Optical Assessment of the Mask with its internal lens support insert of a clip-on type

“RALERI RUGBY GOOGLES”

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1. Introduction & Background

This report provides information on the optical considerations for the Raleri Rugby Goggles, which are currently under trial through the World Rugby International Rugby Board.

The Raleri Goggles consist of a single piece compound curve structure. They can host an included optical insert which can mount prescription lenses.

Figure 1.1

The main scope of this document is to to supply to optometrists, opticians and other optical practitioners the information needed to prescribe and to fit proper corrective lenses in the included clip-on insert. The Author Francesco Vargellini has conduct his own independent studies on some samples supplied by the company meaning to pay the due attention to this aspect that is absolutely relevant for both the involved professionals and for the field users.

Secondarily Raleri designers and technicians found to be important to share with the technical and medical staff of the sporting community some hopefully non obvious considerations that were done during the development of this project. This is the meaning of the participation of Francesco Rambaldi, the project leader, to the drafting.

The comprehension of this paper requires the reader to be familiar with concepts related to facial and frame fitting characteristic like optical centration of lenses (OCL), interpupillary distance (IPD/IDP) and centration distance (CD), back vertex distance (DACL/DAL/BV/BVD/BVP), pantoscopic tilt angle (PANTOS/TILT/FRONT ANGLE), horizontal center line (HCL), dihedral angle (WRAP/BOW) and crest height (CH).

As a matter of fact fitting standards, optical and prismatic tolerances for mounted spectacle lenses must be compliant with what described by the harmonized BS EN ISO 21987 (2009). The definitions “acceptable” or “compliant” as further used to define fitting parameters implicitly refers to this norm and its extensions.

2. Rugby Goggles parameters & Fitting Matters

Here follows a quoted sketch reporting some optically relevant geometric parameters. Those measures are quoted over a factory new insert. We'll see in the following chapters how easily the clip-on can be mechanically modified to comply with different needing in terms of IPD (interpupillary distance), back vertex distance (not listed here as it depends from the user physiognomy) and dihedral angle (wrap).

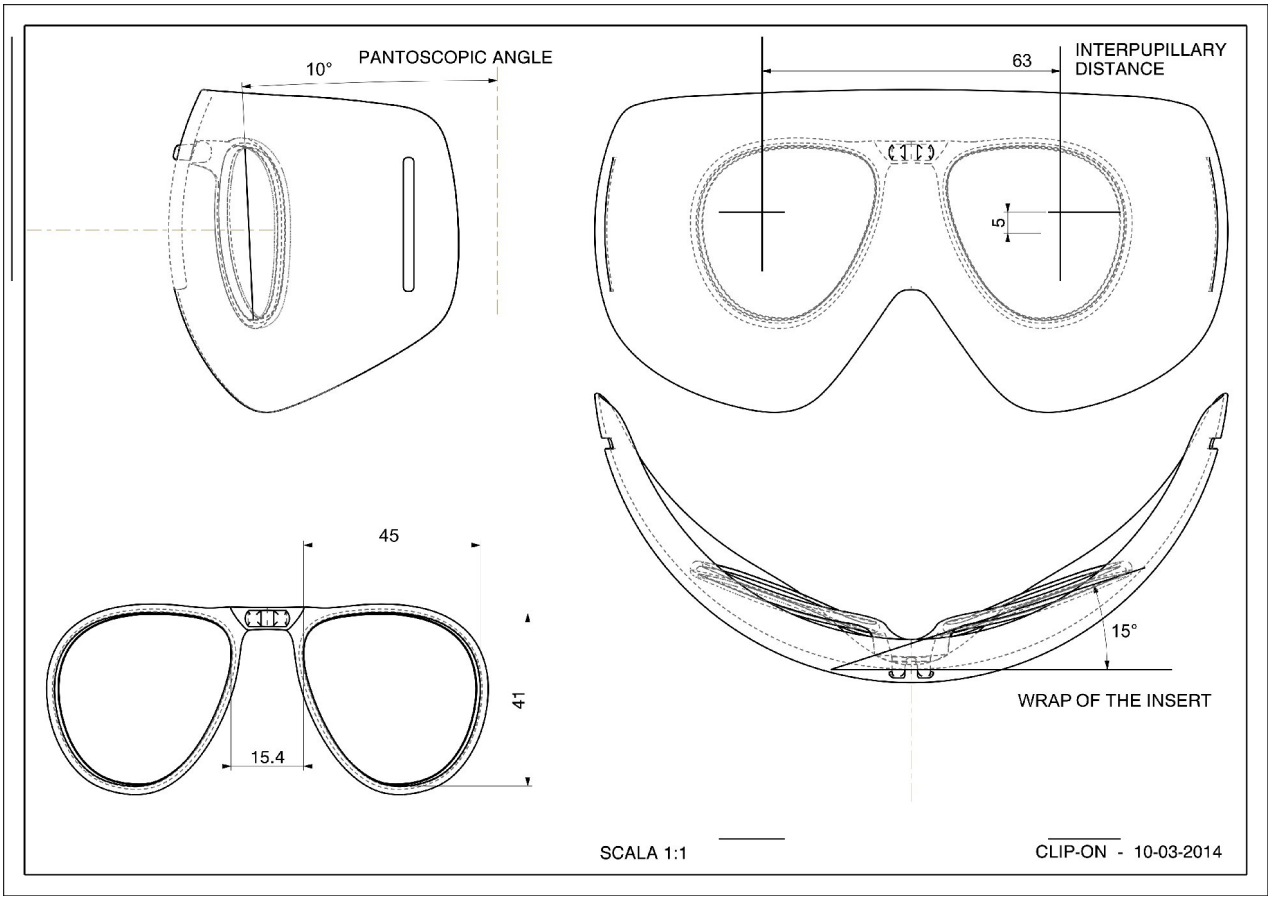

Figure 2.1

In particular we have tested several fitting over subjects ranging from 58mm to a quite rare 77mm IPD:

