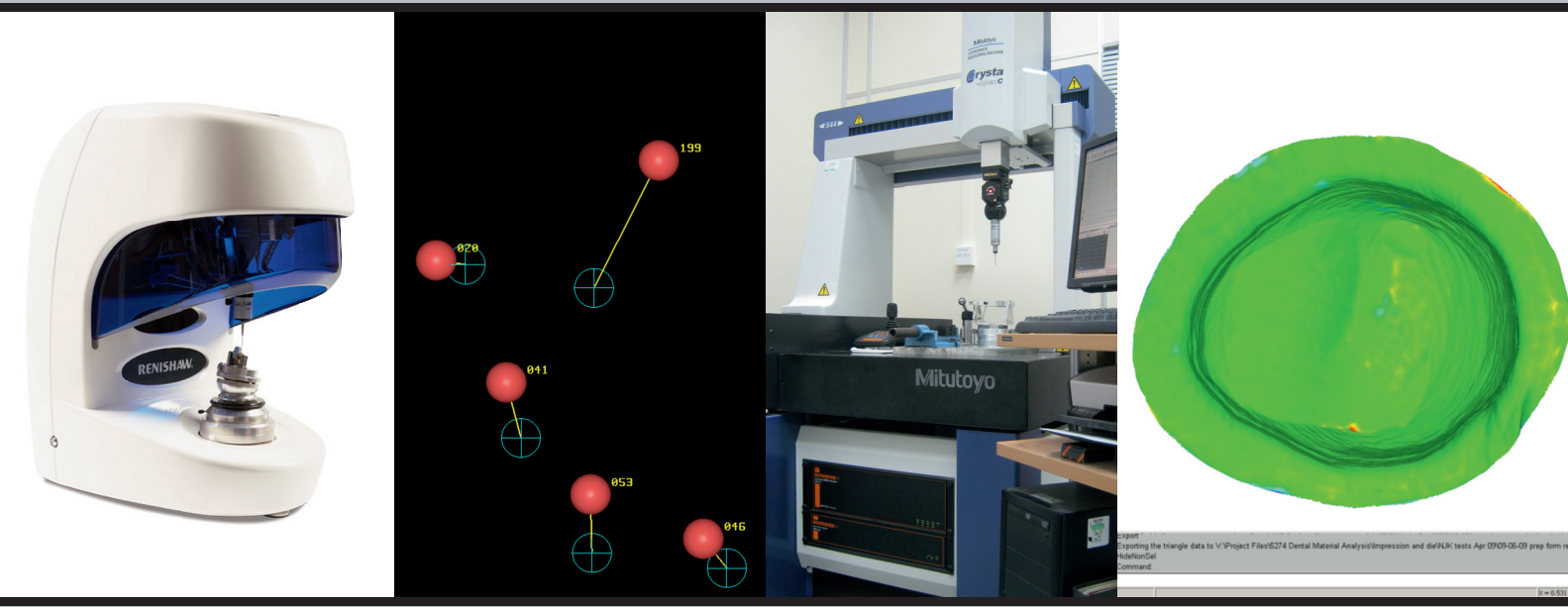
A precise metrology comparison:

Form accuracy and detail reproduction testing of new Identium® and competitive impression materials



Study from Dr. Nigel Knott
(Renishaw PLC and Biomet 3i)
with a variety of impression
materials from three manufacturers

A precise metrology comparison:

Form accuracy and detail reproduction testing of new Identium® and competitive impression materials

