Prepared to Pay to Acquire CAD/CAM Technology Software to Design and Manufacture Jewelry.*

Answer Options		Responses	Frequency (%)
Strongly Disagree		0	0
Disagree		0	0
Neither Agree nor Disagree		1	50
Agree		1	50
Strongly Agree		0	0
Total Responses		**2**	**100**
Mean	3.50		
Variance	0.50		
Standard Deviation	0.71		

In Table 28, six (N = 6) individuals responded to the survey question displayed and indicated their preference of using CAD/CAM technology in designing and manufacturing of jewelry. The table shows the distribution of responses given by industry participants.

Table 28. Industry Responses to: *I Recommend Training in Using CAD/CAM Technology in Designing and Manufacturing of Jewelry*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		0	0
Disagree		0	0
Neither Agree nor Disagree		0	0
Agree		4	67
Strongly Agree		2	33
Total Responses		**6**	**100**
Mean	4.67		
Variance	1.07		
Standard Deviation	1.03		

In this next question, participants were asked to show how much they had accepted the use of CAD/CAM technology and whether or not they were willing to recommend the technology to other jewelers in the industry. Six (N = 6) individuals responded to the question. Table 29 shows the details of responses from participants to the question, "*I recommend using CAD/CAM technology in designing and manufacturing of jewelry***.**"

Table 29. Industry Responses to: *I Recommend Using CAD/CAM Technology in Designing and Manufacturing of Jewelry*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		0	0
Disagree		1	17
Neither Agree nor Disagree		0	0
Agree		2	33
Strongly Agree		3	50
Total responses		**6**	**100**
Mean	4.17		
Variance	1.37		
Standard Deviation	1.17		

Table 30 shows responses of the six industry participants to a survey question on the number of years participants have been using CAD/CAM.

Table 30. Industry Response to: *I Have Been Using/Teaching Jewelry Design and Manufacturing for . . .*

Answer Options		Responses	Frequency (%)
0 -10 yrs		0	0
11-21 yrs		5	83
22-32 yrs		0	0
33-44 yrs		0	0
45-55 yrs		1	17
Total Responses		**6**	**100**
Mean	2.50		

Variance	1.50
Standard Deviation	1.22

Industry Survey – Collaboration Between Art and Design Institutions, and Jewelry Industry

The fifth section of the findings focuses on collaboration between art and design institutions of education and jewelry design and manufacturing industries on the adoption of CAD/CAM technology. The researcher used this question, "*My institution collaborates with the jewelry design and manufacturing industry on the adoption of CAD/CAM technology*" and a demographic question on location to investigate how the two institutions collaborate on adoption and integration of CAD/CAM technology. Six (*N* = 6) individuals involved in industry responded to the survey question on collaboration between art and design institutions of education and jewelry design and manufacturing industries. The purpose of this question was to investigate a possible relationship between the number of art and design institutions offering metals/jewelry education and jewelry industries in the same communities.

Table 31. Industry Responses to: *My Institution Collaborates With the Jewelry Design and Manufacturing Industry on the Adoption of CAD/CAM Technology*

Answer Options	Responses	Frequency (%)
Strongly Disagree	0	0
Disagree	1	17
Neither Agree nor Disagree	1	17
Agree	3	50
Strongly Agree	1	17
Total Responses	**6**	**100**

Mean	4.17
Variance	1.37
Standard Deviation	1.17

Table 32 shows replies of the six industry participants to the question: *The adoption of CAD/CAM technology in jewelry making increases production*. Six ($N = 6$) individuals responded to the question. Table 32 shows the breakdown of the responses received on the question.

Table 32. Industry Responses to: *The Adoption of CAD/CAM Technology in Jewelry Making Increases Production*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		0	0
Disagree		0	0
Neither Agree nor Disagree		2	33
Agree		2	33
Strongly Agree		2	33
Total Responses		**6**	**100**
Mean	4.00		
Variance	0.80		
Standard Deviation	0.89		

The researcher used the question: "*The steep learning curve does not encourage CAD/CAM to be incorporated in jewelry design and manufacturing*" to investigate the effect of the learning experience of participants on learning to use CAD/CAM and on how that learning experience affects perceptions of participants on the acceptability and adoption of CAD/CAM technology into the jewelry industry.

Table 33. Industry Responses to: *The Steep Learning Curve Required Does Not Encourage CAD/CAM to be Incorporated in Jewelry Design and Manufacturing*.

Answer Options		Responses	Frequency (%)
Strongly Disagree		0	0
Disagree		0	0
Neither Agree nor Disagree		2	33
Agree		3	50
Strongly Agree		1	17
Total Responses		**6**	**100**
Mean	3.83		
Variance	0.57		
Standard Deviation	0.75		

In the next question, participants were asked to show whether the investment needed to acquire CAD/CAM technology had an effect on their decision to acquire and incorporate CAD/CAM into jewelry design and manufacturing. Six (N = 6) individuals responded to the question. Table 34 shows details of participant's responses.

