Adoptability of CAD/CAM for Jewellery Making Industry Using Method Comparison Technique

Deepa Sachin Ghag
Department of Mechanical
Shivajirao S. Jondhale College of Engineering, Asangaon, Maharashtra, India

Jayesh J. Dange
Department of Mechanical
Lokmanya Tilak College of Engineering, Koparkhairane, Navi Mumbai, Maharashtra, India

Abstract- This article represents the implementation of CAD and CAM processes in the jewellery design and manufacturing. The methodology is compared to conventional methods in term of time requiring, quality and manufacturing factors. The most important criteria to be considered for method comparison process are based on some technical parameters, which are identified through a case study on different cad software and cam machine. This work proposes parametric rating calculation of each software and identification of effective cost associated with current cad-cam technology in industry. Using the results, by parametric analysis process cad as well cam model, compared with tool like accuracy, compatibility, ease of use , and productivity.

Keywords – CAD/CAM, Rhinoceros, Matrix7, JewelCAD, REVO540C, Viper, InvisionHR.

I. INTRODUCTION

"Computer Aided Design (CAD)" and "Computer Aided Manufacturing (CAM) are the basic software's being used in the jewellery industry today. CAD is used to create images and virtual models, while CAM converts them into wax model. Following three step enough to explain about conversion of Cad design into cam model.

Table-1 2D to 3D Data Conversion.

1 st STEP.	CAD	Creating Virtual DATA.
	Computer Aided Design,	
	Used for - Creating 3D Model	
2nd STEP.	CAE	Checking Virtual DATA.
	Computer Aided Engineering.	
	Used for - Verifying 3D Model.	
3rd STEP.	CAM (Computer Aided Manufacturing).	Converting Virtual DATA into Reality (Giving Physical Existences).

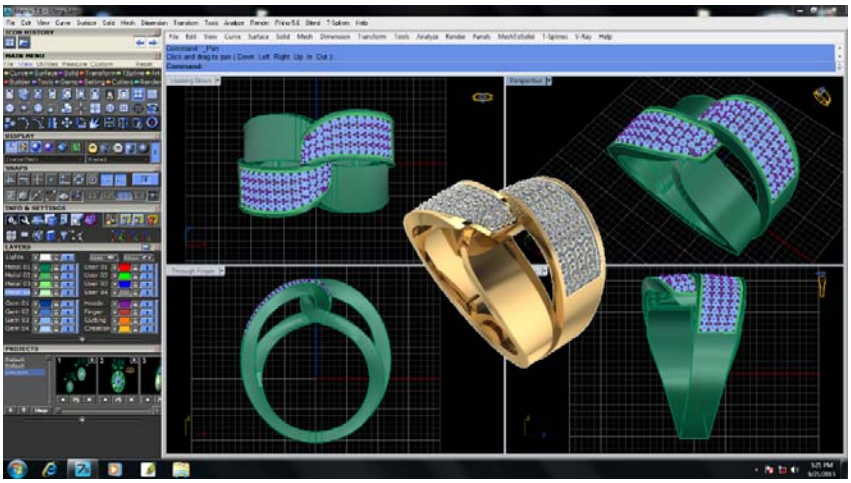

Figure 1.

CAD has opened up a new era of creativity which is still at a nascent stage in the jewellery industry largely due to the traditional outlook of many a jeweller. However, with the many advantages of CAD there has been a growing trend to embrace this technology. Evolving technologies have brought in numerous jewellery manufacturing service providers who are now providing CAD/CAM facilities at more affordable prices. CAM is software that links CAD in such a way that the output from CAD is executed directly by machines which are linked to the system in a production line. The CAM system is categorized into two types Subtractive Prototyping and Additive Prototyping
Subtractive Prototyping In this technique planned tool movements cut away extraneous material from the work piece to form the required design part. Processes include milling, turning or drilling. **Additive Prototyping** In this technique a design part is built up by adding layers of material upon each other directly linked with a 3D model (CAD) i.e. Growing or 3D Printing. The data from the 3D CAD model is converted by the manufacturing equipment into many thin layers building up the final design part. Following three software and three Cam machines are used as tool for comparison respectively for the purpose of case study.
Jewelcad5.1, Rhinoceros4, Gemvision Matrix, and REVO 540c, InvisionHR, Viper etc... .

II. LITRATURE REVIEW.

Rapid Prototyping and Tooling Technology in Jewellery CAD by Somlak Wannarumon and Erik L. J. Bohez In this paper presents the investigation of computer-aided design and rapid prototyping technologies in jewellery design and manufacturing. Computer-aided design (CAD) and Rapid prototyping (RP) [1], The MJSA Technology survey published article on basis of cad cam technology in jewellery. Its research based on CAD/CAM programmed usages training methods for CAD proficiency & uses. This quantification help to framing this researched sequentially *et al*. [2]. Complexity and Cost effectiveness is measure for system design by Marine D. Guenov. Suggested complexity factor calculation based on design parameter. He suggested some method to measure design complexity in initial stage. It's not necessary design equation always linear especially in conceptual stage [3]. By Joan Dalrymple - © 2010 in article The Impact of CAD/CAM on Traditional Jewellery Fabrication suggested, how jewellery can be designed, produced and how it is perceived [4]. Also In this thesis, CAD and RP technology is applied to design and build jewellery prototypes, and Rapid Tooling to build models. The main aim of this paper is to describe the implementation of CAD and RP processes in the jewellery design and manufacturing. The applicability and effectiveness of RP, using Stereo lithography Apparatus (SLA), is investigated in the field of jewellery model and model making, moreover, the methodology is compared to conventional methods in term of time requiring, quality and manufacturing factors. All data collected through the case study because as articles on same topic were very rarely published rather peoples are less aware with technical factor also effect on production though this field related to artistic background.