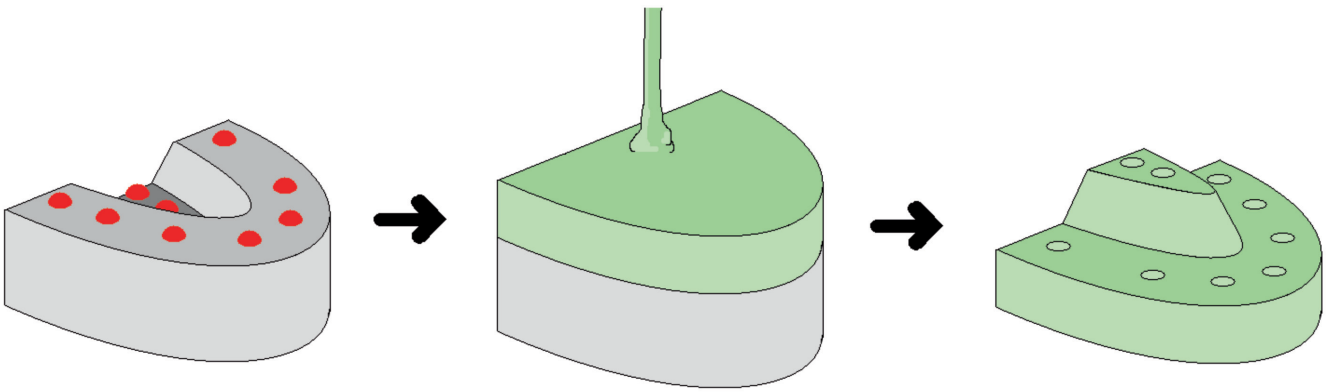
Purpose:

Distortions in impression and model materials can introduce significant errors, especially when magnified over large bridge spans. The purpose of this study was to assess the performance of a new generation of Impression materials and gain a clear understanding of their performance.

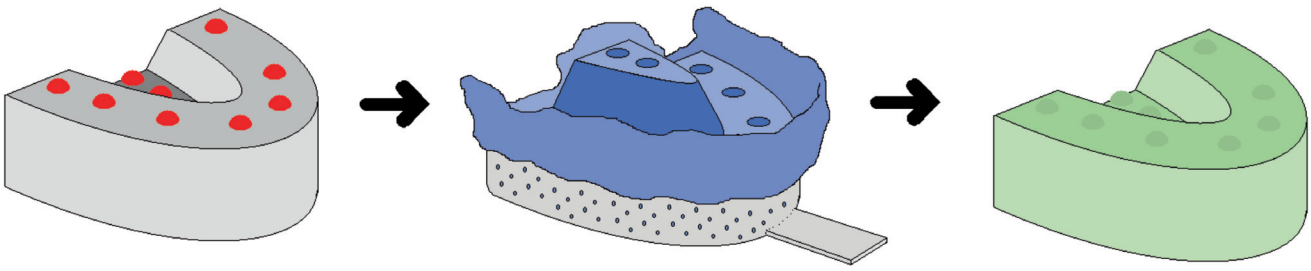
The complex form and fine detail of the artefact in this test was designed to reflect the actual clinical situation.

Material and methods:

An aluminium artefact was developed to represent the dimensions of a jaw. Precision ruby spheres (6mm) were placed exactly half way below the surface of the aluminium to eliminate undercuts. This enables direct pouring of model materials onto the surface. Sphere position and diameter measurements can be made from the negative replica to assess model errors without an impression stage. In detailed evaluations of various gypsum based products Fuji Rock has proved to be superior in every way.



Direct pouring of gypsum material to create a master model (negative) for analysis



Impression taken to create replica master model (positive) of aluminium artefact

Measurements of the positive replica reveal errors in the combination of materials. When poured with a stone material of known behaviour, error vectors can be subtracted to identify the distortion of the impression material.

A variety of materials from Kettenbach, 3M Espe and Dentsply have been tested in various combinations:

Identium® Medium with Identium® Light (Kettenbach®), Impregum™ Penta™ H DuoSoft™ with Impregum™ Garant™ L DuoSoft ™ (3M Espe), Aquasil™ Ultra Heavy with Aquasil™ Ultra XLV (Dentsply).

We know from our previous experience that a matched viscosity two-phase clinical wash used to take an impression in a rigid impression tray will give the best results. The viscosity is a key physical property.

Four impressions were taken with the same impression material combinations in perforated metal impression trays and rigid plastic trays (experimental trays) primed with tray adhesive for comparison.