Figure 2.2

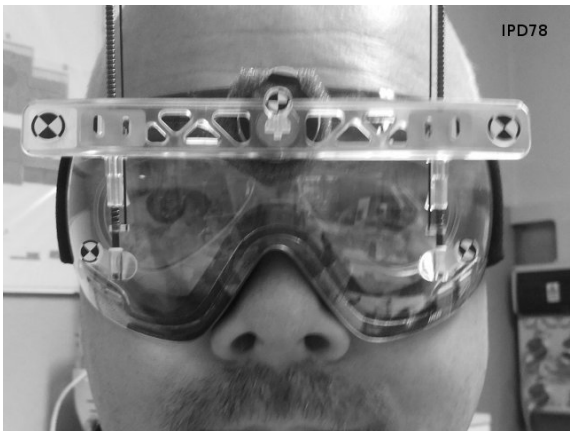

Figure 2.3

All the optically and physiognomy related measurements were made into boxing-ISO standards employing *Hoya iLog*^{TM}*,* an hardware/software video analysis computer system supplied by the Japanese lens producer HOYA^{TM} and used by opticians and other worldwide sales partners to do frames and prescriptive lens related calculations. Were rulers and other analogical tools appears in the pictures it's just to give reader a mere reference. In the following image there are reported the Clip-on basic quotes extracted from a relevant number of measurements and the exceptional IPD 76,9 mapping parameters. For the metrologically relevant aspects and any other precision and functioning related matters please refer to the software website *www.hoya.eu/index.php?page_id=20175*

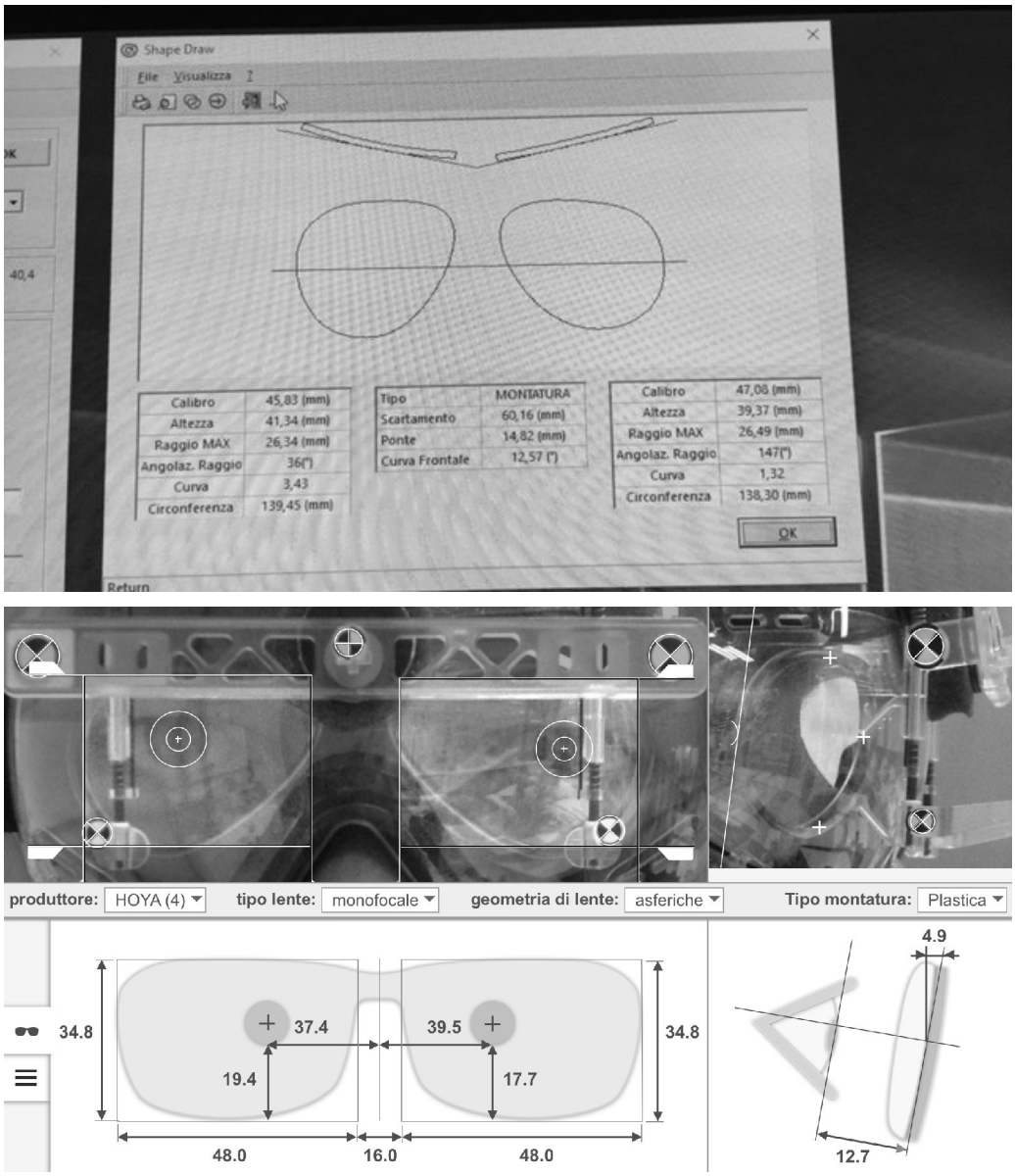

Figure 2.4

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3. Comparison of different clip-on inserts available on the market