III. RESEARCH METHODOLOGY.

In case of two-dimensional image, after a DWT transform, the image is divided into four corners, upper left corner of the original image, lower left corner of the vertical details, upper right corner of the horizontal details, lower right corner of the component of the original image detail (high frequency). Literature You can then continue to the low frequency components of the as **Literature study**

Extensive review of literature related to cad cam technology and manufacturing performance measures was undertaken and various methodologies adopted by researchers were studied in depth.

Developing a theoretical framework

The detail study on jewellery CAD software as well CAM machine with technical speciation of each system.

Case study

Case study based on making CAD model on different software and quantified with parameter. For detailing and process generation, following methodology applied.

Table-2 CAD to CAM Process.

Step 1	Development of 2-Dimensinal Image construction & analysation.
Step 2	Conversion of 2-Dimensional image into 3- Dimensional model by means of different CAD tool.
Step 3	3-Dimensional Modeling and construction.
Step 4	Cam modeling interface and construction by means of RPT.

Parametric analysis

This phase included the statistical analyses (Included accuracy analysis, productivity analysis, and quality analysis) for the development of CAD CAM technology particularly for jewellery industry. CAD CAM and RPT allow designers to simplify the iterative design or to easily change or adjust details of the sketches, to facilitate sketching of jewellery products in any sizes, and to shorten the required time for making me upper left corner of the 2nd, 3rd inferior wavelet transform.

A. Traditional Jewellery Making Flow-Chart.

Basic Jewellery Making Techniques Figure 2 Such as sketching, filing, moulding, and polishing are all covered in the chart. This article will help to recognized basic jewellery making process which was drastically change by the use of CAD CAM and RPT technology.

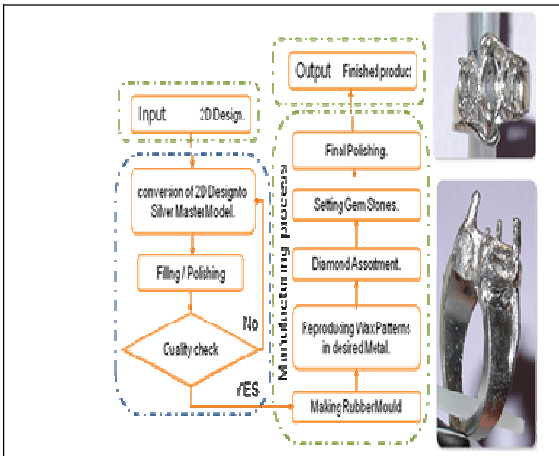

Figure 2.

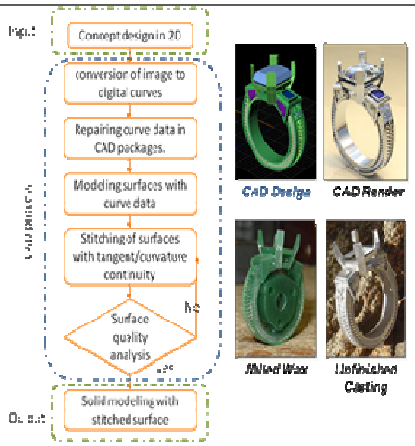

Figure 3.

B. Modern Jewellery Making chart by using CAD system Figure3.

CAD system will itself brief about that “How new technology can help you make better jewellery”.

Also, it will help to the Guide that Jewellery Making goes beyond the basics and demonstrates advanced techniques to fabricate complex jewellery mountings, single stone ring, multiple stone rings, heavy necklaces, bangles, and intricate filigree jewellery.

Manufacturing Process Chart, Figure 4.This chart is explaining manufacturing of whole jewellery manufacturing process. From three dimensional modeling to RP conversion for solid wax model as well as casting to finish product.

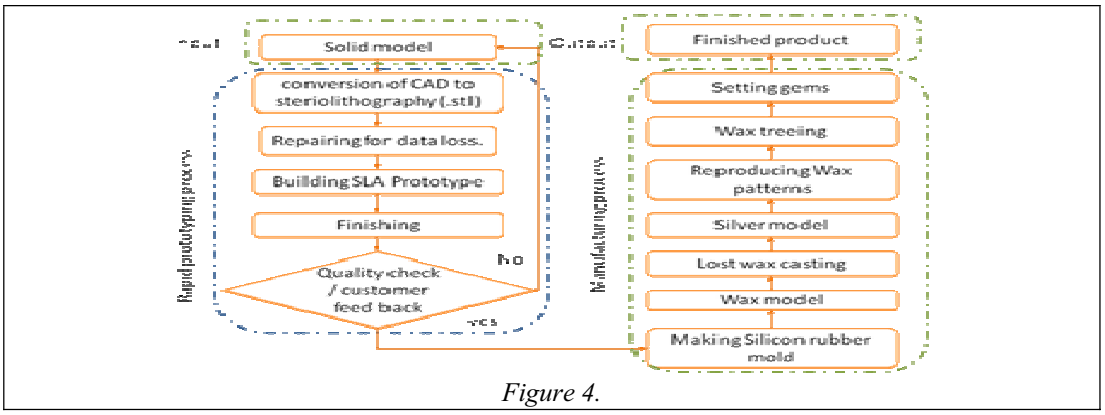

Figure 4.

IV. CAD Software Application and Review.

C. *RHINOCEROS (RHINO).*

Rhino is 3D Design software which works on the powerful NURBS based technology. It is easy to learn and use. It can create, edit, analyses, and translate curves, surfaces, and solids and has infinite possibilities with respect to sizes, angles and complex designs. Complex shapes can be directly modeled or acquired through 3D digitizers and works with a complete range of geometric data. Irrespective of whether you make a simple ring or an intricate necklace, this software helps you develop your ideas in 3D, render and animate them and also gives you the freedom to control and maintain absolute accuracy in your model. RHINO is non-parametric software.

