

29. ULUSAL TÜRK ORTOPEDİ VE TRAVMATOLOJİ KONGRESİ



Bilgisayar Destekli Hastaya Özgü Cerrahi Tedaviler:

Hastaya Özel İmplantlar ve Kullanım Alanları

Prof. Dr. Melih Güven

maguven2000@gmail.com

Hastaya Özel İmplantlar

Medical First: 3-D Printed Skull Successfully Implanted in Woman

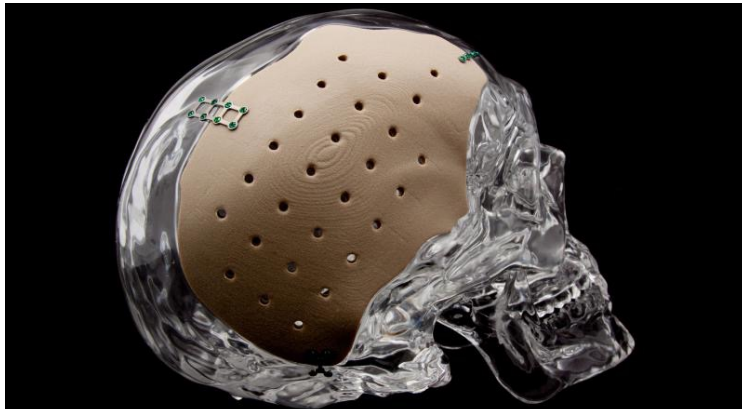


Doctors at UMC Utrecht in the Netherlands replaced the top part of a woman's skull with a 3-D printed plastic one. UMC Utrecht

March 28, 2014, 12:30 AM GMT+2

Sponsored Stories

by Taboola



HOME » TECHNOLOGY » TECHNOLOGY NEWS

3D printer builds new jaw bone for transplant

An 83-year-old woman has become the first person to have a 3D printer-created jaw fitted.

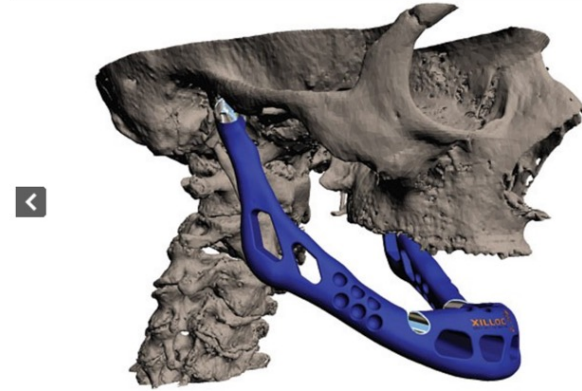
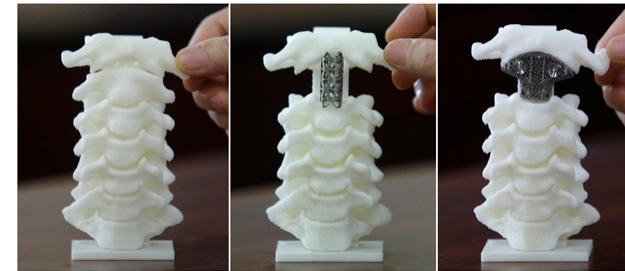


Image 1 of 3

The artificial jaw bone was created using a 3D printer.



Üç Boyutlu (3B) Yazıcılar

Hayal edilen bir parçanın bilgisayar ortamında modellendikten sonra, kısa bir süre içerisinde “*düşük maliyetle*” elle tutulabilir somut nesnelere dönüştürülebildiği makineler



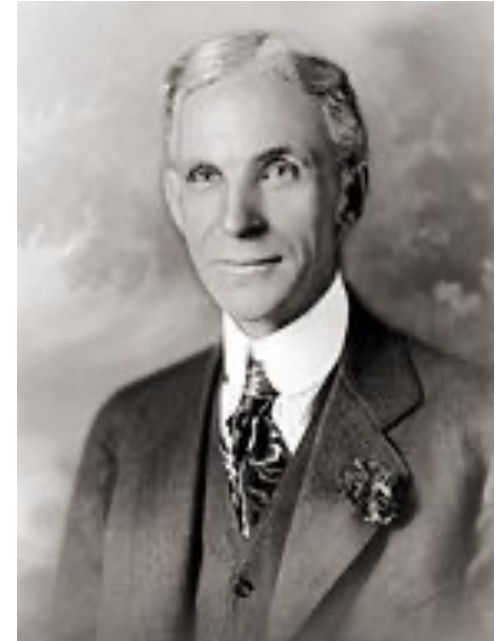
- **3D printing – “*Linear Robots*”**
- **Rapid prototyping** (Hızlı prototipleme)
- **Additive manufacturing** (Katmanlı üretim)



İkinci Endüstriyel Devrim

“Any Customer can have a car painted any colour that he wants so long as it is black”

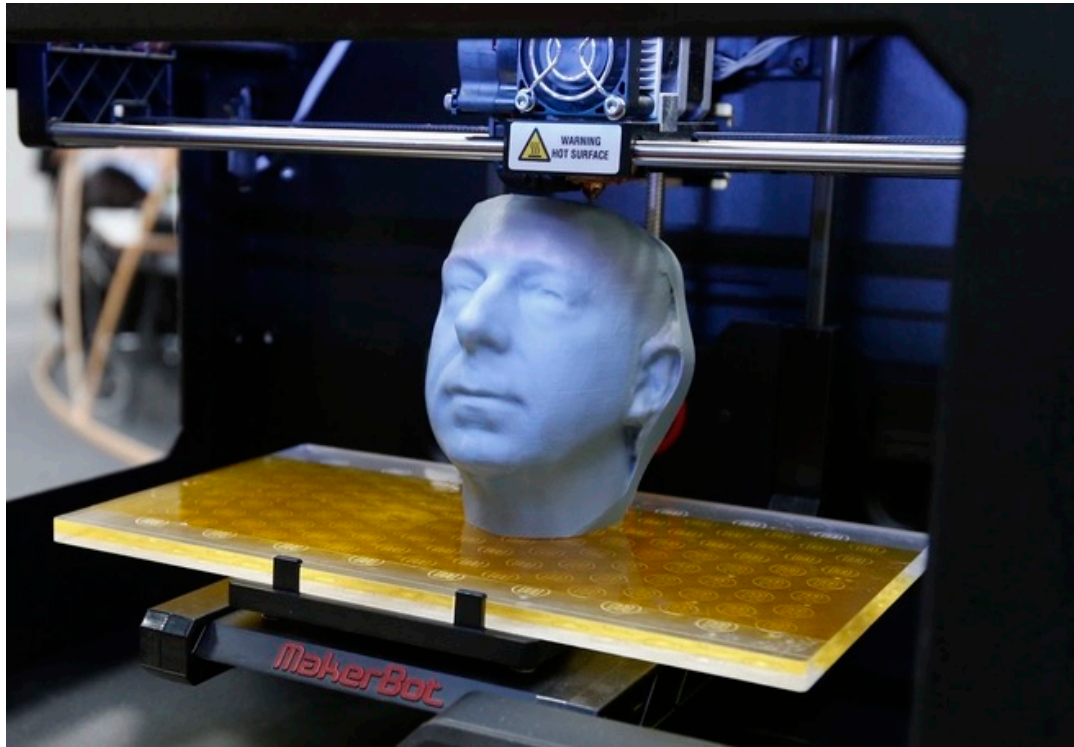
Henry Ford's Remark on the Model T, 1909



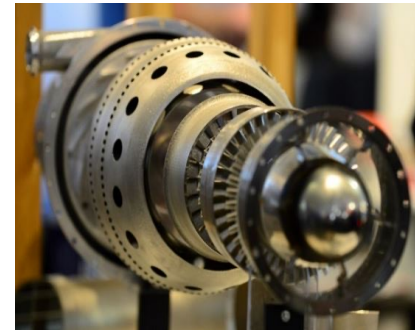
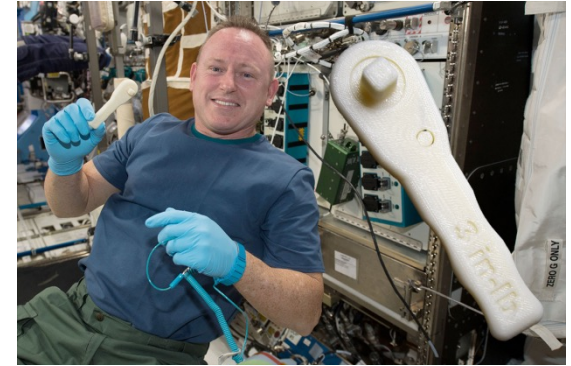
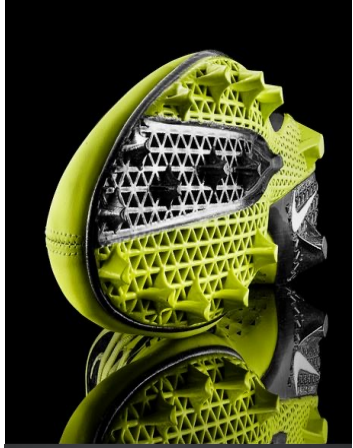


Üçüncü Endüstriyel Devrim

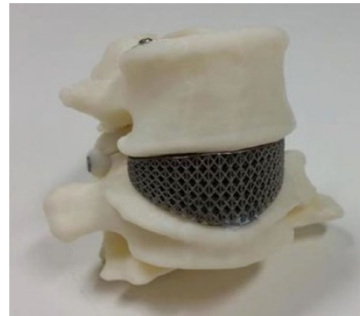
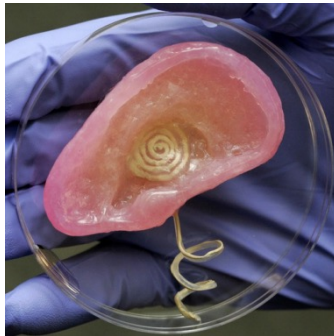
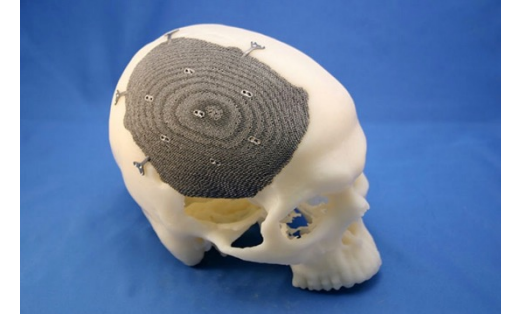
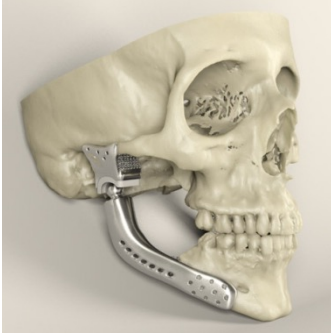
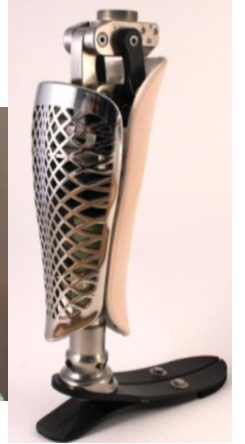
Ürünün ve üretimin kişiselleştirilmesi !!!



