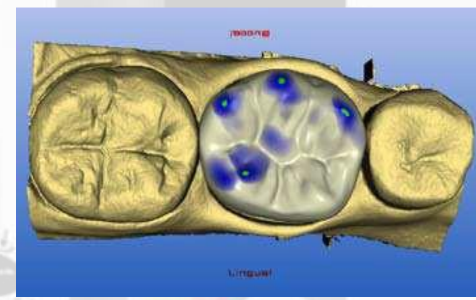
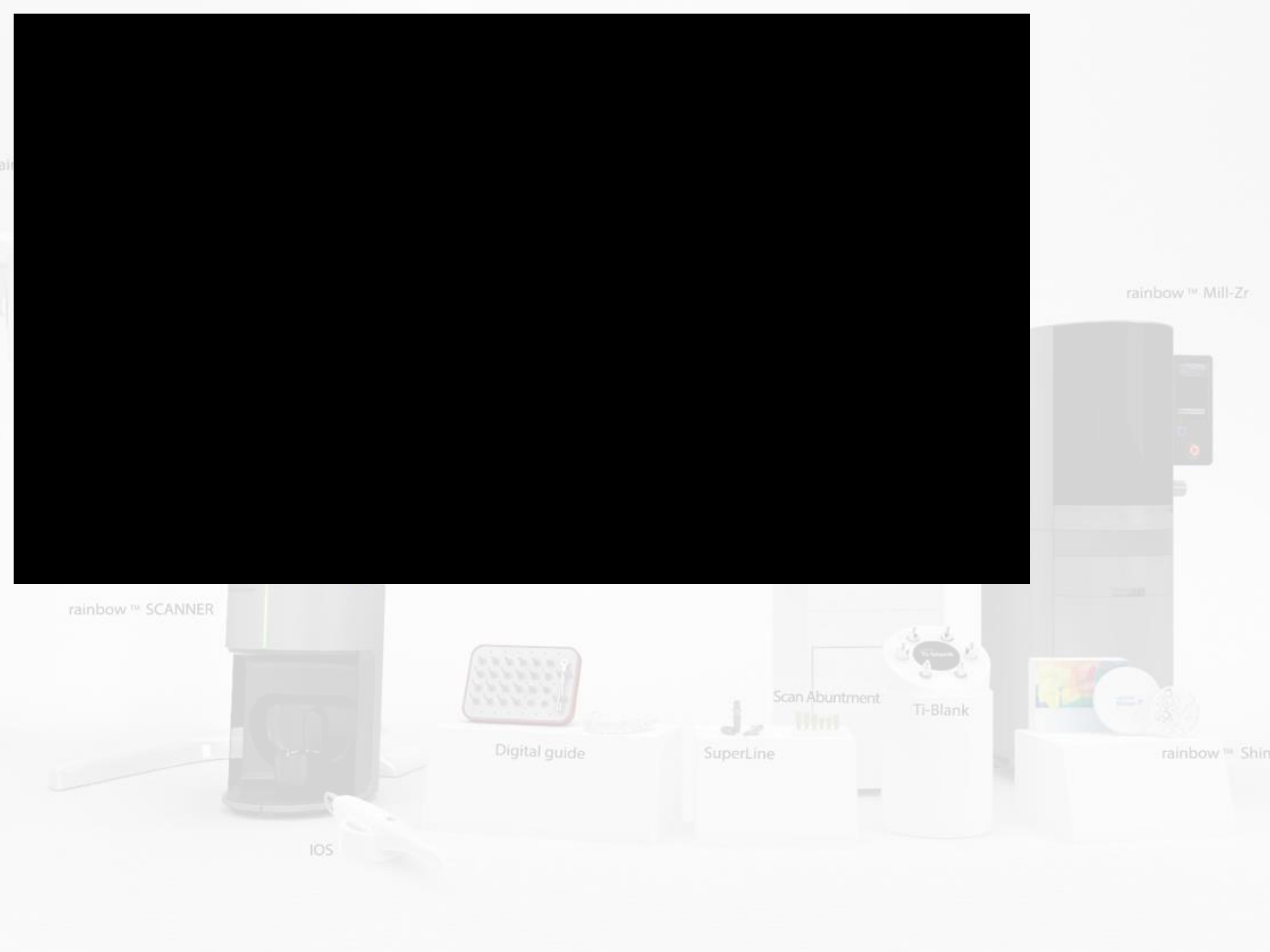
DIGITAL PROSTHATICS

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IOS

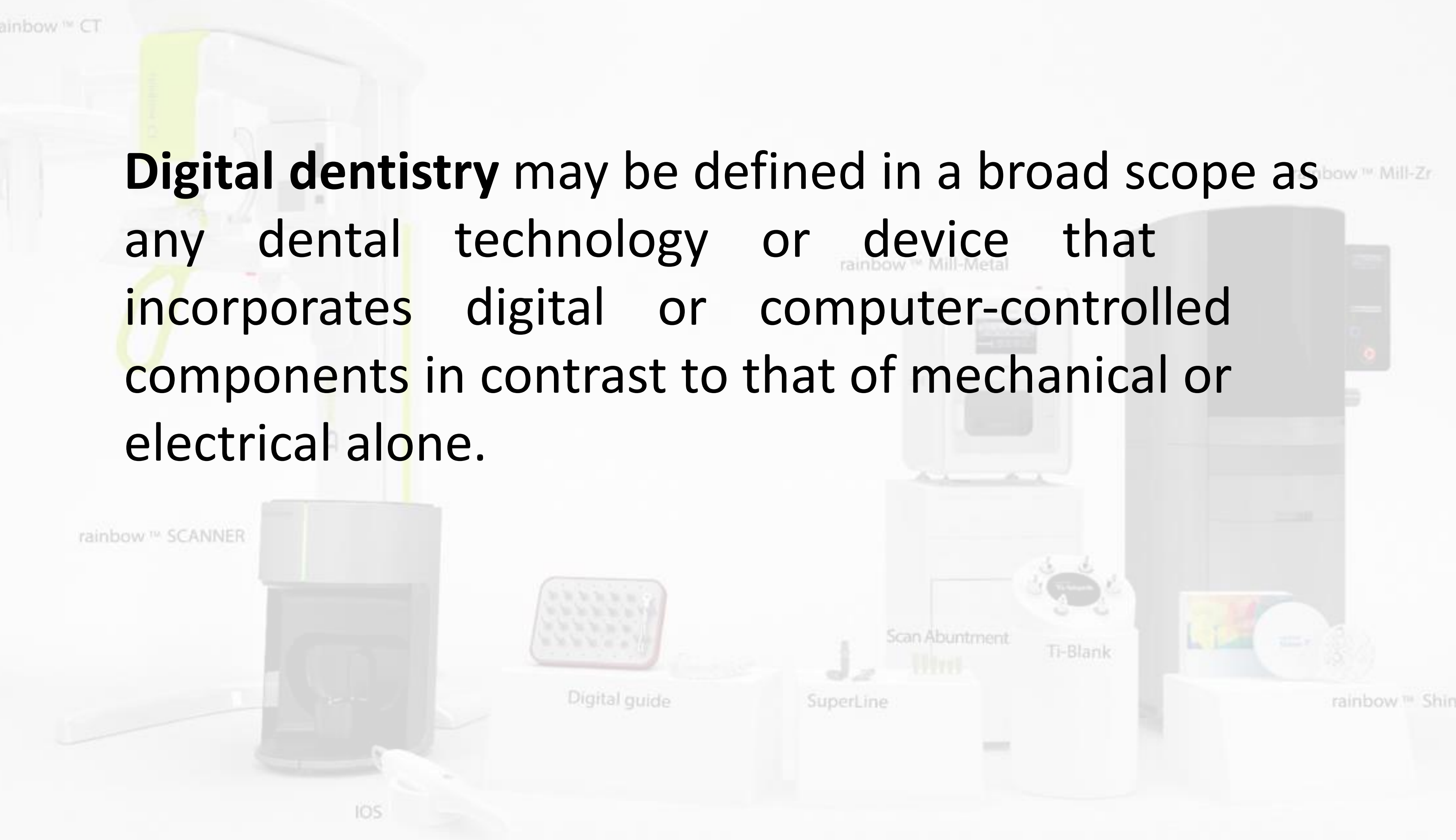
Digital dentistry

DIGITAL PROSTHATICS

- Digital impression
- Digital design

CAD-CAM

Digital dentistry may be defined in a broad scope as any dental technology or device that incorporates digital or computer-controlled components in contrast to that of mechanical or electrical alone.



