An Investigation Into The Automation Of Bespoke CAD Workflow For 3D Printed Eyewear Using Individual Specific Parametric Data

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INTRODUCTION

- Eyewear is a necessity for reading, correcting refractive errors, Safety and most recently, smart glasses. Using individual specific facial measurements, it is possible to create parametric data that will be used 3D printing personalised and customised eyewear.
- Using 3D printed will drive the development of mini factories that are located close to the end user. The issue of improper fit will become a thing of the past. Styles can be chosen, altered and reproduced in less than a day. Production will be on-demand and not to increase inventory.
- Presently, the bulk manufacturing of Eyewear is possibly harming the environment. Manufacturing of eyewear is mainly by centralized manufacturing systems (CMS). A few disadvantages are transportation costs with resulting CO2 emissions and cost for disposal of excess stock.
- Distributing manufacturing systems (DMS) supports regional manufacturing, allows the decentralisation of production, and provides personalised products to customers in its surrounding region. The advantage is cost reduction, short delivery time and reduce CO2 emissions[1].
- The 3D Printed eyewear in conjunction with DMS will enable on-demand manufacturing whilst reducing transport and emissions.
- The multiple steps and personnel in the manufacture of a single eyewear will be streamlined with the use of 3D printing

METHODS

- This was an analytical, non-comparative, non-interventional, observational study . Photographs were taken of 20 consented participants as in Figures A, B and C.
- Data was used in a parametric table, in Computer assisted design (CAD) software for sketching (Figure: F and G). Image was rendered in CAD (Figure H)
- Parametric table: are forms are created by combining basic entities that are inserted in the model after a basic template, which includes their “proper parameters”, is filled. A line, for example, is an entity that becomes part of a model once two parameters, its length and its direction, are specified[2].
- Data extracted from measurements as in Figure D and E: 1) Interpupillary distance, 2) Right and Left Nasopupillary distance, 3) Ear to ear – Frontal, 4) Forehead to ear – Straight, 5) Forehead to ear – Slant

Results

Figure A



Figure B

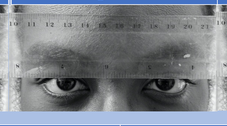


Figure C

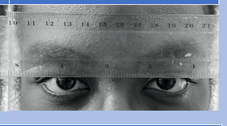


Figure D

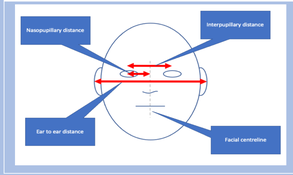


Figure E

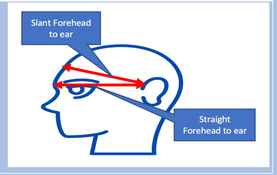


Chart 1

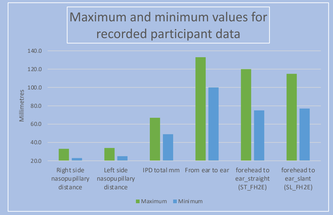


Chart 2

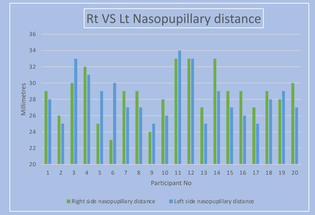
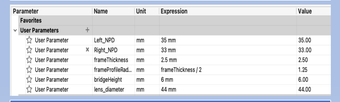


Figure F: Parametric Table



Parameter	Name	Unit	Expression	Value
Favorites				
User Parameters				
User Parameter	Left_NPD	mm	35 mm	35.00
User Parameter	Right_NPD	mm	33 mm	33.00
User Parameter	frameThickness	mm	2.5 mm	2.50
User Parameter	frameProfileBad...	mm	frameThickness / 2	1.25
User Parameter	bridgeHeight	mm	6 mm	6.00
User Parameter	lens_diameter	mm	44 mm	44.00

Figure G: CAD Sketch from Parametric Table

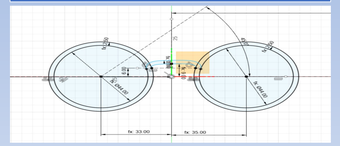
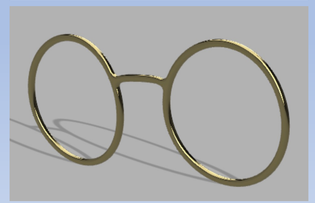


Figure H: Rendered image of Eyewear Frame from parametric table



DISCUSSION

- There was evidence of facial asymmetry 95% of participants
- There was a wide variation in all the measurements (chart 1). Also, asymmetry in comparing the Right vs Left Nasopupillary distance (NPD) showing Nasopupillary distance (Chart 2)
- Usually, opticians us the Interpupillary distance (IPD) to fit prescription eyewear. This will place the mid point at the nasal bridge.
- IPD measurement is a major part of eyewear prescription. It is the measurement of the distance between the left and the right pupil[3] .
- At the opticians, individuals with facial asymmetry will benefit from NPD instead of IPD when purchasing prescription eyewear
- The use of 3D printing for the manufacturing of eyewear is not new. However, it is used in rapid prototyping and in mass customization.

CONCLUSIONS

- The above findings show that the sensitivity of NPD in identifying asymmetry will provide an accurately fitted prescription eyewear and reduce
- Similarly, for facial asymmetry and consequently, Nasopupillary asymmetry (NPA); prismatic effect in prescription eyewear can arise as well as negative effects of off-optical-axis viewing if is used In prescription eyewear (Holland,1999).
- 3D printing will enable easy, quick and cost-effective manufacture of eyewear as well as the ease to personalize and customize in style and facial features. This can all be done in CAD.
- This is a game changer for individuals with significant facial asymmetry, especially children.

References

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