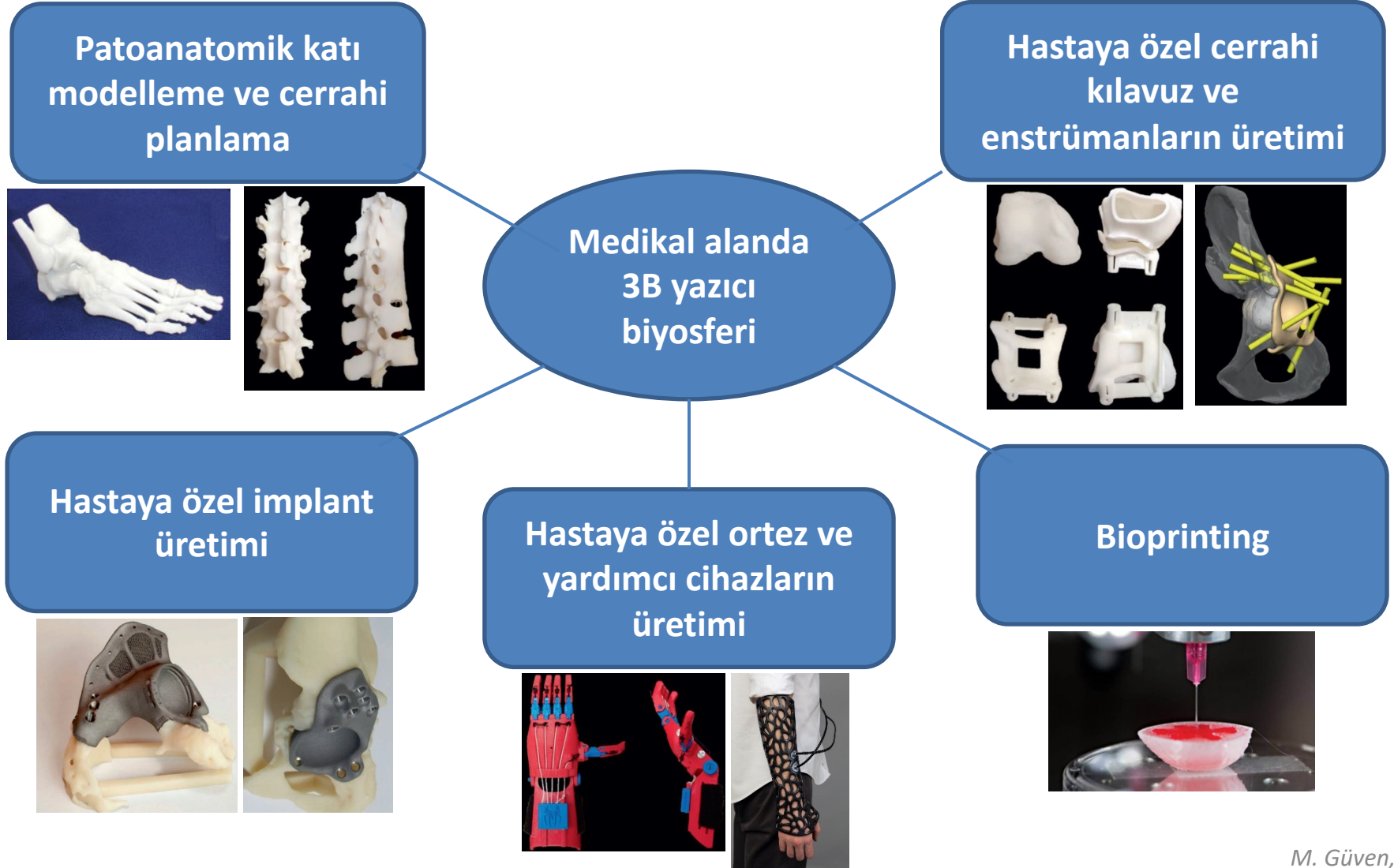
Üçüncü Endüstriyel Devrim



Medikal Alanda 3B Yazıcı Teknolojisinin Kullanımı



Hastaya Özel Cerrahi Uygulamalar



Hastaya Özel Cerrahi Uygulamalar

Tack et al. *BioMed Eng OnLine* (2016) 15:115
DOI 10.1186/s12938-016-0236-4

BioMedical Engineering
OnLine

REVIEW

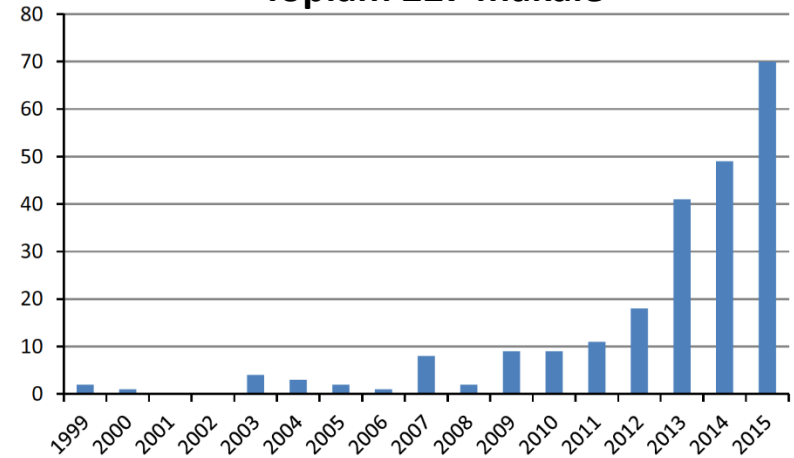
Open Access



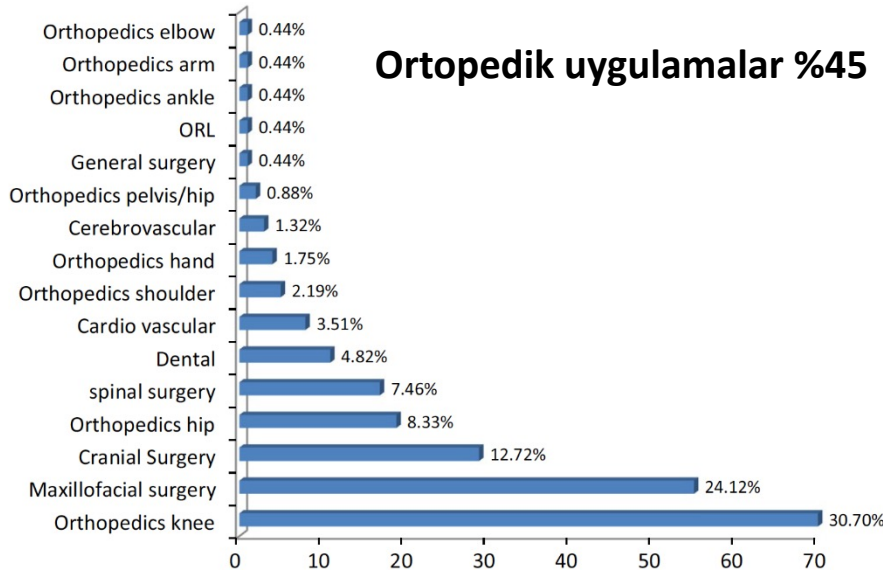
3D-printing techniques in a medical setting: a systematic literature review

Philip Tack^{1*}, Jan Victor², Paul Gemmel³ and Lieven Annemans¹

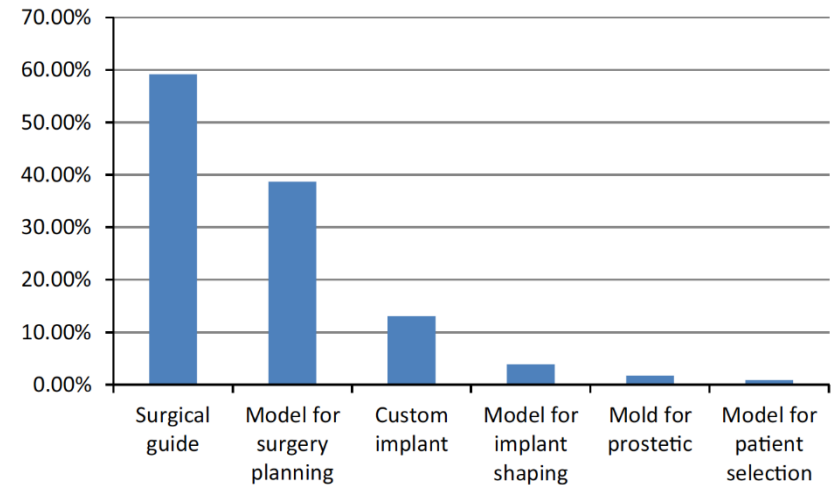
Toplam 227 makale



Ortopedik uygulamalar %45



Hastaya özel implant %12,7 (30 makale)



Ortopedik İmplant Üretimi

- Günümüzde tasarımları genellikle ortalama bir anatomik ölçüt üzerinden yapılmakta
- Ameliyat sırasında farklı boyutlarda üretilmiş olan implantlar içerisinde kişinin anatomik ölçütlerine en yakın olan implant tercih edilmekte



Ortopedik İmplant Üretimi

Güncel sorun...

- İnsan anatomisinin farklılığı
- Genetik ve etnik çeşitlilik



Kişinin kendi kemik anatomisine tam uygunluk sağlayan implantı bulabilmek **her zaman mümkün değil !**

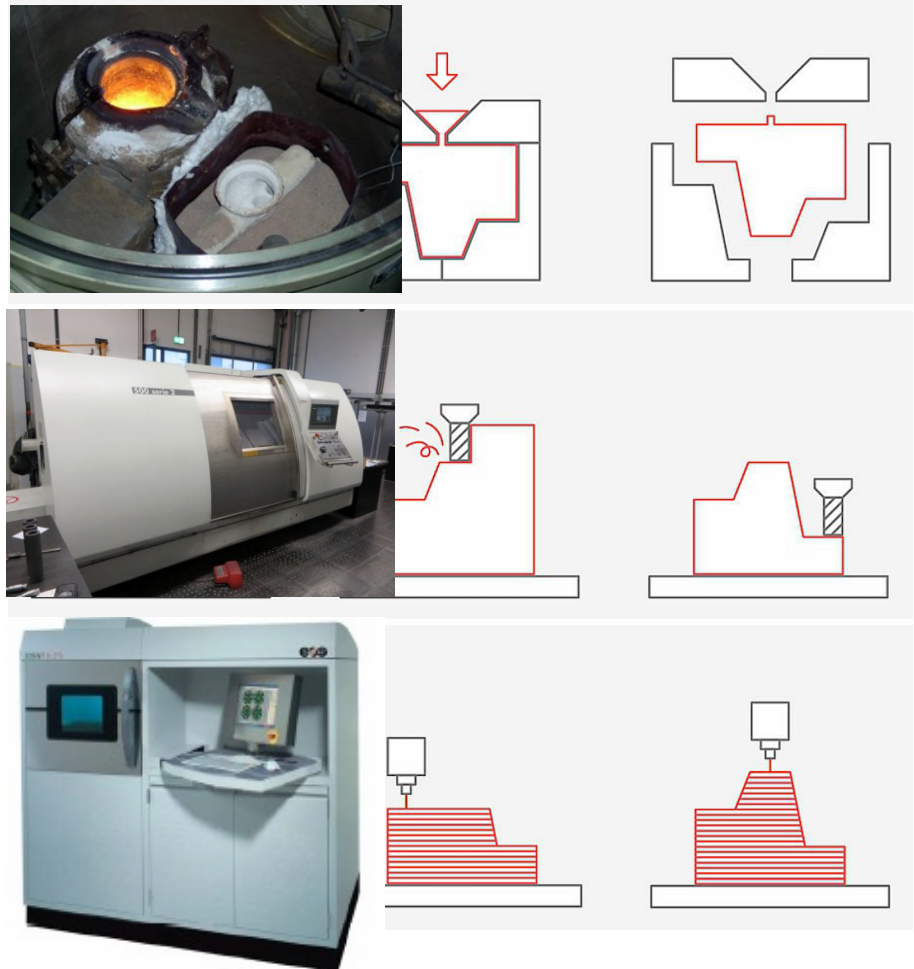
Anatomik Uyumluluđu Tam Olmayan İmplantlar



Çözüm; kişinin kendi anatomisine **tam uyumluluk** sağlayan
kişiyeye özel implant üretimi

İmplant Üretim Modelleri

- **Formative manufacturing**
(enjeksiyon-kalıp üretimi)
- **Subtractive manufacturing**
(CNC, torna-freze üretimi)
- **Additive manufacturing**
(katmanlı üretim)



CNC x 3B Yazıcı

VOL. 11, NO. 1, JANUARY 2016

ARNP Journal of Engineering and Applied Sciences

©2006-2016 Asian Research Publishing Network (ARNP). All rights reserved.

