International Team for Implantology

Using intra oral scanning and CAD-CAM technology to create accurate and esthetic restorations

ITI Canadian Section Meeting, Montreal

May 7, 2011

Electron Microscopy @Univ. of Oslo

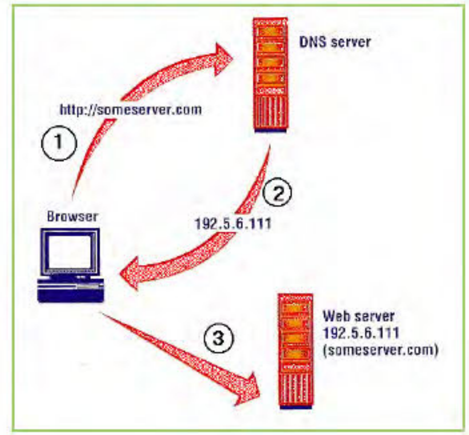
Faculty of Dentistry:	1974-79 UnderGrad.	79-82 Mil.	82 - 84 Clin	84- Research Assistant Department of Anatomy

1984: Scanning & Transmission E.M. as a research field

Jeol 1200 EXII (TEM)

Computers (ND-100) from Norsk Data were used by:
- CERN
- International F-16 pilot training simulator program
- French aerospace agency
- SEM/TEM Etc…

Transmission Control Protocol (TCP) + Internet Protocol (IP) merged to TCP/IP. New protocol was permanently activated January 1, 1983
(→ WWW (Mosaic 1993)



Philips SEM 515

Object-oriented programming; "OOP" e.g. SIMULA / COBOL

8"→5.25"→3.5" floppy disks

Nordic Institute of Dental Materials

Professor
Ivar A Mjor

Jan 1986: Crash of their mainframe computer containing all data accumulated in their clinical studies program over 10 years. Under file reconstruction it was discovered that all the data files were corrupted!

A computer geek dentist was required!!!

← DEC Vax 1986

Nordic Institute of Dental Materials

Professor
Ivar A Mjor

1986: Joined the clinical studies program research team

Cavity designs for class II amalgam restorations

A literature review and a suggested system for evaluation

Asbjörn Jokstad and Ivar A. Mjör
Department of Anatomy, School of Dentistry, University of Oslo, and
NIOM, Scandinavian Institute of Dental Materials, Oslo, Norway

Jokstad A, Mjör IA. Cavity designs for class II amalgam restorations. A literature review and a suggested system for evaluation. Acta Odontol Scand 1987;45:257–273. Oslo. ISSN 0001–6357.

A classification system for variations in cavity design and finish has been developed for application on models of teeth with class II cavities for amalgam restorations. The system was based on a review of the literature, on principles for clinical studies, and on examination of models of 623 teeth in which routine class II cavity preparations had been made. Preliminary data on the agreement of rating of evaluators indicated that the classification system can be used with good consistency for assessment of variations in cavity preparations. Longitudinal clinical studies on the performance of restorations will be decisive for the validity of the selected criteria and for a relevant differentiation between acceptable and unacceptable preparation features. □ *Conservative dentistry; failure of restorations; longevity of restorations; operative dentistry*

Asbjörn Jokstad, Department of Anatomy, Dental Faculty, P.O. Box 1052 Blindern, University of Oslo, N-0316 Oslo 3, Norway

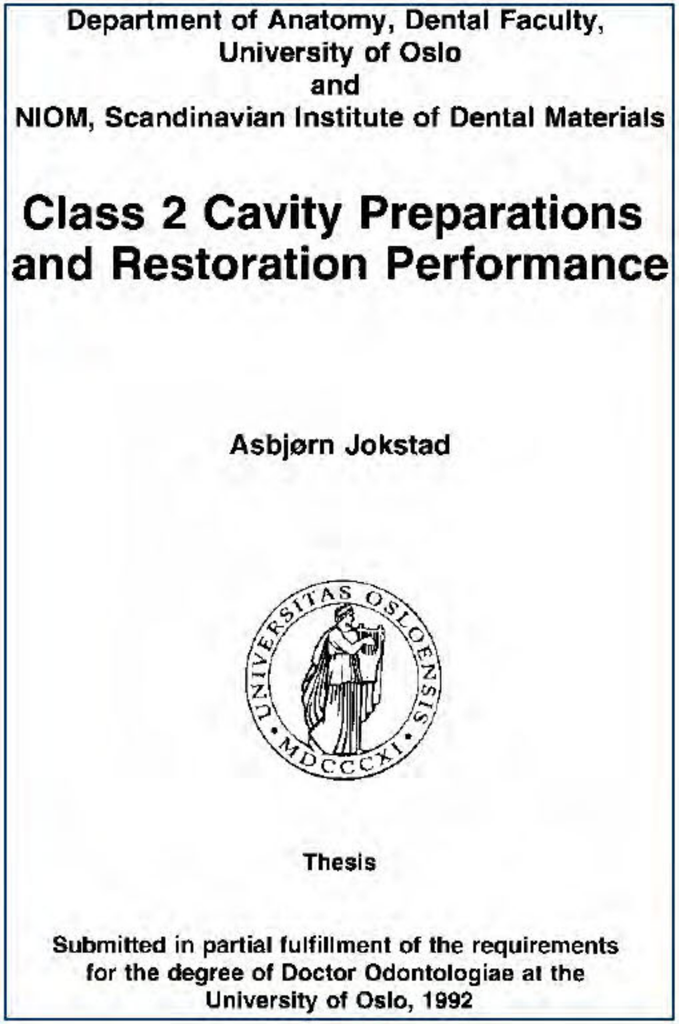
18 *A. Jokstad & I. A. Mjör* ACTA ODONTOL SCAND 4? (19??)

Figs. 1–6. SEM micrographs of a class-II cavity preparation made in 1979. Figs. 1, 3, and 5 are 10-year-old negative replicas made of a condensation silicone elastomer, while Figs. 2, 5, and 6 are 10-year-old positive replicas made of epoxy. Magnification: Figs. 1 and 2, ×10; Figs. 3 and 4, distobuccal fissure on Fig. 1, ×75; Figs. 5 and 6, mesiobuccal fissure on Fig. 1, ×200. The light gray zones on the surface on the epoxy replicas are presumably caused by a chemical interaction between the impression material and the epoxy material at the time of casting.

CEREC ~1985

SEM Pictures

3D measurements of cavities



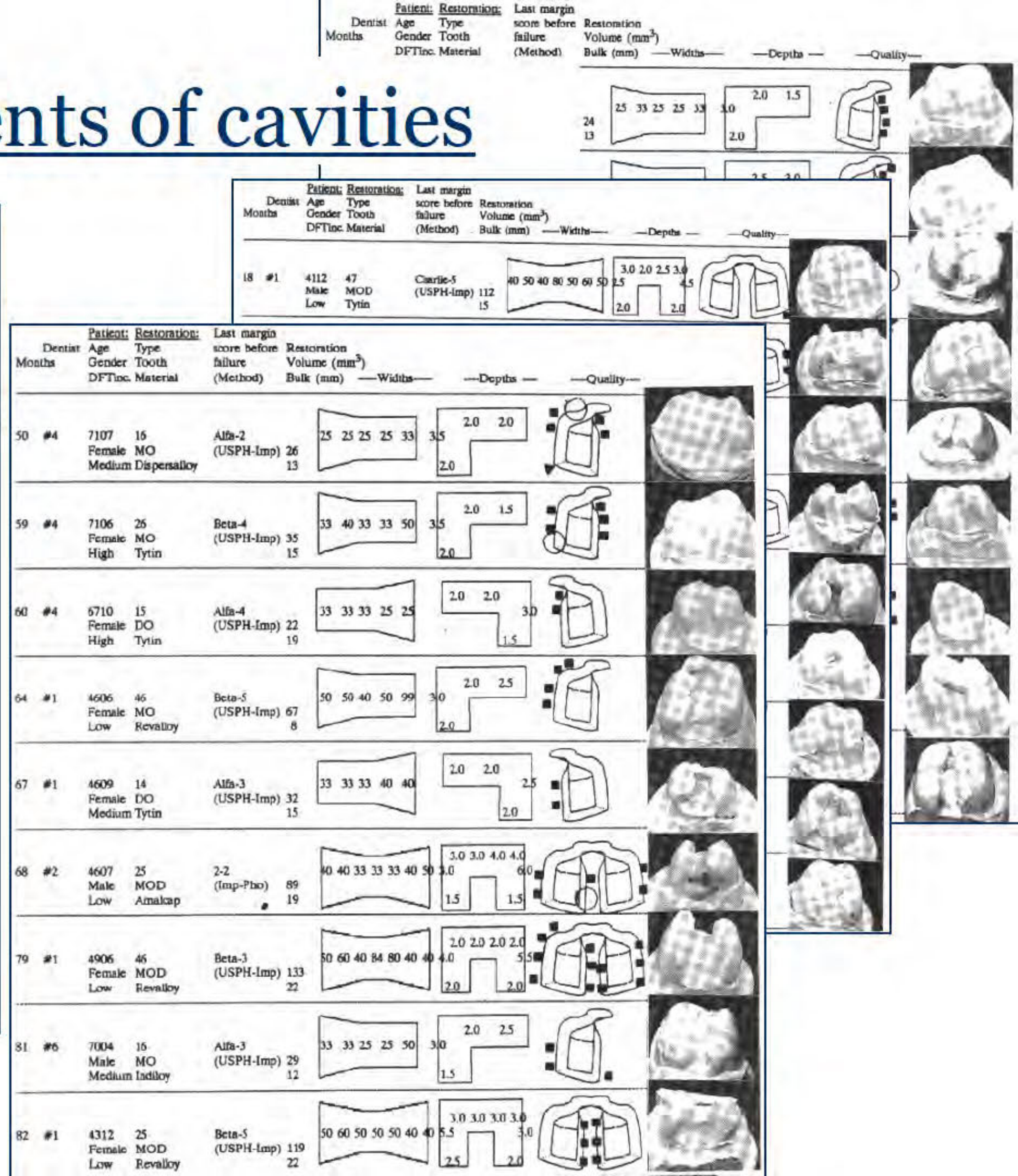
Department of Anatomy, Dental Faculty, University of Oslo and NIOM, Scandinavian Institute of Dental Materials