Table 34. Industry Responses to: *The Investment Required Does Not Encourage CAD/CAM to be Incorporated in Jewelry Design and Manufacturing*.

Answer Options	Responses	Frequency (%)
Strongly Disagree	0	0
Disagree	1	17
Neither Agree nor Disagree	1	17
Agree	4	67
Strongly Agree	0	0

Total responses		**6**	**100**
Mean	3.50		
Variance	0.70		
Standard Deviation	0.84		

Summary – Survey Analysis

Descriptive statistics were used to analyze data in categories (Faculty and Industry) and subsections. Descriptive statistics used frequencies and percentages. To analyze the data, a variety of statistical tests were performed, these included calculations of Standard Deviation, Variance, Mean, and Frequencies for art and design educational institutions and the number of design and manufacturing jewelry industries. An example of this was shown in Table 31 that addresses the question, "*My institution collaborates with the jewelry design and manufacturing industry on the adoption of CAD/CAM technology*." Presenting the results in tabular form gives the reader a summary and visual interpretation of data collected.

The researcher did the analysis by first dividing the data into two main categories – Faculty and Industry. The investigator subdivided the findings of the categories into five sections, namely: demographics, types of CAD/CAM software, knowledge and experience, CAD/CAM versus traditional methods of design and manufacturing of jewelry, and collaboration between art and design institutions and jewelry design and manufacturing industries.

Demographics

The first division of the data focused on demographic distribution. A total of 18 respondents (N = 18) answered the survey section on demographics. There were twelve

(n = 12) respondents from educational institutions and six (n = 6) from industrial institutions. Ten of the respondents were male and eight of the remaining respondents were female. There were as many female respondents as male respondents involved in the design and manufacture of jewelry. Among the faculty respondents, seven were male and five were female.

The survey results on location (city and state) of art and design educational institutions and design and manufacturing jewelry industries indicated that none of the responses recorded showed that participants (academy and industry) came from the same town. Maps obtained from the Bureau of Labor Statistics (2016) – Figure 1 and Figure 2 – were used to examine the distribution of jewelry businesses in the USA and the relationship between those businesses and the density of jewelry employees in different states in the country. Figure 1 and Figure 2 show the distribution of jewelers, precious stone workers, and metal workers.

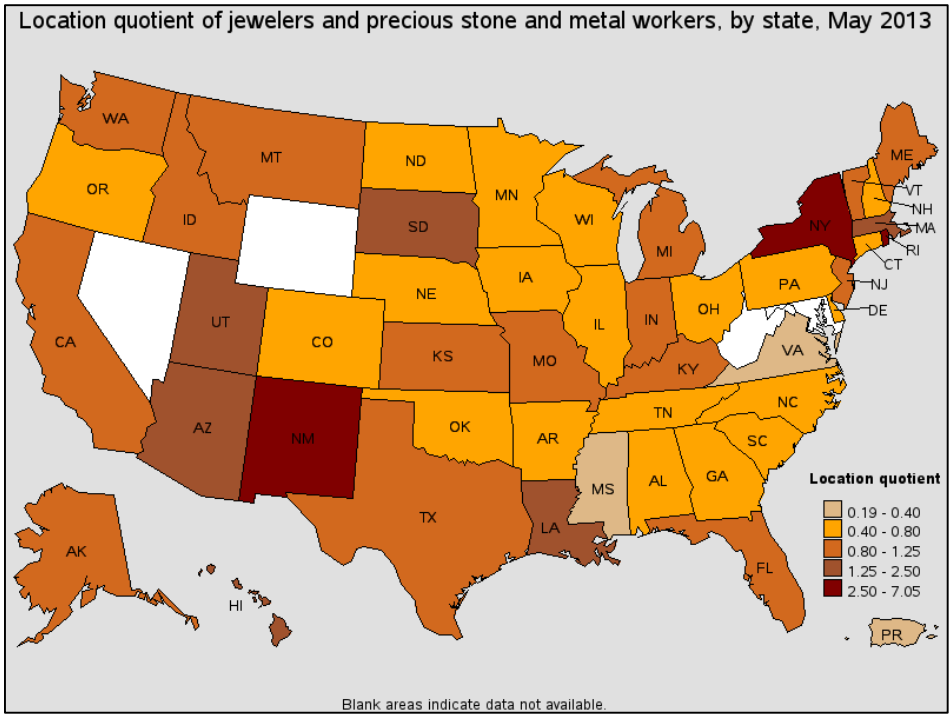

Figure 1. Distribution of Jewelers, Precious Stone Workers, and Metal Workers. Reprinted from "Occupational Employment Statistics: Occupational Employment and Wages, May 2015," by the Bureau of Labor Statistics, 2016, retrieved from http://www.bls.gov/oes/current/oes519071.htm, p. 1. Copyright 2016 by the U.S. Bureau of Labor Statistics.

