This is a device for measuring torque and angulation of the facial surface of mal-occluded teeth on dental models used in lingual and/or labial orthodontic techniques. The Tip & Torque Surveyor has an Anodized Aluminum base with a Stainless Steel working area plate, stainless steel column, and precision aluminum / stainless steel mechanical parts. The mechanical and electronic instrumentation assembly is adjustable along the vertical axis of the column. This assembly includes angulation and torque measuring components plus LCD display for measured data. The Tip (angulation) and Torque (inclination) measuring components are adjustable for precise accuracy.

Technical Field:
The present invention relates to lingual/labial orthodontics.

Background of the invention:
Indirect lingual bracket bonding was done by Ormco using an apparatus called the TARG (Torque Angulation Reference Guide) developed in 1984. The TARG, despite anatomical variations of the lingual tooth surfaces, permitted the bonding of brackets in the laboratory at an accurate distance from the occlusal edge of each tooth with respect to a horizontal occlusal plane. The tooth orientation is made with a gauge or torque blade. The model is tipped on a surveyor base until the long axis of the labial tooth face aligns with the specific gauge curvature at the middle third of the tooth. This orientation allows us to pre-program torque (inclination) and angulation (tip) before starting the treatment. After the TARG horizontal blade is engaged into the bracket slot, it is moved towards the varnished plaster at the bonding level determined by the laboratory technician with respect to the prescription, function and anatomy of the teeth. The bracket is bonded to the plaster with filled resin, which allows the gap between the lingual tooth surface and the metal base of the bracket to be completely filled. A new resin base, which accurately follows the lingual anatomy of each tooth, is therefore integrated to each bracket.

Once all the brackets are bonded to the model, a transfer tray is fabricated. Using only one unique malocclusion model, the TARG permits achieving a virtual set-up without the need to cut the teeth and mount them on wax. It is a quantified multi-dimensional system. The torque, angulation, and height measurements are registered by the technician. Nevertheless, it has been found that a correct alignment can only be obtained by adding a great number of first-order bends, because the TARG does not take into account the labio-lingual thickness of the teeth. One can note that the distance between the bottom of the bracket slot and the labial tooth surface varies for each tooth despite the fact that all the brackets are manufactured with specific, variable thickness.
Fillions ‘Thickness Measurement System’.

Since the TARG is unable to compensate for the unequal distances between the bracket slots and labial tooth surface, Dr Fillion added a digital caliper to the TARG central axis and modified it to present two horizontal blades. The bracket positioning is made directly on the malocclusion model with the TARG (Ormco) and the Thickness Measurement System (Fillion). By this way each bracket is bonded on the teeth according to 4 specific references defined by the orthodontist: Angulation, Torque, Bonding height and Thickness (distance from slot to the labial surface). The digital caliper is used to position the brackets, thus recording thickness from the bracket slot to the labial surface.

The macro-filled resin is applied to the bracket base; then the bracket, placed on the blade, is moved towards the plaster model until the selected thickness measurement appears on the display. The resin excess, even on the gingival margins, is removed before polymerization. By this technique thickness standardization is achieved while the brackets are each supported on different thickness resin pads.
By achieving thickness standardization this eliminated the need for many first order bends in the arch-wire. This procedure invented by Dr Fillion is called the B.E.S.T system, or "Bonding with Equal and Specific Thickness". In this system the master malocclusion model is used directly and not destroyed, giving the advantage of reference and re-mounting lost brackets. Everything is measured and registered: Angulation, Torque, Bonding Height and Thickness and quantifying this information allows custom-made brackets accurately positioned in three dimensions of space.

The Tip and Torque Surveyor - How does it work?

The Tip & Torque Surveyor is an instrument for measuring torque and angulation of the facial surface of mal-occluded teeth. The Tip and Torque Surveyor has the advantage over the TARG of being able to move around the teeth and measure them, not just setting them when we align the middle of the blade with the tooth’s FA points. The slightly curved blade helps us compensate for awkward tooth morphology.

It consists of an anodized aluminum base, including a stainless cover plate for the working area to reduce possible wear. It has a vertical stainless steel column and 3 main assemblies, which are:

- **Angulation adjustment assembly**: the model is placed on a fixed surveyor base and the blade moved around each individual tooth aligning the middle of the blade with the FA point (midpoint of each tooth on its long axis), or the model is placed on an adjustable survey base and tipped on the surveyor until the blade meets with the long axis of the labial face in the same manner as before. Then the angulation adjustment knob is rotated until the blade is exactly aligned to the middle third of the tooth parallel to the long axis of the labial face to read off ’Tip’ or the ’Tip’ is set to a predetermined value. The angulation adjustment knob can then be locked into position. Vertical and horizontal pencil facial markings are used as a reference check. The LCD display shows the angulation measurement to 0.5°, which is more than sufficient accuracy in Orthodontics due to all the clinical variables that come into play via the bio-mechanics. It has a range of more than +50° to -50°. The precision accuracy is achieved using rotary encoders and, low backlash mechanical movement plus unique signal conditioning electronics.