Class 2 Cavity Preparations and Restoration Performance

Asbjørn Jokstad

Thesis

Submitted in partial fulfillment of the requirements for the degree of Doctor Odontologiae at the University of Oslo, 1992



Months	Dentist	Patient: Age / Gender / DFTinc.	Restoration: Type / Tooth / Material	Last margin score before failure (Method)	Restoration Volume (mm³) / Bulk (mm)	Widths	Depths
50	#4	7107 / Female / Medium	16 / MO / Dispersalloy	Alfa-2 (USPH-Imp)	26 / 13	25 25 25 25 33	2.0 2.0 3.5 2.0
59	#4	7106 / Female / High	26 / MO / Tytin	Beta-4 (USPH-Imp)	35 / 15	33 40 33 33 50	2.0 1.5 3.5 2.0
60	#4	6710 / Female / High	15 / DO / Tytin	Alfa-4 (USPH-Imp)	22 / 19	33 33 33 25 25	2.0 2.0 3.0 1.5
64	#1	4606 / Female / Low	46 / MO / Revalloy	Beta-5 (USPH-Imp)	67 / 8	50 50 40 50 99	2.0 2.5 3.0 2.0
67	#1	4609 / Female / Medium	14 / DO / Tytin	Alfa-3 (USPH-Imp)	32 / 15	33 33 33 40 40	2.0 2.0 2.5 2.0
68	#2	4607 / Male / Low	25 / MOD / Amalcap	2-2 (Imp-Pho)	89 / 19	40 40 33 33 33 40 50	3.0 3.0 4.0 4.0 3.0 6.0 1.5 1.5
79	#1	4906 / Female / Low	46 / MOD / Revalloy	Beta-3 (USPH-Imp)	133 / 22	50 60 40 84 80 40 40	2.0 2.0 2.0 2.0 4.0 5.5 2.0 2.0
81	#6	7004 / Male / Medium	16 / MO / Indiloy	Alfa-3 (USPH-Imp)	29 / 12	33 33 25 25 50	2.0 2.5 3.0 1.5
82	#1	4312 / Female / Low	25 / MOD / Revalloy	Beta-5 (USPH-Imp)	119 / 22	50 60 50 50 50 40 40	3.0 3.0 3.0 3.0 5.5 3.0 2.5 2.0

1995: Opto-electronic Jaw Motion Capture System + EMG (Biopac)

ITI

QUALISYS
Motion Capture Systems

$ 75.000 invested by the Prosthodontic department

Complexity was too high! A computer geek dentist needs to be found!!!

1995: Opto-electronic Jaw Motion Capture System + EMG (Biopac)

ITI

QUALISYS
Motion Capture Systems

Infrared light 40MHz

Reflectors

Triangulation

Calibration frame

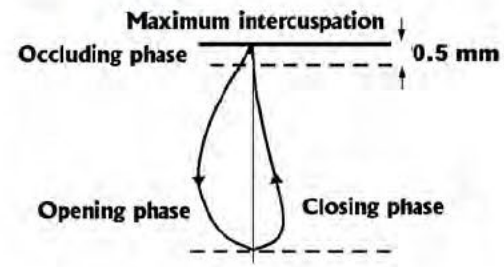
2 IR cameras/detectors → graphics controller → oscilloscopes + EMG → PowerMac

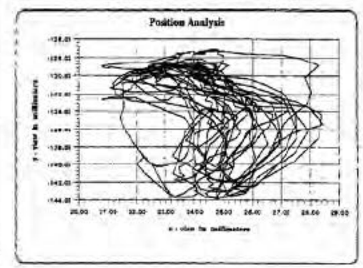
Opto-electronic Motion Capture System

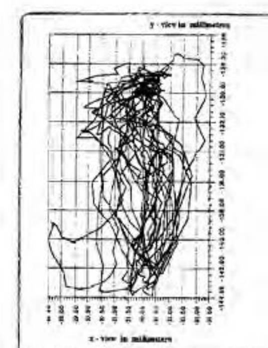
Chewing Movements in TMD Patients and a Control Group Before and After Use of a Stabilization Splint

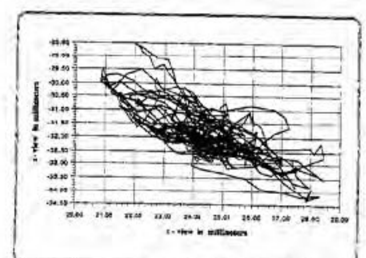
Una Soboleva, DDS, MSc[a]
Asbjørn Jokstad, LDS, Dr Odont[b]
Thomas Eckersberg, LDS, MSc[c]
Bjørn L. Dahl, LDS, Dr Odont[d]

Purpose: This study assessed the effect of using an occlusal stabilization splint in the maxilla for 6 weeks on certain parameters of chewing movements in subjects with and without temporomandibular disorder symptoms. **Materials and Methods:** Twelve male and 30 female temporomandibular disorder patients with and without a prior whiplash incidence, and individuals without signs and symptoms of temporomandibular disorders participated. The participants formed three groups matched according to gender and age ($n = 3 \times 14$). A maxillary stabilization splint was used during sleep for 6 weeks. An optoelectronic system (MacReflex, Qualisys) was used to record chewing movements at baseline, before using the splint, and after 6-weeks' use of the splint. Calculated parameters were the duration of the chewing cycles, the spatial displacement, and the









E.Microscopy → Computing → Clinics

University of Oslo Faculty of Dentistry:	1974-79 UnderGrad.	79-82 Milit.	82 - 84 Clin	84- 92 Research Asst. Dep. Anatomy

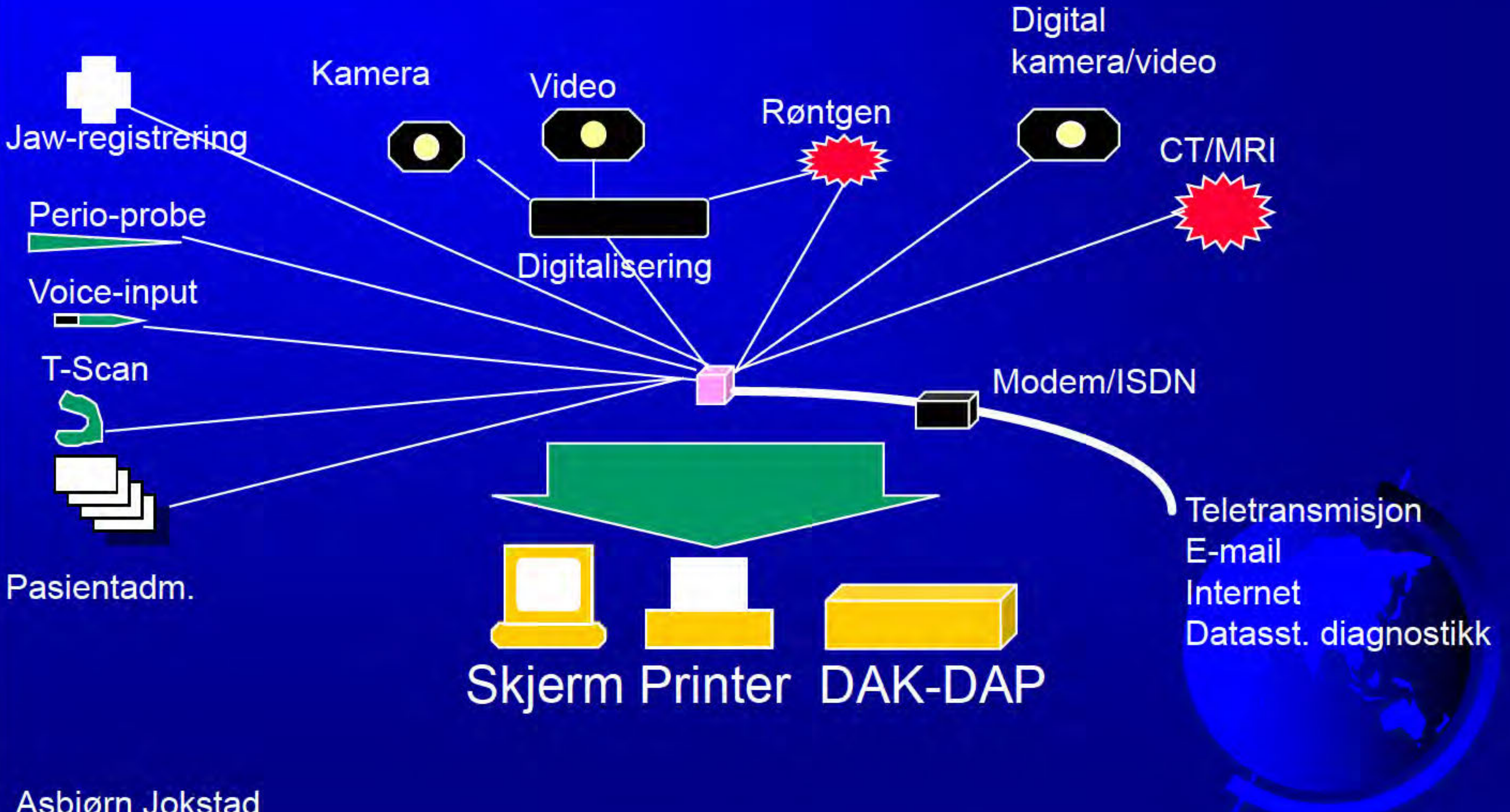
95→ Research Fellow

98→ Restorative D., Assoc Prof. → Prof.