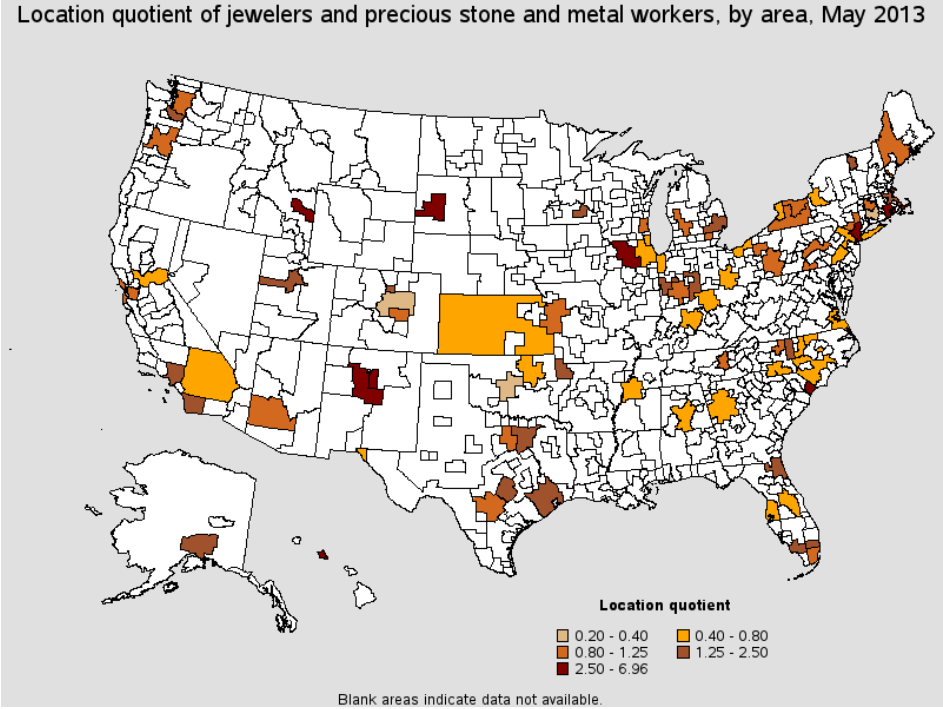

Figure 2. Metropolitan Areas With the Highest Concentration of Jobs and Location Quotients in This Occupation. Reprinted from "Occupational Employment Statistics: Occupational Employment and Wages, May 2015," by the Bureau of Labor Statistics, 2016, retrieved from http://www.bls.gov/oes/current/oes519071.htm, p. 1. Copyright 2016 by the U.S. Bureau of Labor Statistics.

Types of CAD/CAM Software

The second section of the survey analysis discussed types of CAD/CAM software faculty were familiar with. Rhino software (n = 12) was the type most respondents mentioned. However, little information is known about the reasons why Rhino was the preferred choice. The research study did not focus on questions about features of Rhino, or details of the other types of CAD/CAM software programs respondents selected.

Knowledge and Experience

The third section of the findings related to knowledge and experience. Six questions from the survey were used to examine participants' knowledge and experience of CAD/CAM technology. The resultant data collected on these questions are as follows:

Answers to the question, "*I have CAD/CAM teaching experience*" and the question, "*I have CAD/CAM experience*" indicated that out of the total number of participants (*n* = 14) who responded to the "Knowledge and Experience" section, twelve faculty members' responses gave the following results: three respondents (*n* = 3; 25%) *Strongly Disagree*, four (*n* = 4; 33%) *Disagree*, three (*n* = 3; 25%) *Strongly Agree*, and two (*n* = 2; 17%) individuals indicated *Agree*. Additionally, only two (*n* = 2) of the individuals who responded to the question, "*I have CAD/CAM experience*," from the industry selected *Strongly Agree*.

Responses to the questions: "*I have CAD/CAM teaching experience*," and "*I include CAD/CAM in the jewelry curriculum*," show reliability and consistency in the statistical data recorded. The resultant responses are indicated below.

- The resultant answers from 12 faculty respondents on the question, "*I have CAD/CAM teaching experience*," were as follows: four (*n* = 4) or 33% of individuals who responded chose *Strongly Disagree*; and three (*n* = 3; 25%) selected *Strongly Agree* and (*n* = 2; 17%) selected *Agree*. Because three respondents selected *Strongly Agree* and two respondents selected *Agree*, a total of five respondents (*n* = 5; 42%) agreed with the statement.