ISSN 1819-6608



www.arnpjournals.com

MANUFACTURE OF MEDICAL ORTHOPAEDIC IMPLANTS USING COMPUTED TOMOGRAPHY IMAGING AND RAPID PROTOTYPING

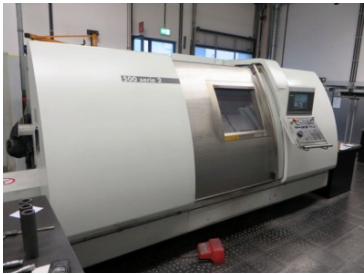
Majid Moayedfar^{1, 2, 3}, Ahmad Majdi Abdul Rani^{1, 2}, S. Emamiana¹, Ali Haghighizadeh³ and NahidJafari³

¹Department of Mechanical Engineering, Universiti Teknologi Petronas, Bandar Seri Iskandar Perak DarulRidzuan, Malaysia

²Centre of Intelligent Signal and Imaging Research, Universiti Teknologi Petronas, Bandar Seri Iskandar Perak DarulRidzuan, Malaysia

³Department of Physics, Islamic Azad University of Lenjan, Lenjan, Esfahan, Iran

E-Mail: majdi@petronas.com.my



CNC

- Standart malzemeler
- Basit ve temel formlar
- Tek materyal/malzeme
- Mass production
- Montaj istasyonları
- Çok adımlı / montajlı üretim

3B yazıcı

3B Yazıcıların Avantajları

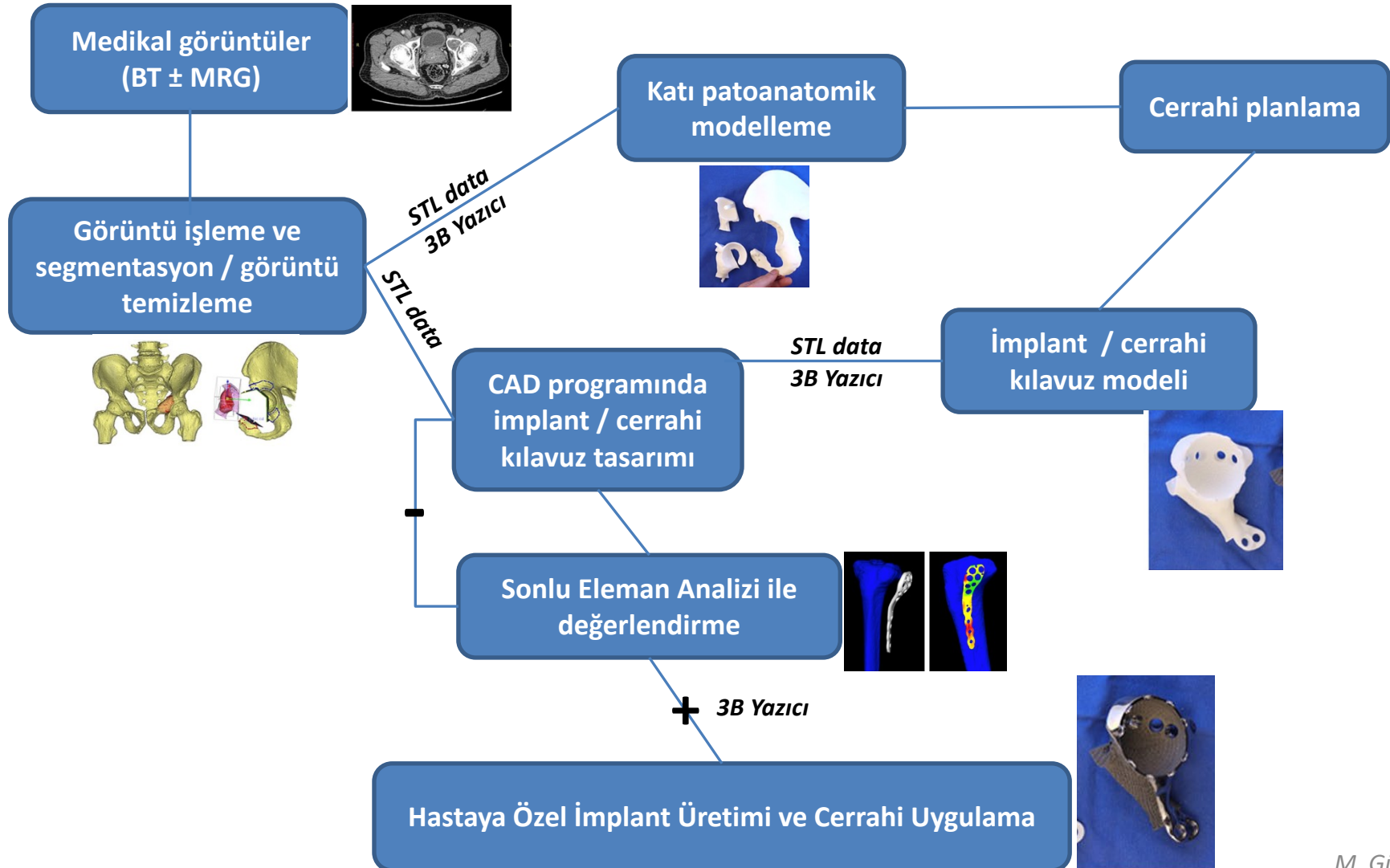
Kısa sürede, hızlı ve düşük maliyetli
prototip üretebilme

Karmaşık yüzey geometrisine sahip
nesnelerin kolaylıkla üretimi

Hammadde ve işçilik maliyeti düşük

Hastaya Özel İmplant Üretiminde Aşamalar

Çalışma Prensibi





Hastaya Özel İmplant Üretiminde Aşamalar

İhtiyaç duyulan bilgisayar programları

Görüntü İşleme (image segmentation) programları

- Osirix *
- Horos *
- Invesalius *
- 3D Slicer *
- Itksnap
- Materialize *
- Amira

Görüntü Temizleme (mesh cleaning- segmentation- editing) programları

- Meshmixer *
- Meshlab *
- Blender *

CAD/CAM programları

- Autocad
- Solidworks
- Catia
- 3D StudioMax
- Fusion 360 *
- Inventor fusion *
- Rhino Ceros *
- 123 Design *
- 123D Catch
- Thinkercad *
- Creo 2.0
- Sketch Up
- Onshape *
- 3D Tin
- 3D Coat
- Strata Design
- Geomagic Design

3D yazıcılara ait dilimleme (slicer) programları

- Cura *
- MatterControl 2.0 *
- KISSlicer *
- Slic3r *
- SliceCrafter
- IceSL
- Octoprint *
- Repetier-Host *
- AstroPrint
- 3D-Tool Free Viewer

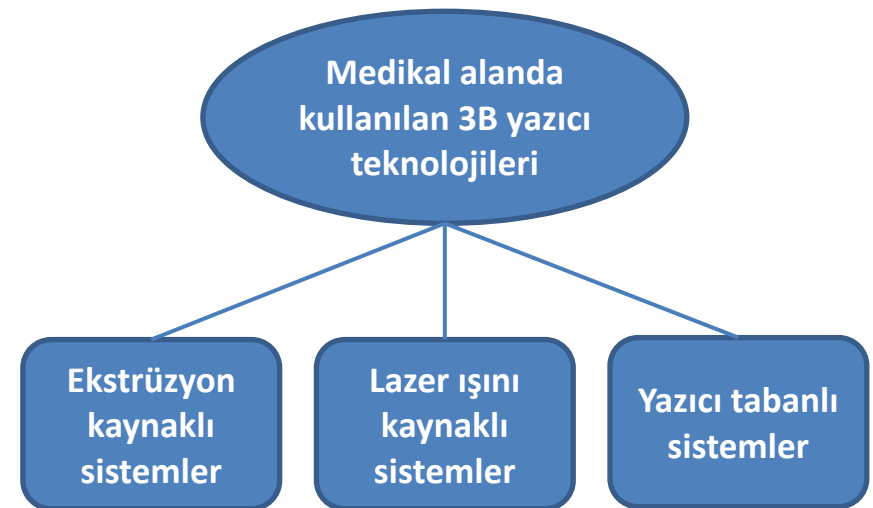


Katmanlı Üretim Teknolojileri

(American Society for Testing and Materials - ASTM)

2010

- Material extrusion (Extrusion Deposit)
- Vat Photopolymerisation
- Material Jetting
- Binder Jetting
- Sheet Lamination
- Powder Bed Fusion
- Direct Energy Deposition



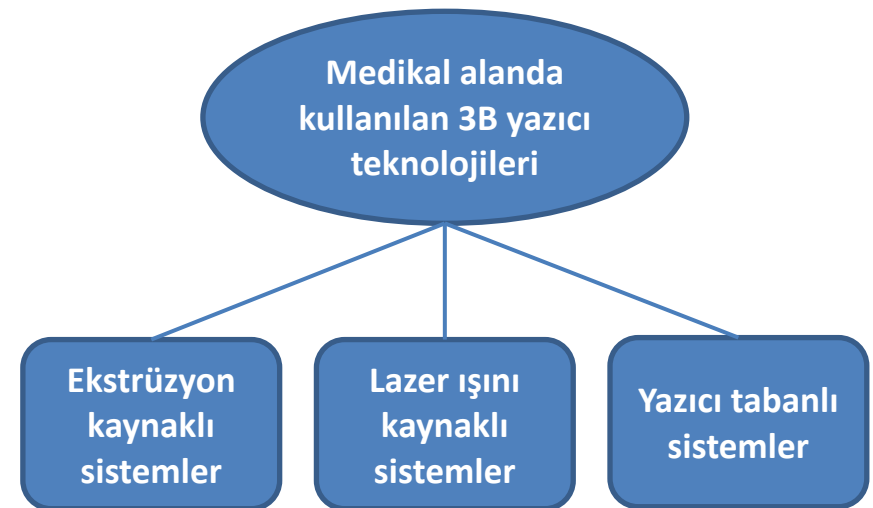


Katmanlı Üretim Teknolojileri

(American Society for Testing and Materials - ASTM)

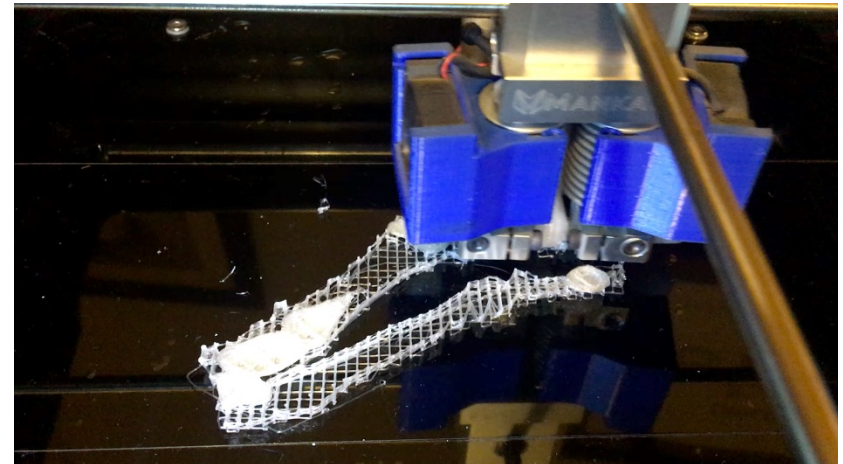
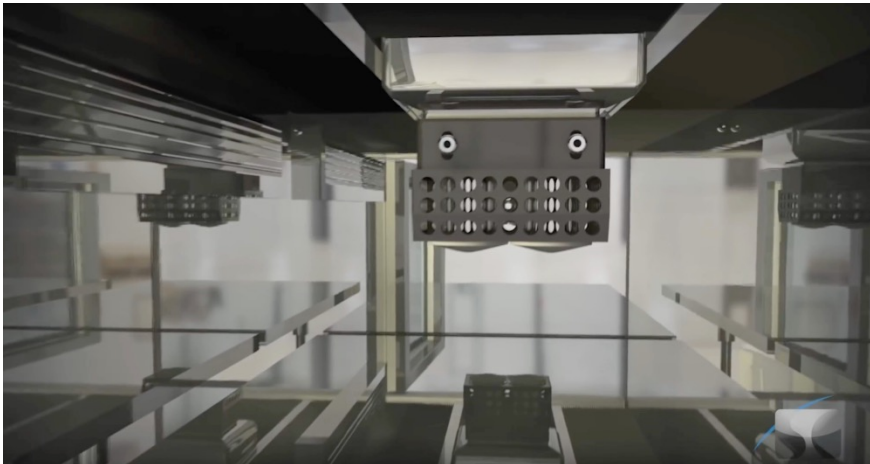
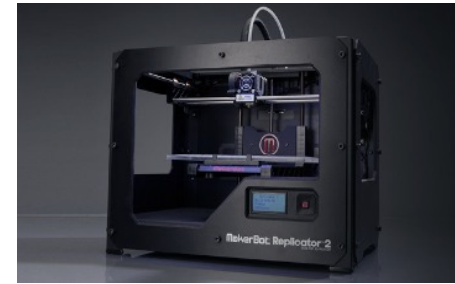
2010