As a starting point Raleri has studied what was available in the market. Here you can see a frontal comparison between different clip-on you can find in the consumer goggles. From top to bottom in the **Figure 3.1** there is Raleri (Rugby Goggles original insert), NIKE ™, ZERO-RH ™ ADIDAS ™.

Figure 3.1

All of listed product design, marks and graphic symbols belongs to their respective proprietaries.

Comparing the frame, bridge and vertical (B) sizes of some of the most common clip-on it can be noticed that the dimension of the lenses are similar to those used for many years in the sports glasses inserts. The vertical B size of the Raleri insert is the largest of the 4 considered in the comparison.

In order to contain within the limits of physiological tolerance any prismatic effects and optical aberrations present in the correction of each eye, it is customary to limit the prescriptive powers to a spherical and toric sum value of +/- 4,00 Dt. This range is the most commonly suggested in the ophthalmic prescription lenses for the clip-on mounting. This limitation can be overcome in most of the cases by an expert optician also following the further chapters suggestions.

In the next table the above shown clip-on inserts are compared in the same order for wrap (dihedral angle) with the exception of last one that has no rigid structure:

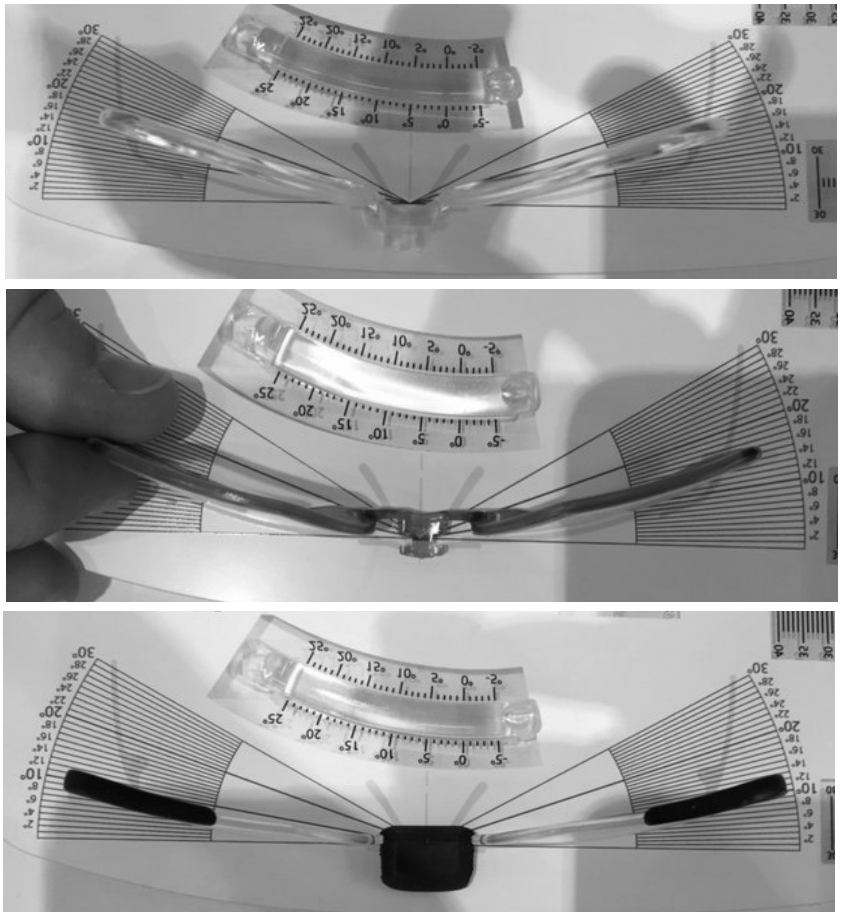


Figure 3.2

It's easy to note that the wrap angles are similar between the different clip-on taken in comparison, and in particular all of them are comprised between 12 ° and 15 ° (tolerance +/- 2 °). This kind of angles, combined to a reasonably BVD, usually don't introduces particular limitations for powers included within +/- 4.00 Dt.

Because of this position, the optical center of the lens will be more external with respect to that one of a typical pair of prescription spectacles (usually set between 8 ° and 10 °).