Measurements were made with the Renishaw testing methods in accordance with ISO 10360 Pt IV and ISO 13485.

Three dimensional assessment

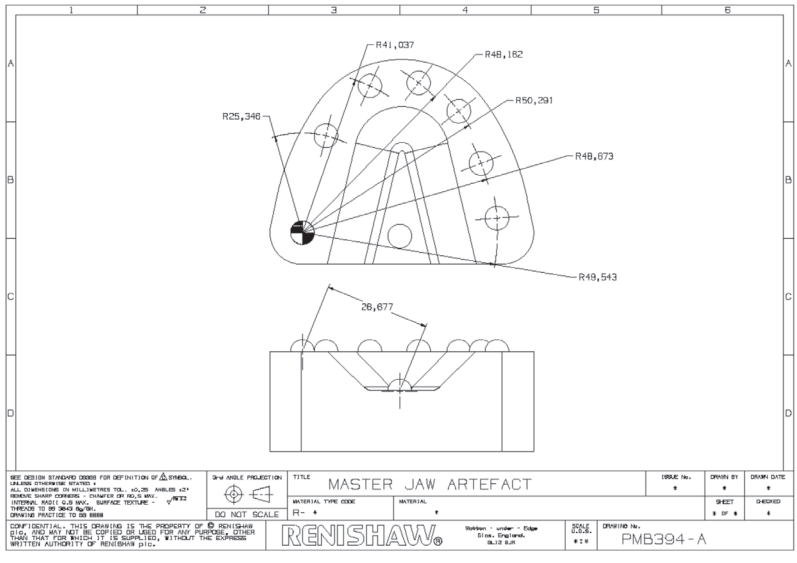
The metrology testing methods are designed to analyse three dimensional behaviour and the reproduction of replica dental surfaces.

Three dimensional data point assessments were obtained from a Co-ordinate Measuring Machine (CMM) calibrated to within an error budget of +/- 3 µm. The machine used in the measurement process was a Mitutoyo CMM.

On the master artefact the exact position of the ruby spheres is known.

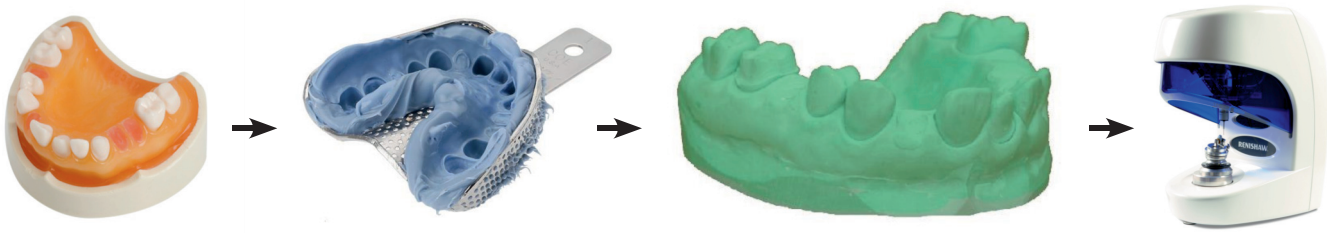
When assessing the results from the Co-ordinate measuring machine (CMM) it is important to understand what the graphs are actually showing. For the purposes of our work we assume one of the spheres is our datum so it will always appear as Zero. The dimensions in microns on the screen shots then show the relative movement of the centre position of the other spheres in relation to this datum.

Because the results are shown this way the dimensions of the artefact are important. If one of the spheres has moved 48 micron and is 48mm away from the datum the % error can then be assessed.



Form error assessment

Outline form errors are assessed in a completely different way. This process involves contact scanning a master tooth model prepared for a full crown restoration with the Incise™ scanning machine (calibrated to ISO10360 Pt IV), then taking an impression of this and pouring and sectioning the model. Finally, we scan also the stone model replica of the original tooth and by using Renishaw software we can compare the form of the original tooth to the stone model replica.