- **Material extrusion (Extrusion Deposit)**
- Vat Photopolymerisation
- Material Jetting
- Binder Jetting
- Sheet Lamination
- **Powder Bed Fusion**
- **Direct Energy Deposition**



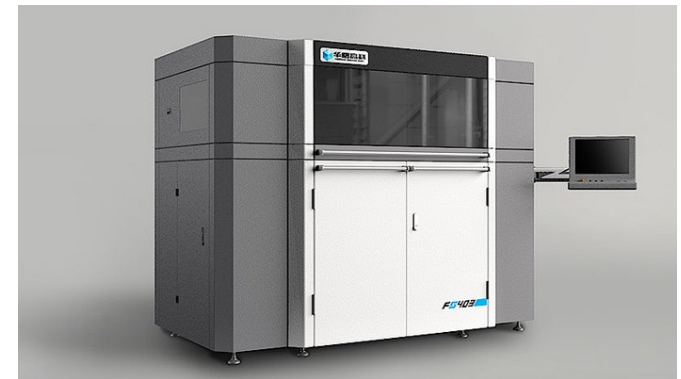
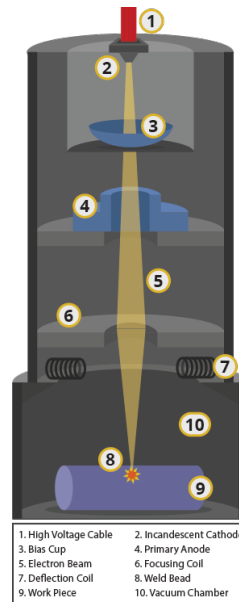
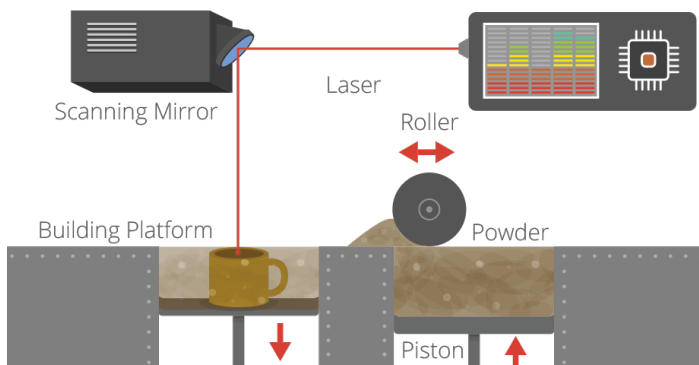
Ham Madde Ekstrüzyonu

- Material Extrusion
- **FDM – Fused deposition modeling**
- **FFF – Free Form Fabrication, Fused Filament Fabrication**
- Erimiş birikimli modelleme (Katman birikimli modelleme)
- Termoplastik malzeme (ABS, PLA, PEEK, PEKK v.s.)



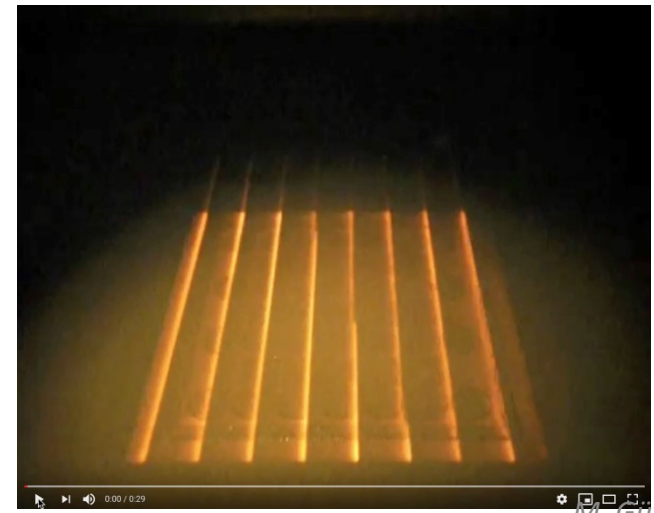
Toz Kaynaştırma

- Powder Bed Fusion
- **DMLS / SLM – Direct Metal Laser Sintering / Selective Laser Melting**
- **SLS – Selective Laser Sintering**
- **EBM – Electron Beam Melting**
- Yüksek güçlü lazer ışını, elektron saçma-ışın
- Thermoplastic polyamide, Metal (Titanyum, Co-Cr, Paslanmaz çelik, Alüminyum), seramik toz



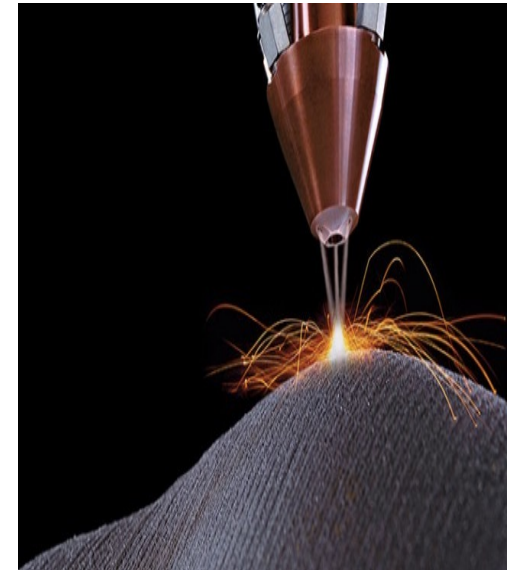
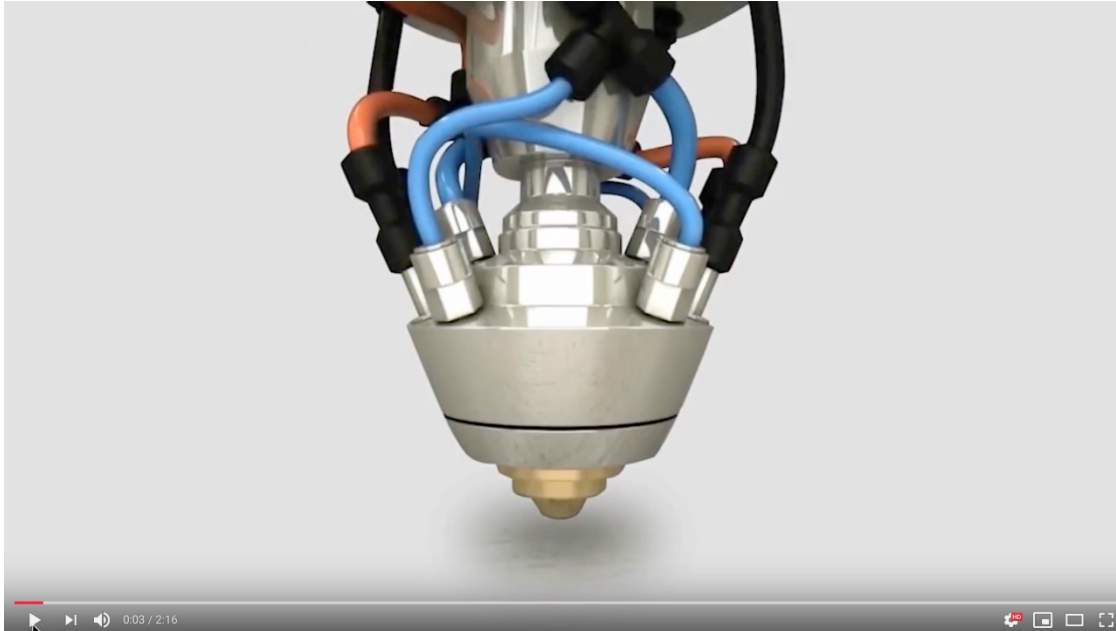
Toz Kaynaştırma

- Powder Bed Fusion
- **SLS – Selective Laser Sintering**
- **DMLS / SLM – Direct Metal Laser Sintering / Selective Laser Melting**
- **EBM – Electron Beam Melting**
- Yüksek güçlü lazer ışını, elektron saçma-ışın
- Thermoplastic polyamide, Metal (Titanyum, Co-Cr, Paslanmaz çelik, Alüminyum), seramik toz



Enerji Biriktirme

- Direct Energy Deposition
- Metal, seramik toz
- Yüksek güçlü lazer ışını, elektron saçma-ışın



3D Yazıcılarda Kullanılan Malzemeler

- **Polimerler**

- Filament, photopolymer resin ya da toz formunda
- Termoplastik
- Termoset



- **Metaller**

- Toz formunda

- **Diğer maddeler**

- Seramik ve seramik kompozitleri
- Cam, ahşap v.s.
- Gıda malzemeleri
- Biyomalzemeler

*Cerrahi İmplant Üretiminde Kullanılan
Malzemeler*

Metaller (Ti4AlV6, 316 L, Co-Cr)

Polyether ether ketone (PEEK)

Polyether ketone ketone (PEKK)

Poly lactic acid (PLA)

Alginate

Chitosan

Collagen

Hydroxyapatite

Tri calcium phosphate (TCP)

American Society of Mechanical Engineers

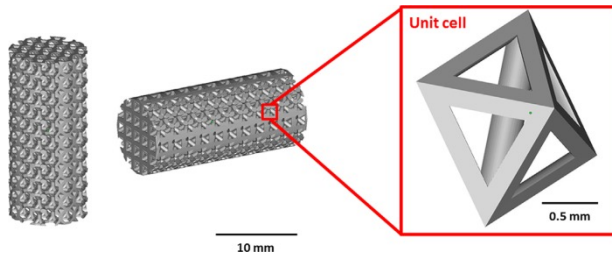
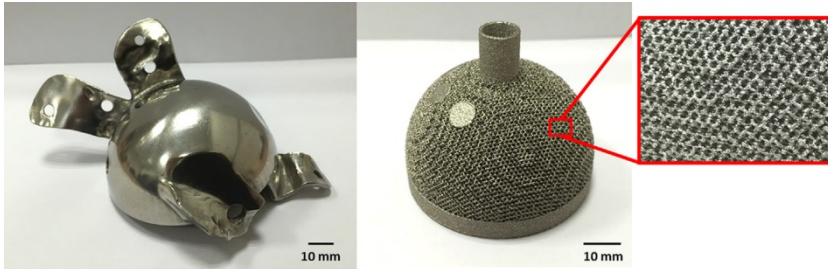
Metal implantlar

JOURNAL OF ORTHOPAEDIC RESEARCH MARCH 2016

Laser and Electron-Beam Powder-Bed Additive Manufacturing of Metallic Implants: A Review on Processes, Materials and Designs