2002→Prosthodontics

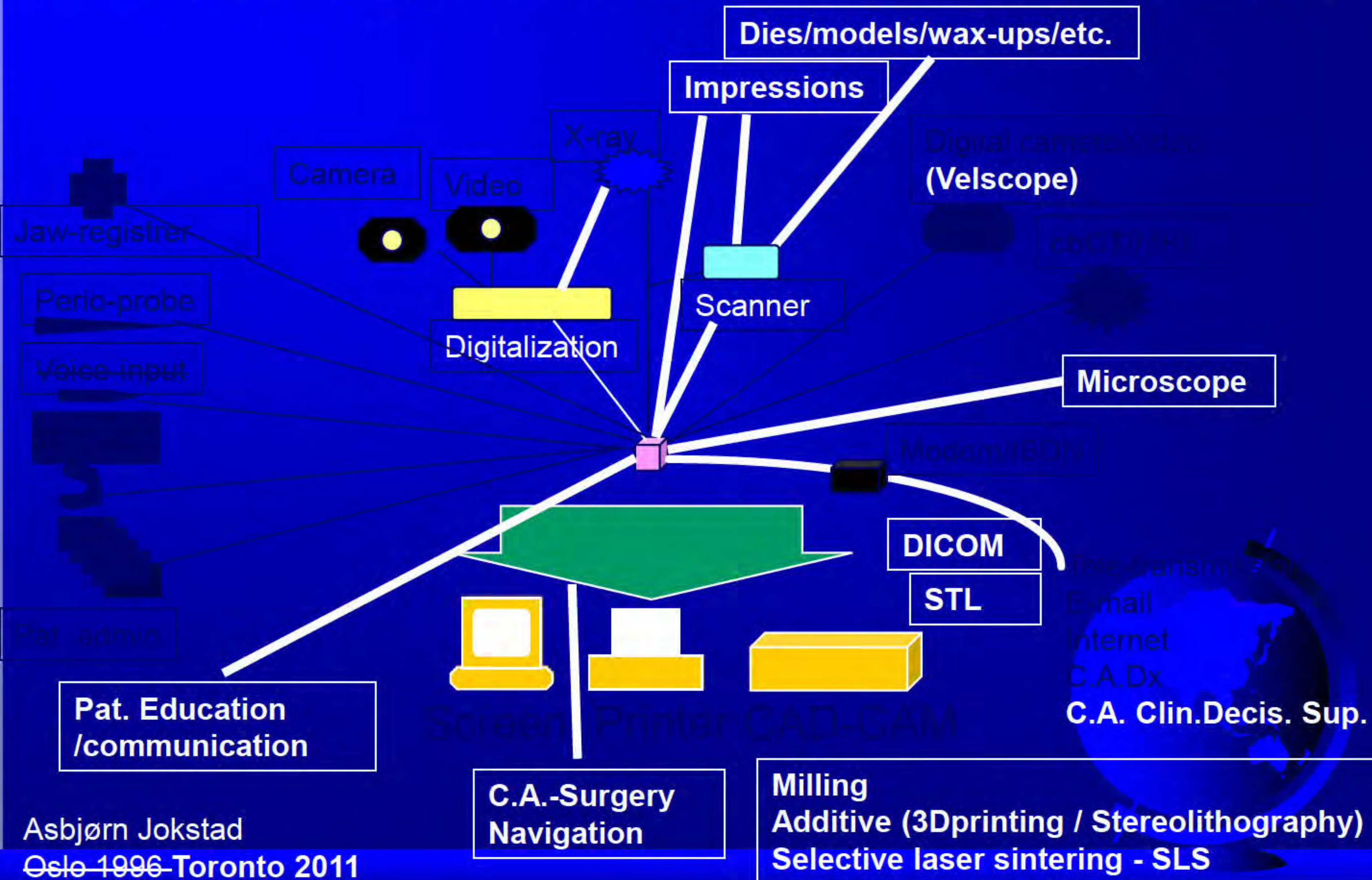
2005→ Toronto Prosthodontics

Mikroprosessoren i tannklinikken



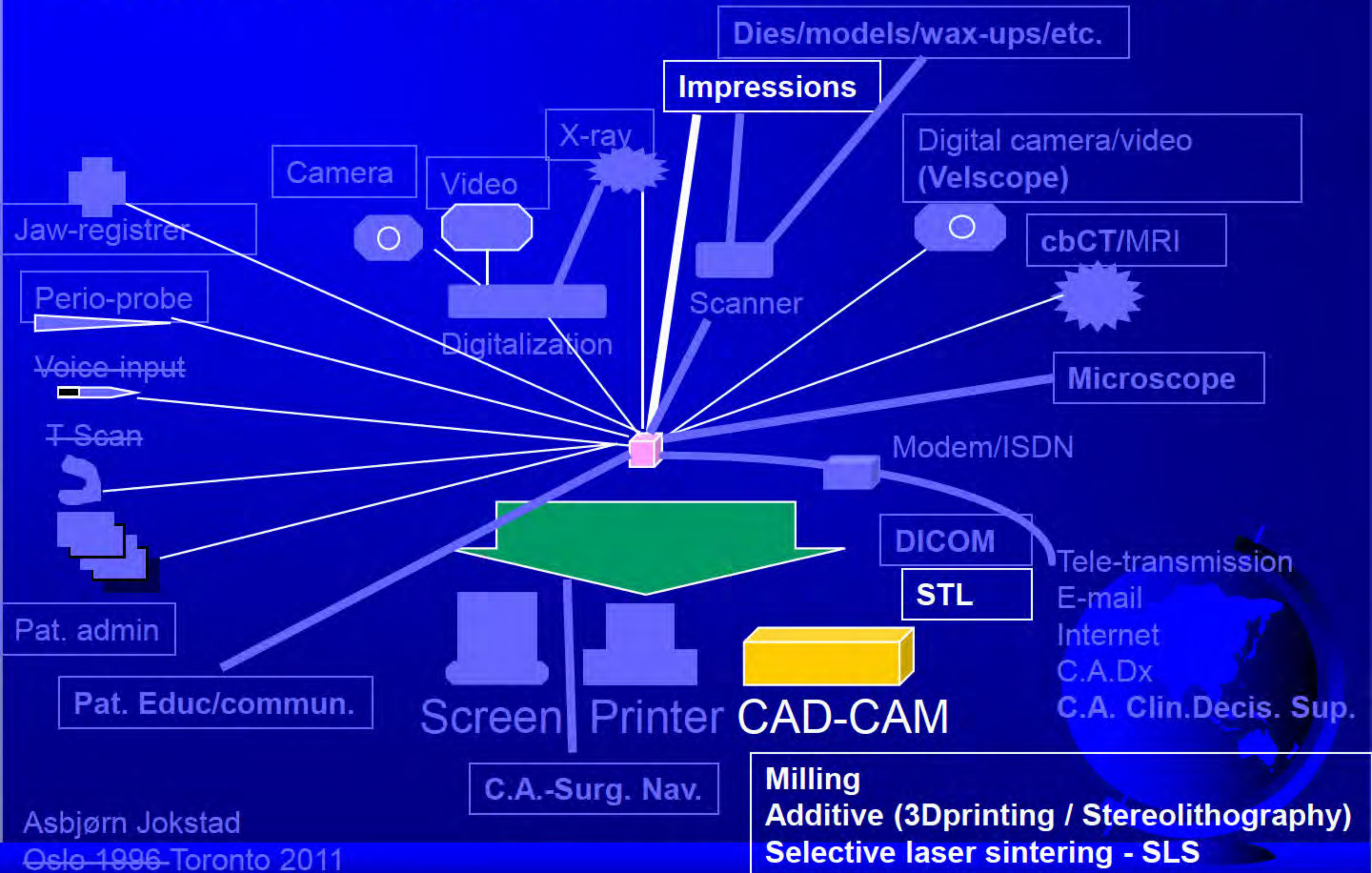
Asbjørn Jokstad
Oslo 1996

The microprosessor in the dental clinic

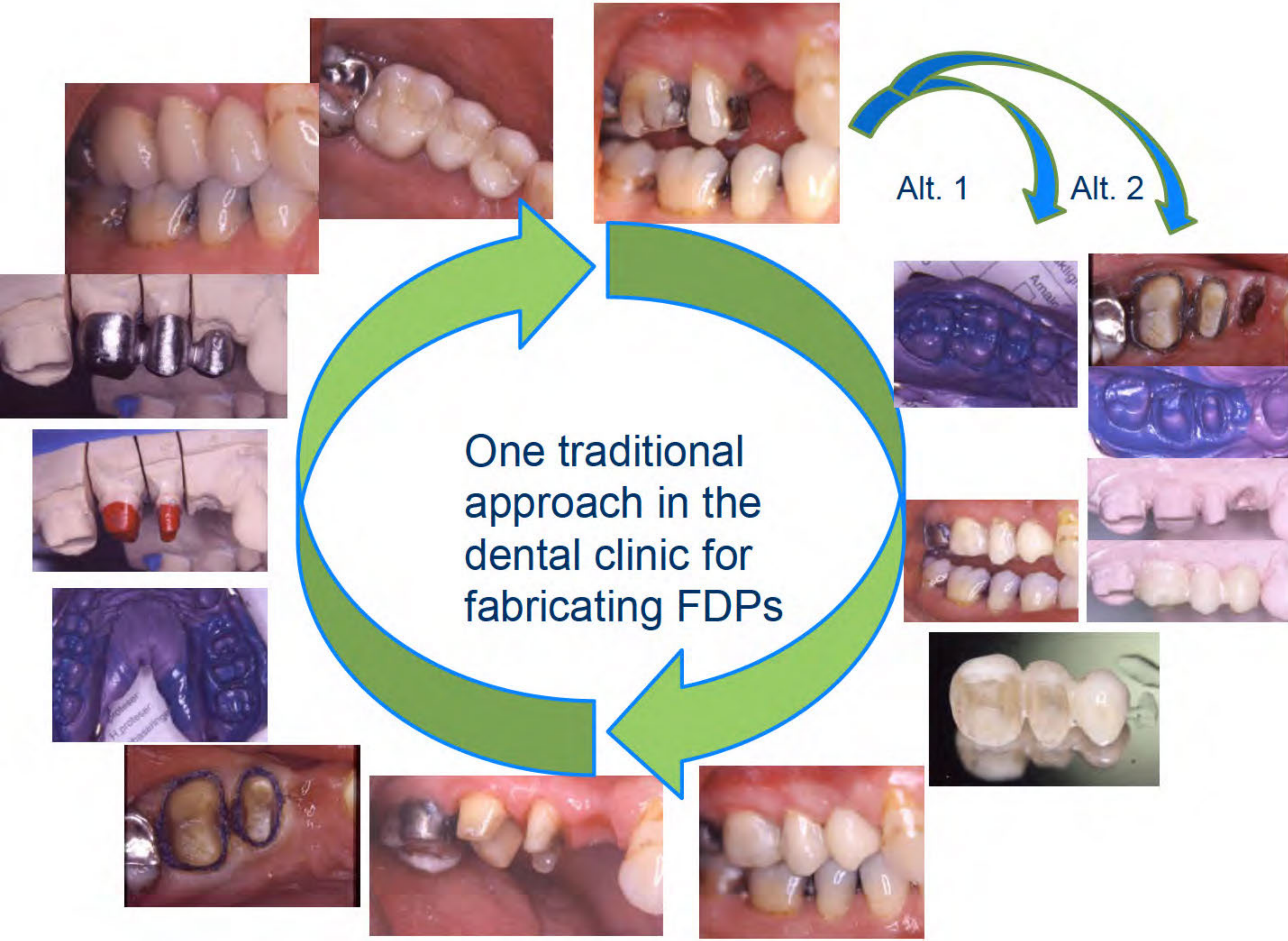


Asbjørn Jokstad
~~Oslo 1996~~ Toronto 2011

Intraoral impressions → CAD-CAM

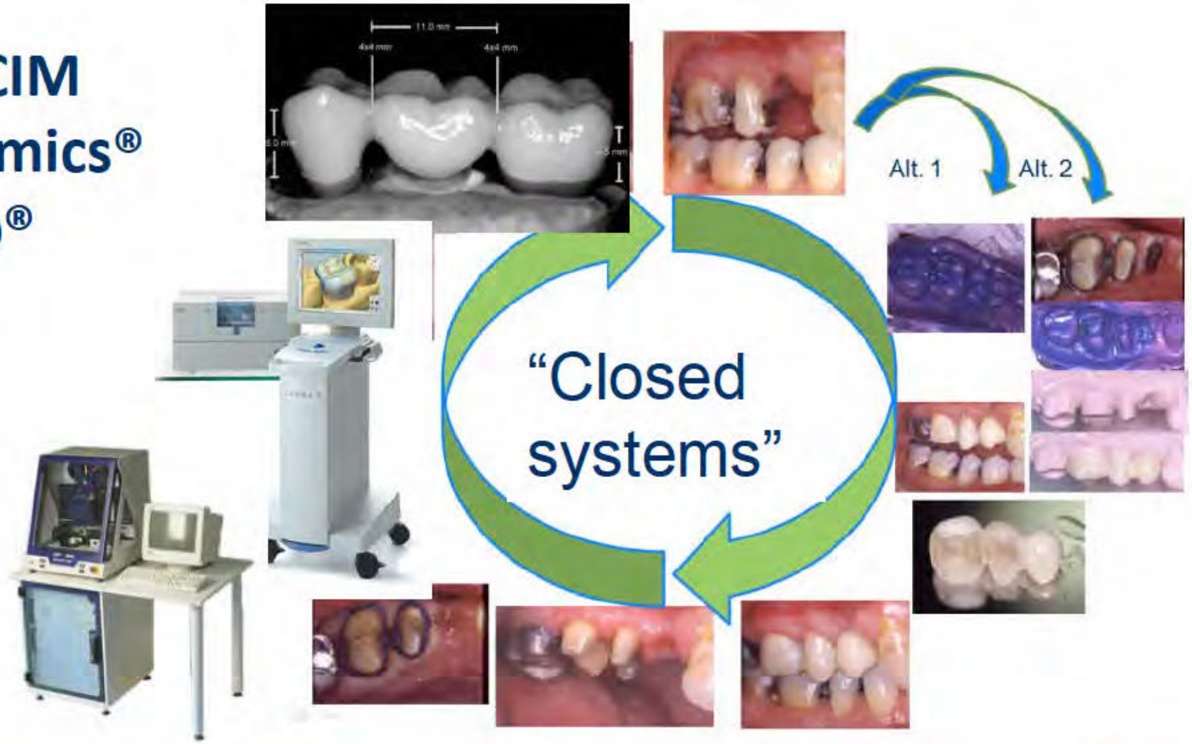


Asbjørn Jokstad
~~Oslo 1996~~ Toronto 2011


Alt. 1
Alt. 2
One traditional approach in the dental clinic for fabricating FDPs

Dr. early adopters – anno 2001

cad-esthetics /DECIM
Cercon smart ceramics®
Cerec 1→3 / InLab®
DCS Precident
Digident
KaVo Everest®
Lava® system

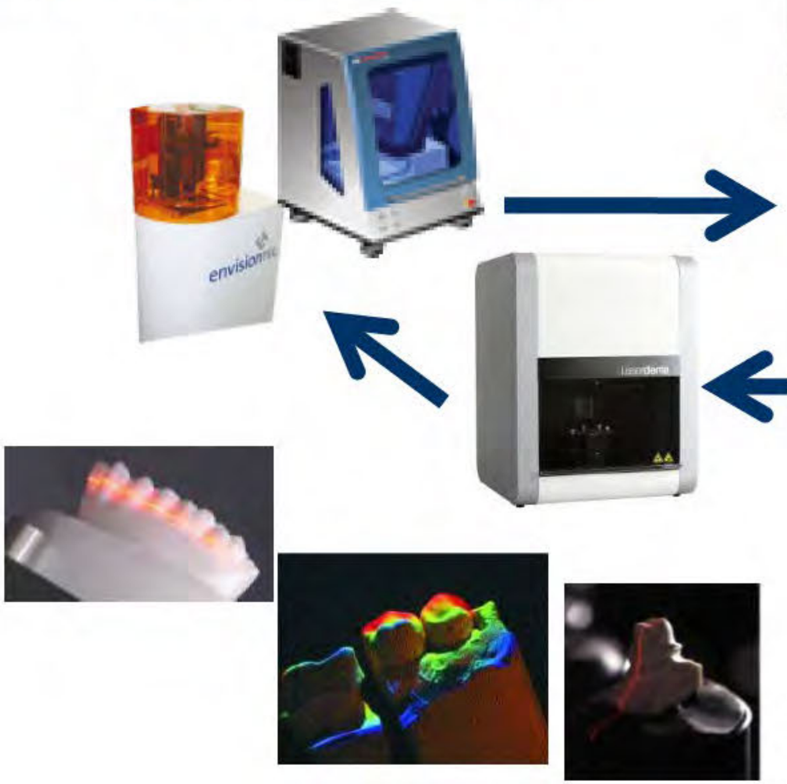


Compact unit: Digital acquisition + Design-software + Manufacturer-software + CNC-Milling (Al_2O_3 -ceramic)

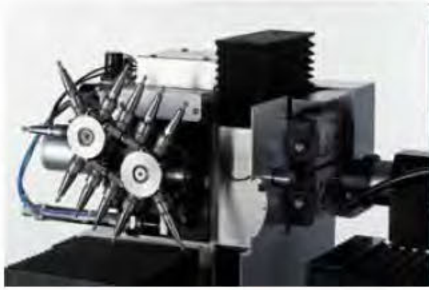
Cheaper alternative: Copy milling

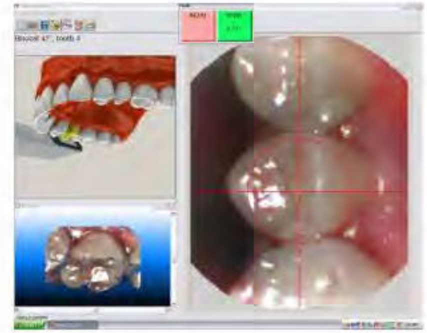
CDT early adopters – anno 2001

Additive or subtractive manufacturing methods