TIP N.1 - *To compensate for this decentralization in order to match the parameters of a specific tolerance, it is recommended a shift of the lens center in the direction of the nose of 0.25 mm per diopter of positive power (horizontal axis). For negative lenses those IPD adjustment are not necessary due to the minor thickness.*

EXAMPLE N.1 - Right Eye +4.00 Sf semi IPD 32 mm / Left Eye Sf +2.00 semi IPD 31 mm
RE +4.00 x 0.25 = 1 mm nasal decentralization / LE +2.00 x 0.25 = 0.5 mm decentralization nasal
New centering: RE 31 mm semi IPD (-1.00 mm from the original)
LE semi IPD 30.5 mm (-0.50 mm from the original)

As said Raleri insert can considerably vary its shape so we'll consider all the other possible adjustment like for example beveling corrections or free-form particular lenses only after considering and discussing the clip-on handling and adapting instruction.

4. Clip-On Operations: Disconnecting and Mounting

The insertion and removal of the clip-on from inside the mask is not particularly difficult, It's anyway strongly recommended to use proper tools and to follow the here provided instruction to avoid damages like the bridge twisting and the stressing lines here represented (due to clip-on bad removal):

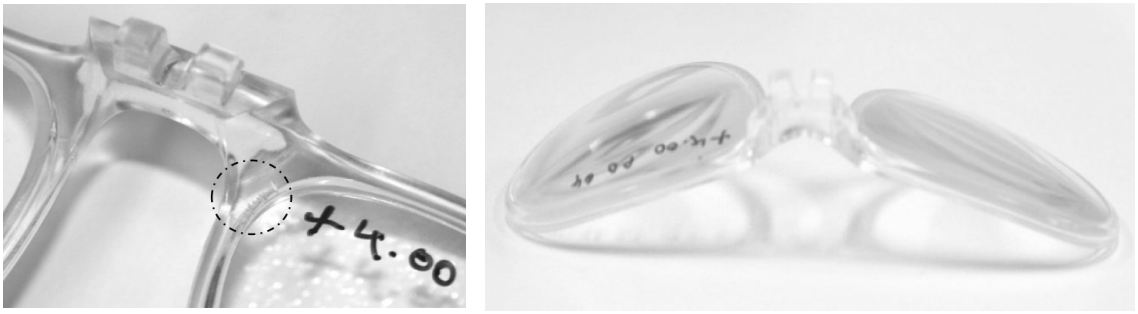
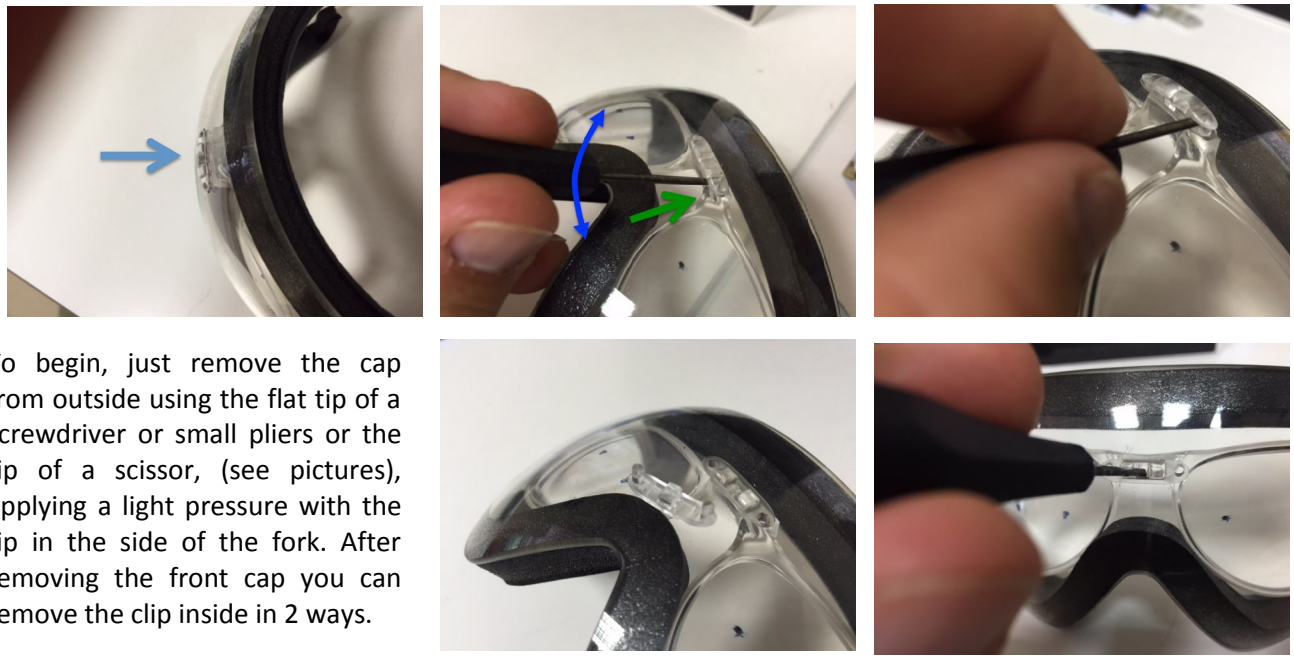


Figure 4.1 – ***from"Critical reports of optical requirements of Raleri Rugby goggle" Author: J Little PhD BSc (Hons) MCOptom FHEA Lecturer in Optometry & Vision Science, University of Ulster.***

In the latest version of the goggles (EVO version), and better in case of antifog coated lenses, the removal of the clip-on is not necessary to eliminate moisture. The antifog action is granted by an organic antifog coated sheet and from vent cuts and holes machined in the mask body. By the way the organic inner lens is very scratch sensitive, so better take care during the removal and installing operations.