Swée Leong Sing,^{1,2} Jia An,² Wai Yee Yeong,^{1,2} Florencia Edith Wiria^{1,3}

¹SIMTech-NTU Joint Laboratory (3D Additive Manufacturing), Nanyang Technological University, HW3-01-01, 65A Nanyang Drive, Singapore 637333, ²Singapore Centre for 3D Printing, School of Mechanical & Aerospace Engineering, Nanyang Technological University, HW1-01-05, 2A Nanyang Link, Singapore 637372, ³Singapore Institute of Manufacturing Technology, 71 Nanyang Drive, Singapore 638075



	DMLS	EBM
Malzeme	Metal toz (ince)	Metal toz (kalın)
Güç kaynağı	Fiber /CO2 lazer (1000 Watt)	Elektron ışını (3000 Watt)
İşlem sıcaklığı	200 °C	650-1100 °C
Destek yapı ihtiyacı	+	-
Ön ısıtma	-	+
İşlem ortamı	Soygaz (argon)	Vakum
Filtre gereksinimi	+	-
Yüzey pürüzlülüğü	12-14 RA	18-20 RA
Üretim hızı	+	+++
Üretim sonrası işlem (post-processing)	+++	+
Mekanik öz. (statik)	Benzer	
Mekanik öz. (dinamik)	+	+++
Maliyet	Benzer	

Polyether ether ketone (PEEK)

Hindawi
BioMed Research International
Volume 2018, Article ID 4520636, 8 pages
<https://doi.org/10.1155/2018/4520636>

Research Article

Patient-Specific Surgical Implants Made of 3D Printed PEEK: Material, Technology, and Scope of Surgical Application

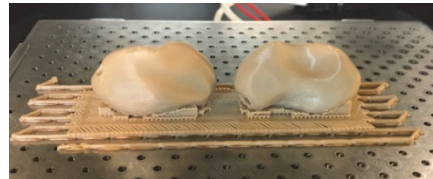
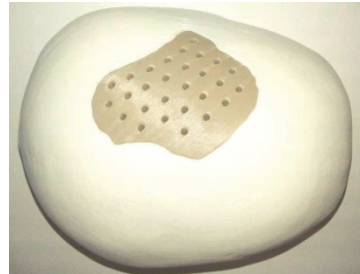
Philipp Honigmann^{1,2}, Neha Sharma^{2,3}, Brando Okolo⁴, Uwe Popp⁴,
Bilal Msallem^{2,3} and Florian M. Thieringer^{2,3}

¹Hand Surgery, Kantonsspital Baselland, Liestal, Switzerland

²Medical Additive Manufacturing Research Group, Department of Biomedical Engineering, University of Basel, Basel, Switzerland

³Department of Oral and Cranio-Maxillofacial Surgery, University Hospital Basel, Basel, Switzerland

⁴Apium Additive Technologies GmbH, Karlsruhe, Germany



FDM teknolojisi ile üretim
Biomimetik materyal
Termoplastik polimer
Radyolusent ve MRG uyumlu
Elastik modülüsü kemiğe yakın



Hastaya Özel İmplant Uygulamaları

- **Ortopedik cerrahi**
- Kraniyal cerrahi
- Maksillofasial cerrahi
- Dental uygulamalar
- Kardiyovasküler cerrahi
- Plastik cerrahi
- Üroloji
- Oftalmoloji
- Genel cerrahi

Tümör cerrahisi
Omurga cerrahisi
Eklem replasman cerrahisi
(primer-revizyon)
Travma cerrahisi
Ayak-ayak bileği cerrahisi
Deformite düzeltme cerrahisi

Tümör Cerrahisi

Fan et al. *World Journal of Surgical Oncology* (2015) 13:308
DOI 10.1186/s12957-015-0723-2



WORLD JOURNAL OF
SURGICAL ONCOLOGY

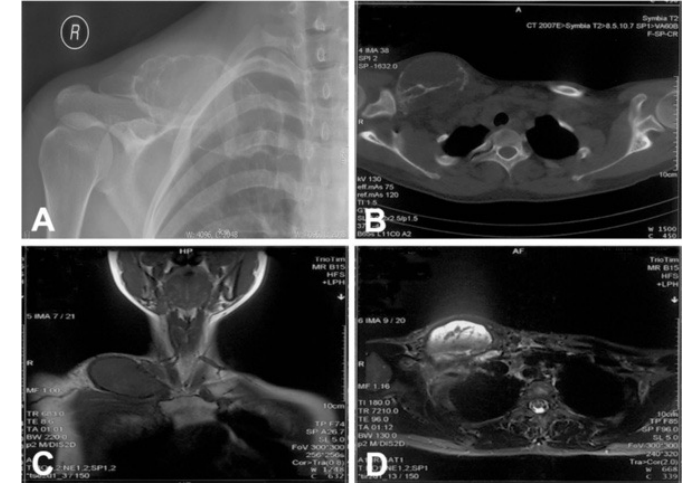
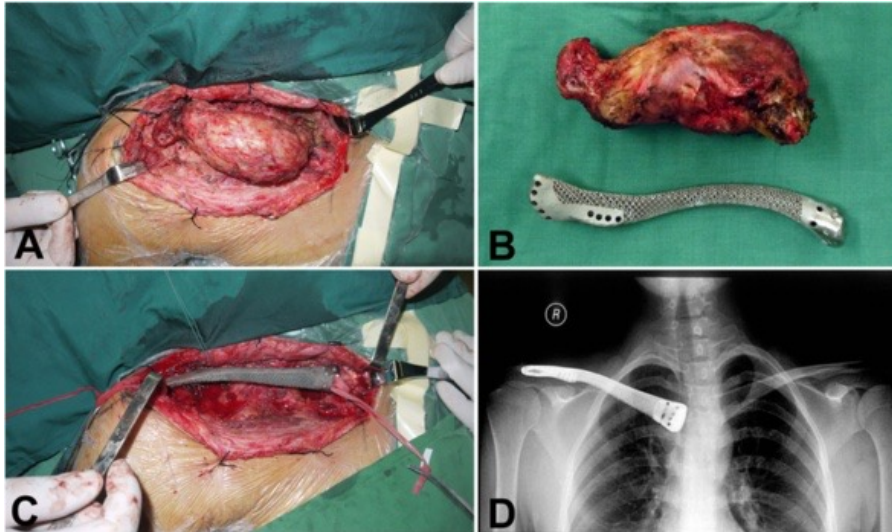
RESEARCH

Open Access



Implantation of customized 3-D printed titanium prosthesis in limb salvage surgery: a case series and review of the literature

Hongbin Fan[†], Jun Fu[†], Xiangdong Li, Yanjun Pei, Xiaokang Li, Guoxian Pei and Zheng Guo^{*}



21 yaş kadın
Sağ klavikula Ewing sarkom
Sanal 3B modelleme
EBM teknolojisi ile titanyum implant
24 aylık takip

Tümör Cerrahisi

Fan et al. *World Journal of Surgical Oncology* (2015) 13:308
DOI 10.1186/s12957-015-0723-2



WORLD JOURNAL OF
SURGICAL ONCOLOGY

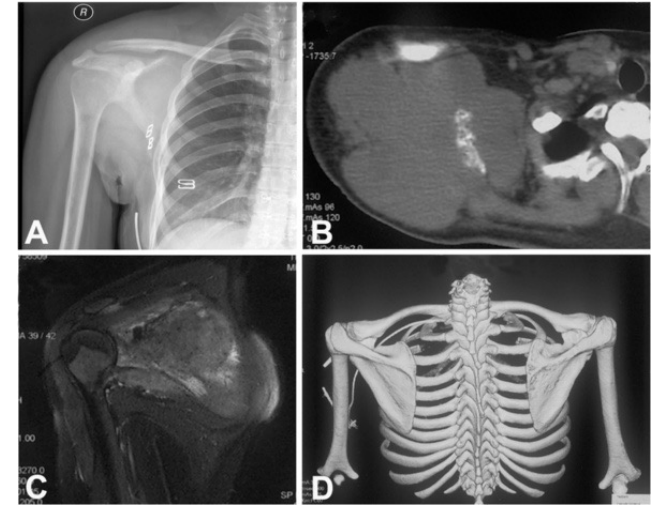
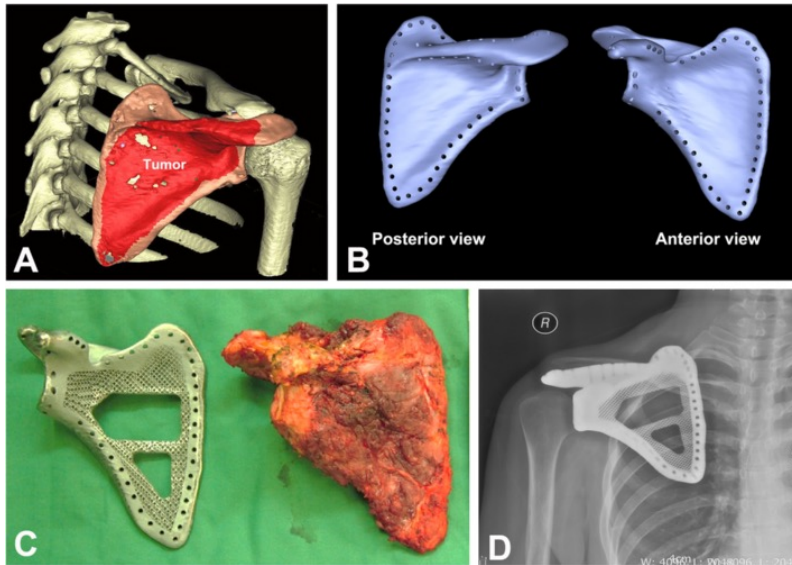
RESEARCH

Open Access



Implantation of customized 3-D printed titanium prosthesis in limb salvage surgery: a case series and review of the literature

Hongbin Fan[†], Jun Fu[†], Xiangdong Li, Yanjun Pei, Xiaokang Li, Guoxian Pei and Zheng Guo^{*}



35 yaş kadın
Sağ skapula Ewing sarkom
Sanal 3B modelleme
EBM teknolojisi ile titanyum implant
21 aylık takip

Tümör Cerrahisi

Fan et al. *World Journal of Surgical Oncology* (2015) 13:308
DOI 10.1186/s12957-015-0723-2



WORLD JOURNAL OF
SURGICAL ONCOLOGY

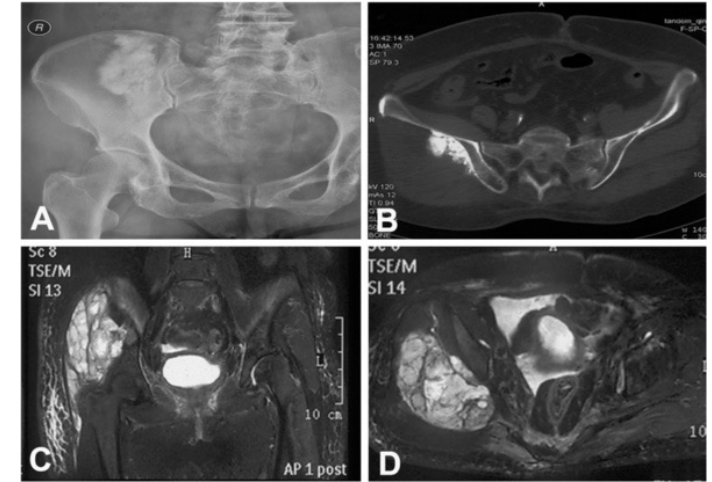
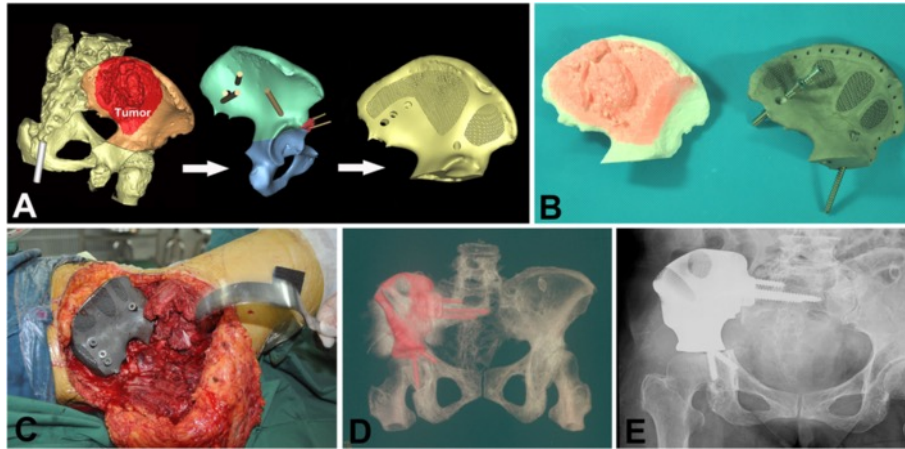
RESEARCH