ELEMENTS OF MODERN CAD-CAM TECHNOLOGIES IN DENTISTRY



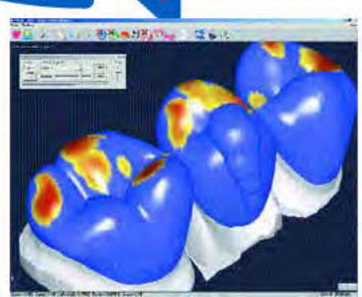


CAD-CAM in Dentistry

Manufacture Process
Device
Applications
Materials

Scanning
Technology
Acquisition
Scan Items
Data export format(s)

Manufacture Software
(Data import format(s))
Manufacture applications
Data export format(s)



Design Software
(Data import format(s))
Design applications
Data export format(s)

Intra oral scanning and CAD-CAM technologies have been made more accessible due to:

- Developments of Digital Technologies
- Developments of Scanning Devices
- Developments of Design & Manufacturer Software
- Developments of additive and subtractive manufacturing concepts, including multi-axial milling
- Developments of Restorative Materials

DEVELOPMENTS OF DIGITAL TECHNOLOGIES

Early computer performance

The clock rate is the frequency of the clock in any synchronous circuit, such as a central processing unit (CPU)

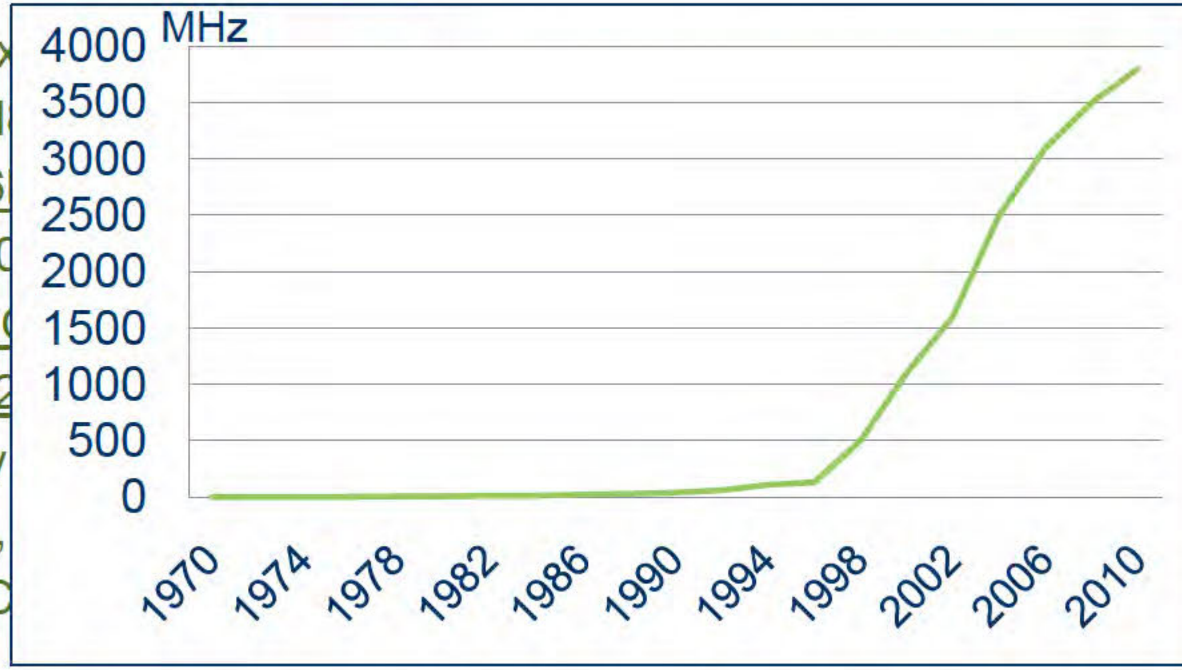
Clock rate (MHz)

