The "M Ruler"

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   It has been shown that the Golden Rule cannot be universally applied to all patients; it therefore became necessary to find a formula adaptable for each patient.

The "M" Ruler is a great guideline replacing the Golden Ruler. The "M" Ruler has a mathematical formula related to the central width and the inter-molar distance, representing the width of the arch. This digital device determines the correct balance for the teeth displayed within the arch to create a pleasing smile.

 Each patient has a unique maxillary width and upper central width (represented by the space between upper laterals). The width of the arch and/or the width of the upper centrals can be changed digitally to project different teeth disposition for different treatment plans in the patient's smile.

This symmetrical device is based on a specific algorithm that is fine-tuned to provide an individualized proportion for each individual patient. This algorithm **(Figure 6)** takes in consideration the following values:

1- Width of both centrals: Both upper central's width divide by 2 gives the average central width
2- Width of the upper arch: Width between the last tooth in the smile, in most cases the first molar
3- Number of teeth involved in the smile
4- "M" Ratio: Directly proportional to the 3 previous values. Display an ideal disposition of all the teeth shown in the smile
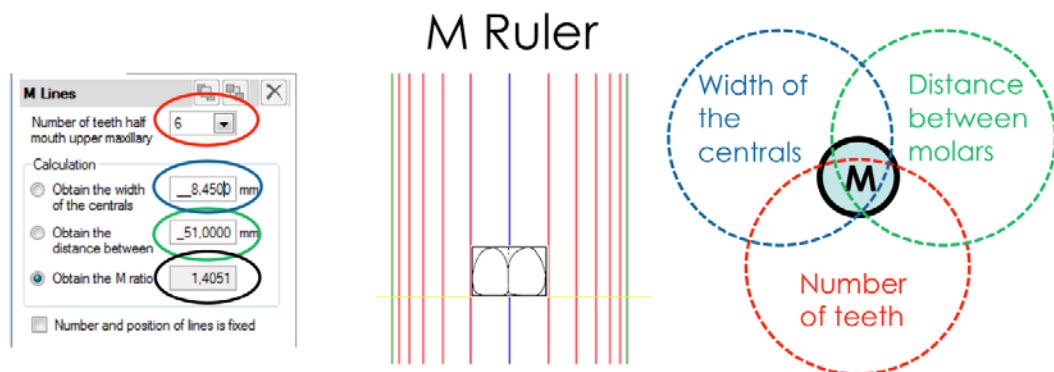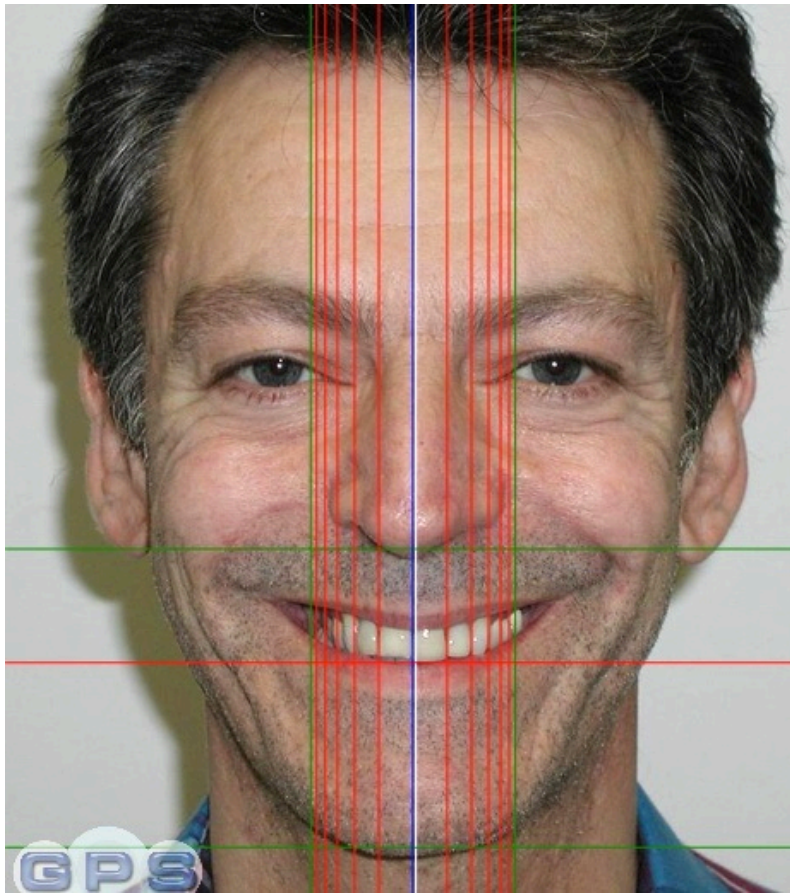