Benefits of digital dentistry

CAD/CAM & digital impression have led dentists to convey additional information to the patients ,improved communication along with exceptional documentation of existing dental issues & collaborate with the dental laboratories quite easily

How constructive digital dentistry is for patients

The technology involve extensive variety of tools & techniques that incorporate digital or computer aided technology. Some of todays highly used digital dental technologies include:

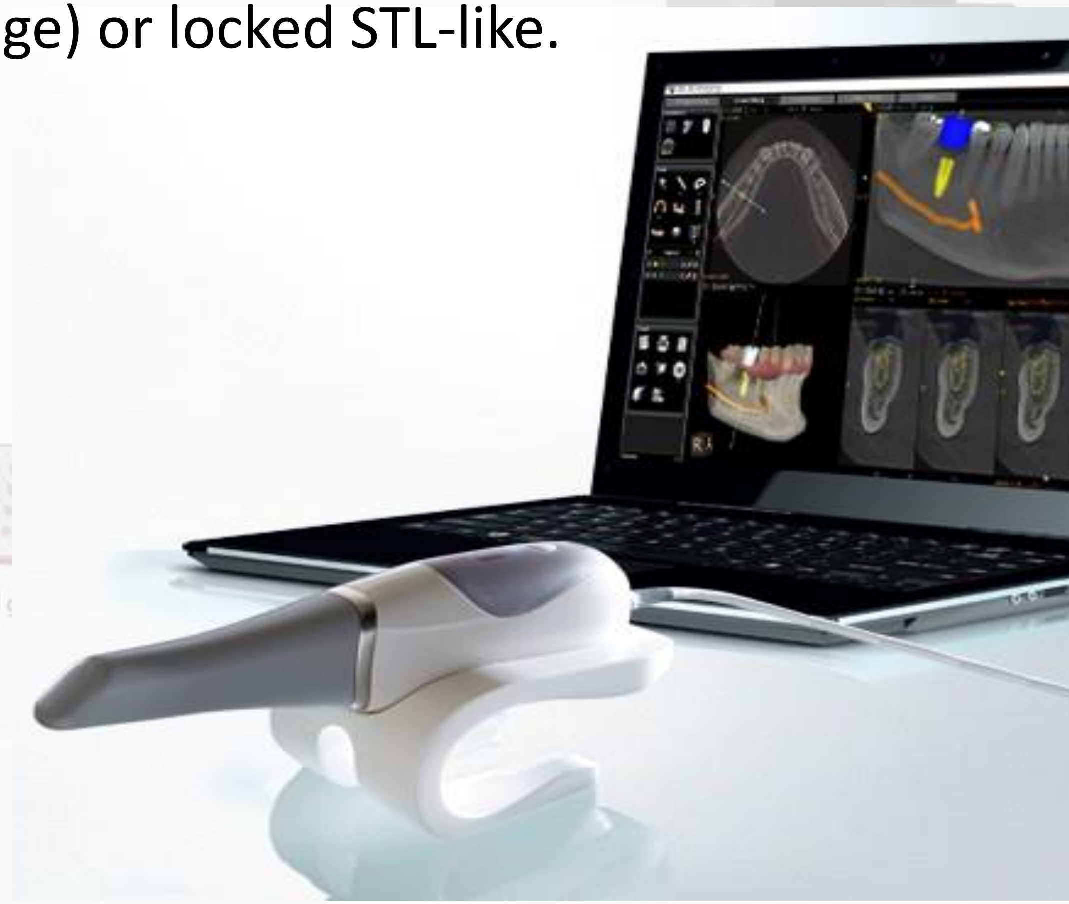
- **Digital radiography (cone beam)**

Changing from analogue to digital radiography has not only made the process simpler and faster but also made image storage, manipulation (brightness/contrast, image cropping, etc.) and retrieval easier.

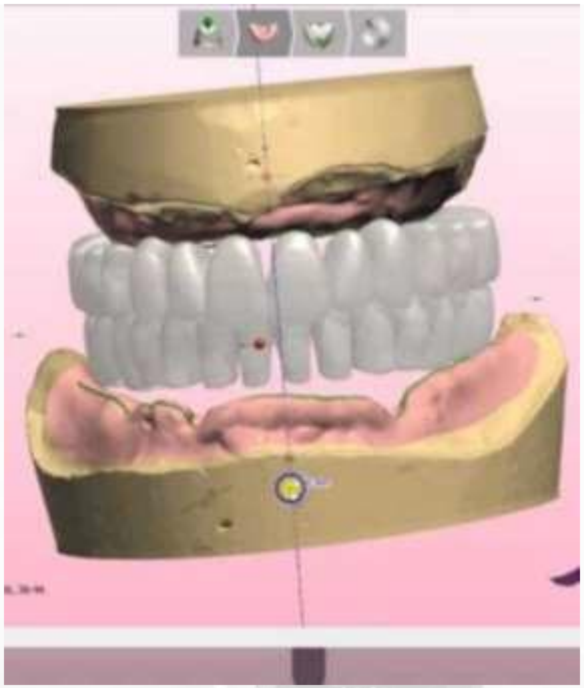
- **<u>Digital impression technology :</u>**

Digital impressions represent cutting-edge technology that allows dentists to create a virtual, computer-generated replica of the hard and soft tissues in the mouth using lasers and other optical scanning devices.

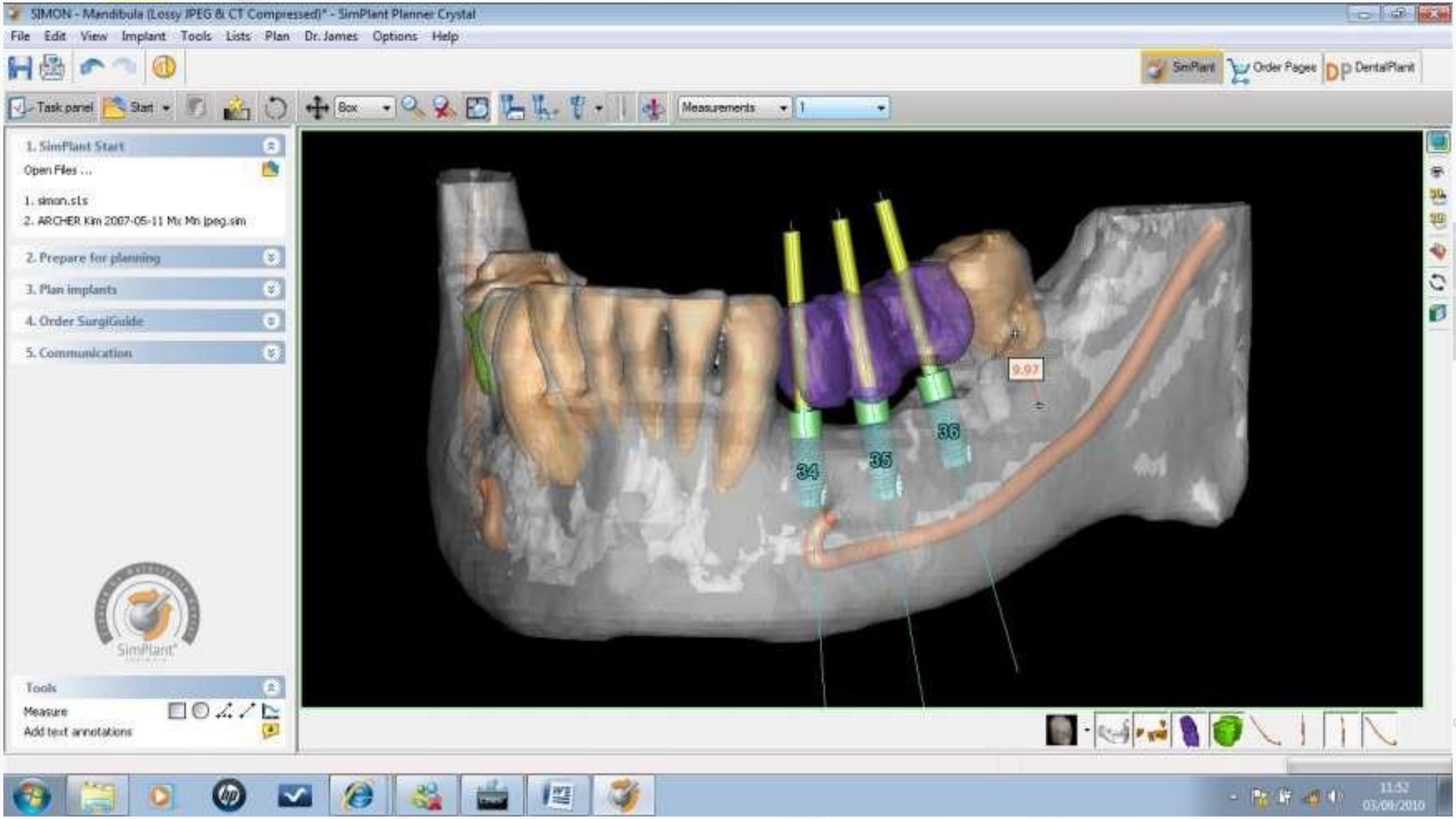
- **intraoral scanner :**
- IOS is a medical device composed of handheld camera (hardware), a computer, and a software. The goal of the IOS is to record with precision the three- dimension geometry of an object. The most widely used digital format is the open STL(standard tessellation language) or locked STL-like.



- **<u>CAD/CAM restorations</u>**: chairside CAD/CAM restorations differ from traditional dentistry in that the dental prosthesis is delivered on the same day avoiding the need of temporaries, providing speedy, convenient, esthetic & conservative restorations.