- The resultant answers from 12 faculty respondents on the question, "*I include CAD/CAM in the jewelry curriculum*" reflected the same pattern as answers from the previous question. Four respondents (n = 4, 33%) strongly disagreed with the statement, and five respondents (n = 5; 42%) strongly agreed with the statement.

CAD/CAM Versus Traditional Methods

The fourth section of the survey analysis presented statistics analysis on respondents' preferences for traditional methods of jewelry making versus integration of CAD/CAM technology for teaching, designing, and manufacturing of jewelry. The fourth category of the data analysis centered on the willingness of respondents to pay the cost needed to acquire CAD/CAM software/tools and the respondents' willingness to endure the long learning curve necessary to learn how to use CAD/CAM.

Collaboration Between Art and Design Institutions, and Jewelry Industry

The final section of data analysis focused on respondents' perceptions of how well their institutions were willing to cooperate with industry in adopting CAD/CAM technology into the jewelry industry. Respondents gave their views on whether or not CAD/CAM increases jewelry production, how the steep learning curve affects adoption of CAD/CAM, and whether or not they perceive their institutions as willing to invest in CAD/CAM software.

Reliability and Validity

Joppe (2000) defined reliability as:

> . . . The extent to which results are consistent over time and an accurate representation of the total population under study is referred to as reliability and if

> the results of a study can be reproduced under a similar methodology, then the research instrument is considered to be reliable. (as cited in Golafhani, 2003)

Reliability and validity in quantitative research show whether the research result is replicable and also represents actual variables which the researcher intends to measure (Golafhani, 2003). It is for this reason that the researcher adopted the quantitative analysis to achieve an accurate representation and validity to these research findings.

The reliability of this nationwide research study depended on the number of respondents who participated in the survey research. According to Gravetter and Wallnau (2013), use of more than half an estimated number of participants gives reliable and valid answers and makes generalization of research findings acceptable. A smaller number of respondents reduces accuracy of test scores (Gravetter & Wallnau, 2013) of a study. The researcher received 18 responses from participants. In this study, three reminders were sent out to participants. To implement the Gravetter and Wallnau research finding, follow-ups were done in order to increase the sample size. An effort was made to entice participants to participate in the survey.

This chapter focused on the reporting of data collected from the research survey. Chapter V will address the genesis of the research study and use the information reported in Chapter IV as a knowledge base to make suggestions, contributions, and conclusions, considering all the limitations and setbacks of the research study. The outcome of the research may contribute to the knowledge base of the jewelry industry and also form a basis for further research.

CHAPTER V

SUMMARY, RECOMMENDATIONS, LIMITATIONS, AND CONCLUSION

Summary

The purpose of this quantitative study was to determine why Computer Aided Design (CAD) and Computer Aided Manufacture (CAM) technology are not included in most metal/jewelry curricula in the United States of America's Arts and Design Institutions. Given the advantages that CAD/CAM technology provides, the jewelry industry is now gradually adding knowledge in CAD/CAM to part of the job requirements for employees of manufacturing companies and faculty in art and design (jewelry) educational institutions. Though the concept of this study is based on the pedagogy of jewelry making in a classroom environment, the relative importance of traditional jewelry making and the design and manufacture of jewelry by jewelry companies was also considered.

The questions which guided this research study include the following:

- What are faculty and industries' perceptions regarding the use of Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) in jewelry design curriculums?
- What level of satisfaction do jewelry manufacturers have in regards to the technical knowledge of employees on CAD/CAM?

- What are the perceptions of the use of CAD/CAM technology from an artist's perspective?

Having been in the jewelry industry in Ghana since 1997 has offered me the opportunity to acquire considerable knowledge and skill in the profession. Unfortunately, it is unrealistic for jewelers and other artists to enjoy the fruits of their labor in Ghana. Some of the jewelers in Ghana copy the intellectual property of other jewelers' designs, and produce them for commercial purposes. These are done without acknowledging and paying compensation to the original owners of designs. Though there are laws governing copyrights in Ghana, it is difficult for government agencies to enforce these laws due to a lack of logistics for such operations. The inability of lawmakers to control intellectual property rights in Ghana and most countries in Africa motivated the researcher to search for a technology which can be used to increase production of jewelry products. The unfairness described above led to a search for skill, knowledge, and technology, which will allow for an increase in the production of unique products purposely for custom made and commercial jewelry.

Though the maps in Figure 1 and Figure 2 show locations and the distribution of jewelry companies in the U.S., it is difficult to use the statistical data to analyze and generalize the research findings on location. This is because the actual number of respondents who participated in the survey were low in number compared to the number of individuals who were asked to participate. An increased number of participants would have made it justifiable to generalize research findings in regard to location (Gravetter & Wallnau, 2013).