<1	1971	Intel4004/ Texas Instrument TMS100
1	1974	Motorola/Intel8008/ZilogZ80 8bit.Cp/M (Commodore 64, Apple II)
4.77	1976/8	Intel 8086 16bit; (Compaq, IBM PC); Intel 8088 (IBM (1981))
8	1978	Motorola 68000 (Macintosh128k, Amiga1000)
6 – 25	1982-85	Intel 80286 DOS(1981); (IBM-AT (1984))
12 – 40	1985-90	Intel 80386 32bit; Motorola 68040 (Macintosh, Amiga, NeXT))
20 – 100	1989-94	Intel i486
	1993-95	Intel Pentium, Pentium MMX → Pentium Pro
110	1994	IBM PowerPC 601 (Power Macintosh 8100)

From: http://www.old-computers.com/museum

Computer performance today

(The clock rate is no longer considered as a reliable benchmark since there are different instruction set architectures & different microarchitectures)



<1	1971	Intel4004/ Tex
1	1974	Motorola/Intel
4.77	1976/8	Intel 8086 16
8	1978	Motorola 6800
6 – 25	1982-85	Intel 80286 D
12 – 40	1985-90	Intel 80386 32
20 – 100	1989-94	Intel i486; Cy
	1993-95	Intel Pentium,
110	1994	IBM PowerPC
133	1996	AMD K5
500	1997	IBM PowerPC 750 (iMac)
0.6→1400	1997-02	Intel Pentium III (Celeron/Zeon)
0.8→3000	2001	IBM PowerPC950 (PowerPC G5)
1.3→3800	2000-08	Intel Pentium 4 (Pentium M/D)
1→3000	2003	AMD Athlon 64
1.9-3200	2005	AMD Athlon 64 X2

DEVELOPMENTS OF SCANNING DEVICES

Scanning - Parameters

Technology

Optical-white stripe-light

Optical-white light

Optical-stripe light

Optical-laser/video

Optical-laser-triangulation

Optical-laser-confocal

Optical-blue light

Conoscopic Holography

Mechanico-electric (laser-adjusted)

Acquisition

Intra-oral

Extra-oral

Intra&extra-oral

Scan export format

Open format (e.g. STL, DICOM)

Closed

Scan Items

Antagonist

Bite registration

Die

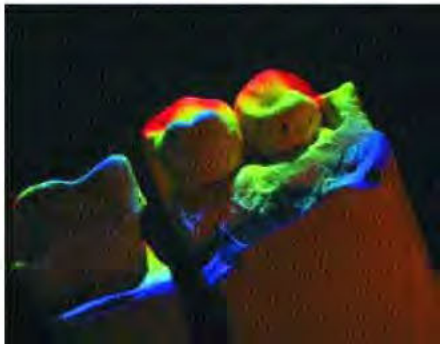
Full arch

Implant Abutment

Model

Prostheses

Wax-up



Intra oral scanning

CEREC BlueCam / AC
(1984→2006/8)

LAVA COS
(2007/8)

Cadent Itero
(2006)

Laser Triangulation

Confocal light

Per 2010;
4 systems
(+E4D)


directScan

A direct scan of the patient\'s situation after the preparation in the patient\'s mouth by the dentist enables the elimination of faults of the impression within the dental medical process.

Hint-ELs directScan closes the gap between the dentist and the dental laboratory using a Hint-ELs® system for production. Hereby the company\'s philosophy that everybody should make what he was educated in and what he can do most economically, is consequently realized.
The dentist takes the virtual impression (scans the situation in the mouth).

Hint-Els GmbH (2009)

Intra oral scanning

CEREC BlueCam / AC (2006/8)

Densys (info unavail.)

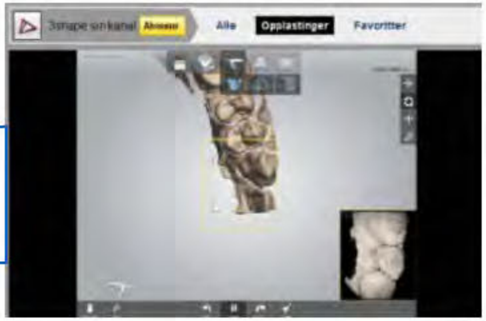
LAVA COS (2007/8)

Per 2010/2011: 4 additional systems introduced

IODIS - Clõn

Cyrtina IO scanner

Cadent Itero (2006)



3Shape ("Optical Sectioning technology")

Photographs: Slawek Bilko LHM

DEVELOPMENTS OF DESIGN & MANUFACTURER SOFTWARE

Design / Manufacturer Software Parameters

Import format(s)

Open

Scanner-CAD bundled (Closed)

Export format(s)

Open (e.g. STL)

CAD-CAM bundled (Closed)

Applications

3 →- 16u-FDPs

(4cme → 7cm)-FDPs

Crowns

Customised abutments

Implant-Bars

In-/Onlays

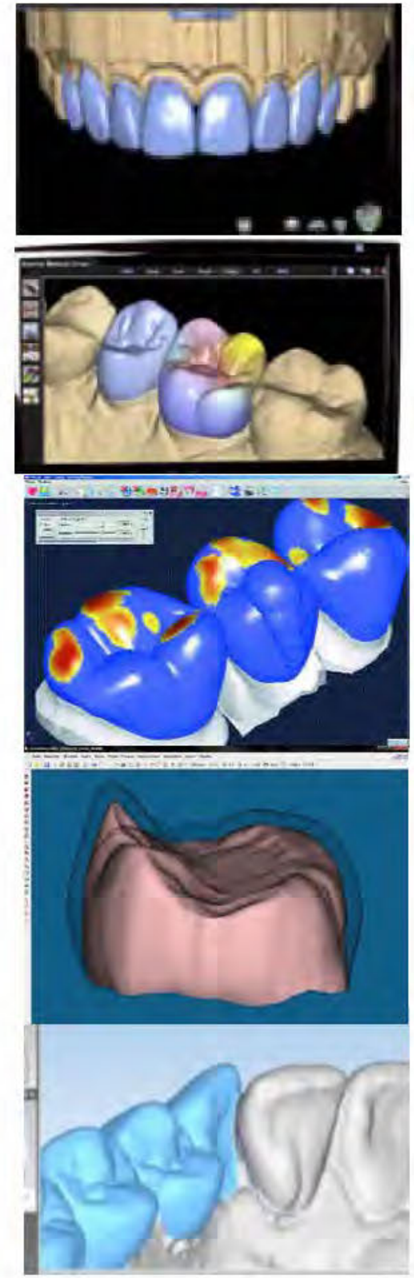
Meso-structures

Monolithic Crowns

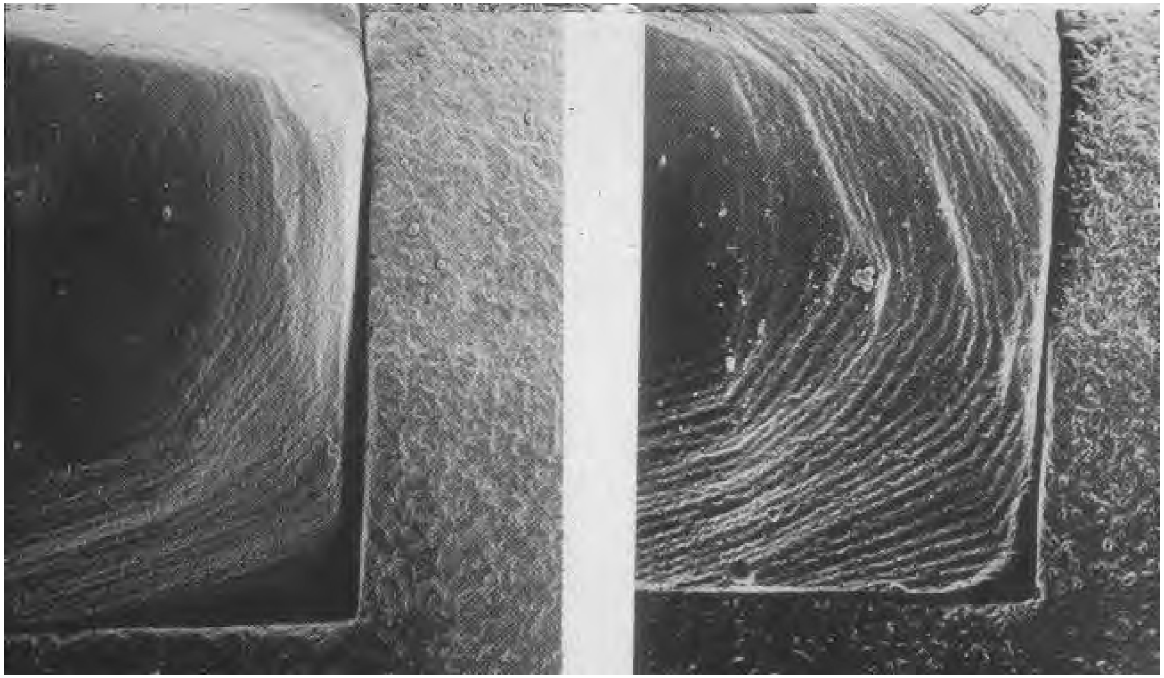
Partial Removable Dental Prosthesis

Single-unit copings

Wax-ups



The sum of Hardware + Software Improvements



CEREC 1 (~1986)

CEREC 2 (~1992)