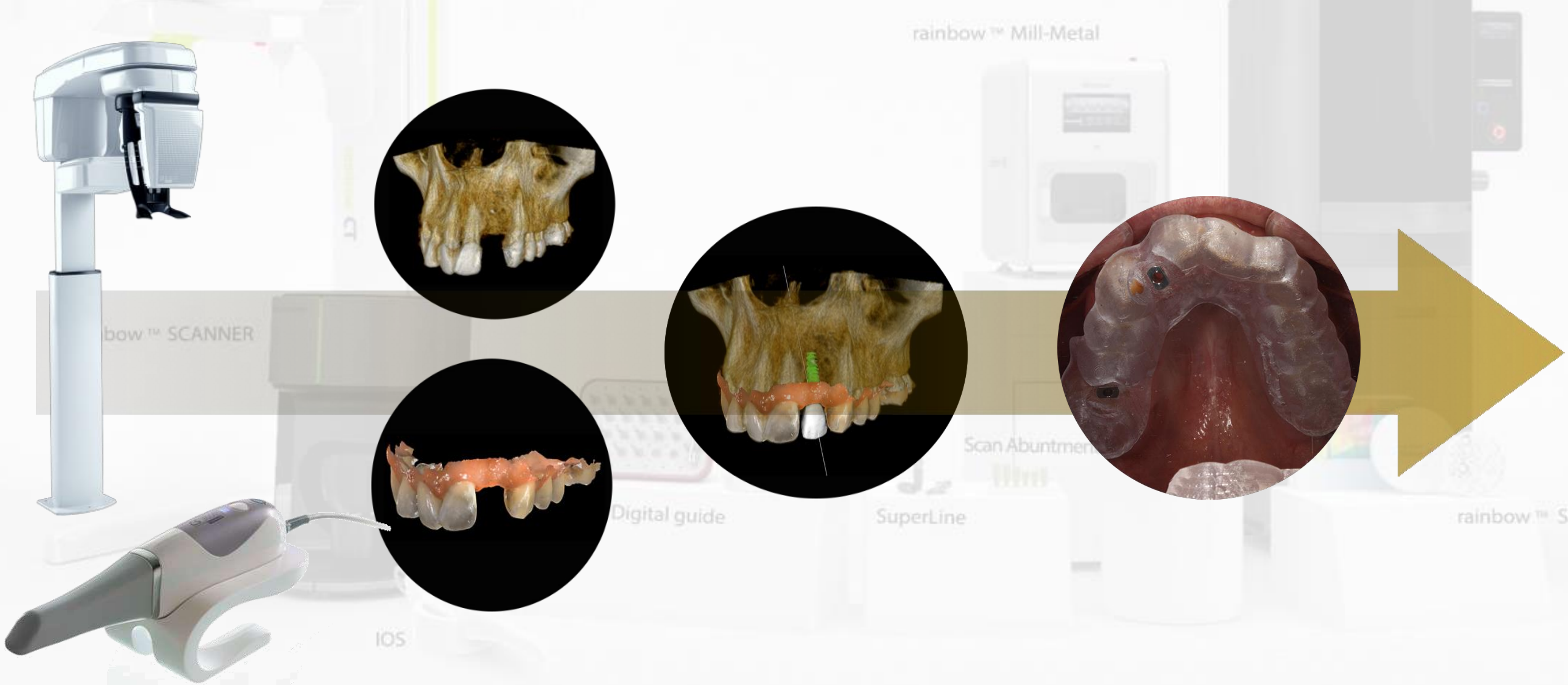


- Digital Treatment Planning

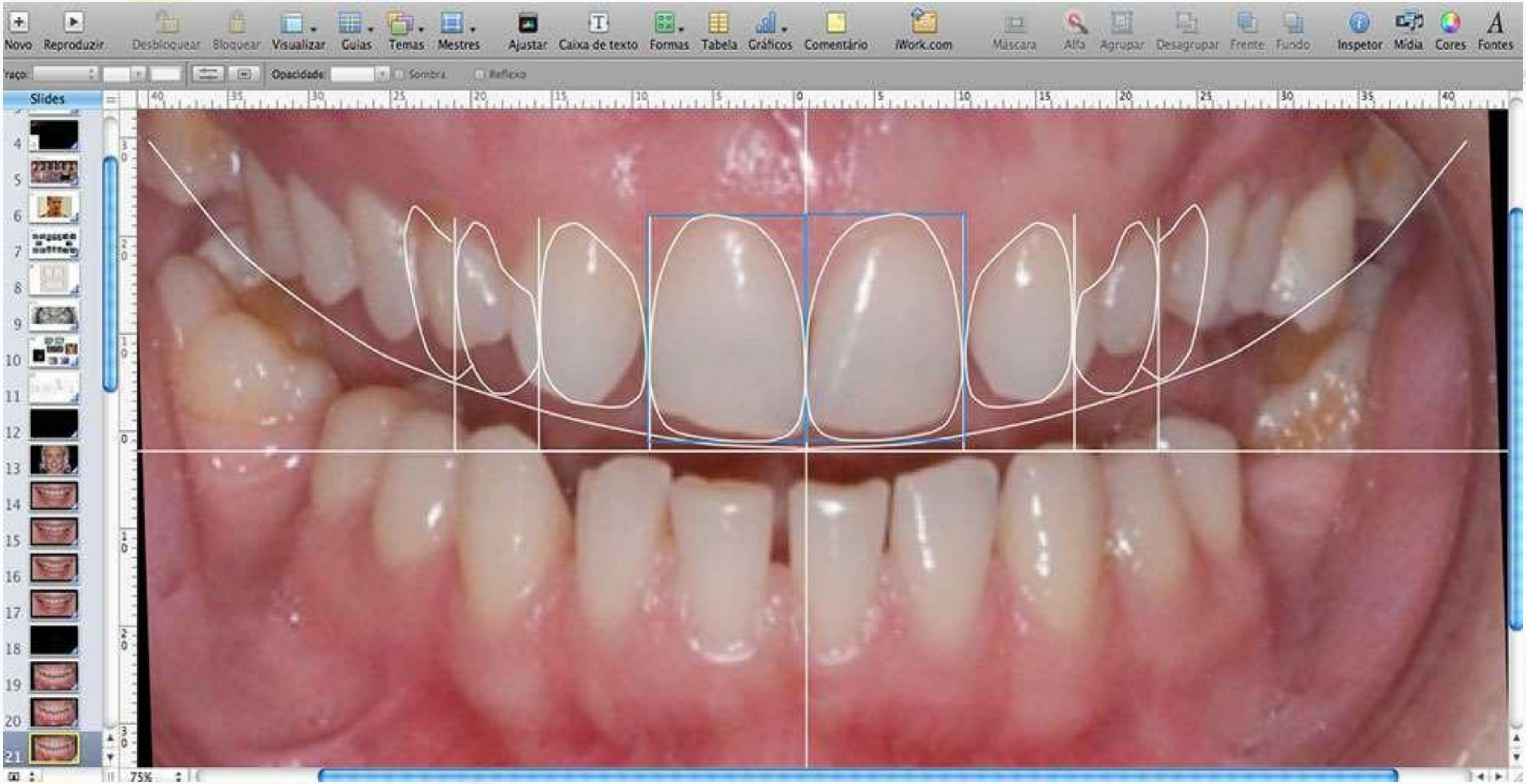


Computer guided implant dentistry:

This technology enable a dentist to precisely evaluate anatomic landmarks, prosthetic treatment planning & accurate surgical extension.