Data Preparation

Data preparation included data coding, data entry, and verification. All entries were carefully checked more than once to look for incorrect entries and to limit errors. Questionnaires were reviewed to detect any discrepancies in the data collected. In other studies, data obtained from answers to questionnaires which were omitted were not considered valid for statistical analysis (Mertler & Vannatta, 2002). However, in this investigative study, all responses or data collected were used in the analysis of the research.

Limitations

Policy makers' attitudes toward fine arts is not encouraging. Some policy makers do not see fine arts as being in mainstream academia, because institutional managers and administrators consider fine arts as a practical course and give little attention to the art discipline. "An art school may very well be considered a place in which changes are welcome, accepted, and elaborated. And this may very well be a reason why it can seem dangerous and be discredited as useless" (Vettese, 2013, p. 16). Therefore little investment goes into the arts, and sometimes arts sections at academic institutions are closed instead of investing in and upgrading them. The following are some of the examples of actions educational administrators have taken to downsize institutions:

The global economic downturn often makes administrators create policies and decisions to either downsize or close sections of art and design institutions. Policy makers and managers of higher educational institutions find it difficult to raise funds to undertake research, provide scholarships, provide tuition waivers, and run other operations of these institutions of learning. Officials, most often when confronted with such a difficult

scenario, tend to use fine arts as an area where they can make cuts which in the long run affects the growth of art and design institutions. The following are examples of these tendencies:

- Emory University, Atlanta, Georgia is closing down their visual arts department, in the name of restructuring. (Fox, 2012).
- Jack Risley, chairman and sculpture professor in the Department of Art and Art History at the University of Texas (UT) made reference to the fact that the studio art program in the college, is undergoing curriculum changes, including cutting ceramics and offering only one more semester of intermediate and advanced metal courses in the fall, effectively ending both programs (Ayala, 2013).

The cost of operation for some of these programs is expensive. Therefore, administrators may be reluctant to expend resources on technology such as CAD/CAM, which just act as a tool to assist the student artist. The cost of acquiring computers, software, and 3D printers for the CAD/CAM technology content is an increased expense for struggling art design institutions which want to include these tools in the pedagogy of educational programs.

Discussion

When one thinks of art, what often comes to mind is a painting by a famous artist. When one thinks about technology, what comes to mind are computers, smart phones, and flashy cars. For many years, technology has been part of the arts in areas such as graphic design, architecture, ceramics, metals and jewelry, fibers, and music. In recent

years, technology such as CAD/CAM has had a positive growth impact on the design and manufacture of jewelry due to advantages that CAD/CAM technology provides.

There has been a constant introduction of new tools and machines in the art community for the design and creation of works of art. This makes it difficult to evaluate art and thus creates apprehension about the use of technology in the making of art works in the art educational institutions. I believe technology has always been in art and continues to aid artists in designing and making works of art, and artists need to accept technology as an aid and a third hand in helping an artist push beyond the boundaries to create unique artworks.

Research findings show a gap between art and design educational institutions and jewelry design and manufacturing businesses. For example, the study showed that faculty members with knowledge in CAD/CAM are prepared to use the technology to teach jewelry making. The jewelry design and manufacturing businesses, on the other hand, are taking advantage of CAD/CAM technologies and use these technologies to be competitive and also to maximize their profit.

The study also demonstrates the versatility of some faculty members. Thirty-three percent (33%; $n = 2$) of the respondents to the survey were individuals who design and manufacture jewelry, while 67% ($n = 4$) of participants were individuals who taught jewelry making and also designed and manufactured jewelry. Though the survey records show different frequency values, both academic participants and industry participants gave answers which were the same in percentage values on demographics. The records show that more professionals are able to teach as well as design and manufacture jewelry for the industry than only teach or only design and manufacture

jewelry. Perhaps it is easy for professionals who teach jewelry making in art and design institutions to transition into the jewelry industry, and that career transition does not require much additional training and certification.

The demographic section of *Occupation* exhibits interesting findings. The academic survey result values indicated that individuals who "teach jewelry only" represent (n = 4) 33% of respondents; and there were eight (n = 8, 67%) participants who taught jewelry making as well as designing and manufacturing jewelry for the industry.

The data collected on demographics indicated that *Years of Service* for both faculty and industry registered 11 to 12 years as the range most professionals in the jewelry discipline had served. The result explains that apart from the 18% who served less than 10 years, most professionals in both academic and industrial areas had worked more than 11 years. These findings therefore confirm reasons why few teachers have included CAD/CAM technology in their curriculum to teach jewelry making.

Conclusion

What appears to be emerging from this study is that CAD/CAM technology may have added a new direction to the process and methods of creating works of art as witnessed in the initial introduction of computer into the graphic design industry. Fine arts departments have come to adopt the use of the computer, after initial reservations, as the major tool in the operations of creating graphic designs. The graphic design industry is an example of how technology has been integrated into the arts and has expanded the potential of the art field.