Open Access



Implantation of customized 3-D printed titanium prosthesis in limb salvage surgery: a case series and review of the literature

Hongbin Fan[†], Jun Fu[†], Xiangdong Li, Yanjun Pei, Xiaokang Li, Guoxian Pei and Zheng Guo^{*}



56 yaş kadın
Pelvik kondrosarkom
Sanal 3B modelleme
EBM teknolojisi ile titanyum implant
18 aylık takip

Tümör Cerrahisi

COMPUTER AIDED SURGERY
2015, VOL. 20, NO. 1, 14-23
<http://dx.doi.org/10.3109/10929088.2015.1076039>



Taylor & Francis
Taylor & Francis Group

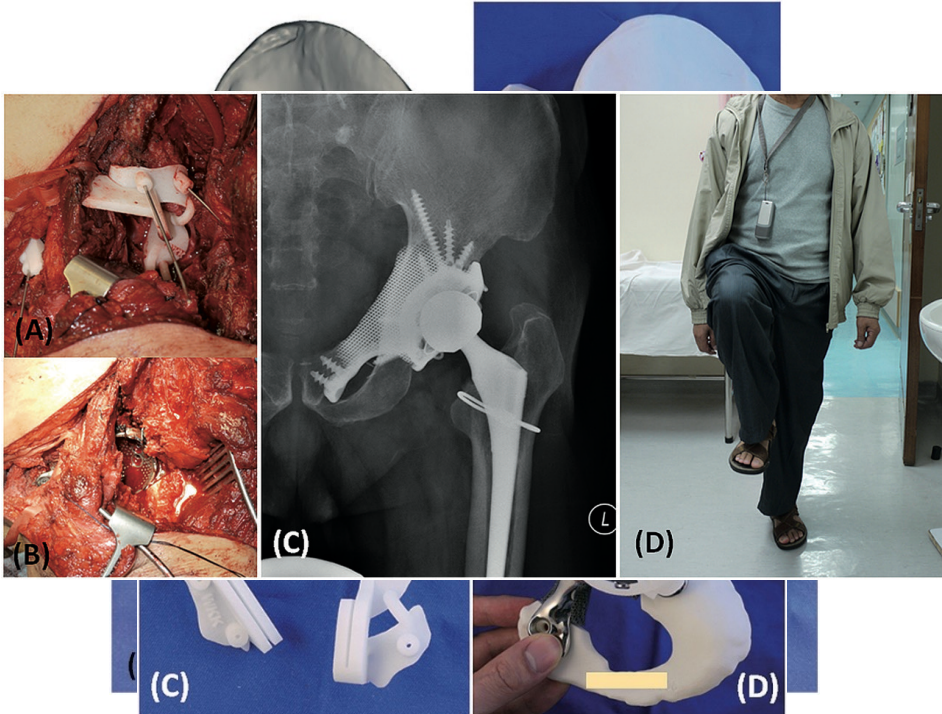
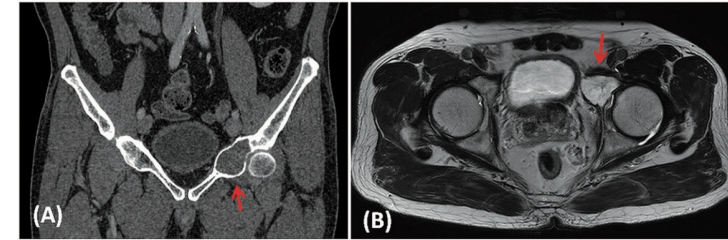
ORIGINAL ARTICLE

OPEN ACCESS

One-step reconstruction with a 3D-printed, biomechanically evaluated custom implant after complex pelvic tumor resection

K. C. Wong^a, S. M. Kumta^a, N. V. Geel^b, and J. Demol^b

^aDepartment of Orthopaedics and Traumatology, Prince of Wales Hospital, Shatin, Hong Kong and ^bMobelife NV, Leuven, Belgium



65 yaş erkek
Sol asetabulum kondrosarkom
Sanal 3B modelleme ve cerrahi
simülasyon
Kişiyeye özel cerrahi kesi kılavuz
SLM teknolojisi ile titanyum implant
11 aylık takip

Omurga Cerrahisi

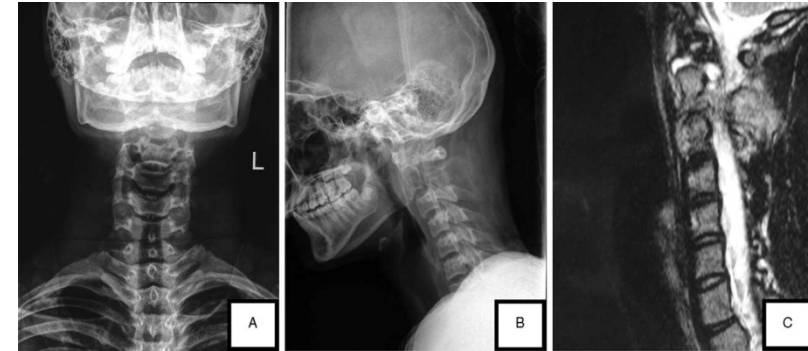
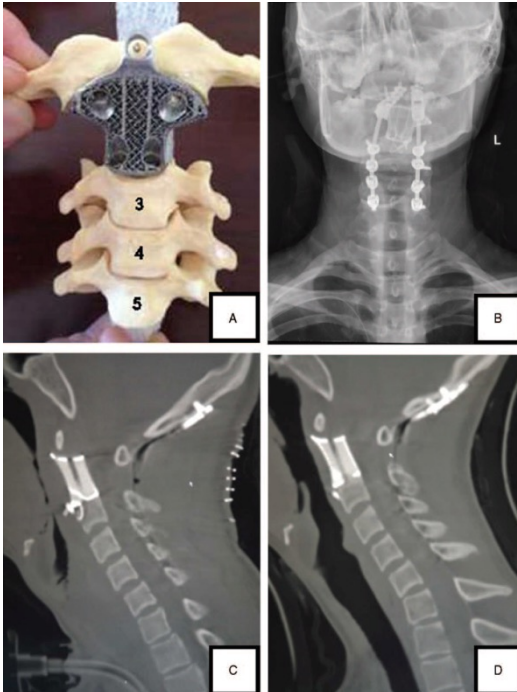
Spine

SPINE Volume 41, Number 1, pp E50–E54
© 2016, Wolters Kluwer Health, Inc. All rights reserved

CASE REPORT

Reconstruction of the Upper Cervical Spine Using a Personalized 3D-Printed Vertebral Body in an Adolescent With Ewing Sarcoma

Nanfang Xu, MD, Feng Wei, MD, Xiaoguang Liu, MD, Liang Jiang, MD, Hong Cai, MD, Zihé Li, MD, Miao Yu, MD, Fengliang Wu, MD, and Zhongjun Liu, MD



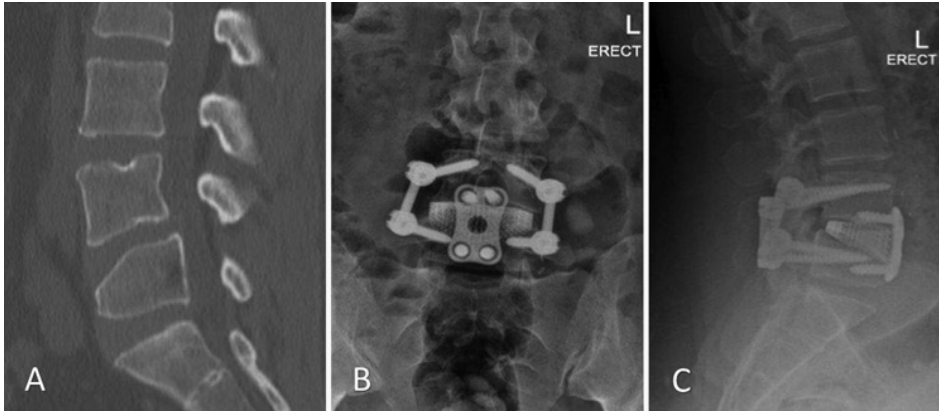
12 yaş erkek
C2 Ewing sarkom
Çift aşamalı cerrahi
EBM teknolojisi ile titanyum vertebral
body implantı
12 aylık takip

Omurga Cerrahisi

The utility of 3D printing for surgical planning and patient-specific implant design for complex spinal pathologies: case report

Ralph J. Mobbs, MD, FRACS,¹⁻³ Marc Coughlan, MBBS, FRACS,²
Robert Thompson, MBus, BInfoTech, DipAppSci,⁴ Chester E. Sutterlin III, MD,⁵⁻⁷ and
Kevin Phan, BSc¹⁻³

¹NeuroSpine Surgery Research Group (NSURG), Prince of Wales Private Hospital, Sydney; ²Prince of Wales Private Hospital, Sydney; ³University of New South Wales, Sydney; ⁴Anatomics Pty. Ltd., Melbourne, Australia; and ⁵Department of Neurosurgery, University of Florida, Gainesville; ⁶Spinal Health International, Inc., Longboat Key, Florida; and ⁷ProCRO Pty. Ltd., Sydney, New South Wales, Australia



52 yaş kadın
L5 konjenital hemivertebral, segmental kifoz
EBM teknolojisi ile titanyum disk protezi
12 aylık takip

Eklem Replasman Cerrahisi

The Journal of Arthroplasty 28 (2013) 1770–1775

Contents lists available at ScienceDirect

The Journal of Arthroplasty

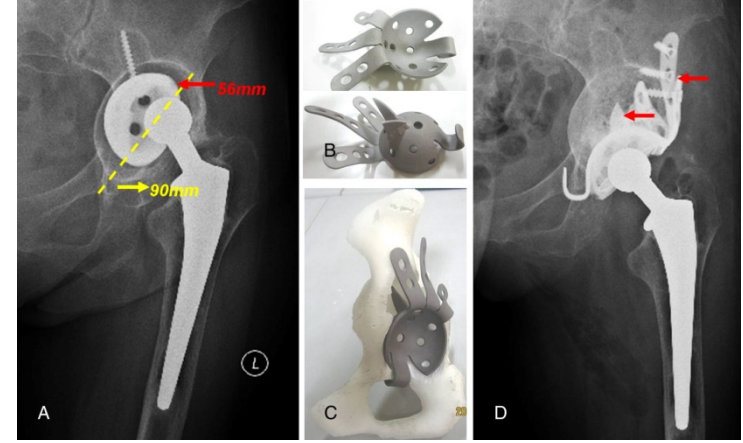
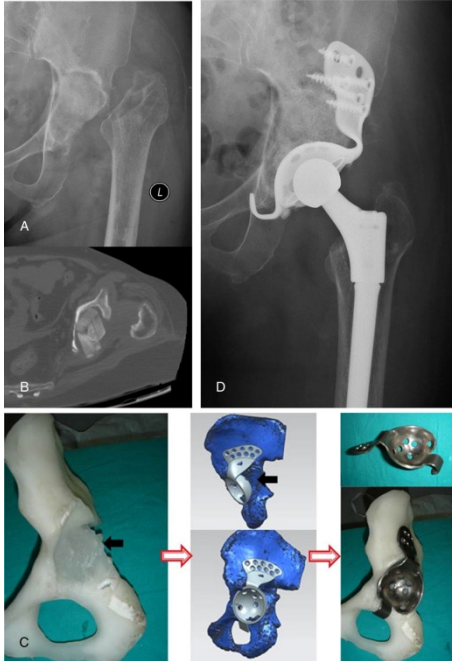
journal homepage: www.arthroplastyjournal.org