- Digital Smile Design

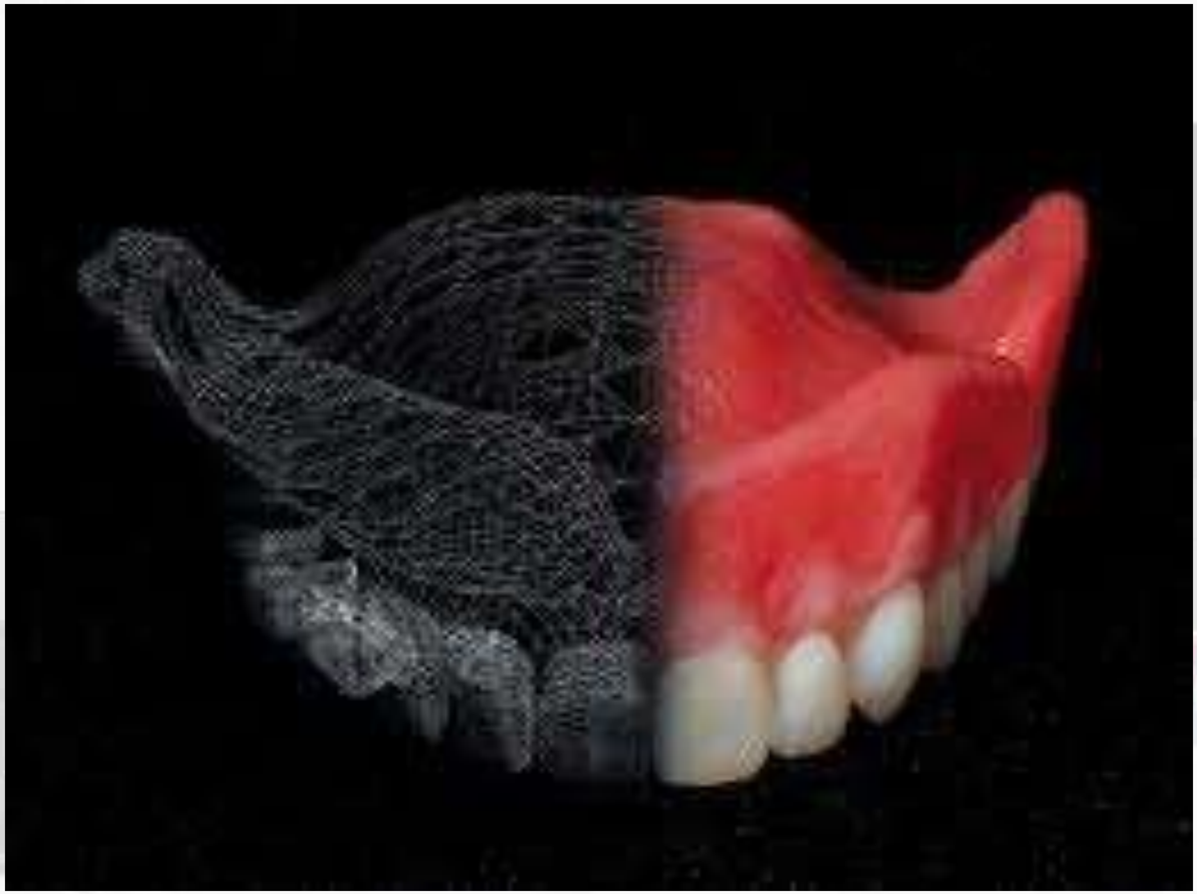


Digital Smile Design

Digital Smile Design

Digital Smile Design

- Digitally Guided Processing

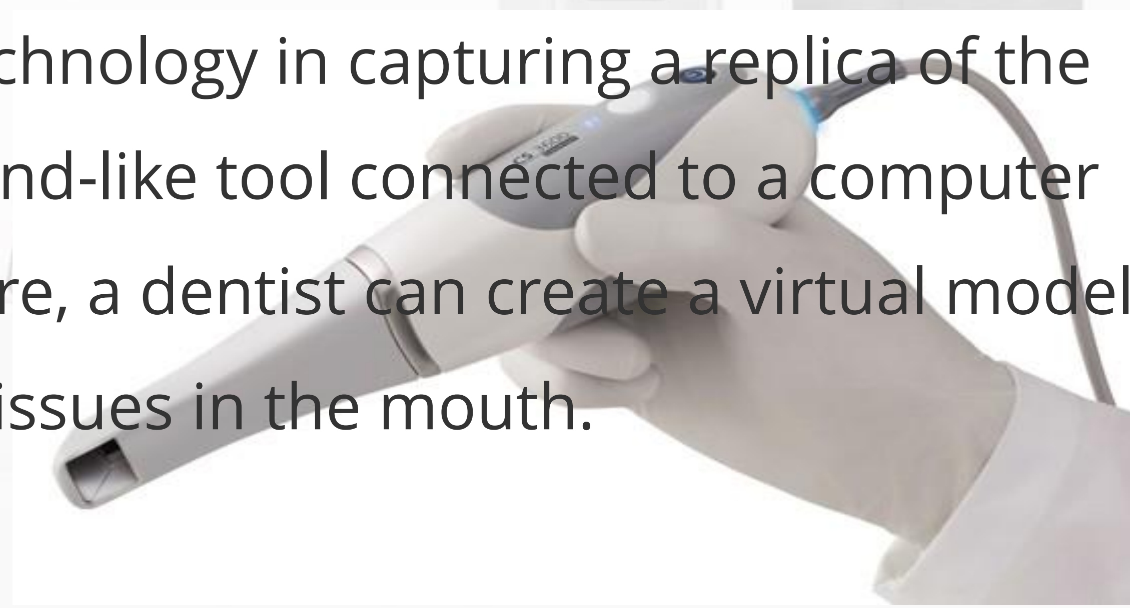


- **<u>Occlusal analysis system:</u>**

helps clinicians to locate or identify premature contacts, maximum forces & interrelationship of occlusal surfaces. This technology helps dentists to balance patients occlusion with accuracy .

"***Impression***" is defined as "a negative likeness or copy in reverse of the surface of an object; an imprint of the teeth and adjacent structures for use in dentistry"-GPT-8

Digital Impressions (also known as 3-D intraoral scanning **IOS**) are the latest technology in capturing a replica of the mouth. By using a wand-like tool connected to a computer and advanced software, a dentist can create a virtual model of the hard and soft tissues in the mouth.



Why digital impressions?

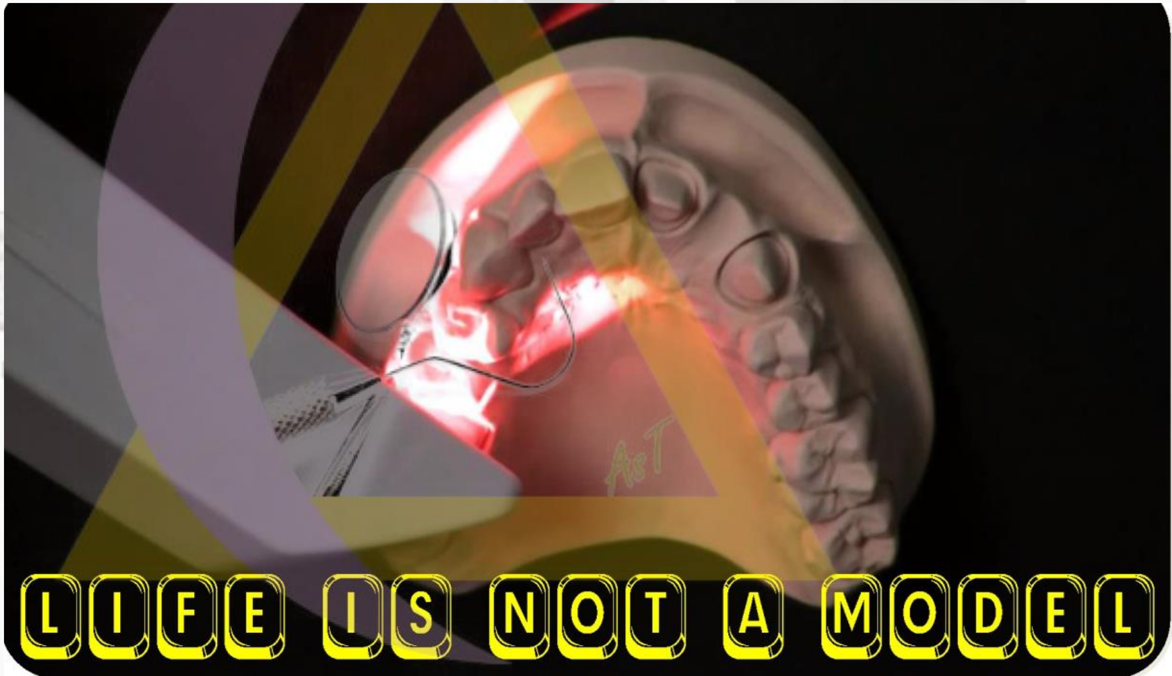
1-Digital impressions are less messy and more pleasant than the goopy traditional mold material.

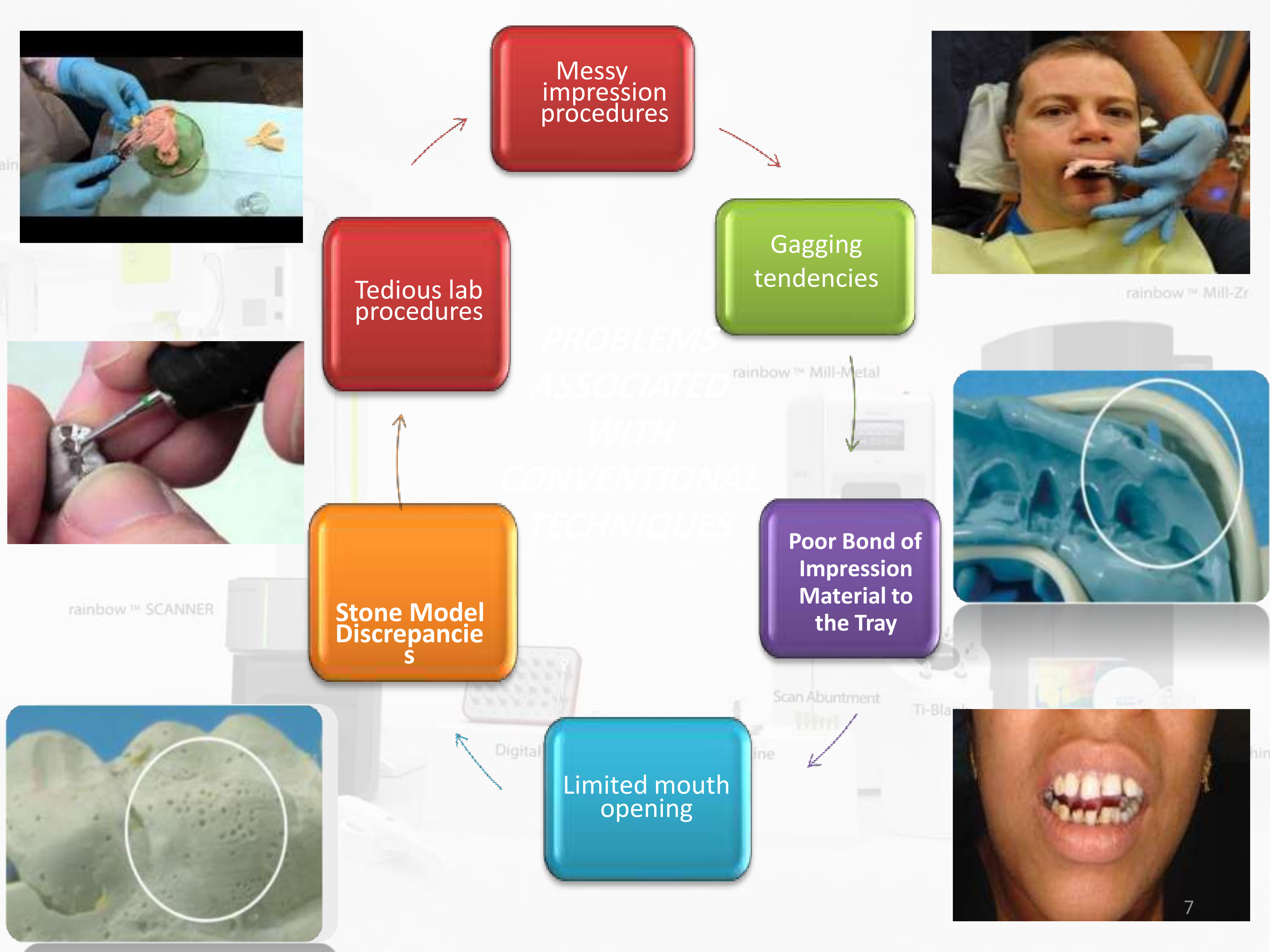
2- Highly comfortable for patients as the ergonomic design allow easy & comfortable placement in the patient's mouth.