The Renishaw software can compare the form of master artefacts to stone model replicas and produce an error chart as shown below. Being able to read and interpret the findings are vital to our understanding of the behaviour of impression materials and the preparation of accurate master models.

Blue is shown as a contraction (smaller than the original) and red as an expansion (larger than the original).

RENISHAW PLC AND BIOMET 3i –

NOW PROVIDING THE LATEST DIGITAL DENTISTRY SOLUTIONS TO LABORATORIES, DENTAL IMPLANT PROFESSIONALS AND PATIENTS

Gloucestershire, UK – Renishaw plc, a leading manufacturer of in-lab dental scanning systems announces a collaboration with Biomet 3i, an industry leader in implant dentistry and a subsidiary of Biomet, Inc., to offer comprehensive digital solutions to dental professionals and patients worldwide.

Building on its portfolio of Patient Specific CAD/CAM Restorative Products, Biomet 3i is expanding the boundaries of a traditional "dental implant" company by providing a series of innovative digital solutions from which laboratories, clinicians and patients can benefit. For Renishaw, which supplies precision engineering products to sectors as diverse as aerospace and neurosurgery, it represents the opportunity to spread its expertise in dental manufacturing to a wider global audience.

These digital solutions offered by Biomet 3i and Renishaw include:

- 3i incise Copings and Frameworks;
- Renishaw contact scanners;
- 3i incise CAD software; and
- Renishaw in-lab milling machines

Using the Renishaw scanner and 3i incise CAD software, laboratories can obtain broader access to a wide range of dental milling options, including the ability to scan precision copy milled bar patterns.* Laboratories utilizing the ProceraForte® Scanner can also benefit from all of these options by using the 3i incise CAD software.

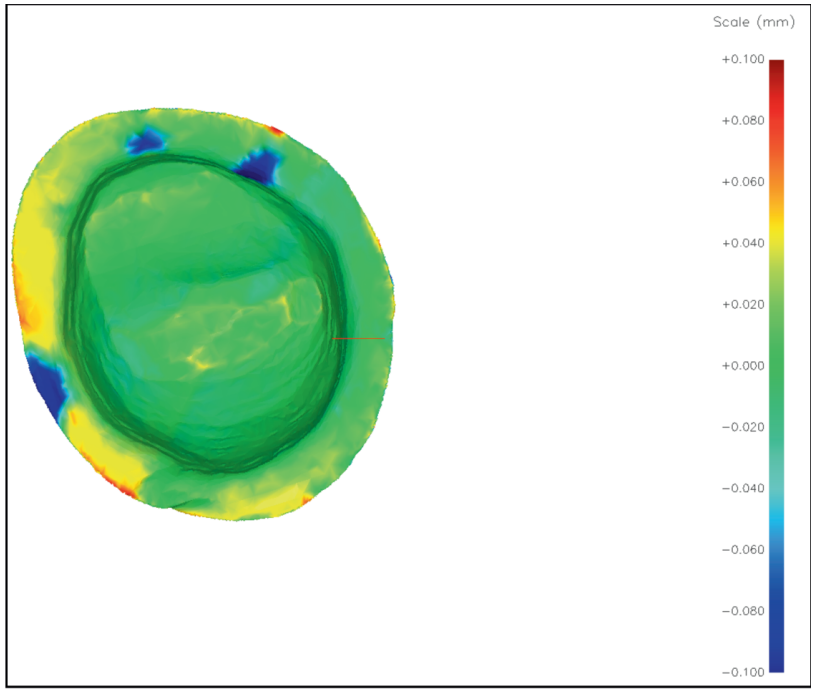
Clinicians can now offer patients 3i incise Copings and Frameworks in Zirconia and Cobalt Chrome** and precision copy milled bars.* These options are patient specific and designed to result in beautifully crafted new smiles.