Revision of Complex Acetabular Defects Using Cages with the Aid of Rapid Prototyping

Huiwu Li, MD, Liao Wang, MD, Yuanqing Mao, MD, You Wang, MD, Kerong Dai, MD, Zhenan Zhu, MD

Department of Orthopaedics, Shanghai 9th People's Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai 200011, P.R. China



25 hasta (15 kadın, 10 erkek)

Ort. yaş 61 (43-89)

Kompleks asetabuler defekt (Pap. Tip 2 ve 3)

13 olguda hastaya özel asetabuler implant

Ort 4,4 yıl (1-9) takip

Harris k.s. 36,1 – 82,6

1 hastaya postop dislokasyon

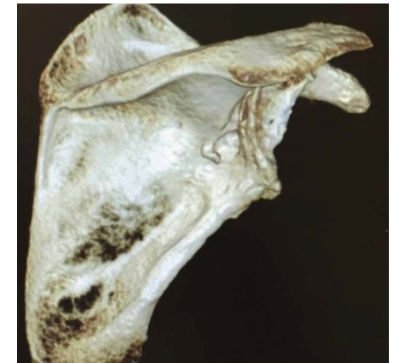
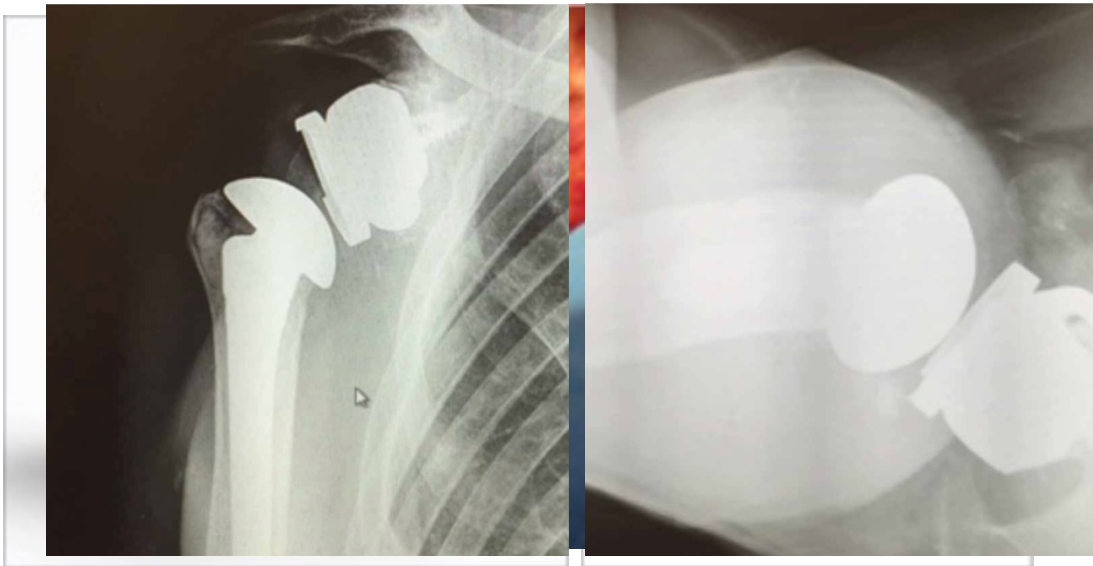
Mekanik yetmezlik ve gevşeme yok

Eklem Replasman Cerrahisi

The American Journal of Orthopedics® March/April 2017

Novel Solution for Massive Glenoid Defects in Shoulder Arthroplasty: A Patient-Specific Glenoid Vault Reconstruction System

David M. Dines, MD, Lawrence Gulotta, MD, Edward V. Craig, MD, and Joshua S. Dines, MD



Travma Cerrahisi

Medicine®

OBSERVATIONAL STUDY

OPEN

Treatment of Intercondylar Humeral Fractures With 3D-Printed Osteosynthesis Plates

Feng Shuang, MD, Wei Hu, MD, Yinchu Shao, MD, Hao Li, MD, and Hongxing Zou, MD



Distal humerus interkondiler kırıklı 13 hasta
7 hastada konvansiyonel plak osteosentezi
6 hasta kişiye özel dizayn plak osteosentezi
Ort. takip süresi 10,6 ay (6-13)
Kişiye özel plak grubunda ameliyat süresi
daha kısa
Son takiplerde gruplar arasında dirsek
skorlaması farklı değil

Travma Cerrahisi

J Hand Surg Am. Volume 42, Issue 9, Pages 747.e1–747.e6

SCIENTIFIC ARTICLE

Biomechanical Properties of 3-Dimensional Printed Volar Locking Distal Radius Plate: Comparison With Conventional Volar Locking Plate

Sung-Jae Kim, MD,* Young-Hoon Jo, MD,† Wan-Sun Choi, MD,‡ Chang-Hun Lee, MD,§
Bong-Gun Lee, MD, PhD,† Joo-Hak Kim, MD, PhD,|| Kwang-Hyun Lee, MD, PhD†



Biyomekanik çalışma

12 sentetik kompozit radius

3B yazıcı ile üretilmiş plak x Konvansiyonel plak

Segmental osteotomi sonrası statik ve dinamik yüklenme testleri

3B yazıcı ile üretilmiş plakta daha yüksek direngenlik, yüklenme dayanımı

Anatomik uyumun ve vida pozisyonunun avantajı

Ayak – Ayak Bileği Cerrahisi

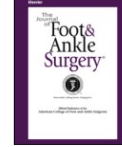


ELSEVIER

Contents lists available at [ScienceDirect](http://ScienceDirect.com)

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org



Case Reports and Series

Large Osseous Defect Reconstruction Using a Custom Three-Dimensional Printed Titanium Truss Implant

Eric So, DPM¹, Vincent H. Mandas, DPM², Lee Hlad, DPM³

¹Chief Resident, Grant Medical Center, Columbus, OH

²Resident, Grant Medical Center, Columbus, OH

³Foot and Ankle Surgeon, Step Lively Foot and Ankle Centers, Columbus, OH



64 yaş kadın

Lapidus prosedürü sonrası septik nonunion

2 aşamalı cerrahi

Debridman sonrası AB spacer ve monoplaner fiksator

Truss tipi özel üretim implant ile rekonstrüksiyon

17 aylık takip

Ayak – Ayak Bileği Cerrahisi

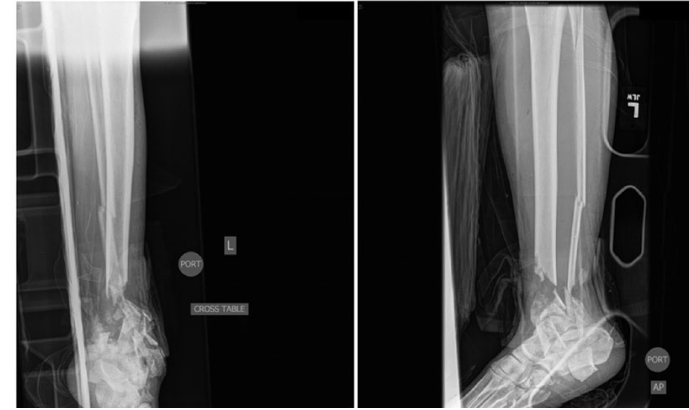
Case Report

Salvage of Severe Foot and Ankle Trauma With a 3D Printed Scaffold

Kamran S. Hamid, MD, MPH¹, Selene G. Parekh, MD, MBA¹,
and Samuel B. Adams, MD¹

AMERICAN ORTHOPAEDIC
FOOT & ANKLE SOCIETY.

Foot & Ankle International®
1-7
© The Author(s) 2016
Reprints and permissions:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/1071100715620895
fai.sagepub.com



46 yaş kadın
Sol açık tibia distal eklem içi kırık
Parçalı fibula, talus, kalkaneus,
metatars ve kuboid kırıkları
2 aşamalı cerrahi
Geçici eks. Fiks. ve K teli tespiti + AB
spacer
Truss tipi özel üretim implant ile
rekonstrüksiyon + IM çivi ile pantalar
artrodez
13 aylık takip



Hastaya Özel İmplantlarda FDA Perspektifi

3D printing in the research and development of medical devices

12

Huan Zhou¹ and Sarit B. Bhaduri²

¹School of Mechanical Engineering, Jiangsu University of Technology, Changzhou, P.R. China,

²Department of Mechanical, Industrial and Manufacturing Engineering, The University of Toledo, Toledo, OH, United States

Biomaterials in Translational Medicine. DOI: <https://doi.org/10.1016/B978-0-12-813477-1.00012-8>

© 2019 Elsevier Inc. All rights reserved.

No.	Establishment	Product	Application
1	4WEB medical	Lateral spine truss system	Spine
2	Joimax	EndoLIF on-cage	Spine
3	K2M	CASCADIA lateral interbody system	Spine
4	ChoiceSpine	HAWKEYE vertebral body replacement system	Spine
5	ChoiceSpine	Tiger shark porous interbody system	Spine
6	EIT	Cellular titanium cervical cage	Spine
7	Medicrea	IB3D TLIF-banana	Spine
8	Camber Spine Technologies	SPIRA open matrix ALIF	Spine
9	Renovis Surgical Technologies	Posterior lumbar tesera porous Titanium interbody fusion systems	Spine
10	Centinel Spine	FLX devices	Spine
11	Stryker	Tritanium TL curved posterior lumbar cage	Spine
12	Zimmer Biomet	Unite3D bridge fixation system	Foot and ankle joint
13	Additive Orthopedics	3D printed bone segments, bunion correction system, locking lattice plating system, osteotomy wedge system	Fractures, osteotomies and arthrodesis of small bones
14	SI-BONE	iFuse-3D implant	Sacroiliac joint
15	Materialise	3D printed patient-specific radius and ulna osteotomy guides	Surgical guides

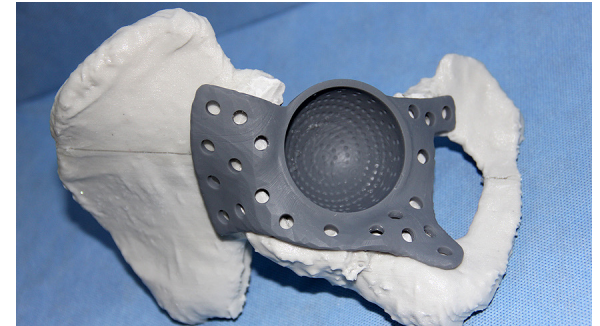
No.	Establishment	Product	Application
16	Mighty oak medical	FIREFLY pedicle screw navigation guides	Surgical guides
17	Zimmer biomet	Unite3D bridge fixation system	Ankle and foot
18	Onkos surgical	ELEOS limb salvage system	Oncology
19	BioArchitects	Titanium cranial/craniofacial implant	Cranium
20	Oxford performance materials	OsteoFab patient-specific facial device	Cranium
21	MedShape	FastForward bone tether plate	Hallux valgus
22	Oventus medical	O2Vent device	Sleep apnea
23	Candid	Teeth aligners (candid)	Orthodontics
24	Align technology	Teeth Aligners (invisalign)	Orthodontics
25	DynaFlex	Teeth aligners (EZ-align)	Orthodontics
26	EnvisonTEC	E-denture, E-guard, E-IDB, E-shell, E-guide, E-dent (materials for 3D printing)	Dentistry
27	Taulman3D	Guideline (material for 3D printing)	Surgical tools and implants
28	Lantos technologies	3D ear scanning system	Ear canal
29	3D Systems	VSP system	Software
30	Materialise	Mimics inPrint	Software
31	Phonak	Virto B-titanium hearing aids	Hearing aid