3-Patients with a severe gag reflex or sensitive teeth can enjoy a more comfortable experience while a dentist takes the digital impression.

4- the accuracy of the scan.

5-The patient's record can be efficiently stored electronically avoiding confusions




PROBLEMS ASSOCIATED WITH CONVENTIONAL TECHNIQUES
Messy impression procedures
Gagging tendencies
Poor Bond of Impression Material to the Tray
Limited mouth opening
Stone Model Discrepancies
Tedious lab procedures
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Scan Abutment
Digital

What makes digital impressions different from the traditional impressions?

- The conventional or traditional impression making procedure involves use of numerous materials & at times more steps or visits.

- Whereas, digital impressions eliminate much of the physical work, chances of errors & conjecture associated with the traditional impressions.

- With traditional impressions it's quite difficult to evaluate errors.

- Also, the use of digital scans allows a clinician to magnify the impression & evaluate carefully.

- The system also indicates insufficient tooth reduction (if present).


Productivity
Accuracy
Accessibility
Comfort
Communi
cation
Quality
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Indications

Crowns and Bridges

Veneers, inlays and onlays

Temporary crowns and virtual diagnostic wax-ups

Post and core

Removable partial dentures

Abutments, implant bridges and bars

Implant planning and surgical guides

Orthodontics and Splints

SCANNER

- Data collection tools that measure three dimensional jaw and tooth structures and transform them into digital data sets.

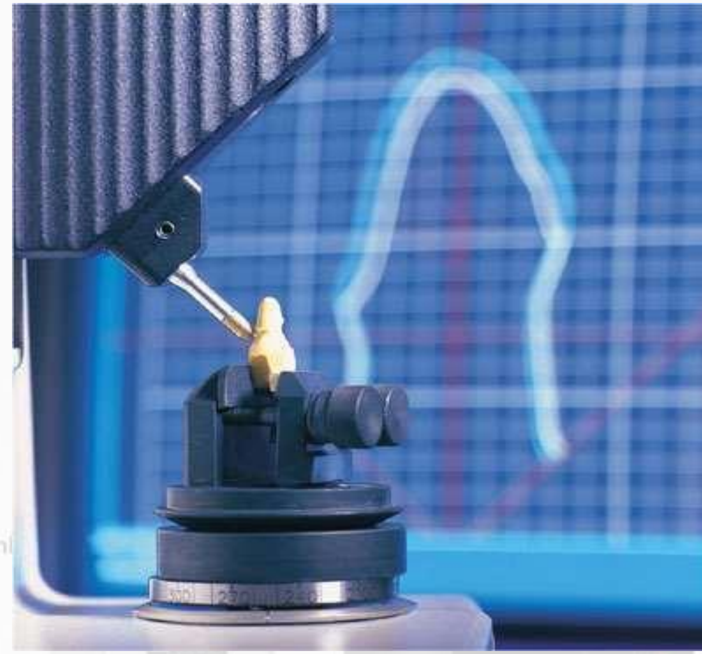
a) Optical scanners

- The basis of this type of scanner is the collection of three-dimensional structures in a so-called ***'triangulation procedure'.***
- The source of light (eg laser) and the receptor unit are in a definite angle in their relationship to one another. Through this angle the computer can calculate a

three-dimensional data set from the image on the receptor unit.

b) Mechanical scanner

The master cast is read mechanically a ruby ball and the three-dimension



- E.g. Procera Scanner from Nobel Bi
- A high scanning accuracy

The diameter of the ruby ball is set to the smallest grinder in the milling system, with the result that all data collected by the system can also be milled

Drawbacks

- Very expensive
- Long processing times compared to optical systems.

Design software

- The data of the construction can be stored in various data formats.
- Standard transformation language (STL) data format- commonly used

What is CAD/CAM?

CAD/CAM (computer-aided design and computer-aided manufacturing) refers to computer software that is used to both design and manufacture products.

This technology first adopted to automotive industry and used to design automobile bodies, but now it is spread to the other areas of the industry and one of the major area is dentistry.

Uses of CAD/CAM in Dentistry

It permits the dental restoration fabrication that includes inlays, onlays, crowns, and bridges.

It has also been used to make prosthetic, orthodontic appliances.

It uses computerized engineering to give an incredibly precise and realistic finish to a product which would be very difficult to manufacture.

Components of CAD/CAM Systems

1. A digitalisation tool/scanner that transforms geometry into digital data that can be processed by the computer

2.Software that processes data and, depending on the application, produces a data set for the product to be fabricated

3. A production technology that transforms the data set into the desired product.

When to Choose CAD/CAM Dentistry?

Every tooth can be treated with a CAD/CAM restoration. Your dentist will determine if a CAD/CAM restoration is among the best treatment options for your condition. Talk to your dentist to see if it is best solution for restoring your smile. With this new technology you can get healthy, happy smile in less time.

The Benefits of CAD/CAM Technology

- If the CAD/CAM equipment is readily available in the dental office, your dentist does not create a molded impression of your teeth.
- With the introduction of this technology helps the technician to mill high strength materials which provides strength aesthetics.
- A temporary restoration or a return visit to the dental office for a permanent restoration is no longer required.

Many production centres also offer laboratories without a scanner the possibility of sending the master cast to the centre for scanning, designing and fabrication.

- An additional simplification in CAD/ CAM production consists of intraoral data collection (optical impression)

Possible directly to the judge quality the of preparation

intraorally, before data are finally sent to the dental laboratory or production centre.

CAD/CAM COMPONENTS

- **Scanner**

a) Optical scanners

b) Mechanical scanner

- **Design software**
- **Processing devices-** 3-axis devices

4 axis devices

5 axis devices.

Processing devices

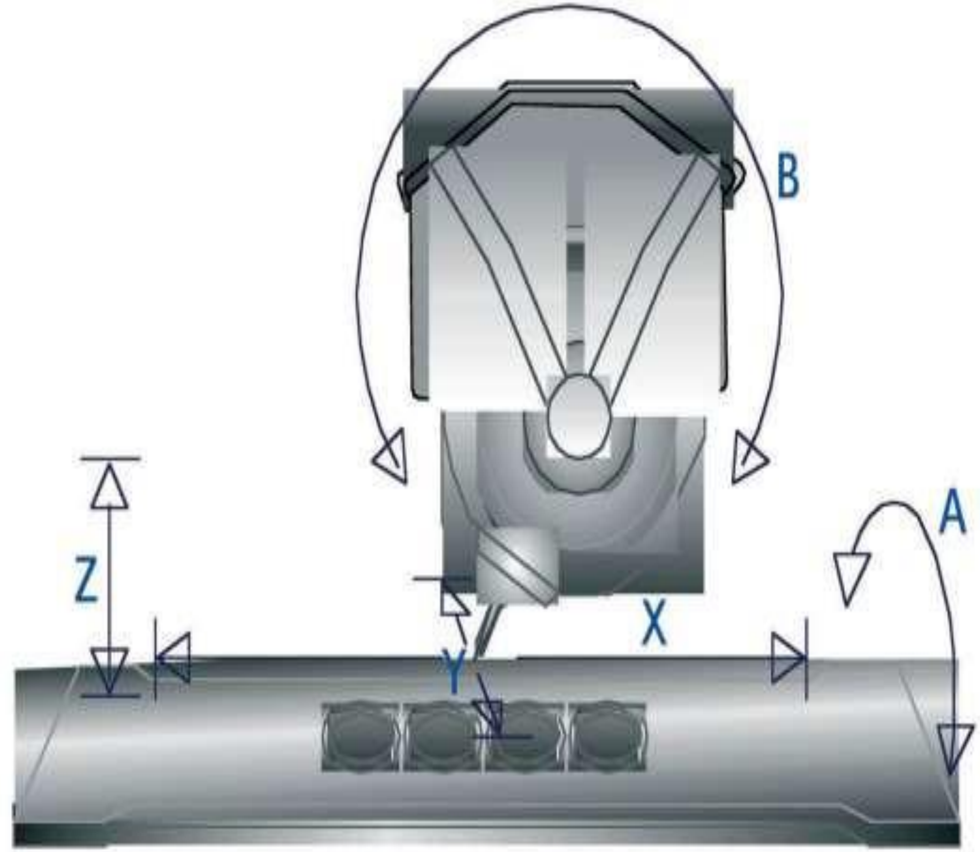
The construction data produced with the CAD software are converted into milling strips for the CAM-processing and finally loaded into the milling device.

Processing devices are distinguished by means of the number of milling axes:

- 3-axis devices
- 4-axis devices
- 5-axis devices.

a) 3-axis milling devices

This type of milling device has degrees of movement in the three spatial directions.