Renishaw contact scanner

About Renishaw plc

Renishaw is well established as the world's leading provider of in-lab scanning systems, having produced systems both under the Renishaw brand and under the brand of a number of other key dental companies, for over 10 years. As a leading engineering technology company, Renishaw has extensive research and development programs , enabling users to benefit from over 35 years of cutting-edge innovation in industrial measurement and CAD/CAM, bringing a new understanding and precision to the manufacture of metal-free dental frameworks. Renishaw is based in Gloucestershire, England, with operations internationally. For more information about Renishaw plc, please visit www.renishaw.com.

In the example (scale +/- 100micron) shown, the dark blue areas are either inclusions or air pockets that will probably not affect the final crown. The area of yellow and red around the margin area on the left side of the image is a concern and a margin gap of 40+ microns could be expected on the final restoration.



Mitutoyo CMM (Coordinate Measuring Machine)

About Biomet 3i

Biomet 3i, a division of Biomet, Inc., is a leading manufacturer of dental implants, abutments and related products. Since its inception in 1987, Biomet 3i has been on the forefront in developing, manufacturing and distributing oral reconstructive products, including dental implant components and bone and tissue regenerative materials. The company also provides educational programs and seminars for dental professionals around the world. Biomet 3i is based in Palm Beach Gardens, Florida, with operations throughout North America, Latin America, Europe and Asia-Pacific. For more information about Biomet 3i, please visit www.biomet3i.com or contact the company at (800) 342-5454; outside the US dial +1 (561) 776-6700.

About Biomet

Biomet, Inc. and its subsidiaries design, manufacture and market products used primarily by musculoskeletal medical specialists in both surgical and non-surgical therapy. Biomet's product portfolio encompasses reconstructive products, including orthopedic joint replacement devices, bone cements and accessories, autologous therapies and dental reconstructive implants; fixation products, including electrical bone growth stimulators, internal and external orthopedic fixation devices, craniomaxillofacial implants and bone substitute materials; spinal products, including spinal stimulation devices, spinal hardware and orthobiologics; and other products, such as arthroscopy products and softgoods and bracing products. Headquartered in Warsaw, Indiana, Biomet and its subsidiaries currently distribute products in approximately 90 countries. For more information about Biomet, please visit www.biomet.com or contact the company at (800) 348-9500. Outside the U.S., dial +1 (574) 267-6639.

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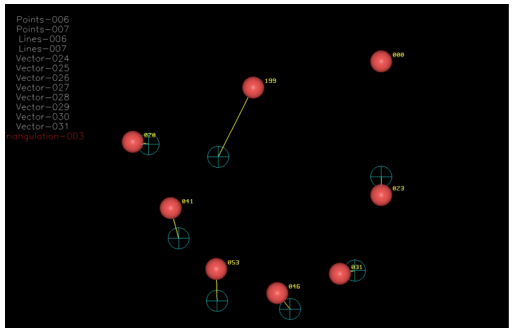
*510(k) pending for precision copy milled bars scanned on Renishaw Systems, not available for sale in the United States
**Cobalt Chrome only available in Europe
Nobel Biocare Services AG is the owner of ProceraForte mark.

Results:

Dimensional assessment

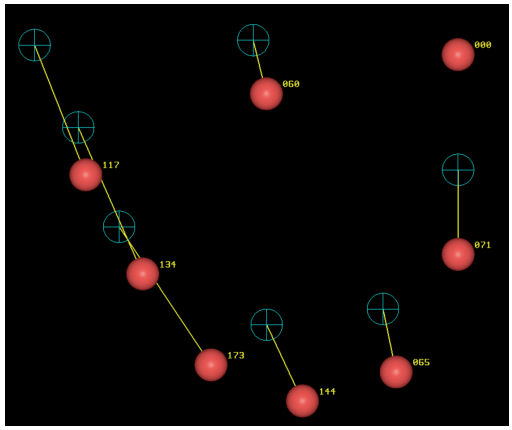
The following pictures show the position of the spheres on the replica models compared to their positions on the master artefact. Movements are represented by position vectors.