Parametric - Parametric drawing means all the dimensions within a design are interconnected. Whenever one dimension is altered, the rest of the dimensions in the design are automatically adjusted to reflect the change.

Non-Parametric - This approach means all dimensions within designs whenever one dimension altered rest of dimensions will not be change. Following sketches explain how two dimensional sketches turn into three dimensional views. It is compatible with other designs, CAM (CNC and rapid prototyping), rendering and animation software. Complex IGES-MESH files can be read and repaired. An IGES (Initial Graphics Exchange Specification) is a standard that defines a neutral form for the exchange of information among dissimilar computer-aided design (CAD), computer-aided manufacturing (CAM), and computer visualization systems. Various plug-in can be used with this software, for example Flamingo, Maxwell Render, V-Ray, for ray-trace rendering. The tool path can be generated directly in rhino with the help of additional plug-in for CAM & CNC milling.

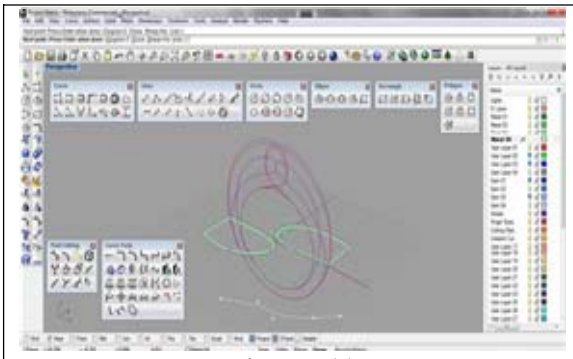

Figure 5 (a)

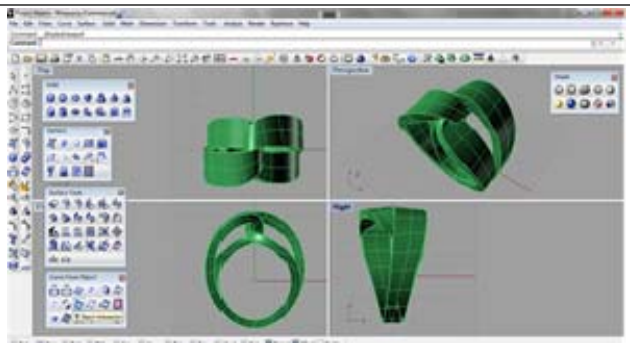

Figure 5 (b).

Approaching with 2D Tools. Figure 5 (a).

Approaching with 3D Tools. Figure 5 (b). *(Advance 3D Tools library make possibility to develop solid structure as per required manner)*

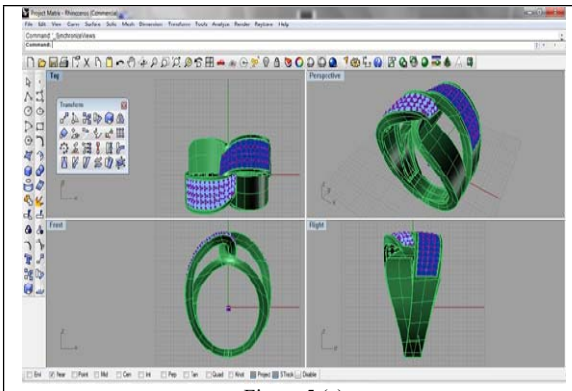

Figure 5 (c)

Excellent tools to show customer design possibilities. Figure 5 (c)

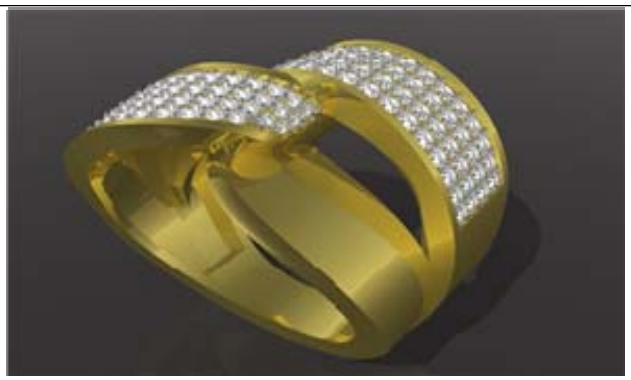

Figure 5 (d)

Render image is the best way show the design possibility and actual features of model. Figure 5 (d)

Table-3 Analyse Output from Case study for Rhinoceros Software.

Software Cost.	$ 1295 (Including supporting software flamingo).
Total Investment Year	2 approximately
CAD Proficiency.	3 to 6 Months.
Time required to complete design	6.5 Hrs. required completing the cad model. (maximum 8 hrs. to 10 hrs. would be working hours for any organization) If one design required 6 hrs. To make then in an 8 hrs. Approximately 1.2 no's designs would be made per day on an average). (1.2 *26 = 31 models per month)
CAD Software Monthly Productivity.	31 Cad model per month
CAD Model Cost (Month).	$1.80

D. GEMVISION MATRIX.

Matrix is Plug-in for Rhino & it is jewellery-specific, which includes automating jewellery-related features so they are faster and easier to build, control & change. In Matrix also adds more functionality than Rhinoceros like builders that create jewellery-specific models, interactive controls that allow users to quickly adjust aspects of a model & save customised library of designs. It contains more realistic rendering & animation tools which gives more realistic Images and animations files. In addition to offering all the advantages of Rhino, Matrix has a whole series of additional builders and special tools for making all the repetitive and painstaking tasks of jewellery design (such as pave and prong settings) fast and easy in matrix . Because of all these additional tools, Matrix will get you amazing production quickly. Matrix is fully parametric software introduce in jewellery industry. Flexibility of the software because – Library items make for quick builds, Make it all sizzle with enhanced presentations. Apply quick and consistent looks with Style Sheets. Turn 2D art into 3D designs - Integrated right into the software, Matrix Art is a fully-featured height field from bitmap modelling tool program which is integrated into Matrix. Let implemented for case study in matrix same cad model which design in rhinoceros cad software.