Different possibilities of the working axis: 3 spatial directions X, Y and Z (3 axis milling devices); 3 spatial directions X, Y, Z and tension bridge A

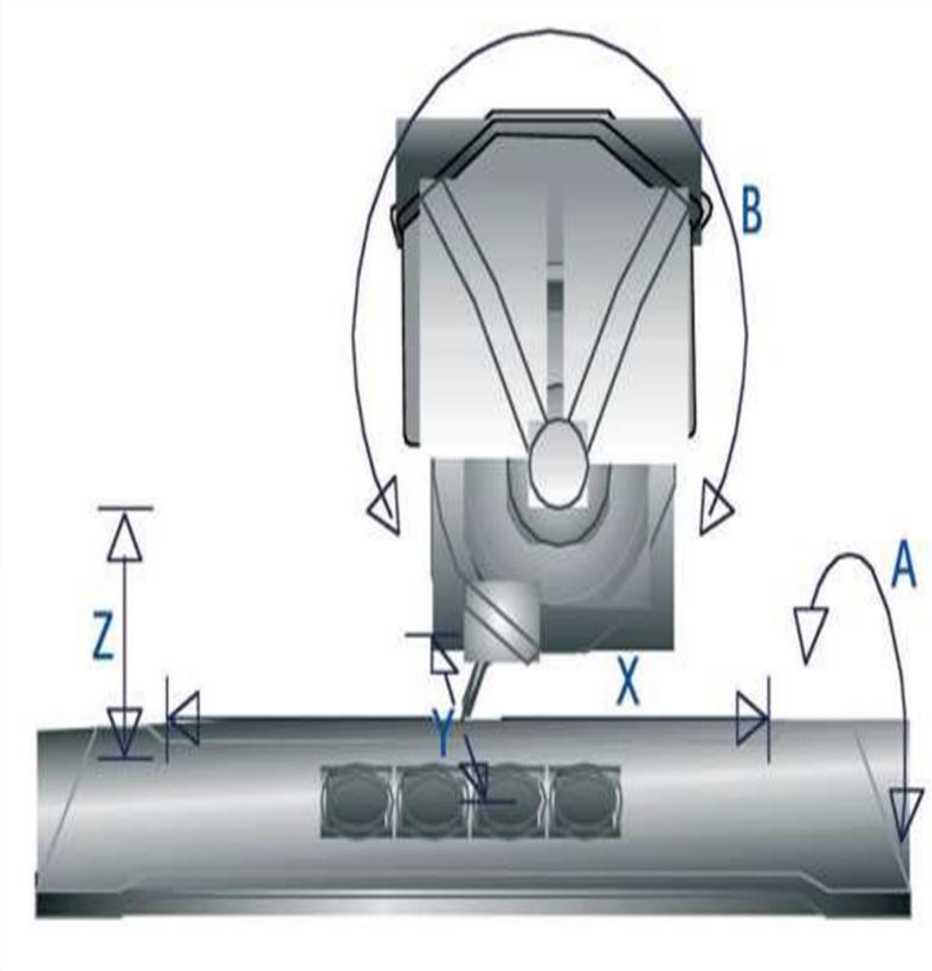
- A milling of subsections, axis divergences and convergences, however, is not possible. This demands a virtual blocking in such areas.
- All 3-axis devices used in the dental area can also turn the component by 180° in the course of processing the inside and the outside

ADVANTAGES

- short milling times
- simplified control
- less costly than those with a higher number of axes.
- Examples of 3-axis devices: inLab (Sirona), Lava (3M ESPE), Cercon brain (DeguDent).

b) 4-axis milling devices

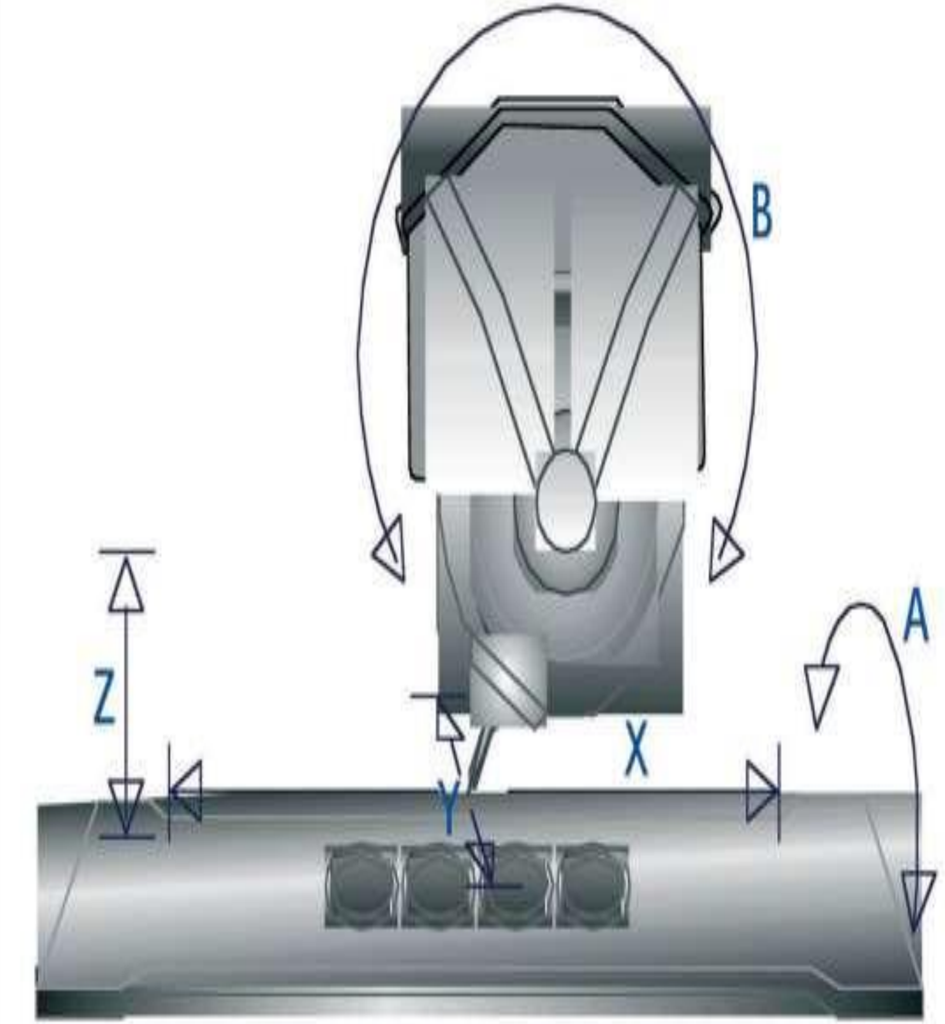
In addition to the three spatial axes, the tension bridge for the component can also be turned infinitely variably As a result it is possible to adjust bridge constructions with a large vertical height displacement into the usual mould dimensions and thus save material and milling time. Example: Zeno (Wieland-Imes).



4 axis milling devices); 3 spatial directions X, Y, Z, tension bridge A

c) 5-axis milling devices

Rotating the milling spindle (5th axis) enables the milling of complex geometries with subsections, e.g, lower jaw FPDs on converging abutment teeth (end molar tipped towards the medial plane) , or also crown and FPD substructures that, as a result of anatomically reduced formation, demonstrate converging areas



(5 axis milling devices) 3 spatial directions X, Y, Z, tension bridge A and milling spindle B

master cast of converging abutment teeth for a fixed restoration in the mandible. At least a 4 milling axis is required for the milling unit to fabricate a substructure for this situation

MILLING VARIANTS

- **Dry processing**

  Zirconium oxide blanks with a low degree of pre-sintering.

  Advantages

  Minimal investment costs milling device

  No moisture absorption by the die ZrO_2 mould, as a result of which there are no initial drying times for the ZrO_2 frame prior to sintering.

  Disadvantages:

The lower degree of pre-sintering results in higher shrinkage values for the frameworks.

e.g, Zeno 4030 (Wieland- Imes), Lava Form and Cercon brain

- **Wet milling**

  Milling diamond or carbide cutter is protected by a spray of cool liquid against overheating of the milled material.

  Metals and glass ceramic material in order to avoid damage through heat development.

  Zirconium oxide ceramic with a higher degree of pre-sintering is employed for the milling process. A higher degree of pre-sintering results in a reduction of shrinkage factor and enables less sinter distortion.

  Everest (KaVo), Zeno 8060 (Wieland- Imes), in Lab (Sirona).

MATERIALS FOR CAD/CAM PROCESSING

- **Metals**
- **Resin materials**
- **Silica based ceramics**
- **Infiltration ceramics**
- **Oxide high performance ceramics**
  - *Aluminum Oxide (Al2O3)*
  - *Yttrium stabilized zirconium oxide*

Metals

- Titanium, titanium alloys and chrome cobalt alloys are processed using dental milling devices

Resin materials

- Used for the milling of lost wax frames for casting technology
- Used directly as crown and FPD frameworks for long- term provisional or for full anatomical long term temporary prostheses

Silica based ceramics

- For the production of inlays, onlays, veneers, partial crowns and full crowns .
- In addition to monochromatic blocks, various manufacturers now offer blanks with multicoloured layers [Vitablocs TriLuxe (Vita), IPS Empress CAD Multi (IvoclarVivadent)], for the purpose of full anatomical crowns.