DEVELOPMENTS OF ADDITIVE AND SUBTRACTIVE MANUFACTURING CONCEPTS, INCLUDING MULTI-AXIAL MILLING

Manufacturing Parameters

Device - additive
3D Laser sintering
3D Printing
Device - subtractive
3/3.5/4/5/6-axis-milling

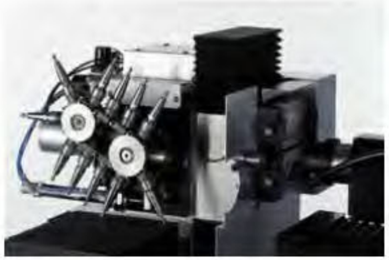
w. / w.o.
Sintering-furnace

Applications
In-/Onlays
Single-unit copings
Crowns
Monolithic Crowns
3 → 16unit(/4 → 7cm)-FDPs
Custom abutments
Implant-Bars
implant-suprastructure-Meso-structures
Partial Removable Dental Prosthesis
Wax-ups

Materials
Base alloys
Gold alloys
Non-precious alloys
Titanium / - alloys

Composite resins
Cast Resins / Wax
PMMA

In-Ceram (Porous Al_2O_3)
Al_2O_3 (sintered)
Feldspathic
$Li_2Si_2O_5$
ZrO_2 (porous/green state)
ZrO_2 (pre-sintered state)
ZrO_2 (sintered)
ZrO_2(sintered & HIP-ed state)



Additive manufacturing

incl: 3D printing / Additive (freeform) fabrication / Layered manufacturing / Rapid prototyping/-manufacturing / Robocasting /Solid freeform fabrication (SFF)

Additive manufacturing physically constructs 3D geometries directly from 3D CAD.

Process introduced in the mid-1980s. Original name was rapid prototyping since the first use was to make prototypes of parts without having to invest the time or resources to develop tooling or other traditional methods.

As the process and quality controls have evolved additive manufacturing has grown to include production applications

Comparison of solid freeform fabrications methods

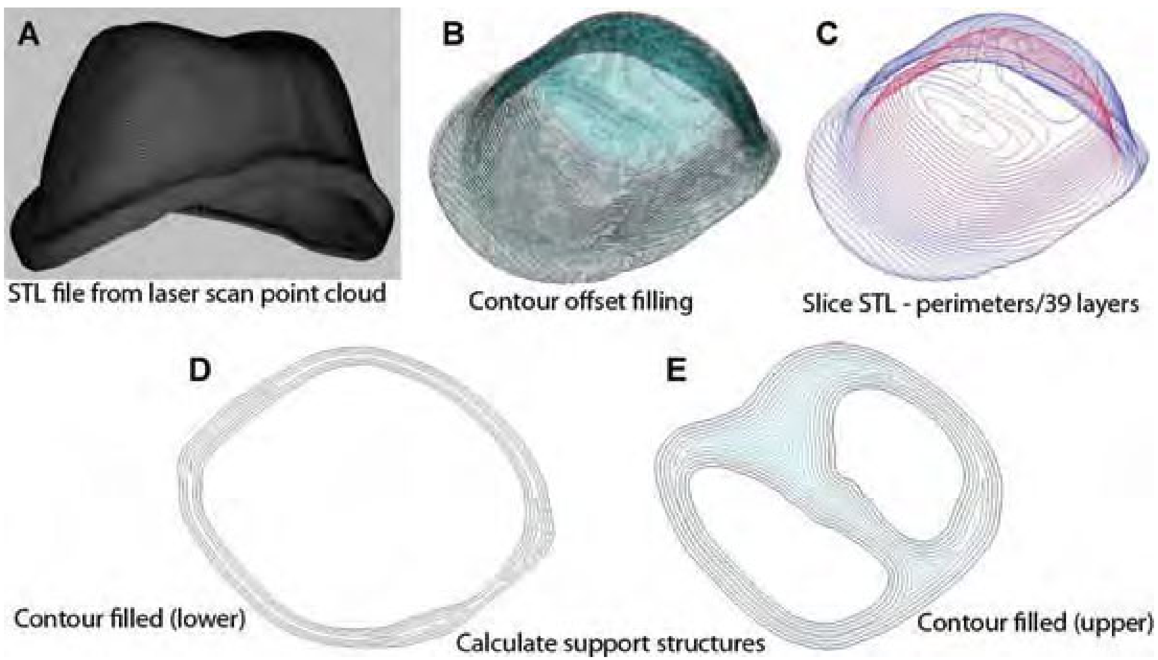
Method	Accuracy (mm/mm)[6]	Maximum part size (mm)[7]	Process time (hh:mm)[8]
Fused deposition modelling	0.005	254 x 254 x 254 (Stratasys)[9]	12:39
Laminated object modeling	0.01	812 x 558 x 508 (Cubic Technologies)	11:02
Selective laser sintering	0.005	381 x 330 x 457 (3D Systems)	4:55
Solid ground curing	0.006	508 x 355 x 508 (Cubital)	11:21
Stereolithography	0.003	990 x 787 x 508 (Sony)	7:03
Robocasting	0.1 (Fab@Home)	240 x 240 X 240 (Fab@Home)	TBD

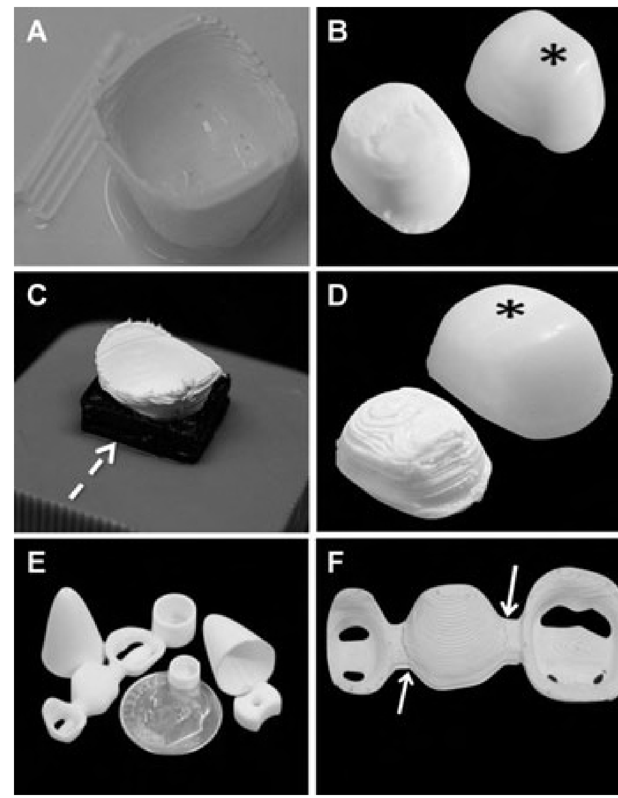
From: wikipedia.com

Additive manufacturing technologies: Robocasting

A material is deposited at room-temperature material -- in the form of a viscous gel or ceramic slurry -- from a robotically controlled syringe or extrusion head.

The material hardens or cures (rather than freezes) after deposition





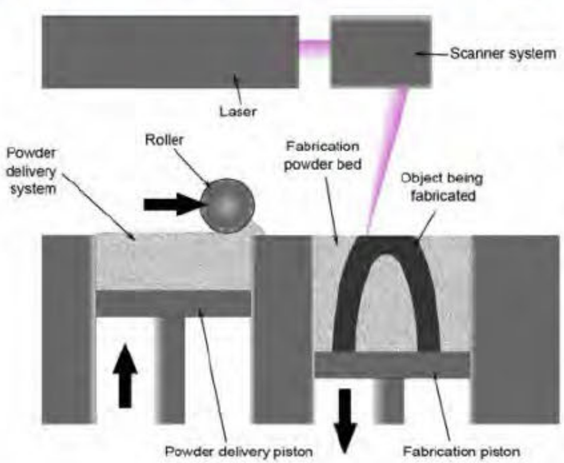
From: Silva ea J Prosthodont 2011

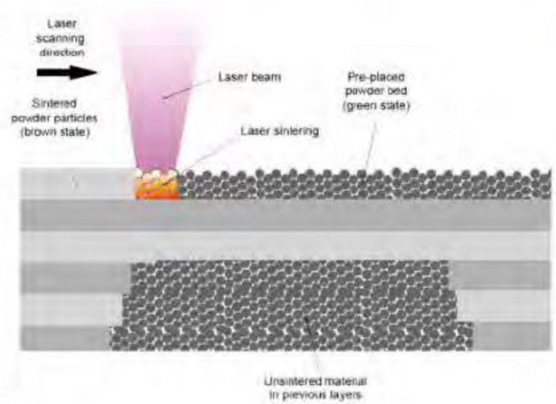
Additive manufacturing technologies: Selective laser sintering (SLS)

Uses a high power laser (e.g., Co2) to fuse small particles of plastic, metal (direct metal laser sintering), ceramic, or glass powders into a mass that has a desired 3-dimensional shape.

The laser selectively fuses powdered material by scanning cross-sections generated from a 3-D digital description of the part on the surface of a powder bed. After each cross-section is scanned, the powder bed is lowered by one layer thickness, a new layer of material is applied on top, and the process is repeated until the part is completed.

Unlike some other additive manufacturing processes, such as stereolithography SLS does not require support structures due to the fact that the part being constructed is surrounded by unsintered powder at all times





From: Traini ea Dent Mater 2008

Stereolithography (SL or SLA)

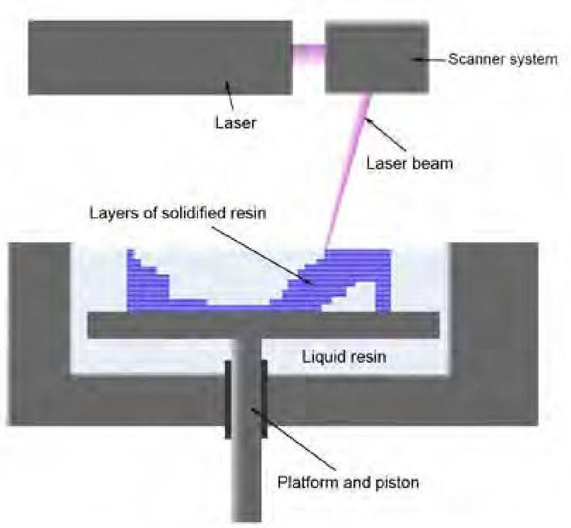
A additive manufacturing technology for producing models, prototypes, patterns, and in some cases, production part. The term “stereolithography” was coined in 1986.