Figure 6   Several parameters influence the « M » Ruler: The algorithm gives a subjective « M Ratio » which is clinically different from the Golden Proportion

On the screen, the **"M" Ruler** is formed by _the combination of one horizontal line passing at the incisal edge of the centrals and a central vertical line passing between the centrals_, _beside the vertical central line it display a series of vertical lines that are related between each other_ with the "M" proportion decreasing symmetrically and proportionally from the centrals to the last tooth shown in the smile. It gives a specific ratio for each upper arch called the "M" Ratio **(Figure 7)**.

Figure 7 a,b The "M Ruler" helps to diagnose facial and dental asymmetries to provide the most aesthetic tooth position, shape and smile design to fit the patient's facial frame. The "M" Ratio will change if one of the values is changed. In this case the patient present a severe asymmetry.

The "M" Ruler is a teeth disposition device. However it is not a height and width (h/w) ratio device. Many authors made researches on the influence of h/w ratio in pleasant smiles. Those researches are not revealing in using specific ratios for Smile Design.

The "M" Ruler combined with morphing simulation software called (GPS) takes specific smiles libraries of full arch smile, and shows the immediate smile design and patient's look on the image **(Figure 8).** The "M" Ruler primarily gives the best width and position of teeth in the dental arch. Using GPS and morphing libraries inside the "M" Ruler shows different looks of the patient smile in respect with patient gum architecture, upper lip line and smile line. The smiles morphed are adjusted on the patient's face to get the best esthetic result. The user sets the height of teeth from centrals to molars for the best esthetic and functional result. Occlusal plane can be change in full mouth rehabilitation to fit the contour of lips to improve function and esthetic, and the transfer is don smoothly from the GPS smile prescription to physical or digital articulators using GPS Connect.

We can not consider a specific w/h ratio from centrals to molars, each tooth have a different h/w ratio that are not in relation to each other on a mathematical basis.
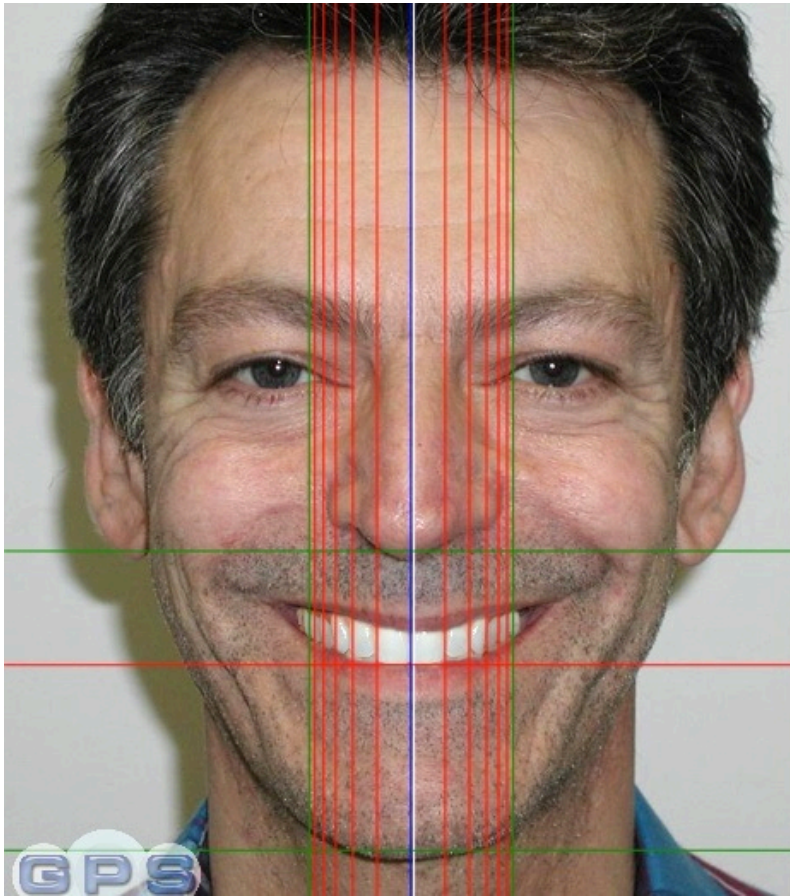
Figure 8 By morphing a 2D teeth library inside the "M Ruler" we can visualize the final result.