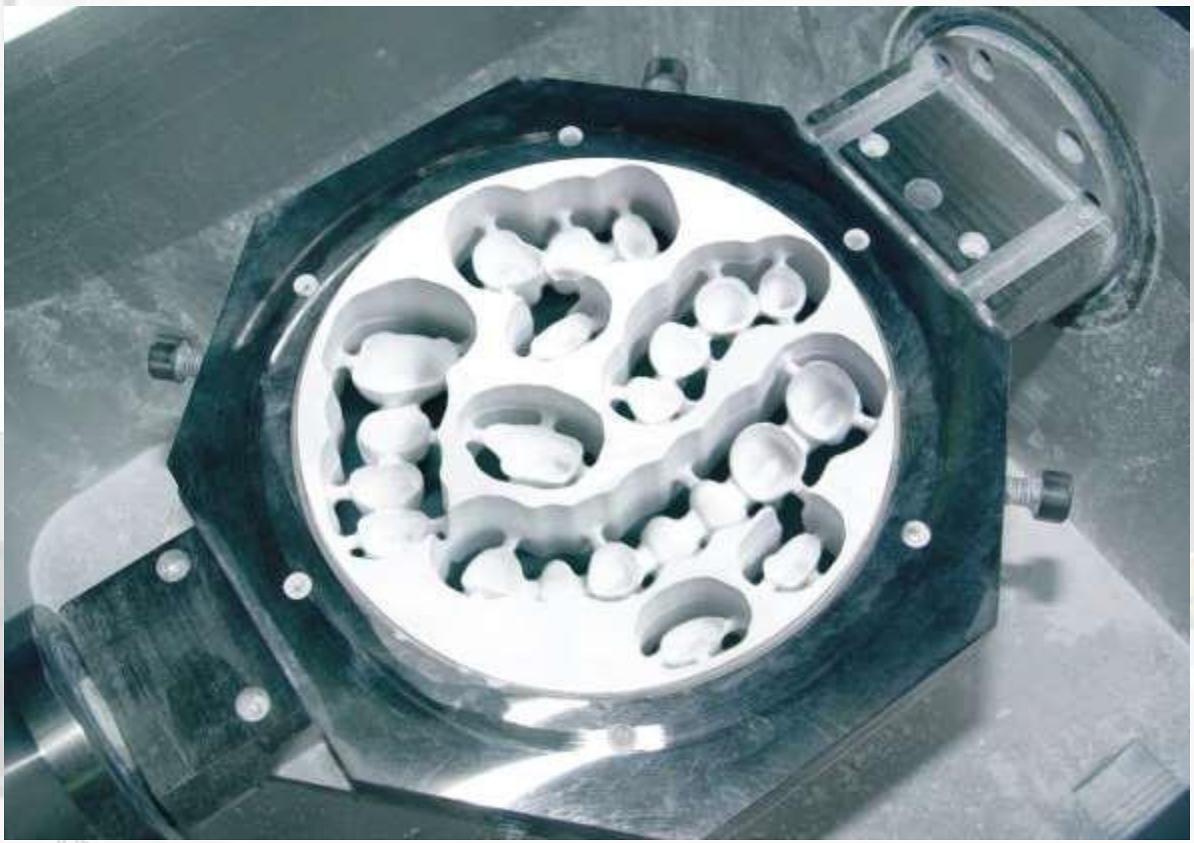
Infiltration ceramics

- Grindable blocks of infiltration ceramics are processed in porous, chalky condition and then infiltrated with lanthanum glass.
- Vita In-Ceram Alumina (Al_2O_3): Crown copings in the anterior and posterior region, three-unit FPD frameworks in the anterior region
- Vita In-Ceram Zirconia (70% Al_2O_3, 30% ZrO_2):Crown copings in the anterior and posterior region, three-unit FPD frameworks in the anterior and posterior region. Has superior masking ability and is suitable for discoloured abutment teeth
- VITA In-Ceram Spinell ($MgAl_2O_4$): Highest translucency of all oxide ceramics and is thus recommended for the production of highly aesthetic anterior crown copings, in particular on vital abutment teeth and in the case of young patients

SIGNIFICANCE FOR THE DENTIST

- The stability values of zirconium oxide ceramics permit the use of this material as an alternative to metal frames for permanent prosthesis
- Production of long-term temporary prosthesis has, as a result of the use of a virtual wax up on the computer, become faster, more convenient and more predictable
- The production of the definitive prosthesis should also be carried out by CAD/CAM technology and represents merely a copying process of the temporary prosthesis into the definitive prosthesis by a different material.

Enlarged zirconium oxide after the milling process before sintering to the desired dimension



IMPORTANT STEPS TO BE CONSIDERED BY THE DENTIST

- Include appropriate tooth preparations with the creation of a continuous preparation margin, which is clearly recognisable to the scanner, for example in the form of a chamfer preparation.
- Shoulderless preparations and parallel walls should be avoided.
- A tapered angle of between 4° to 10° is recommended.
- Subsections and irregularities on the surface of the prepared tooth as well as the 'creation of troughs' with a reverse bevel preparation margin can be inadequately recognized by many scanners

EVALUATION – ADVANTAGES AND DISADVANTAGES OF COMPUTER-ASSISTED PRODUCTION

- ADVANTAGES
- ✓ The quality of dental prosthesis has improved significantly by means of standardized production processes.
- ✓ Increased productivity
- ✓ Possible to machine interesting new materials like the high performance ceramics and titanium with high accuracy.

Now the CAD/CAM technology is core part of dentistry. All ceramic restorations including those fabricated using CAD/CAM technology tend to be expensive restoration solution but, research suggests that today's milled CAD/CAM restorations are more stronger and tougher than those milled from earlier materials and are less likely to fracture. Hence day by day it is gaining more popularity.

- CAD/CAM technology has already changed dentistry and will replace more and more of the traditional techniques in fabricating dental restorations.

Intresting facts about Zirconia

Zirconium is the source of the closest mimic of diamond - Cubic Zirconia (CZ). It is popularly fashioned as a diamond simulant .

Visually discerning a good quality cubic zirconia gem from a diamond is difficult, and most jewellers will have a thermal conductivity tester to identify cubic zirconia by its low thermal conductivity (diamond is a very good thermal conductor).

FUTURE TECHNOLOGIES

- **Generative production methods**

- This method in contrast to grinding technology, do not work by subtracting, but rather by **Adding material.**
- ‘Laser sintering devices’ are used to produce crown and bridge frames from chrome cobalt alloys.
- Since the productivity of such devices is very high, dental restorations can be produced very cost-effectively.
- Geometries are conceivable with this technology that cannot be realized with grinding technology.

What Generative Design Is and Why It's the Future of Manufacturing

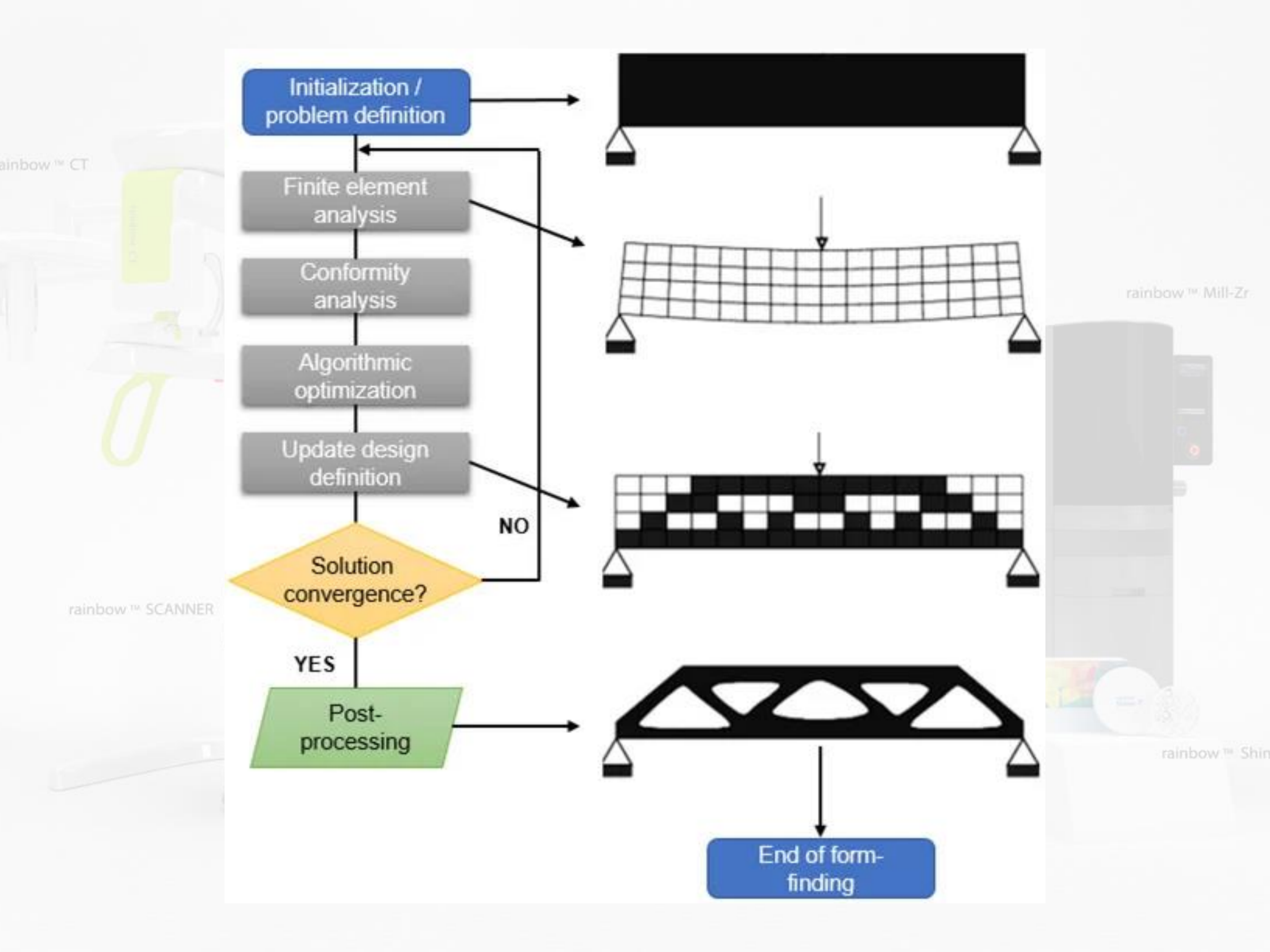
- Generative design replicates natural world's evolutionary approach with cloud computing to provide thousands of solutions to one engineering problem.
- The way everyday items - from chairs to cars to power tools - are made is being reimagined through a new process called generative design.
- Using artificial intelligence (AI) software and the compute power of the cloud, generative design enables engineers to create thousands of design options by simply defining their design problem - inputting basic parameters such as height, weight it must support, strength, and material options.