A method and apparatus for making solid objects by successively “printing” thin layers of the ultraviolet curable material one on top of the other.

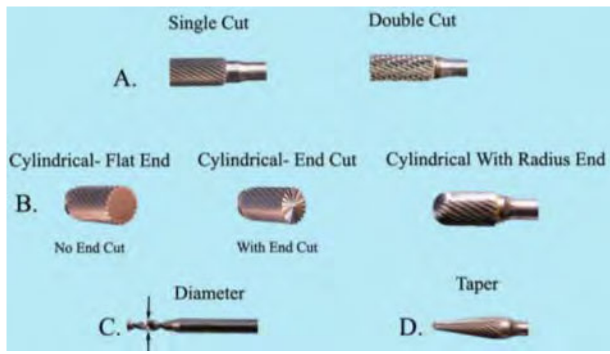
A concentrated beam of ultraviolet light focuses onto the surface of a vat filled with liquid photopolymer. The light beam draws the object onto the surface of the liquid layer by layer, causing polymerization or cross-linking to give a solid.

The process must be computer-controlled because of the complexity

3D Systems

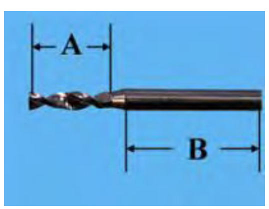


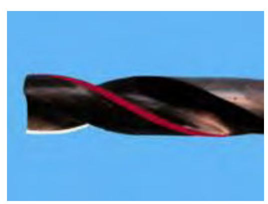
Milling in Dentistry – From 3 axes → 5 → 5+5 milling axes



→

From: ferrarodental.com





Milling machines today are manually operated, mechanically automated, or digitally automated via computer numerical control (CNC) re. e.g. torques, feed-rate, nature of cutters, etc..

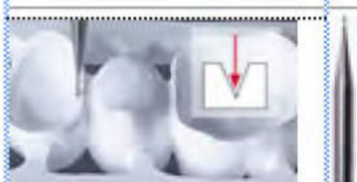
Cutters for dental (5 axis) milling

Milling Bur 4 L
Used to mill pre-sintered zirconia (rough preliminary and internal milling)

Milling Bur 3 L
Used to mill pre-sintered zirconia (rough milling)

Milling Bur 2 L
Used to mill pre-sintered zirconia (defined milling/precise milling)

Milling Bur 1 L
Used to mill pre-sintered zirconia (precise milling)



Milling Bur 0,5 S
Used to mill pre-sintered zirconia (high precision milling)

Milling Bur 1 XXL
Used to mill pre-sintered zirconia (abutment)

Milling Bur 2 A
Used to mill pre-sintered zirconia (abutment)

Milling Bur 1,5 A
Used to mill pre-sintered zirconia (abutment)

Milling Bur 0,6 A
Used to mill pre-sintered zirconia (abutment)

Milling Bur 2W30
Used to mill screw seats

Milling Bur 3 C
Used to mill pre-sintered zirconia (2° coned flank)

Milling Bur 1 XL
Used to mill pre-sintered zirconia (precise milling of deep)

Milling Bur 3 U
Used to mill pre-sintered zirconia (undercut)

Milling Bur 2 U
Used to mill pre-sintered zirconia (undercut)

Round Head Bur 2 K Rapid and easy smoothing of surfaces and undercuts

Milling Bur 0,3 C
Used to mill occlusal fissures

Milling Bur 2 UR
Used to mill undercuts

Milling Bur 2,5 UR
Used to mill undercuts

From: ZirconZahn

Milling errors compensated for by software algorithms

- Geometrical compensation
- Force compensation
- Thermal compensation

Finite Element Modeling calculations

- Errors in the final dimensions of the machined part are determined by the accuracy with which the commanded tool trajectory is followed, combined with any deflections of the tool, parts/fixture, or machine caused by the cutting forces
- Sophisticated error compensation algorithms reduce the effect of geometric errors in the machine structure
- High performance axis drives coupled with modern control algorithms improve the cutting tools' trajectory

Submarine’s propellers

1. as thin as possible so the submarine can produce low noise
2. as strong as possible so the submarine can achieve speed

- *The accuracy of parts produced in milling is crucial in high-precision industry*
- No advanced milling technology = no possibility for production

State-of-the-art manufacturing of propellers

1. Bronze continuous/industrial casting
2. Quenching
3. Milling
4. Berillium layer on the bronze
5. Repeat milling

"Акула”

CoCom

CoCom is an acronym for *Coordinating Committee for Multilateral Export Controls*. CoCom was established by Western bloc powers in the first five years[1] after the end of World War II, during the Cold War, to put an arms embargo on COMECON (Warsaw Pact) countries.

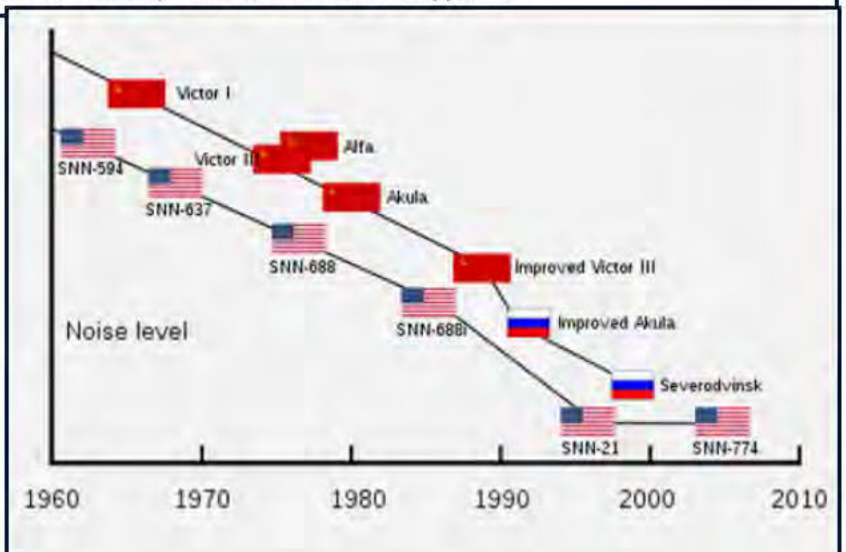
CoCom ceased to function on March 31, 1994

Magyar vontatkozású COCOM-listás termékek [szerkesztés]

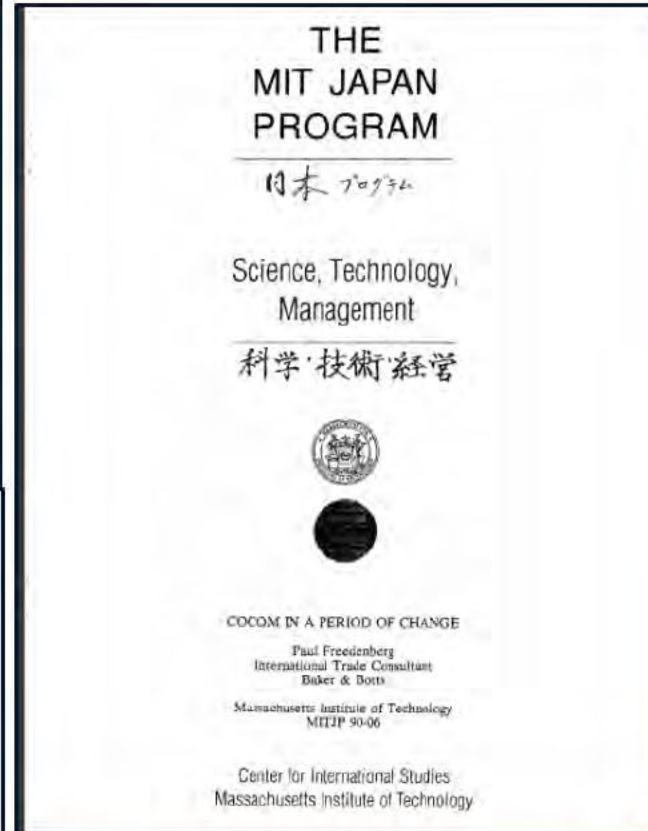
- Informatika (A "turista importban" bejutó termékekre pedig a magyar kormány vetett ki magas vámot)
  - Hardver
    - Commodore 64
    - Ethernet hálózati eszközök (1990-ig)
    - IBM számítógépek
      - IBM PC XT és AT
        - A Magyarországra került gépeket általában alkatrészként szétszerelve hozták be, és rakták össze [7]
      - Mainframe-ek
        - 9221 Model 150 [8]
        - 5110 (BASIC és APL nyelven programozható, 8" floppy disk, 64 kB memória [9]
    - Apple Macintosh [10]
    - Digital Equipment Corporation termékek kilencven százaléka [11][12]
      - PDP, VAX (a KFKI-n visszafejtették a gép működését, ebből lett a TPA - Tárolt Programú Analizátor. Ritka esetekben a TPA átcímkézett és becsempészett PDP és VAX gépeket is jelentett)
    - Amiga
    - 4 GB-ot meghaladó kapacitású merevlemez [13]
  - Szoftver
    - AutoCAD

A Commodore 64 az 1980-as évek közepén került le a COCOM-listáról

During this same period the U.S. Government was pushing its Allies to increase the resources they devoted to export licensing and enforcement. The plans for increased effort fell on deaf ears until the uncovering the now-famous sale of precision machine tools and software by Kongsberg Vaapenfabrik of Norway and the Toshiba Machine Company of Japan. In the fall of 1986, U.S. intelligence agencies discovered an on-going scheme by these two companies to supply nine-axis submarine propeller milling machines and the necessary software to the Soviet Navy propeller production facility in Leningrad--the Baltic Shipyard. The equipment included computer-aided design and computer aided manufacturing software, so-called CAD/CAM, as well as the numerical controllers from Kongsberg and the actual machine tools supplied by Toshiba Machine. The transaction began in 1981 and continued until the time of its discovery in 1986. It involved shipment and installation of the machine tools, as well as modification of the software to meet the specifications of the shipyard.