Computer technology has become a significant component of curricula and educational pedagogy. The research study conducted shows that many faculty members

who have been teaching jewelry making for more than 10 years have little or no experience in CAD/CAM technology. As such, they do not include CAD/CAM technology in their jewelry teaching curriculum. The findings of this study support research done by Russell, Bebell, O'Dwyer, and O'Connor (2003), who established that older teachers did not incorporate information and communications technology (ICT) in their teaching.

On the other hand, the current generation of jewelers are seeing and using CAD/CAM technology. Technology has always been part of the jewelry manufacturing process. CAD/CAM technology has been seen by some art professionals and academics as a threat to the jewelers' skill and other traditional methods of jewelry production, where jewelry fabrication is more labor intensive. However, CAD/CAM technology has added an enhanced creative dimension to jewelry design and manufacturing, and this inventive technology has allowed jewelry design and manufacturing to push beyond creative and innovative boundaries. The introduction of CAD/CAM technology, if fully adopted and integrated, into the pedagogy of jewelry making and the design and manufacture of jewelry, will accelerate the growth of the jewelry industry.

Working by hand makes work unique as the introduction of the hand adds an individualistic touch to jewelry being designed. CAD/CAM technology also has the potential to increase the value of a jewelry product, and expresses the creativity and personality of a jeweler. But there seems to be general agreement by both jewelry professors and jewelers in the design and manufacturing industry and in the art community:

1. That the hand is still needed in product design even if a product is created in CAD and printed in CAM, and
2. Having experience as a traditional jeweler is a definite asset when working in the CAD environment, though there may be some "jewelers" who could master CAD/CAM without background knowledge in formal jewelry training.

CAD/CAM technology and traditional methods of making jewelry and a jewelers' skill are of mutual benefit to the jewelry industry, and a student-jeweler having knowledge of both methods of fabricating jewelry is an added advantage, and this will give the would-be-student jeweler an upper hand or head start in the ever challenging job market.

Professors of a visual arts or jewelry department need to be encouraged to use CAD/CAM technology as a teaching aid in their pedagogy of jewelry training. Administrators, on the other hand, need to collaborate with the jewelry industry to know their expectations of graduating students coming from metal/jewelry programs. This will enable administrators to demand incorporation of CAD/CAM technology in their jewelry curriculum.

Technology is a tool to aid a jeweler and is therefore one of the numerous means to an end. The incentive behind jewelry design creativity and innovation will always be inventiveness. Though technology makes manufacturing processes of jewelry faster, simpler, and economical, and gives detailed, accurate, and precise outcomes, technology will never replace the talents and creative skills of jewelers or artists.

Future Study

Future research needs to involve students. This research would employ a revision of jewelry teaching syllabi to include CAD/CAM technology in the pedagogy of jewelry training, and assess past student work in the jewelry-making field and their knowledge of both CAD/CAM technologies and of traditional jewelry making. The results of such a study would make known whether the inclusion of CAD/CAM technology would enable students to demonstrate their understanding of jewelry design and manufacturing and exhibit their preparedness to work and excel in the jewelry industry. The introduction of students into the study would serve as an additional channel to receive feedback. Student responses would form the basis to refine course structure and better train students to meet requirements of the jewelry industry.

Questions to be addressed in future research include the following:

1. What type of software should be used to teach students CAD designing? It would be a problem if graduated jewelers' employers used B CAD software to design jewelry when the graduate learned CAD designing by using A CAD software in the classroom.
2. Determining the type of software to be used to teach jewelry design can be problematic. There are unique features to most CAD software programs, and these features perform specific functions. Computer software performs specific functions based on their unique features.
3. The art and design community's unfavorable view of the inclusion of technology in the creation of artworks can influence whether some faculty

members will be willing to include CAD/CAM technology in the jewelry design and manufacture curriculum.

4. What year should CAD/CAM technology be introduced into a course structure?

Recommendations and Suggestion for Researchers

This research design was limited by one major factor, which is that though the defined population was nationwide, the sample was relatively small and did not cover the entire selected population. A total number of one hundred participants from both the jewelry industry and arts and design educational institutions were selected to participate in the research study, but only 18 people participated. This makes it difficult to generalize the research findings. Though the research design was investigative, the study cannot be generalized and should not be used for generalizing (Singh, 2007). Consequently, before the findings from this study can be generalized, further studies need to be conducted with a larger sample size.

The selected population should be well defined. The researcher should be specific about which participants were selected from jewelry businesses and which from art and design educational institutions. Another study should focus on a narrower group of participants from 2 year or 4 year programs, graduate students, undergraduate students, traditional jewelers, and representatives of multinational corporate jewelry companies instead of the broad population selected for this study.