REMOVAL OF THE CLIP-ON The removal is necessary periodically in order to access the inner side of the mask, in order to clean the front face of the ophthalmic lens and the rear face of the mask. Operation to do with just a damp microfiber cloth or better with the surfactant cleaning kit available by Raleri. In the following top view of the mask there is a particular of the front fork shaped cap which must be removed in order to extract the clip-on. The shape of the fork-cap it's a tapered and curved profile, so that the edges are smooth when it is in correct position of use.



To begin, just remove the cap from outside using the flat tip of a screwdriver or small pliers or the tip of a scissor, (see pictures), applying a light pressure with the tip in the side of the fork. After removing the front cap you can remove the clip inside in 2 ways.

• Method 1 (Recommended)
Using the same plant used to remove the front fork pushing from the outside against the center of the bridge.

• Method 2 (Field use only, when tools are not available): Taking in and grabbing the clip with two fingers near the bridge doing little oscillatory movements with the hand.

Before to apply the second option, please mind that the sharp tip of a pen is enough to avoid damages. ***In any case don't try to remove the clip-on with the fork-cap installed.***

For installing the clip-on the process is exactly the reverse; Introduce the clip inside, then attach the front fork. The fork has a “one-way” entry: if you try to insert it in "inverted", the force to apply is greater, its integration is unstable and the fork will be projecting a non smooth edge, so you can not be confused.

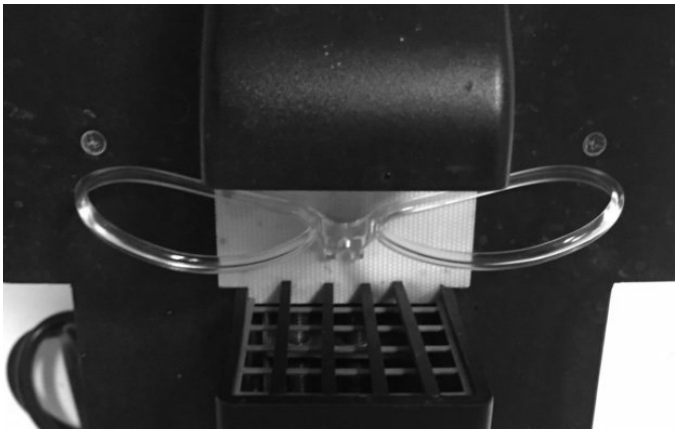
Where no ophthalmic lenses are needed and ***when the insert is used only as protection it's still recommend to put the cap in its place*** so to avoid possible cutting edges that can cause a “skin suction” effect during the strongest impacts. Two caps are provided with the goggles for your commodity.

In case of damages most of the goggles part are provided as spares for the goggle refurbish: clip-on with cap, inner acetate lens, face foam and two size straps (30mm and 40mm widht).

Figure 4.3

5. Clip-On Shape Adjustment

The original shape of the clip-on can be changed after heating it in the rims area. Taking care not to heat the bridge, for ease of handling and moulding. The insert can be shaped with a warming around 70°C easily reached with a common frame heater like the one in the picture.



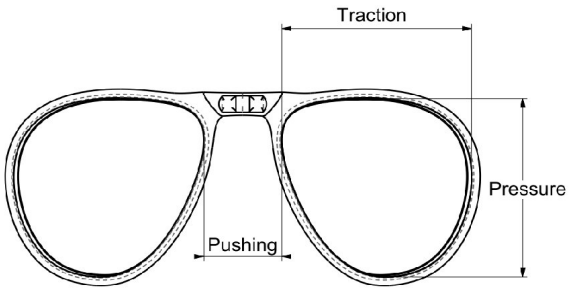
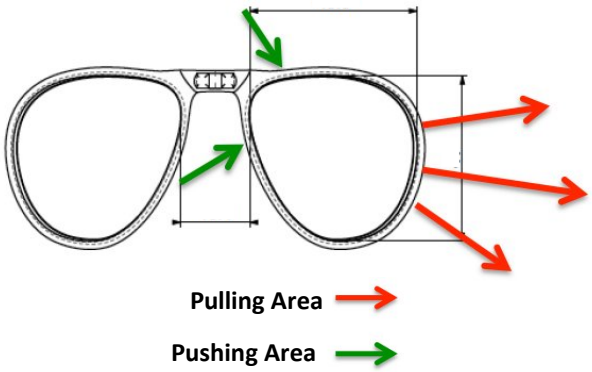


Figure 5.1

Exerting adequate pressure and traction in structural clip-on areas you can change its shape to get bigger frame length, suitable for people with IPDs wider than average. Changing the eyepiece shape it's needed to improve the visual output, enabling people with IDP above average to reach a correct binocular field of view with enough angular width to play rugby, and more in general to do activities and sports where a dynamic sight is needed. To improve the binocular visual performance, you must modify the original 45 x 41 mm caliber)

Pressure and traction maneuvers for changing the shape of the clip-on eyepiece:



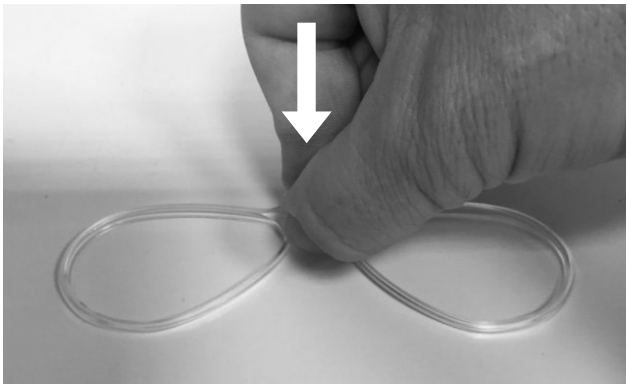


Figure 5.2

The field of view is obviously limited by the use of the protective mask. During use the useful portion of the field of view included in the mask area will vary depending on the combination of several optical and anatomical factors of the athlete, most important of which are IPD, BVP and Powers.