The Difference Between Topology Optimization and Generative Design

Generative design and topology optimization have become buzzwords in the CAD design space,

Topology optimization isn’t new. It has been around for at least 20 years , its process requires a human engineer to create a CAD model, applying loads and constraints with project parameters in mind. The software then generates a single optimized mesh-model concept ready for an engineer’s evaluation. In other words, topology optimization requires a human-designed model from the outset to function, limiting the process, its outcomes, and its scale.

In a way, topology optimization serves as the foundation for generative design. Generative design takes the process a step further and eliminates the need for the initial human-designed model, taking on the role of the designer based on the predefined set of constraints.


Initialization / problem definition
Finite element analysis
Conformity analysis
Algorithmic optimization
Update design definition
NO
Solution convergence?
YES
Post-processing
End of form-finding
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Applications of Generative Design

- Generative design applications exist across many industries—from aerospace and architecture to manufacturing and consumer goods. Engineers who use generative design are often trying to solve complex engineering challenges. Such challenges include reducing component weights and manufacturing costs, scaling component customization, and optimizing performance.

Benefits of Generative Design

- **Simultaneous exploration**
- **Accelerated design timeline**
- **Leverage advanced manufacturing processes**

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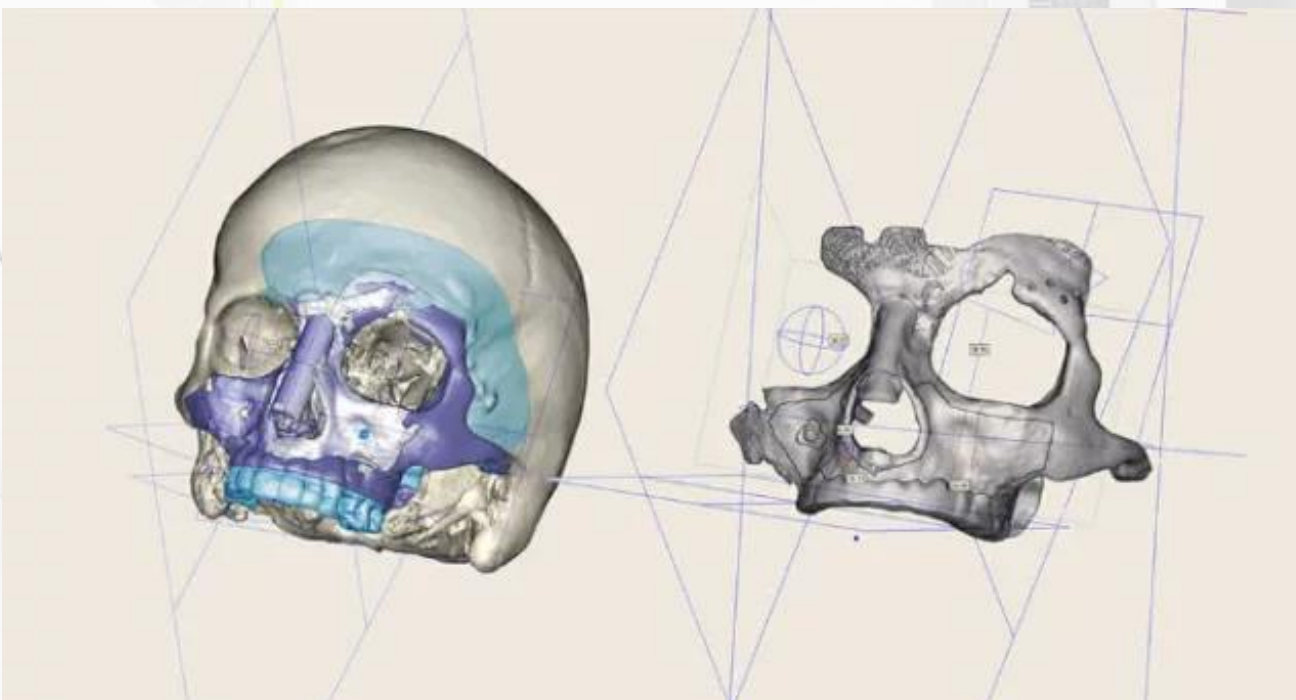

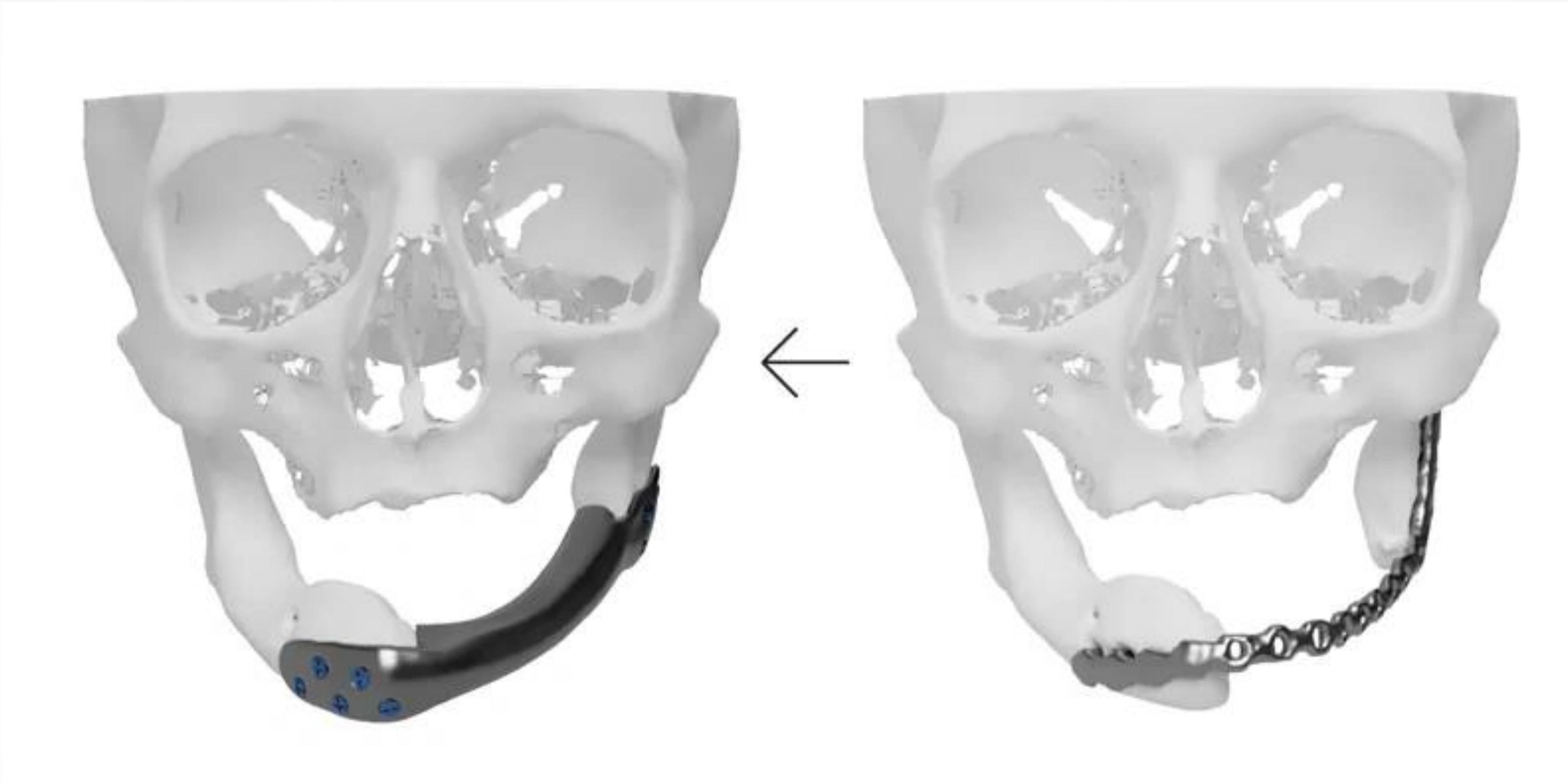

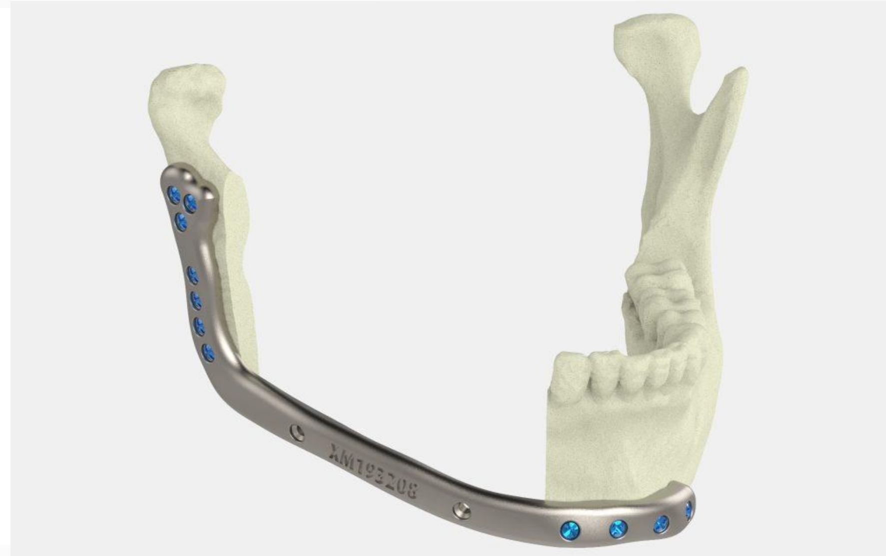

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Thank you