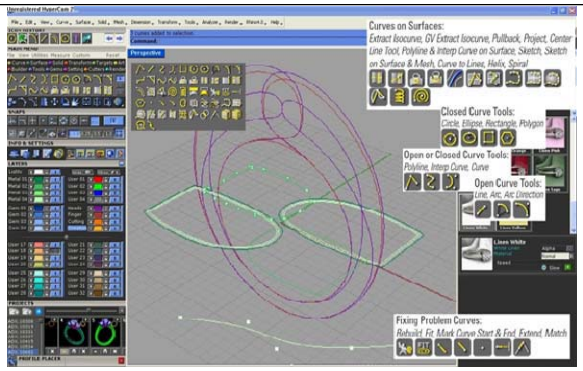

Figure 6 (a)

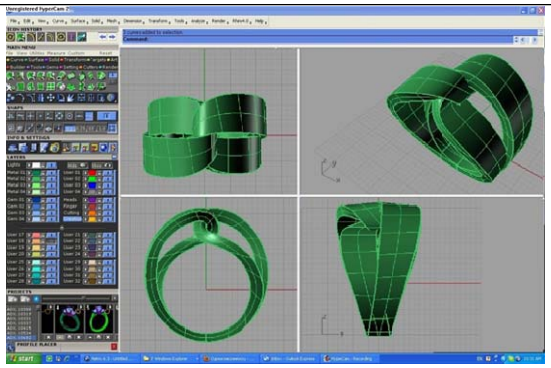

Figure 6 (b).

Approaching with 2D Tools (User extendable database for 2D curve making easier to develop free form shape of any curve or design as per required manner Figure 6 (a).

Approaching with 3D tool (Different kind of in build section as well as its virtual library for solid modelling) - Enhance the possibility of accuracy and also the making of the design convert into easier and faster rate. Figure 6 (b).

Figure 6 (c).

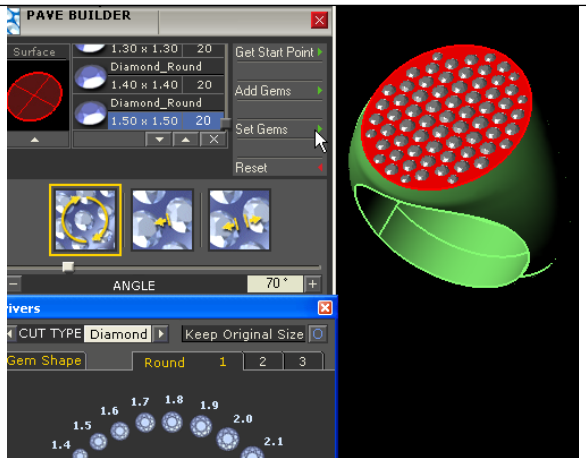

Figure 6 (d).

Ability to store large virtual Diamond Inventory. Figure 6 (c).

Automatic Diamond placement on surface with different diamond size and specific space. Figure 6 (d).

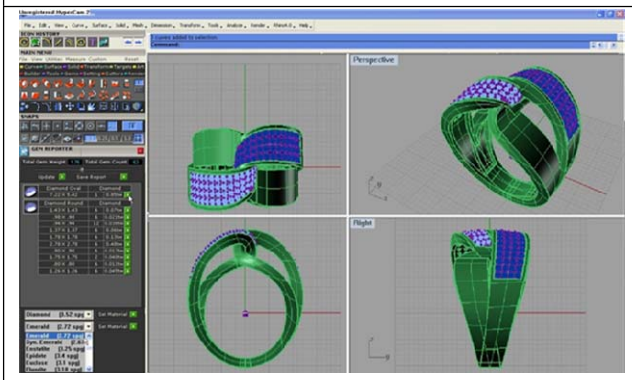

Figure 6 (e).

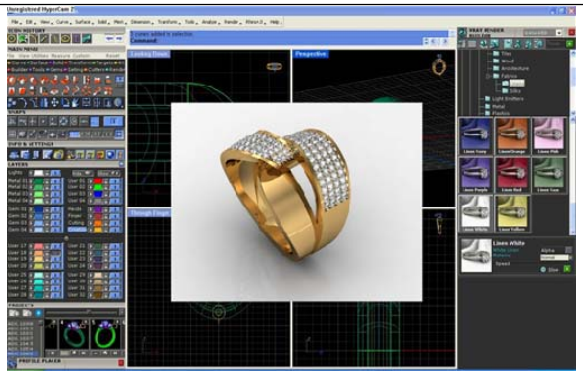

Figure 6 (f).

Advance Jewellery Designing Tools Approached (i.e. Counting number of gem its sizes as well gold weight in different carat visualised at the same time). Speed of the design process, Speed up your creativity with Builders. Matrix uses advanced 3D technology and the specific gravity of precious metals to accurately tell you how much your design will weight in a variety of gold carat.

Realistic Rendering
Excellent sales tools to show customer design possibilities - Matrix lets you take your stunning and realistic jewellery images. Animation Builder helps you set up and create moving animations. And Matrix Viewer lets your customers see and interact with your 3D design. Figure 6 (f).

Figure 6 (e).	
 Figure 6 (g).	 Figure 6 (h).
Rendering Tool Presentation - Same ring in different gold carat. Figure 6 (g).	Rendering Tool Presentation - Same ring in different gold carat Figure 6 (h).

Table-4 Analyse Output from Case study for Matrix Software.