Submarine and noise level. US vs Russians



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Science, Technology, Management

科学・技術・経営

COCOM IN A PERIOD OF CHANGE

Paul Freedenberg
International Trade Consultant
Baker & Botts

Massachusetts Institute of Technology
MITJP 90-06

Center for International Studies
Massachusetts Institute of Technology

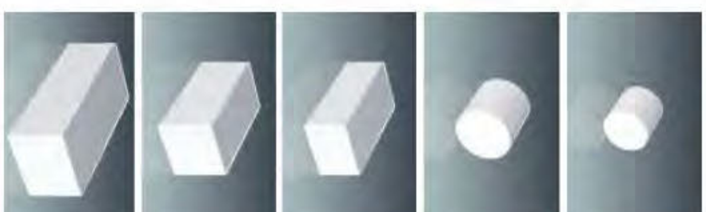
DEVELOPMENTS OF RESTORATIVE MATERIALS

Examples of prefabricated blanks for supra-constructions

Siro

ø99 mm x 10 - 25mm

DCS (Hip)



KaVo Everest

E4D

Milling units

Zirconia milling substrates are not alike! 1/3

TZP=(tetragonal zirconia polycrystals)

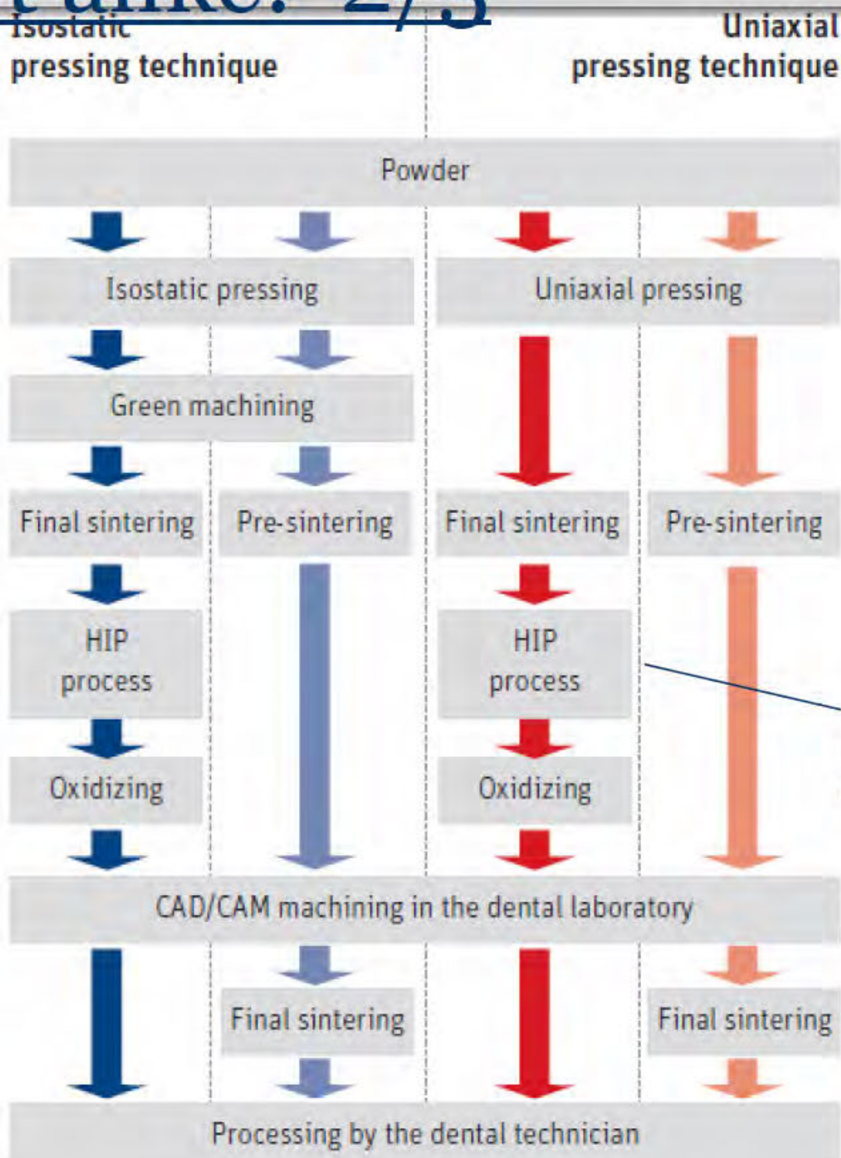
		%
TZP	ZrO_2 / Y_2O_3	95 / 5
TZP-A	ZrO_2 / Y_2O_3 / Al_2O_3	95 / 5 / 0.25
FSZ	ZrO_2 / Y_2O_3	90 / 10
PSZ	ZrO_2 / MgO	96.5 / 3.5
ATZ	ZrO_2 / Al_2O_3 / Y_2O_3	76 / 20 / 4

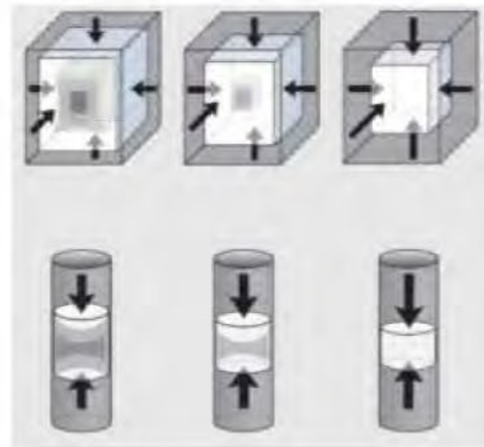
Great variations:

Hardness **Fracture resistance**
Tension strength **Grain size**
Elasticity module **Opacity**
Sintering time

Zirconia milling substrates are not alike! 2/3

Partially sintered





Isostatic

Uniaxial

(HIP process: hot isostatic post compaction

Final sintering: ~1350°C (cercon) -1500°C (lava) -1530°C (vita)

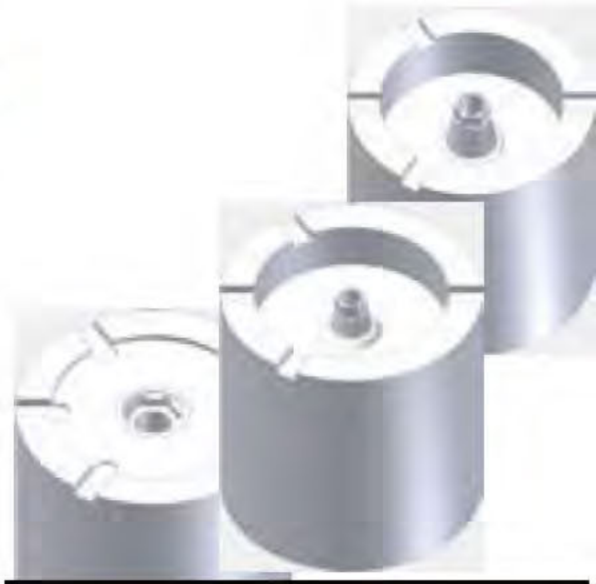
Zirconia milling substrates are not alike! 3/3

3 point 4 point biaxial flexural test

Prefabricated blanks for customised implant abutments

ESSENTIALS:

- It's the **Doctor's responsibility** to maintaining the control of and overview of the chain of materials and fabrication methods
- Fabrication processes and material choices may be incompatible
- Stay with a validated concept or upgrade your knowledge about modern material properties as well as modern additive & subtractive manufacturing methods



CAM fabricated bodies – a concern today for problems tomorrow?

ITI

Proc Inst Mech Eng H. 2005 Jul;219(4):233-43.

Near-surface damage--a persistent problem in crowns obtained by computer-aided design and manufacturing.

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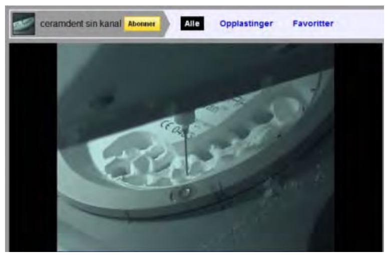
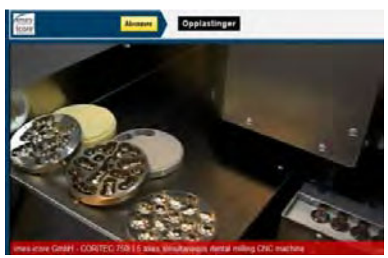
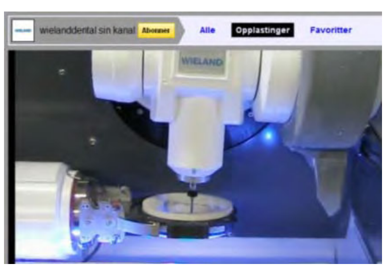
Abstract

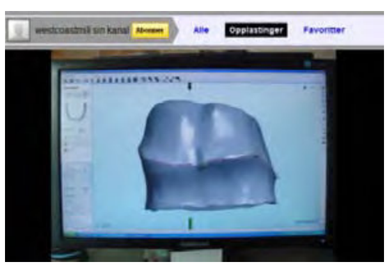
Robust dental systems obtained by computer-aided design and manufacture (CAD/CAM) have been introduced and, in parallel, the strength of the ceramic materials used in fabricating dental crowns has improved. Yet all-ceramic crowns suffer from near-surface damage, limiting their clinical success, especially on posterior teeth. Factors directly associated with CAD/CAM fabrication that contribute to the degree of damage include material selection and machining parameters and strategies. However, a number of additional factors also either create new damage modes or exacerbate subcritical damage, potentially leading to catastrophic failure of the crown. Such factors include post-fabrication manipulations in the laboratory or by the clinician, fatigue associated with natural occlusal function, and stress fields created by compliance or distortion within the supporting tooth structure and/or adhesive material holding the crown to the tooth. Any damage reduces the strength of a crown, increasing the probability of catastrophic failure. The challenge is to understand and manage the combination of competing damage initiation sites and mechanisms, limitations imposed by the demand for aesthetics, and biologically related constraints.

Dental Milling centres









CADCAMexpert

Croftmania

Ceramdent

Roeders

Wieland

DATRON High Speed CNC Machining Centers

Imesicore

WestcoastMill

Thank you for your kind attention