Impression material:
Impregum™ Penta™ H DuoSoft™ with Impregum™ Garant™ L DuoSoft™ (3M Espe)

Impression tray:
Perforated metal tray

Stone material:
Kerr Suprastone

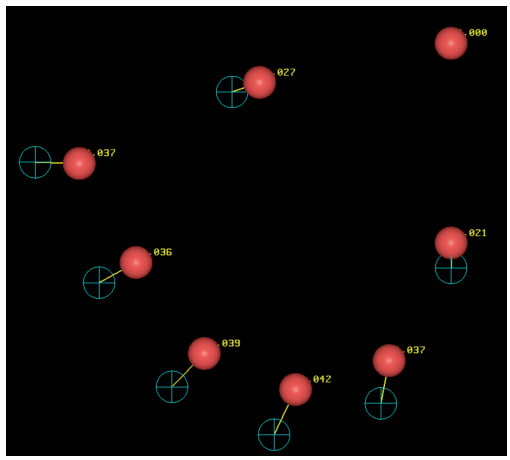


Impression material:
Aquasil™ Ultra Heavy with Aquasil™ Ultra XLV (Dentsply)

Impression tray:
Rigid perforated plastic tray (Coltene)

Stone material:
FujiRock Master Model Material

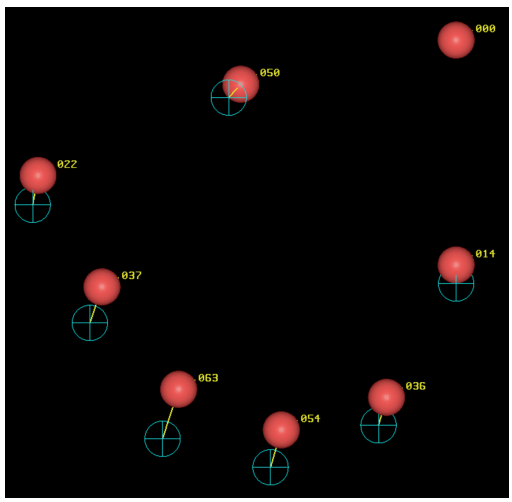
Of all the materials tested the initial results confirm that Identium Light used as a clinical wash combined with Identium Medium Body as a tray material gives the best metrology results. When used in combination with FujiRock the results are consistently within a 50 micron error budget.



Impression material:
Identium® Medium with Identium® Light

Impression tray:
Unperforated metal tray (Schreinemakers)

Stone material:
FujiRock Master Model Material



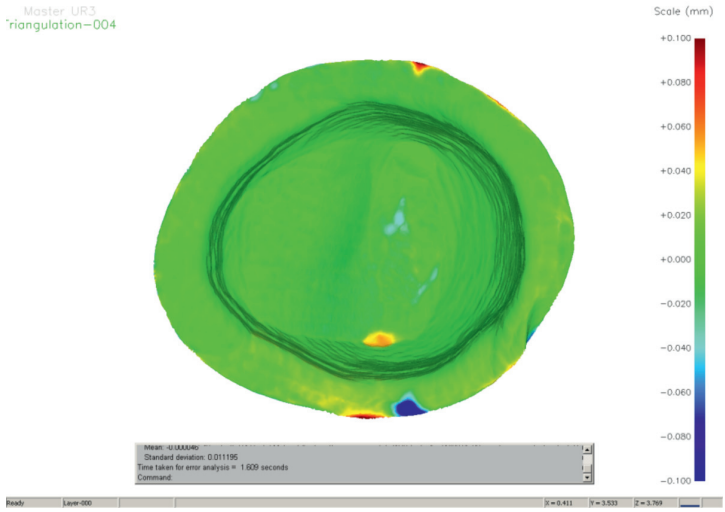
Impression material:
Identium® Medium with Identium® Light

Impression tray:
Rigid experimental plastic tray (Kettenbach)