Software Cost.	$ 6000
Total Investment Year	2 approximately
CAD Proficiency.	3 to 6 Months.
Time required to complete design	5 Hrs . . . . / (maximum 8 hrs. to 10 hrs. would be working hours for any organization) If one design required 5 hrs. To make then in an 8 hrs. approximately 1.6 no's designs would be made per day on an average) (1.6 Models per day. Ex. 1.6*26=42 Models Per Months.)
CAD Software Monthly Productivity.	42 per month
CAD Model Cost (Month).	$5.55

E. JewelCAD.

It is a 3D free-form surface based solid modeller. It is a non-engineering approached for jewellery designing. It provides powerful free-form modelling tools that allow freedom in creating artistic and stylish designs with intricate shapes and sizes. These tools are flexible and intuitive and they can be easily learned and used by any non-technical person .Its file format is not based on NURBS technology or any other commonly-used geometry for 3D modelling. It cannot export to *.STL format, however the file size is very large and difficult to use with other programs such as prototyping machine and other 3-D modelling programs. JewelCAD is widely used in most jewellery manufacturing companies in China, India and Thailand. Users are enjoying the efficiency and price performance provided by system. But JewelCAD Pro is much improved in its STL data export, photo quality rendering and automatic tools for diamond setting. JewelCAD Pro will be also very suitable for jewellery designers and design studio to create their custom jewellery and publish marketing materials over the various internet sites. In JEWELCAD it's now get possible that Parametric mapping onto curves and surfaces. Projection mapping onto curves and surfaces, Transforming and Deforming individual CV's of curves and surfaces can be picked for transformation and deformation operation. Let implemented for case study in JewelCAD same cad model designed in rhinoceros and matrix software to acquiring comparison table for all three above mention software.

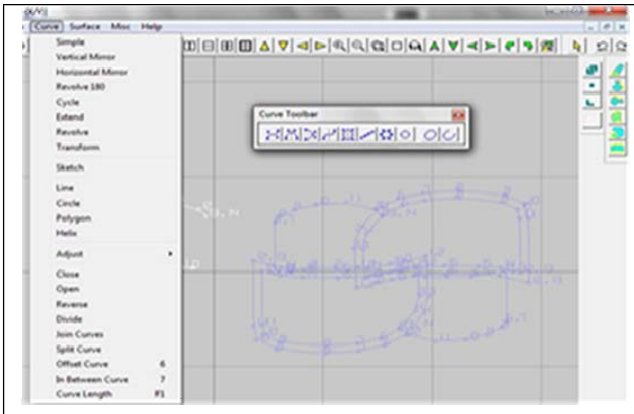

Figure 7 (a).

Approaching with 2D-3D Tools Step by step - User extendable Database. Figure 7 (a).

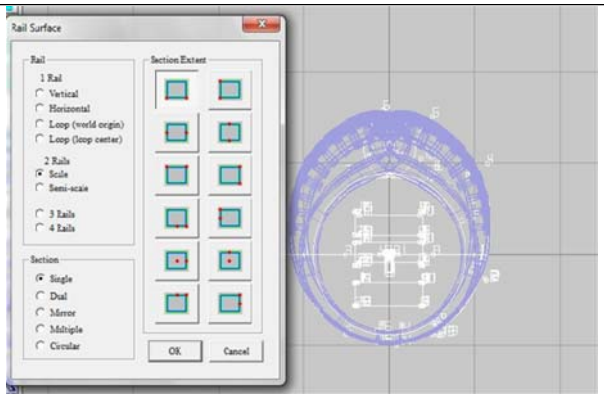

Figure 7 (b).

Approaching with 3D Tools (As shown in Figure the rail surface window and its available options are the heart of this software which enable 3D conversion from 2D sketch. Figure 7 (b).

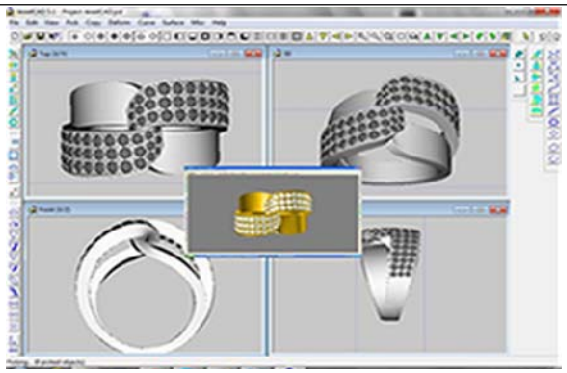

Figure 7 (c).

Jewellery Designing Tools Approached after solid Modelling. Figure 7 (c).

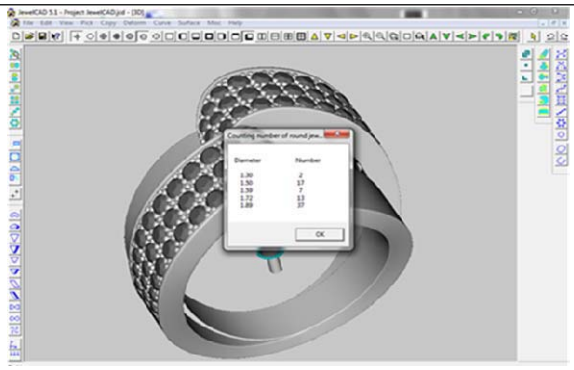

Figure 7 (d).

Excellent sales tools to show customer design possibilities - Round Gem Calculating facility.
But in JewelCAD only round gems can be calculated other than round it's unable to calculate. Figure 7 (d).

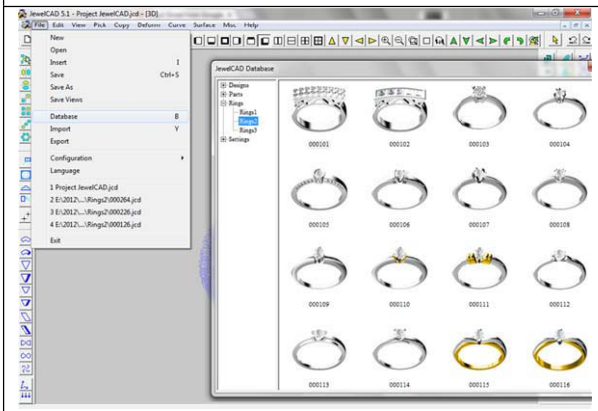

Figure 7 (e).