Hastaya Özel İmplant Üretimi

- **METÜM**

- GATA bünyesinde kurulan ve şu anda Sağlık Bilimleri Üniversitesine bağlı olan medikal tasarım ve üretim merkezi
- 2011 yılından itibaren faaliyette
- TSK Elele Vakfı ve ODTÜ işbirliği
- 4.3 milyon euro proje maliyeti
- Temel amaç
 - Kurum içi medikal ihtiyaçların karşılanması (cerrahi öncesi modelleme !!!)
 - Cerrahi öncesi eğitim amaçlı modelleme
 - Kişiyeye özel implant tasarım ve üretimi
 - AR-GE faaliyetleri





Hastaya Özel İmplant Üretimi

- **BTECH innovation (www.btech.com.tr)**
 - Endüstriyel 3D yazıcı kullanımı ile özel sektörde kişiye özel medikal ürün tasarımı ve üretimi
 - 3D yazıcı satımı, modelleme
 - Kalça, tümör ve omurga implantları üretimi
 - Özel girişim + Üniversite desteği (Hacettepe Üniv. ve ODTÜ)



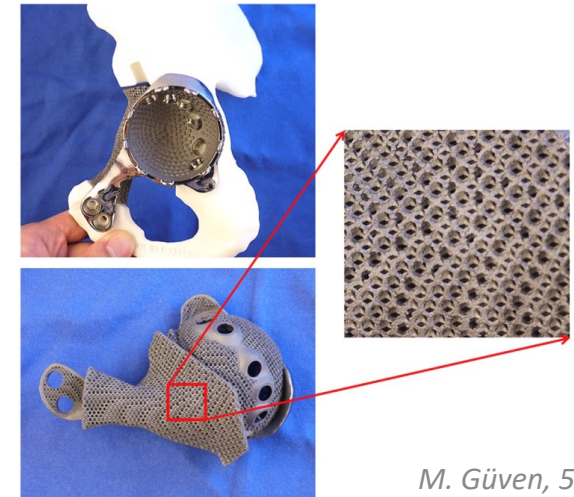
Hastaya Özel İmplantlar

Advantages and disadvantages of
3-dimensional printing in surgery:
A systematic review

Nicolas Martelli, PharmD, PhD,^{a,b} Carole Serrano, PharmD,^a Hélène van den Brink, PharmD, PhD,^b Judith Pineau, PharmD,^a Patrice Prognon, PharmD, PhD,^a Isabelle Borget, PharmD, PhD,^{b,c} and Salma El Batti, MD,^{d,e} Paris, Châtenay-Malabry, and Villejuif, France

- **Avantajlar**

- Hasta anatomisine tam/mükemmel uyum
- Kompleks geometriye sahip formların kolay üretimi
- Cerrahi sürenin kısalması
- Ameliyat sonrası klinik skorlardaki yükseklik
- Daha iyi ve sorunsuz kemik-implant integrasyonu
- İmplant ilişkili sorunların daha az olması (stress shielding, gevşeme, yetmezlik v.s.)





Hastaya Özel İmplantlar

Advantages and disadvantages of
3-dimensional printing in surgery:
A systematic review

- **Dezavantajlar**

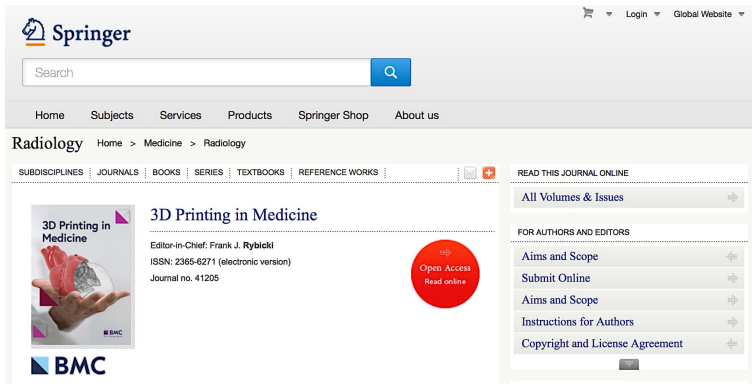
- Yüksek maliyet
- Tasarım ve üretim aşamalarındaki süre
- Cerrahi içerisindeki esnekliğin olmaması
- Üretim sonrası (postprocessing) işlem gereksinimi (finishing, cleaning)
- Mevzuat ve ruhsatlandırma sıkıntıları

Nicolas Martelli, PharmD, PhD,^{a,b} Carole Serrano, PharmD,^a H       van den Brink, PharmD, PhD,^b
Judith Pineau, PharmD,^a Patrice Prognon, PharmD, PhD,^a Isabelle Borget, PharmD, PhD,^{b,c} and
Salma El Batti, MD,^{d,e} Paris, Ch            , and Villejuif, France

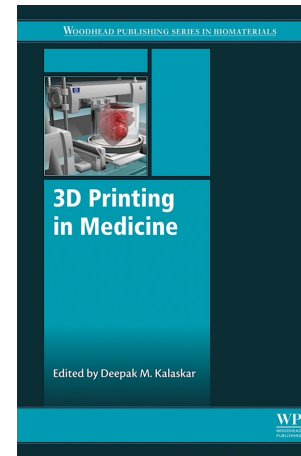


Bilimsel Literatürde

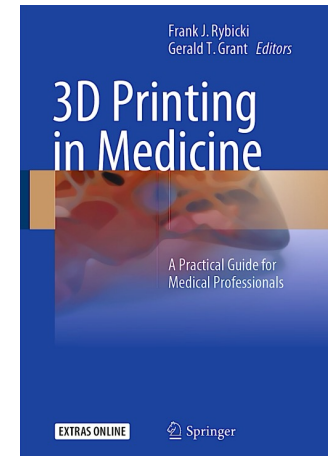
2015



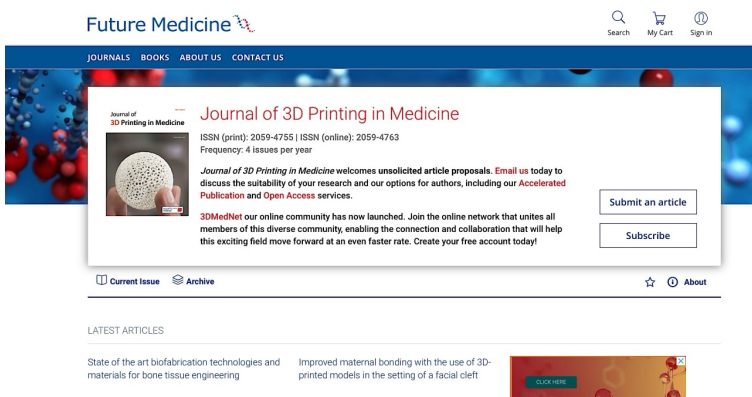
2017



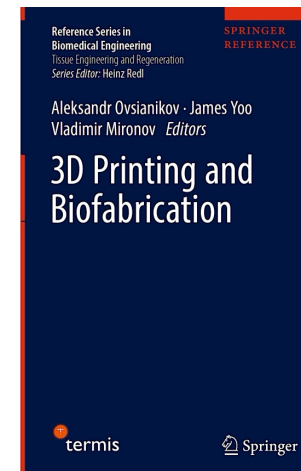
2017



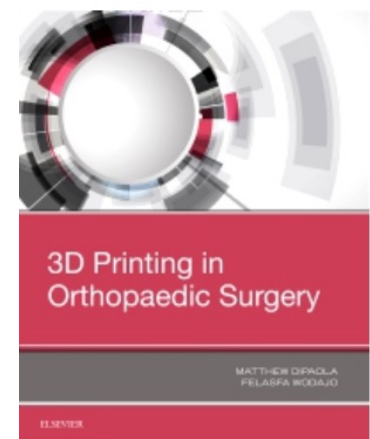
2017



2018



2019



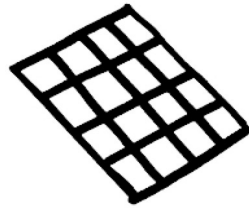


Hastaya Özel İmplant Üretiminde Gelecek

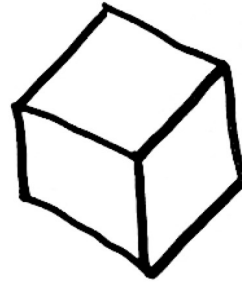
- Biyomimetik materyallerdeki gelişmeler
- 3B yazıcılarla üretilmiş skafold + biyomolekül / ilaçlar
- Bioprinting
- Bu amaca yönelik geliştirilmiş all-in-one bilgisayar platformları



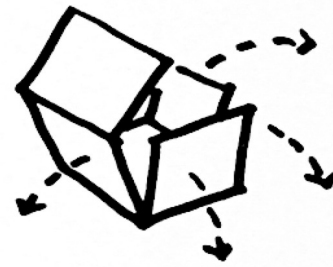
1D



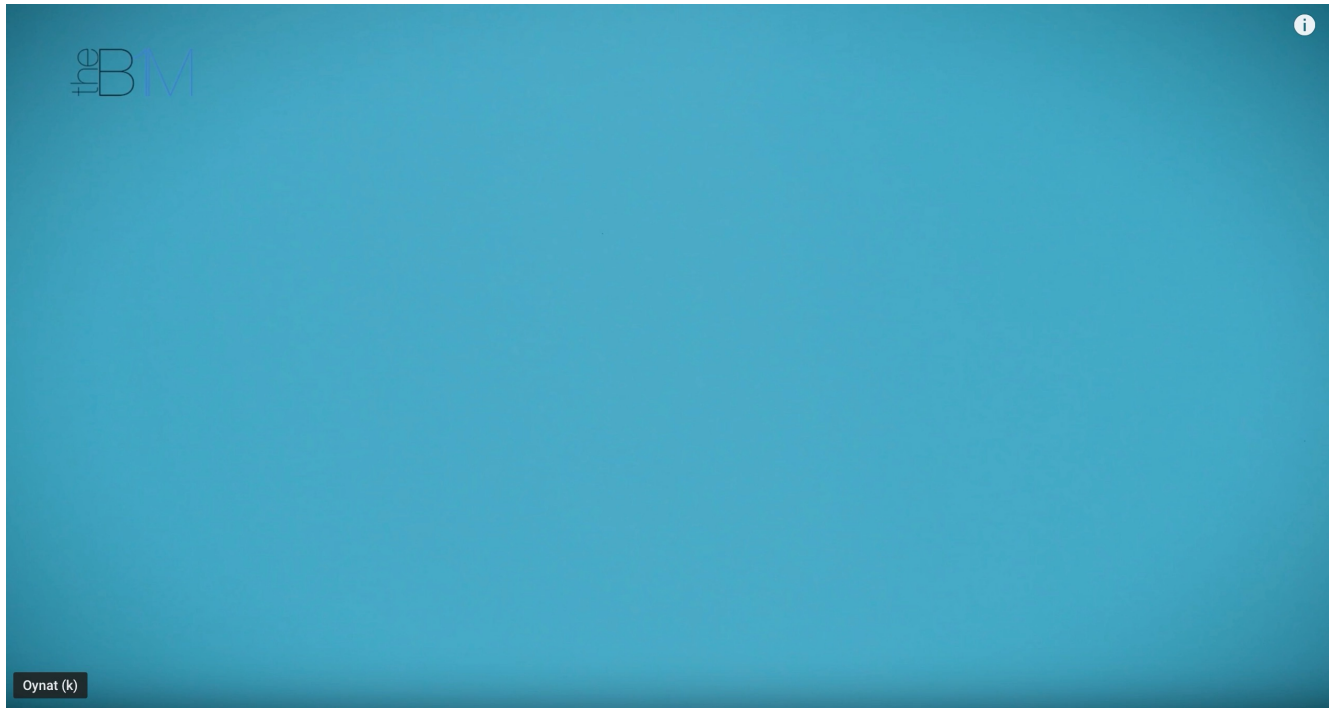
2D



3D



4D...





Teşekkür ederim ...