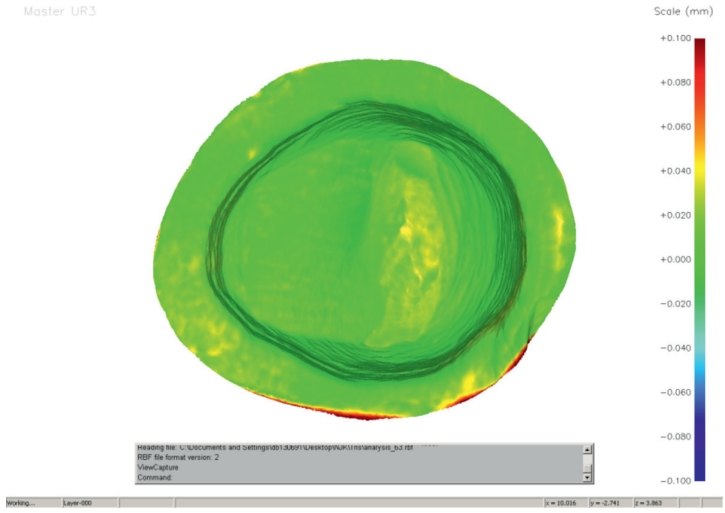
Stone material:
FujiRock Master Model Material

Form error assessment

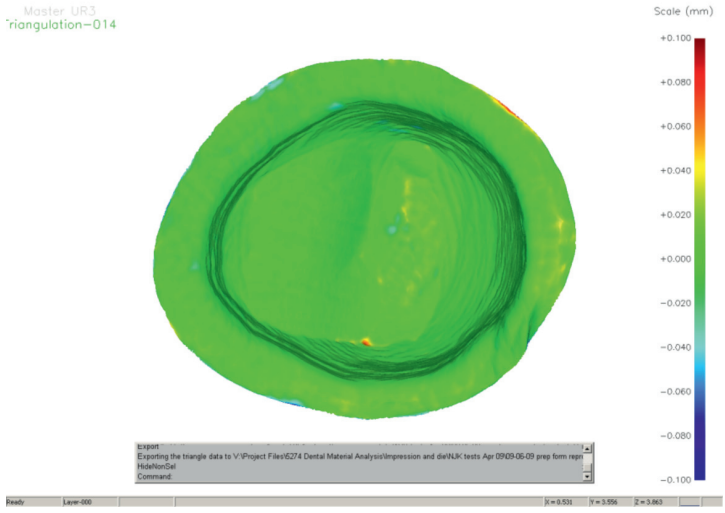
Scans of the stone replicas were compared to scans of the original master preparations. Incise™ software compares these large files of geometrical data outputting an error map of each part. Blue shows areas where the model is smaller than the original, red shows where the model is larger and green shows areas where the model is identical or nearly identical to the master preparation.



Impregum™ Penta™ H DuoSoft™ with Impregum™ Garant™ L DuoSoft™ (3M Espe) in the rigid experimental plastic tray (Kettenbach), stone model with FujiRock



Aquasil™ Ultra Heavy with Aquasil™ Ultra XLV (Dentsply) in the rigid experimental plastic tray (Kettenbach), stone model with FujiRock



Identium® Medium with Identium® Light (Kettenbach) in the rigid experimental plastic tray (Kettenbach), stone model with FujiRock

Conclusion:

It is possible to investigate dimensional changes in the spatial geometry of dental impressions and replicated master models with a very high degree of precision using a Renishaw Incise Contact Scanner and a Mitutoyo Coordinate Measuring Machine. Having screened various materials and methods using CMM technology to identify the best performing combinations, a number of tests were repeated using the Renishaw Incise™ Contact Scanner. The specialised software offers a precise metrology comparison of the impression/master model geometry with the actual tooth surfaces.

Identium® Light used as a clinical wash in combination with Identium® Medium body as a tray material in a two-phase technique has produced exceptionally accurate impressions with great consistency. When these impression materials are used with selected impression trays to manufacture a replica master model in Fuji-Rock, the results are outstanding and surpass all other materials and methods that were tested.

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11 June 2010