Ability to store large virtual inventory for ready references.

Ready reference library help to import any required shape if available in inventory which reduce the time required for making particular design and also it will help to developed new design concept by using same design. Figure 7 (e).

Table-5 Analyse Output from Case study for JewelCAD Software.

Software Cost.	$ 4000
Total Investment Year	2 approximately
CAD Proficiency.	3 to 6 Months.
Time required to complete design	6 Hrs . . . . / (maximum 8 hrs. to 10 hrs. would be working hours for any organization) If one design required 5 hrs. To make then in an 8 hrs. Approximately 1.6 no's designs would be made per day on an average) (1.4 *26 = 36 model per month).
CAD Software Monthly Productivity.	36 per month
CAD Model Cost (Month).	$5.56

V. CAM MACHINE'S APPLICATION & REVIEW.

In this topic I have covered Milling System & Rapid Prototype machines with details & technical specifications. All these machines is specifically used for jewellery industry to produce CAM wax pieces, by defining high as well as low machine productivity. A) Revo540 Multiple-Axis Milling System Subtractive Prototyping, b)Viper Machine Additive Prototyping. C) Invision HR 3D Printer Additive Prototyping.

F. REVO 540c is 4-Axis Milling System based on Subtractive Prototype Technology.

Features - In REVO 540 multiple axis machine content Dual spindle technology saves time, Most Simplified fixtures as well as easy set up and monitoring. Dual pump technology help to keeping continues cooling effect throughout the cycle process for best surface finished. Material used is traditional wax which helps to keep better finishing on surface in wax model as well as in casting model also. Easy secondary operations, quick & easy to generate the tool-path.

Table-6 *REVO 540c Technical Specification* Figure 8.

Travel X, Y, Z (Work Envelope)	
X = 172mm (6.7"), Y = 110mm (4.3), Z = 200mm (7.8"). This is the maximum travel range of each axis.	
Max Cutting Feed Rate	
2500mm/Min. This is the maximum feed rate possible regardless of cutting tool capabilities or part geometry.	
Drive Motor Type Stepper Motor X, Y and Z Axis - Size 23 NEMA– 3.0A 2.1V.	
A axis – Size 17 NEMA - 1.8A 3.2V	
Lead Screw Type Ball Screw – 15.24mm (0.600") diameter.	
Way Type Linear Rail Ball Ways (12mm diameter)	
Tool Holding Arrangement Collet (NSK).	
Spindle Drive Motor Type DC Variable Speed.	
Spindle Speed Range Vertical spindle - 0 to 30,000 RPM. Horizontal spindle – 0 to 20,000	

Power Requirements 3A @ 120V – or 360VA/ 216W – Minimum, UPS 260W/450VA – 3 to 5 minutes back up.	 Figure 8.

G. ***Viper*** *Machine Additive Prototyping* Figure 9 (a).

Features.

Machine content dual resolution part building system along with long solid state laser technology and material used for part building is Accura. As shown in Figure 9 (c). In high resolution mode it builds 44 rings (even different ones) at a size of 6 mm x 22.5 mm x 21.3 mm in only 10 hour. Advantages - Achieve excellent fine feature capability. Realize outstanding part quality and sidewall surfaces. Manage quick material switches between builds. Maximize control with a fully integrated system. Easily castable with specific casting parameters Figure 9 (b). Small to medium-sizes prototype, concept and communication.

	
Figure 9 (a).	Figure 9(b).
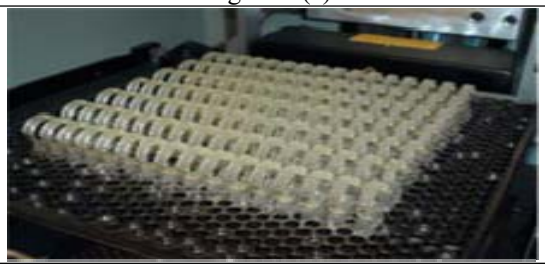	
Figure 9 (c)	

Table-7 Viper Machine Technical Specification.

Type Solid state Nd:YVO4	
Wavelength (epoxy resins) 354.7 nm	
Power at vat 100 mW available	**System controller and software**
Laser Warranty 7,500 hours or 12 months (whichever comes first)	Operating system Windows NT (4.0)
Recoating system	Input data file format .stl .slc
Process Zephyr™ recoating system	Network type and protocol Ethernet, IEEE 802.3 10/100 Base-T
Minimum build layer 0.05 mm *	**Power**
Optical and Scanning	100 - 120 VAC +/-10% 50/60 Hz, 6 amps 15 amp, 115V
Beam (diameter @ 1/e2) Standard mode 0.250 +/- 0.025 mm	220 - 240 VAC +/-10% 50/60 Hz, 3 amps 8 amp, 220-240V
VAT Capacity	UPS requirement ≥ 2 KVA
Maximum build envelope in standard mode 250 x 250 x 250 mm XYZ	**Size**
Maximum build envelope in HR mode 125 x 125 x 250 mm XYZ	Uncrated machine W134 x D86 x H178 cm

H. ***Invision HR*** *3D Printer* Figure 10 (a).

Multi-Jet Modelling (MJM). Technology used in this machine along with Thermal material application. An affordable, dependable, easy-to-use high-resolution (HR) 3-D printer optimized to produce finely detailed jewellery patterns and models. Print high quality, durable models for design communication or production-quality patterns for direct casting. Highly repeatable printing technology. Print one, dozens or hundreds of a part at same time. Figure 10 (a). Advantages - Durable acrylic photopolymer material, Blue model material colour offers excellent feature definition and contrast for visual inspection, Easy to use - no training needed, Uses standard office power.

Table-8 Invision HR *Technical Specification* Figure 10 (a).