The field of view (FOV) included in the correction, related to said factors, can naturally benefit from several conditions. In particular it increases when:

- The subject has an IPD less than or equal to the average to HUMAN IPD, 62 mm:
  AVG IPD MALE 62 (range 60-64 mm) / AVG IPD FEMALE and UNDER 12 KIDS (range 58-62 mm)
  NOTE - The IPD value can easily reach values higher than average, around 70 mm and can infrequently reach values up to 75-80 mm, but very rarely overcome those limits, also in the bigger rugby players.

- Decreasing distance between the eye and lens (BVP)

- In subjects with the negative spherical powers (nearsighted or myopic astigmatism) due to the prismatic effect at the outer base of the negative lenses, for which the higher is the myopia the greater will be the angular field of view that the subject may use doing the same eye movement.

Clip on modifications may deal only with the first two options.

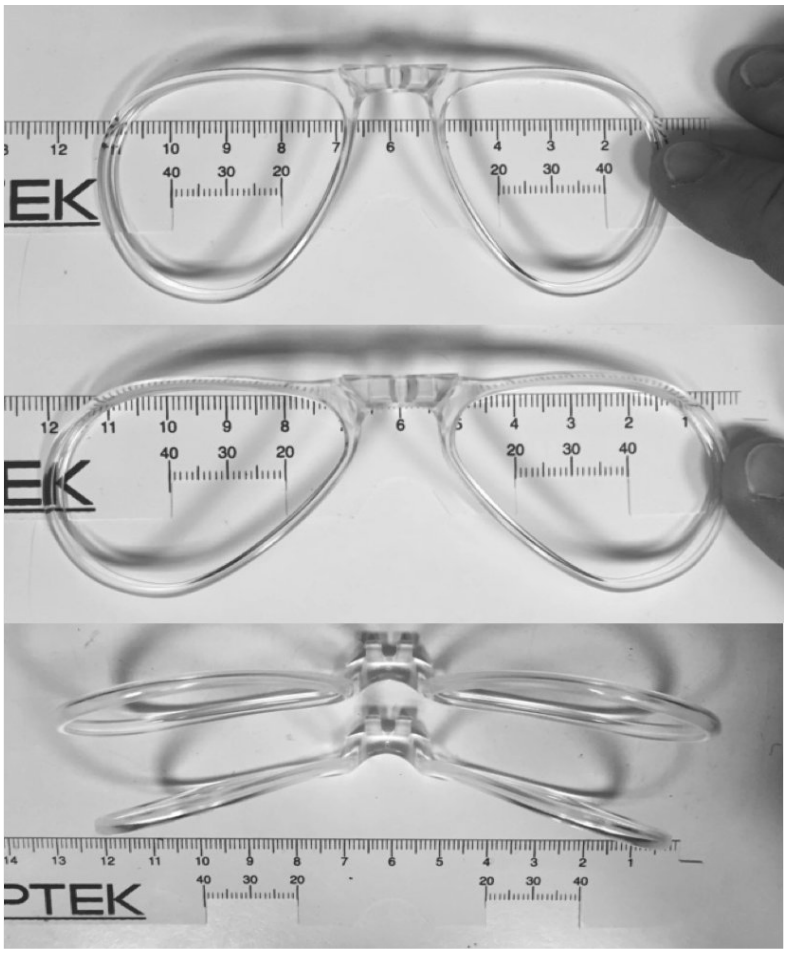


Figure 4.2

As can be seen in the above picture original wrap 15° and lens boxing size 45x41mm is mostly suitable for equal to the average or medium and small faces like kids and women. The second shape is obtained after the previously described heating and manipulation. You can notice the change in overall width, with a new 55x33mm boxing size and a flatten dihedral angle obtained. The 10° so obtained will bend over a little (14° to 17° depending on lens type) when put again in the resting goggle. Here we have to face another fitting variable: the face size and the worn goggle adaptive positioning. The following chapter explains why those modifications are suggested only for IPD equal or grater than average (> 64 mm) and for large faces.

6. Raleri Rugby Goggles Extra Fitting Information

Representation of the backing zones of the mask, on medium to large faces:

As the size of the face grow, the mask spreads leaning to its natural zygomatic, orbital and temporal bones supports (**Figure 6.1**). This 4-point backing give the goggle steadiness and safety also when applied on medium to large faces. Usually larger IPD are also associated to faces over the average.

This intersection of anatomical characters makes possible a reduction in the BVP. The face, widening the shape of the mask, allows a further approach, thus maintaining a good BVP ratio and an acceptable field of view, even in individuals with above-average cranial size. To achieve this, it is recommended to apply the elastic band having width of 4 cm instead of the thin 3 cm ones.