Professors with knowledge in CAD/CAM are willing to include the technology in their pedagogy on jewelry in the classroom environment. The art educational community needs to accept technology as an aid in the design and creation of art.

APPENDICES

APPENDIX A

Letter to National Association of Schools of Art and Design (NASAD)

University Of North Dakota
417 Northwestern Drive
Grand Forks,
ND 58203

December 4, 2014

NASAD
11250 Roger Bacon Drive, Suite 21
Reston, VA 20190-5248

Dear Sir/Madam,

I am a graduate student pursuing a master degree in Technology at the University of North Dakota; Grand Forks. I am writing this letter to request your assistance as an accredited organization, for the information about institutions providing Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) curriculum in Metals/ Jewelry Arts programs. The subject of my study is: - *Demand and Supply: College faculty's perception on CAD/CAM for jewelry Design & Production.*

I am looking forward to use randomly selected accredited Arts and Design institutions as participants for the research survey. I will use the information, which will be provided for the purpose of this research, and treat it completely confidential, and use them as would be required. I promise to send your organization a copy of my research findings.

My advisors have highly recommended that I engage your institute due to its reputation as an Arts and Design accreditation board. I hope the information I am requesting will be made available to me. You can reach me by this email (patrick.awotwe@my.und.edu) or on phone (7016103072) if further information is needed. Thank you very much in advance for your support and time. I look forward to hearing from you at your own possible earliest time.

Yours faithfully,
Patrick Awotwe.

APPENDIX B

Response from National Association of Schools of Art and Design (NASAD)

Dear Mr. Atwotwe,

Thank you for your email and interest in the National Association of Schools of Art and Design (NASAD). The NASAD Web site offers a Directory List of accredited institutions that you might find helpful in your research. Please find directions below to assist in the use of the Directory List.

To use the Directory Lists:

- locate the website at www.arts-accredit.org and enter the Association's Web site
- click on *Directory Lists* in the 5th box down on the left side of the page
- click on the heading of the directory list you wish to access

When accessing the *Accredited Institutional Members* List:

- access the *Directory Lists* as stated above
- click on *Accredited Institutional Members*
- scroll to the bottom of the page to access the complimentary *Simple Search*
- the best way to utilize this search is by only engaging the state drop down box

- from the list of institutions provided by the search, click on the one(s) of interest to access specific institutional information

You may purchase the *Accredited Institutional Members* List *Advanced Search Tool*:

- log in to the Association's Web site using the Login and Password you created when purchasing the *Advanced Search Tool*
- click on *Directory Lists*
- click on *Accredited Institutional Members*
- scroll to the bottom of the page to access the *Advanced Search Tool*
- enter your search criteria as offered
- from the list of institutions provided by the search, click on the one(s) of interest to access specific institutional information

Should you have further questions, please do not hesitate to contact the National

Office.

Regards,

Stacy McMahon

Stacy A. McMahon
Office Manager
11250 Roger Bacon Drive, Suite #21
Reston VA 20190
Telephone 703-437-0700 Ext 110
Facsimile 703-437-6312
www.arts-accredit.org

APPENDIX C

Letter to the Society of North American Goldsmiths (SNAG)

SNAG

Dear Sir/Madam,

I am a SNAG member and graduate student pursuing a Master of Science degree at the Technology Department of University of North Dakota; Grand Forks; inviting members of this association to participate in an online survey. As part of a Thesis research study on the topic – *Uses of CAD/CAM: design and production of Jewelry in an Arts program.* My advisors have highly recommended that I engaged your outfit due to the diverse nature of SNAG members and high reputation of the association.

The research is to find out why the CAD/CAM is not part of Metals/Jewelry Art and Design programs. The literature review or the preliminary research shows that in recent time the Metal/Jewelry industries are using these technologies in designing and manufacturing of their products. However the industry is learning these technologies not from the Arts and Design institutions but from manufacturers of these technologies. I am looking forward to find jewelry industries' experience and perspective on the adoption of these technologies, and instructors' or faculty's perspective on the use of the CAD/CAM as part of teaching and learning tool.

In this study, you will be asked to complete an electronic survey. Your participation in this study is voluntary and you are free to withdraw your participation from this study at any time. The survey should take only 10 to 15 minutes to complete. Through your participation I hope to understand the reason or reasons why the CAD/CAM is not part of most Design and Art curriculum.

There are no risks associated with participating in this study. The survey collects no personal information of any participant. All of the response in the survey will be recorded anonymously.

I will use all the information for the purpose of this research, and treat the information that will be provided completely confidential, and use them as would be required. I will not ask for your name. And I promise to send your outfit a copy of my research findings. All information collected in this study will be kept completely confidential to the extent permitted by law.