Product Invision HR 3-D printer system (Invision HR 3-D printer, software,	
VisiJet® HR material starter kit, warranty)	
Printer Invision HR 3-D printer	
Materials Model material - VisiJet HR-M100	
Support material - VisiJet S100	
Printer	
Technology Multi-Jet Modeling (MJM). Thermal material application, with UV-curing	
Resolution 656 x 656 x 800 DPI (xyz)	
Maximum Build Volume W127 x D178 x H50 mm (xyz)	
Maximum Single Part Size 64.5 cm2 (xy) x 5 cm (z)	
Certifications UL certified, CE marked, CB certified	Figure 10 (a).
Electrical 100-127 VAC, 50/60 Hz, single-phase, 15A; 200-240* VAC, 50 Hz, single-phase,	10A; IT Power System Specification Compliant (Nordic countries)
Noise <60 dBa estimated (at medium fan setting)	Operating Temperature Range 18-28°C (64-82°F)

Network Compatibility Network ready with 10/100 Ethernet interface	
Client Hardware Recommendation 1.8 GHz Pentium IV with 1 GB RAM (with OpenGL support and	Mechanical Properties (HR-M100) Test Method Value
minimum 64 mb video RAM) or higher	Tensile Modulus ASTM D638 112.4 Ksi (775 MPa) ±35
Client Software OS Support Windows XP Professional/2000/NT 4.0	Tensile Strength ASTM D638 3.48 Ksi (24 MPa) ±0.5
Input Data File Format .stl (.slc support planned)	Tensile Elongation at Break ASTM D638 15.6%
Flexural Strength 6.1 Kpsi (42 MPa)	Impact Strength (Notched Izod) ASTM D256 0.25 ft-lb/in (13.3 J/m)
Specific Gravity 1.14 (cured)	Flexural Modulus ASTM D790 16 Ksi (110 MPa)
Ash Content HR-M100 - 0.01% (average); S100 - 0.0%	Material Color HR-M100 - Blue; S100 - Natural

VI. EXPERIMENT AND RESULT.

Table-9 Different Software Parameter Comparison & Rating.

(Rating Criteria is 0.1 is Minimum & 1 is for Maximum).			
I.	FROM ABOVE CASE STUDY IT'S CONCLUDED FOLLOWING PARAMETER RATING.		
	Software's Name		
	MATRIX	**RHINO**	**JEWELCAD**
ACCURACY	NURBS based software with Engineering approached gives Precision and Accuracy.	NURBS based software with Engineering approached gives Precision and Accuracy.	In Solid based & NON-Engineering approached software is based on assumptions & gives less precision with less accuracy.
	1	1	0.8
COMPATIBILITY	MATRIX can import & export more than 50 new compatibility enhancements. ***Library*** allows 100 of other application to read and write MATRIX native 3DM file.	Similar to Matrix Rhinoceros software import & export more than 50 new compatibility enhancement. ***Library*** allows 100 of other application to read and write MATRIX native 3DM file.	JEWELCAD can read only slc format so very restricted compatibility. JewelCAD can import stl files but it's never export slc files.
	1	1	0.5
FLEXIBILITY	MATRIX is highly flexible due to fully furnished library and advance database also advance Jewellery Designing CAD tool. Only for jewellery purpose.	RHINO is flexible but no database library. Rhinoceros is also suitable all manufacturing industries.	This non parametric software it includes limited database and library compare to matrix software.
	1	0.7	0.8
EASE OF USE	MATRIX required approximately 30 days becoming proficient.	RHINO is required approximately 25 days to become proficient.	JewelCAD required approximately 20 days becoming proficient.
	0.8	0.9	1

PRODUCTIVITY	Matrix can Produced 42 CAD models per months.	Rhinoceros can produce 31models per months.	JewelCAD can produce 36 models per months.
	1	**0.7**	**0.8**
Total Rating	**4.8**	**4.3**	**3.9**
Out-of	**5**	**5**	**5**

VII. Result & Parametric Analysis.

From above case study we are concluded some result in term of rating. Total five parameter compared with existing software i.e. Accuracy, compatibility, flexibility, ease of uses and productivity.

Analyse Output from Case study for each CAD software.

Table-10 CAD Software Conclusion.

CAD Software Conclusion.			
	Jewel CAD	Rhino-ceros	Matrix
CAD Designing Hours	6	6.5	4
CAD Programmed Usage in % (from MJSA Journal)	6	43	43
Rating	3.9	4.3	3.9
CAD Productivity Per Month	36	31	42
Single CAD Model Cost	5.56	1.8	4.55
Note :-			

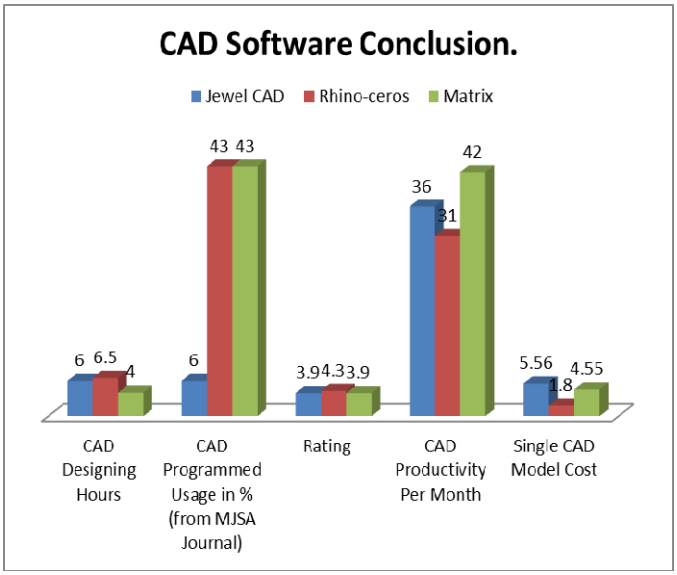

Figure 11 (a).