The wider strap, when tightly applied to the head circumference, allows the mask to spread enough to compensate, while fitting in the correct position. (**Figure 6.2**)

Figure 6.1

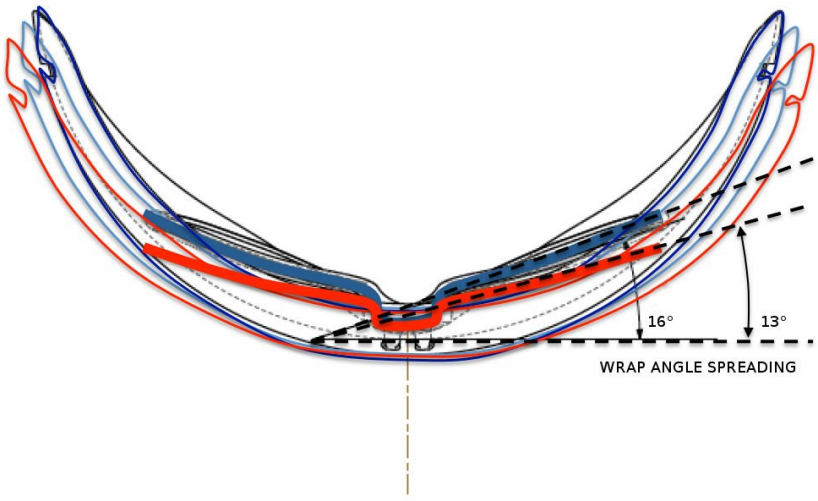


Figure 6.2

7. Compensation of the Refractive Powers & Fine Tuning

Generally speaking the geometrical compensation of refractive power for the ophthalmic lens has to be made taking into account the new positioning of the lens relatively to its prescription position. Compensate would mean change the lens geometry to work with the new position variables (BVD, FRONT & WRAP angles, etc...)

Assuming that the position of prescription lens could be made with varying distances between about 10 and 25 mm away from corneal apex (the said Back Vertex Distance or Position), and that this distance is generally not reported in any ophthalmic prescription, it follows that the compensation of the back vertex distance should be considered approximate. This also happens during the preparation of the glasses where the frame can be worn at a variable distance from the eyes depending on the measurements of the front and more of the bridge ones. The shape of the face, the prominence of the root of the nose and the position of the eyeball in the skull can cause difficulties for the prescriber to respect the suggested BVD distance.

However, each subject presents a limited range of distances in which the glasses can be placed, resulting from the morphological data of the head/nose and prominence of the orb. Knowing the normal distance of the subject, the BVP with the Raleri Rugby Google can also be measured the using the same system of the normal frame.

The two systems currently most used are:

- Optical ruler system: classic but reliable
- Electronic centering system: based on a tablet or a PC connected with camera

After detecting the extent of the BVP it's possible to compensate it. The compensation must be made for the long discussed different parameters:

- BVD (as said the distance from corneal apex to lens)
- WRAP (frame bow / dihedral angle)
- PANTOS (front angle, or TILT)

Many companies provides a computing systems for these parameters, simply supplying them data during lens ordering process, through website or independent software.

Surfing the web, you can find accredited sites where you can enter the centering, and position of the lens, to calculate the lens to be ordered according to its actual position.

Example, www.Opticampus.com, where the link
http://www.opticampus.com/tools/calculators.php

You can calculate the effective power to order.

Figure 7.1

The positioning of the clip-on may also need the compensation of the prismatic effect induced by the position of the lens worn, in particularly from the dihedral angle. The angle of the wrap is 15° to 16° in an average of 10 sample measured. In the case where the mask is fitted to faces from medium to large, the curvature of the mask tends to expand allowing, if necessary, a reduction of the nominal value of the wrap.

To give a first practical example, the changes in refractive powers at the variation of the distance between the corneal apex and the lens (DACL or BVP) is a parameter normally compensated during the prescription of a contact lens. The prescription is for obvious reasons performed with ophthalmic test lenses installed on a trial frame or on a phoropter. The power is changed according to a known formula or with tables pre-built using an empirical method (see Table 1) performed considering the average values of BVP of 12-13 mm.

Dioptric Range (+/-) .ca	From 3,00 To 4,00	From 4.00 To 5,50	From 5,50 To 7,00	From 7,00 To 8,50	From 8,50 To 10,00
Dioptric Variation	It's necessary to verify for + / - and for the BVP	0,25	0,50	0,75	1,00

Table 7.1. Typical changes in the refractive powers during the passage between glasses and contact lenses.

$$P_{lac} = \frac{1}{\frac{1}{P_{oft}} - DAL}$$

Plac = contact lens powers
Poft = refractive powers (ophthalmic)
DAL= back vertex position

The range in which the prescription test was run is not often indicated on the prescription. Normally it can vary from a minimum of 9-10 mm (depending on the length of the lashes) to a maximum of 25-30 mm. During the preparation of the frame this distance may differ from what measured by the prescriber.