The participation in this study may benefit the profession in the future by better understanding information on the adoption of CAD/CAM technologies in the jewelry industry. You can reach me by this email or phone if further information is needed.

Thank you very much in advanced for your support. Thank you for your time, and I look forward to hearing from you at your own possible earliest time.

Yours faithfully,
Patrick Awotwe

APPENDIX D

Response From Society of North American Goldsmiths (SNAG)

Hi Patrick,
See your survey listed. Yeah!!!

Warmly, Renee
Renee Zettle-Sterling
Associate Professor
Department of Art and Design
Grand Valley State University
1828 Calder Art Center
1 Campus Drive
Allendale, MI 49401

Ofc: 616/331-3076
Cell: 616/262-8820

Survey Opportunity

"I am a SNAG member and graduate student pursuing a Master of Science degree at the Technology Department of University of North Dakota-Grand Forks. I am inviting members of SNAG to participate in an online survey as part of a thesis research study on the topic - *Demand and Supply: College faculty's perception on CAD/CAM for jewelry Design & Production.*

Additional questions can be directed to the principal investigator at patrick.awotwe@my.und.edu or 701-610-3072. Thank you, Patrick Awotwe"

Take the Survey

APPENDIX E

Questionnaire as Posted Online

Consent information:
Study: *Demand and Supply: College faculty's perception on using CAD/CAM for jewelry.* In this study, you will be asked to complete an electronic survey, which takes about 5 minutes to complete. Participation in this study is voluntary. You are not obliged to answer every question, and are also free to withdraw from participating at any time. There are no risks associated with participating in this study, and no personal information of participants will be collected. All responses in the survey will be recorded anonymously.
If you want to win one of the four $25 gift cards and two African Silver Signet ring kindly include your email address after completing the survey.
By pressing the submit button means you have given your consent in participation of this survey.

What are faculty's and industry's perception regarding the use of computer aided design (CAD) and computer assisted manufacturing (CAM) in jewelry design and manufacturing?

Demographics

Gender

- ○ Male
- ○ Female

Location by City and State

I have being using/teaching Jewelry design and manufacturing for

- 0 -10 yrs
- 11- 21 yrs
- 22 - 32
- 33 - 44
- 45 - 55

How many Jewelry manufacturing industry(s) are in your communities?

- None
- 1 - 10
- 11 - 21
- 22 - 32
- 33 or more

Occupation

- Designs/Manufactures Jewelry
- Teaches Jewelry
- Designs/Manufactures and Teaches Jewelry

	If **Teaches Jewelry** Is **Selected**, Then Skip To **I have CAD/CAM teaching experience. [SURVEY A]**
	If **Designs/Manufactures Jewelry** Is **Selected**, Then Skip To **I have CAD/CAM experience. [SURVEY B]**
	If **Designs/Manufactures and Te...** Is **Selected**, Then Skip To **I have CAD/CAM teaching experience. [SURVEY A]**

Study Questionnaire

[SURVEY A]

I have CAD/CAM teaching experience.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

I include CAD/CAM in the jewelry curriculum.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

It is simple to use the CAD/CAM technology to teach jewelry making methods.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

I prefer teaching using traditional jewelry making methods more than CAD/CAM jewelry methods.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

I am prepared to pay to acquire CAD/CAM technology software to teach jewelry.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

What is the name of CAD/CAM software you are using to teach/produce jewelry design and manufacturing now?

Have you used any different CAD/CAM software in the past for teaching?
*(If **Yes** please list all in order of preference).*

[SURVEY B]

I have CAD/CAM experience.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

I include CAD/CAM in the jewelry design and manufacturing processes.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

It is simple to use the CAD/CAM technology in jewelry making processes.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

I prefer using traditional jewelry making methods more than CAD/CAM jewelry.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree

- Strongly Agree

I am prepared to pay to acquire CAD/CAM technology software to design and manufacture jewelry.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

What is the name of CAD/CAM software you are now using to produce jewelry design and manufacturing now?

Have you used any different CAD/CAM software in the past for jewelry design and manufacturing?
*(If **Yes** please list all in order of preference)*

[CONCLUDING QUESTIONS FOR ALL PARTICIPANTS]

I recommend training in using CAD/CAM technology in designing and manufacturing of jewelry.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

I recommend using CAD/CAM technology in designing and manufacturing of jewelry.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

My institution collaborates with the jewelry design and manufacturing industry on the adoption of CAD/CAM technology.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

The adoption of CAD/CAM technology in jewelry making increases production.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

The steep learning curve required does not encourage CAD/CAM to be incorporated in jewelry design and manufacturing.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
-

Strongly Agree

The investment required does not encourage CAD/CAM to be incorporated in jewelry design and manufacturing.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

If you want to win one of the four $25 gift cards and two African Silver Signet ring kindly include your email address after completing the survey.

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