JewelCAD is non-engineering approached for jewellery designing also it mostly popular in some Asia country only.

Rhinoceros & Matrix Highly engineering approached for jewellery designing and mostly both software is worldwide popular.

Percentage Of Respondents for CAD, Figure 11 (a).

Table-11 (% of CAM system Used.)

From the reference journal of MJSA Technology presented percentage of users by carrying survey in particular Jewellery zone and concluded following result. Figure 11 (b).

Type of CAM System Used	% of Respondents who use In-House CAD systems.
Gemvision Revo540 Milling System	26%
InvisionHR 3D Printer	5%
Viper	3%

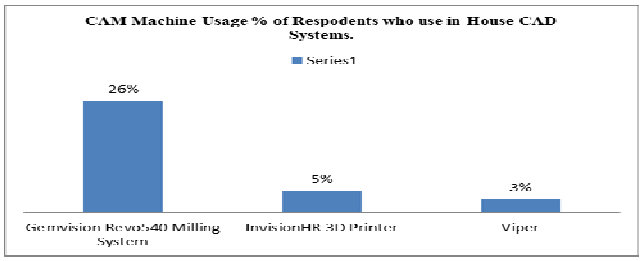

Figure 11 (b).

VIII. CAM Study Conclusion and Accuracy Checking.

Now we are in position to concluded result on cam model by taking physical dimension and comparing this with respective CAD files so we can able to find out percentage of accuracy of each machine.

Table-12 (% of Accuracy.)

Accuracy Figure 11 (c).

Sr. No	Particular.	CAD Designing Parameters (in MM).	CAM Dimension in MM.		
			Viper	Invision HR	REVO 540C
1	Ring Width in TOP.	16.60 mm.	16.60 mm.	16.60 mm.	16.80 mm.
2	Ring Size i.e. Ring Diameter (Dia.).	Dia.17.40 mm.	17.35 mm.	17.35 mm.	17.30 mm.
3	Ring Shank Thickness at 3O'clock.	2.45 mm.	2.45 mm.	2.45 mm.	2.89 mm.
4	Ring Width at Bottom.	4.70 mm.	4.70 mm.	4.70 mm.	4.90 mm.
5	% of Accuracy.		95%	95%	98%

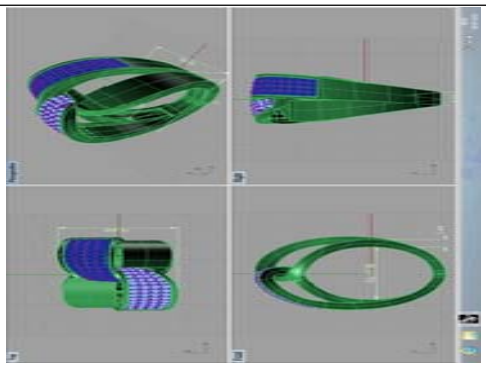

Figure 11 (d).

IX.CONCLUSION

This researched quantified ability of jewellery CAD software's as per the productivity, Investment, Approached, Accuracy & Accordingly Acceptability can be encountered. CAD/CAM allows designers to simplify the iterative design or to easily change or adjust details of the sketches, to facilitate sketching of jewellery products in any sizes, and to shorten the required time for making models. Matrix software it is engineering approached with parametric & non-parametric for producing jewellery 3D CAD models with high productivity, high accuracy, low production cost

for per CAD design, quick editing in models possible because several specialized jewellery designing tools available, good presentation tool with rendering images & animation tools for Sales & Marketing. Matrix CAD software is design & develop for producing jewellery 3D CAD models but still it can be used for sales & making jewellery related accessory. JewelCAD is non-engineering approached for producing 3D jewellery models due to it is lacking behind in accuracy (But in jewellery industry it is acceptable). Specially design for jewellery making only. Model editing is quick, rendering and presentation tool are Average in front of Matrix CAD software. Despite of this still the Capital investment is high in comparison with Matrix & Rhinoceros software. Rhinoceros is again engineering approached software for producing Jewellery 3D CAD models. Rhinoceros won't contain specific jewellery related designing tools like Matrix & JewelCAD software having but still it is good 3D designing tools for jewellery. Capital investment is very low in comparison with Matrix and JewelCAD. CAM is based on Capital investment, Production Capacity, Suitable for Industry & Everyday Maintenances Cost. Viper & InvisionHR is best suitable machine in terms of Large Production Capacity. Both Machines are suitable for large scale production unit. Large Production Capacity will help to recover the capital investment to meet day to day maintains cost to lower down the production cost & recovered the capital investment in stipulated time frame. REVO is again suitable for small scale production unit. The capital investment, day to day maintains cost & production cost is very low in comparison with above two machines.

REFERENCES

[1] Somlak Wannarumon. Product Design and Manufacturing using in The Jewellery Industry, Master M. Eng. Thesis, Asian Institute of Technology, Thailand, 2000.

[2] The MJSA Technology Survey http://www.mjsa.org 05/08

[3] Complexity and cost effusiveness measures by system design by Marine D.Guenov.mk 43 oal from united kingdom

[4] By Joan Dalrymple - © 2010 in article The Impact of CAD/CAM on Traditional jewellery fabrication

[5] JewelCAD. ―JewelCAD the Computer Aided Design and Manufacture Software for Jewellery Jewellery CAD/CAM Ltd., Hong Kong. Available at: http://www.jcadcam.com.

[6] Terry Wohlers. New developments and trends in product design, prototyping, tooling, and reverse engineering, Wohlers Associates, Inc., 2000. Colorado, USA.

[7] Chris McMahon, Jimmie Browne. Rapid Prototyping. In CAD/CAM Principle, Practice and Manufacturing Management, second edition, pp. 386-388, Addison Wesley Longman Limited 1998, USA.