A few millimeters incremental variation, as often happens during the fitting of the Raleri Goggles or other competitors ones, is considered normal into masks equipped with optical clip-on inserts, and requires a compensation in the optical lenses. The next table shows a calculation summary for sampled typical distances:

BVD at 10mm for Rx	±6.00D	±4.00D
BVD increases to **13mm**	Lens power changes by **0.11D**	Lens power changes by **0.05D**
BVD increases to **16mm**	Lens power changes by **0.21D***	Lens power changes by **0.10D**
BVD increases to **20mm**	Lens power changes by **0.34D***	Lens power changes by **0.15D***
BVD increases to **25mm**	Lens power changes by **0.50D***	Lens power changes by **0.23D***

Table 7.2 extracted from the paper "Critical reports of optical requirements of Raleri Rugby goggle" Author: J Little PhD BSc (Hons) MCOptom FHEA Lecturer in Optometry & Vision Science, University of Ulster.

If measuring an increase in the BV distance of the subject with the fitted mask, you will have to compensate by varying the prescribed powers, according to the usual optical indications, as shown in **Table 7.2**

To reduce the BVP distance, in the case of positive lenses having medium or high power (> Sf +3.00) you can use the method of installation with "front edge". This method is commonly used for fittings ophthalmic lenses where the dihedral angle is > 10°. Both the BV distance that the dihedral angle can be decreased by about 2.4 ° and 2.1 mm (the reduction varies with the power and thickness of the lens). In the case of high power lenses the reduction will be the higher for both parameters. In **Figure 7.2**, the line of the "front edge" is the continual lighter one and the normal line of the rib is the dashed dark one. This bevelling of the edge where necessary may help decreasing the BV and dihedral angle.

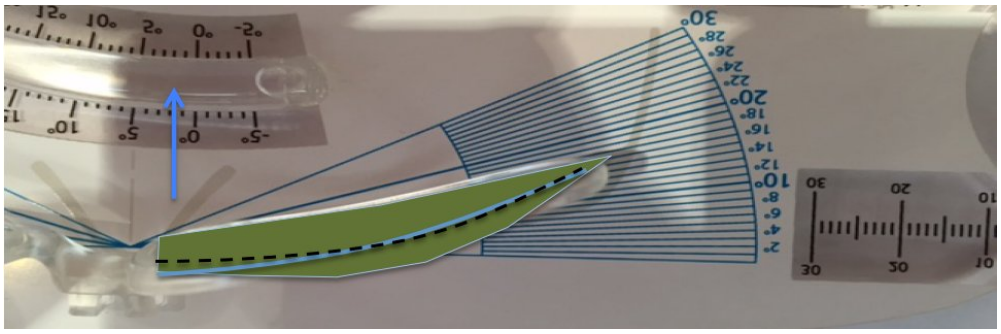


Figure 7.2

In the following Picture group the installation of Sf +4.00 lenses CR39 Diam 60 mm CT 4.5, IPD mounted 70 mm. The template of the clip has been modified to accommodate a lens mount with an eye distance of 70 mm total. Like in the **Figure 4.2**

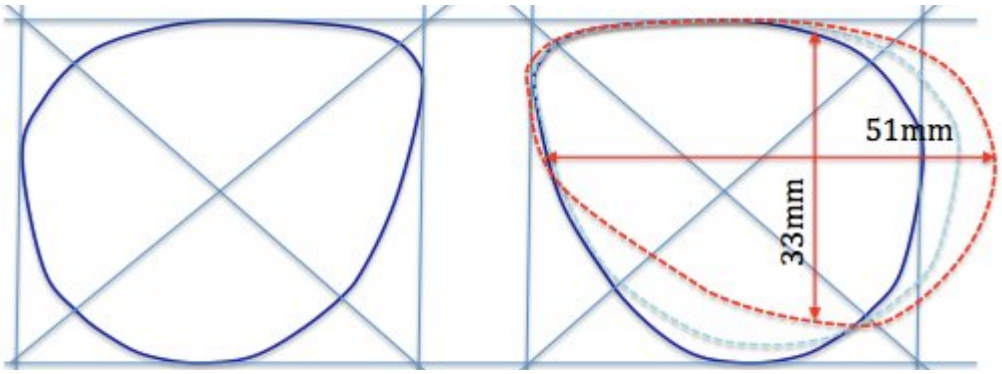


Figure 7.3

Figure 7.4

8. Conclusions

1. The mask "Raleri Rugby Google" has a retention clip-on system without harshness and external surface that cannot harm.

2. The clip-on can be easily disassembled for cleaning the lenses and the inside of the mask, acting with a thin surface to the tip, such as a flat screwdriver.

3. The clip-on can easily mount lenses hemisphere spherical power between +4.00 and -4.00 hemisphere. Higher values of spherical power can be mounted by assessing the characteristics of refractive index, basic geometry of the lens and constructive technology (free form).

4. The basic shape of the template can be easily modified with the warmth of a laboratory frame warmer, increasing the initial diameter, which will increase from a value of 45mm to 51mm and over. This new shape is able to compensate the reduction of visual field present in subjects with interpupillary distances above average (>64 mm), without substantial reductions in the field of view in the vertical plane.

5. In the event of changes to distance of the lenses compared to that calculated by the prescriber during his examination, the power of the lens must be modified following the normal rules that regulate the optical power of an effective optical correction as happens, for example, in the transition between normal prescription for spectacles to the contact lenses one.

6. The distance use of the clip-on in the case of medium to large faces, is partially offset by the transverse wrap diameter of the mask, creating an effect that can approach the clip-on of about 2-3mm. This approach is possible provided that the mask is mounted with the of 4 cm width strap, suitably adjusted to a position narrower than the normal fit.