The practitioner can change each value of the "M" Ruler, to obtain different set up for different treatment plans. This bilateral and symmetrical device is applied over a facial photograph of the patient and gives the best position of the upper arch in the face and the best position of the maxillary teeth in the arch. One of the 3 values can easily be changed to increase the esthetic appearance or increase the function of the case.

Value 1: Both upper centrals width is taken to obtain the average central width **(Figure 9)**, and to calibrate the picture. Then the practitioner can take measurements on the screen over the picture. In the majority of cases, the left and right centrals don't have the same width due to several situations like the rotation of one or both centrals or restored centrals.
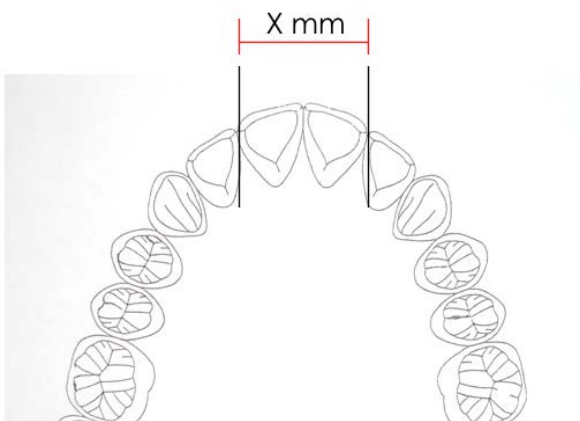
Figure 9 Measuring the width of the two upper centrals on the patient or the models has 2 purposes: 1- to get the "M" Ratio and 2- to calibrate the picture.

Value 2: The maxillary width is determinate transversally from the buccal crest of the left and right first molars where the last line of the "M" Ruler usually ends. **(Figure 10)**
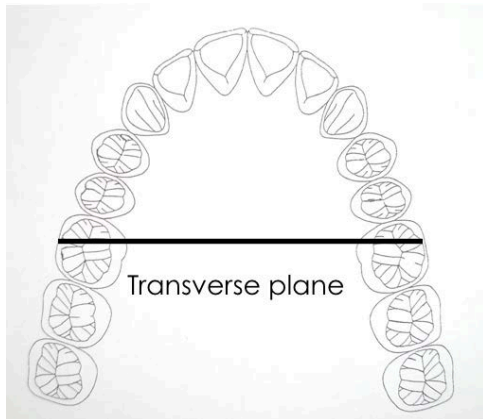

Figure 10 The maxillary width is determinate transversally from the buccal crest of both upper first molars.

Value 3: The number of teeth showed in the smile will edit the number of lines in the "M" Ruler. **V or U arch form** can be diagnosed and treatment planned with the "M" Ruler. For the same arch width both central width will affect the V or U arches. The ideal arch form remains the U arch **(Figure 11)**.
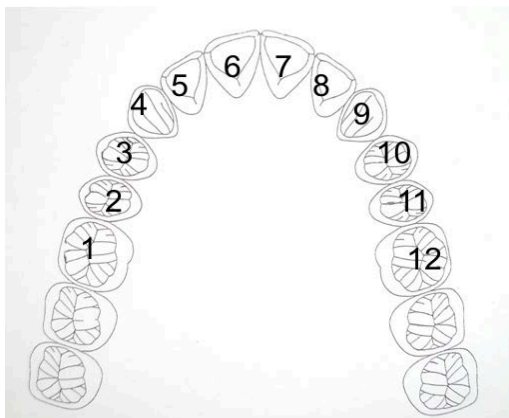