- **Torque adjustment assembly**: On the shaft of the torque adjustment knob is a gear wheel connected to rack dovetail guide that slides in an arc movement. Rotating the torque adjustment knob moves the blade in arc of +50° to -50°. The blade is at 0° with an average curvature. The blade is either moved around a stone dental model on a fixed horizontal table or the model is tipped on the adjustable surveyor base until the blade meets with the long axis of the labial face is exactly aligned to the middle third of the tooth to the predetermined tip & torque. The torque adjustment knob can then be locked into position Vertical and horizontal pencil facial markings are used as a reference check. The LCD display shows the torque measurement to 0.1 ° with the range of +50° to -50°. The precision accuracy is achieved using rotary encoders and, low backlash mechanical movement plus unique signal conditioning electronics.

- **LCD display assembly**: This comprises of the Tip and Torque Surveyor microprocessor PCB, LCD display, power supply & USB interface cable. The microprocessor PCB inputs torque & angulation encoder-position that is fed into a signal conditioning and translation circuitry. The main microprocessor takes the encoder-position information and turns this into torque & angulation measured data in degrees, which is then shown on the LCD display. An example of Angulation measurement would be: A + 9.0° (the top of the blade movement downward direction towards the center line / midline of the model, to give a positive value). A – 5.5 would indicate the top of the blade moving away from the center line. An example of Torque measurement would be: T - 15 ° (arc movement upward direction to give a negative value). A + 10 would mean the blade moving in a downward direction around the arc. See the following images:-
On the ‘Advanced Version’ there is an ‘Interactive Measurement Head’ and pressing the save button connected to the PC (via USB interface) actively captures the current settings and you use a visual interface on the screen to navigate around the teeth. I.e. you click on a particular tooth on the display and then move the measurement head to that tooth. When the angles are set correctly you click a save button on the screen. The PC can record all the torque & angulation history for each Job No.

+5V DC Power is provide either by a special USB cable (with voltage protection) connected to a power block. Or a standard USB cable connected to the PC providing +5V DC.

**Goal of Invention:**
The goal of the Tip and Torque Surveyor is to provide precision accuracy for torque and angulation measurements by utilizing smart technology and innovative design thus removing the inaccuracies of today’s orthodontic devices. The TTS’s unique flexible design now gives the orthodontist the option to do individual prescriptions with ease and accuracy. This high precision reduces the errors from indirect lingual/labial bonding techniques, which significantly reduces the chair-time for orthodontic procedures. Reliable, repeatable, strong, compact and easy of use, plus very low maintenance was paramount to give the orthodontist confidence in correct torque and angulation measurements.

**Division of Technology within Invention:**
- Precision mechanical machined parts
- Rotary position encoders
- Electronics microprocessor card providing signal conditioning/translation/control/measured data display
- LCD display for torque and angulation measured data

**Reason for Invention of the ‘Tip and Torque Surveyor’:**
We wanted to make easy and precise torque, angulation measurements to improve the accuracy of lingual/labial techniques, giving the orthodontists access to information needed to modify their prescriptions.

**Parts Diagram:**
How the Invention can be used in Orthodontics:

1. Is where the orthodontist wishes to 'survey' a prepared study model, in which case the surveyor base is set to Horizontal Occlusal Line (as described by Andrews) and then the Tip and Torque Surveyor is adjusted to give the best fit for angulation and torque. Therefore providing the orthodontist a precise digital measurement of the existing state in the mouth so he or she can calculate a suitable prescription for the treatment.

   The brackets which are manufactured to varying values for tip and torque can then be best suited to the case or the Orthodontist can write a bonding chart for a laboratory which uses the same device in conjunction with a "Bracket Positioning Device / Instrument" such as the B.P.D. for precise indirect bonding.

2. The Laboratory uses it in the opposite sense and pre-sets the angulation and torque then orientating the survey base to the best fit, thus giving a reference to then transfer the work over to the Bracket Positioning Device.

Unique Features of the Invention:

- High precision accuracy torque and angulation measurements
- Utilizes smart technology and innovative design
- Quick learning time and easy to use
- Precision increments using the torque and angulation fine adjustment controls
- Locking knobs for pre-set torque and angulation values to stop mechanism movement
- LCD display to clearly show measured data
- Reliability, repeatability, strong, compact and low maintenance
- Fast technique time
- Saving of torque and angulation data via USB interface to PC
- PC can record all the torque & angulation history for each Job No.
- Flexible design now gives the orthodontist the option to do individual prescriptions

Summary of Invention:

Our aim is to provide an affordable and simple to use device, which is well engineered and can either: fit an existing system of ‘Bracket Placement’ or be used on its own to analyze malocclusion models, before deciding their prescription, thus allowing the orthodontist to customize their prescription in favour of their patients.

Therefore the market target is not just laboratories involved in ‘Bracket Placement’, but also the orthodontists themselves.

For more info visit: www.pi-bonding.com or www.torque-angulationlab.com

Peter D. Sheffield
Chiang Mai
Thailand