Figure 11

Maxillary teeth best position should be disposed between the "M" Lines in respect of the centrals width and the width of the upper arch (always considering the frontal view of the picture) The vertical lines guide the professionals to see the best position of the upper arch and teeth in the patient's face, with patient's lips and gums in a full natural smile for smile design creation. From a frontal point of view, each vertical line should match the *distal part* of the 6 front teeth and the *buccal part* of posterior teeth by giving the ideal maximum contour and position of each tooth on both side of the dental midline **(Figure 12)**.
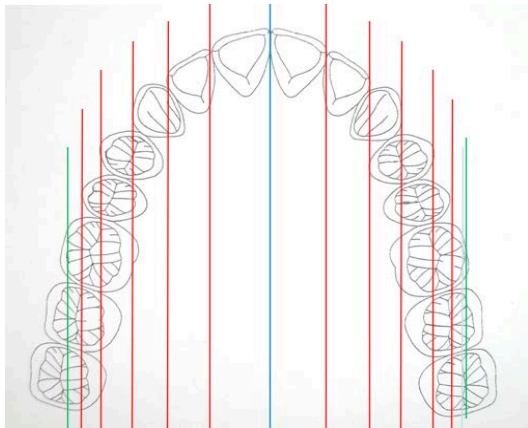
Figure 12

The number of teeth in the smile influences the number of guidelines on the screen. (These lines will then help the lab waxing up the future smile) with the contour and pixels of the 2D wax up as indicators.

Those indicators are then transmitted to the lab as a guideline to the technician in the manual wax up of the future smile on a physical articulator using GPS Connect 2D to 3D digital face-bow platform (BioArt) **(Figure 13).** GPS Connect 2D to 3D digital connection (Dental GPS) is also available has an overlay picture of the 2D wax-up over 3D software to wax up directly on the desktop of 3D software like Cerec in office, 3D lab software.

Figure 13

The X, Y and Z coordinates from the 2D project are used to mouth the pre op model and to wax up the Smile Design 2D project to the 3D model **(Figure 14).**
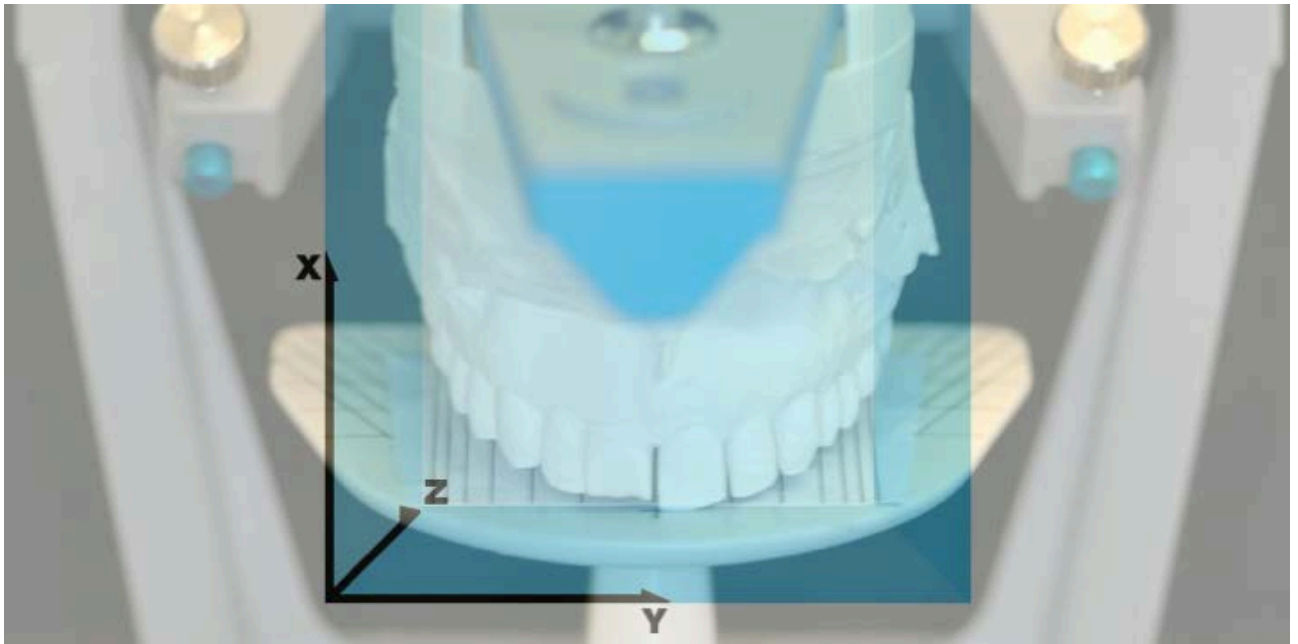
Figure 14

The Z-axis; measurements are easily available on a 1mm grid with the "M" Lines **(Figure 15).**
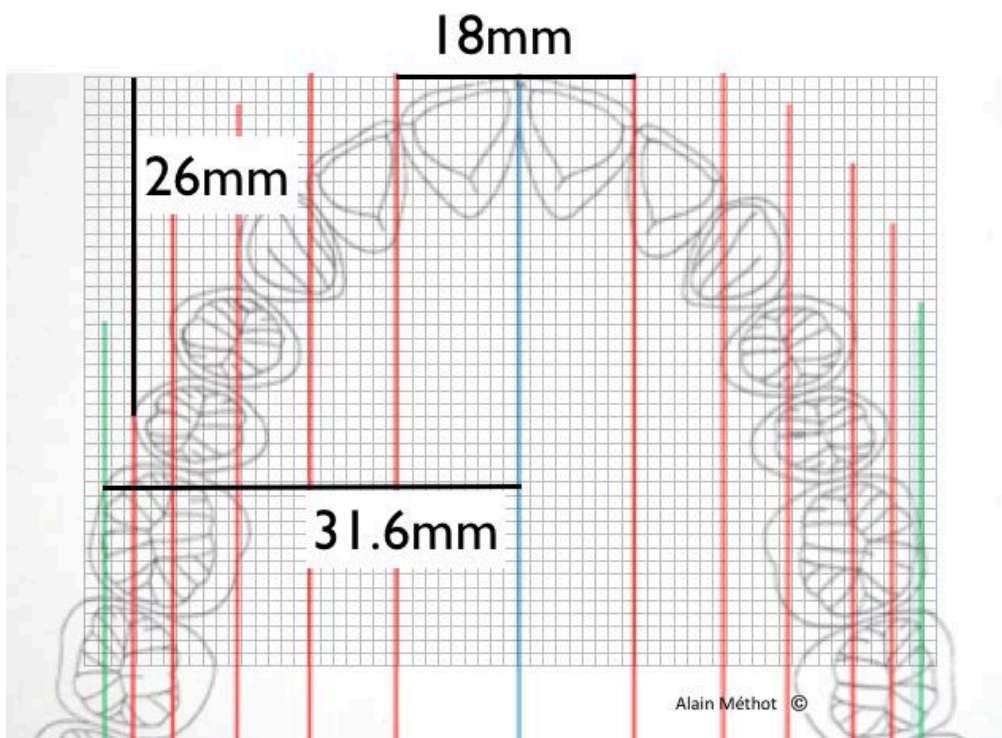

Figure 15 The Z-axis grid

Once the "M" Ruler is digitally apposed on the patient face:

As a first step the "M" Ruler acts as a diagnostic tool, giving an immediate idea of the dental midline deviation compared with the facial midline. It's then easy to see facial and arches asymmetries, malposition of the maxillary laterally and vertically.

In a second step, the "M" Ruler suggests the ideal position of teeth in the arch, orthodontic treatment or prosthodontic treatments can by visualized, heights and proportions in the dental arch for prosthodontic treatment are done with morphing software producing a 2D wax up. This gives the clinician a tool to help him in projecting the new smiles and diagnose different treatment plans. Different full arches libraries of natural teeth or dentures teeth can be changed in the patient's mouth to visualize immediate global look. Each tooth can be changed in contour, height, width and angulation individually.

In the last step, the "M" Ruler can be printed on a paper as a template and placed on a platform of a conventional articulator to produce wax-ups or to set up dentures. Patient's models are mounted with the Pitch, Roll and Yaw prescribe in GPS smile simulation, over the "M" Ruler showing the ideal position of teeth in the patient's arch, helping the lab to realize a 3D wax up of the 2D set up on-screen (simulated smile). This is a very important aspect of the process improving not only the communication between the clinician and its patient, but also to connect patient's set up with the dental lab. This way, the smile design process becomes more objective and the project can be realized in respecting all the clinician's coordinates.