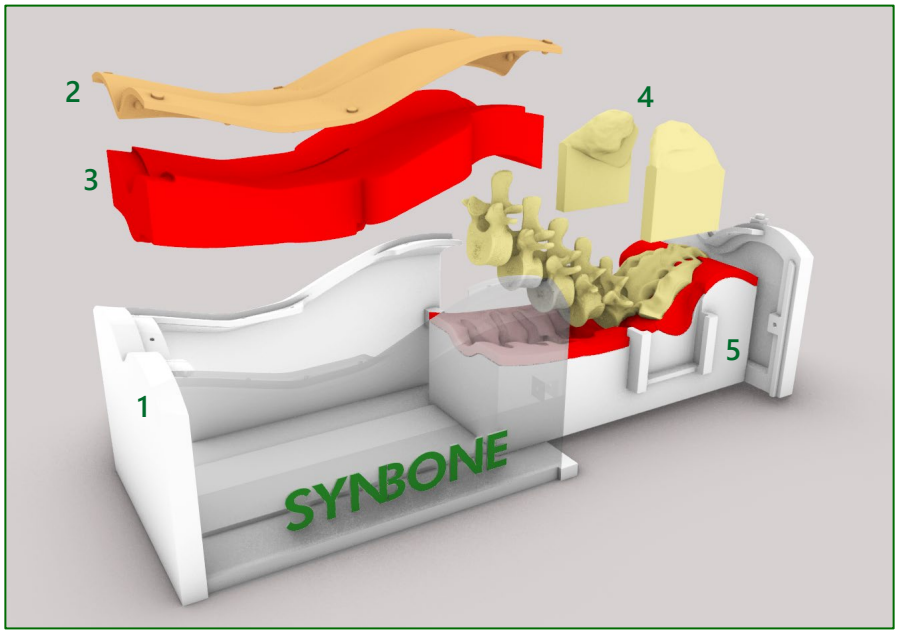
SYNBONE®
better education outcome

New Launch: Modular Lumbar Spine Task Trainer

This modular Lumbar Spine Task Trainer designed by SYNBONE® can be used for MIS-approach and various procedures for the dorsal access to the spine. The radio-opaque consumables guarantee good CT data quality. After each training only the consumables need to be replaced.

- **Customizable modular Task Trainer concept** to fit your needs
- **Skin Layer – easy to cut skin** with intermuscular fascia to avoid tearing while suturing
- **Soft Tissue Layer** – simulating muscle allows quick and accurate bone replacement
- **Bone Consumables** – Vertebraes L1–L5, Sacrum, Ilium left & right are easy to replace

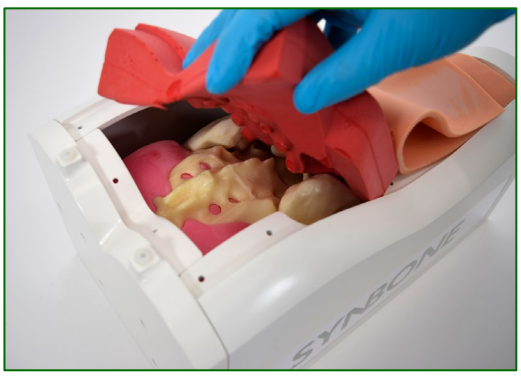


Components

1. Base plate with housing
2. Skin Layer
3. Soft Tissue Layer
4. Bone Consumables
5. Extendable back panel

Additional options on request

- Dura and Spinal Cords
- Nerves
- Disks and Ligaments
- Others to be defined

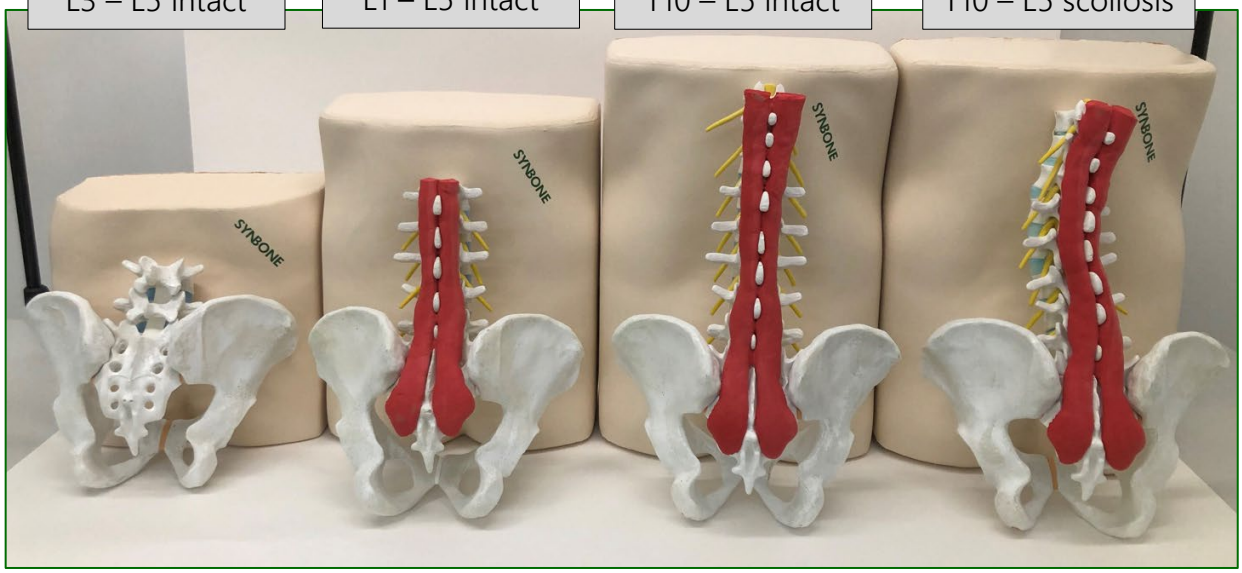


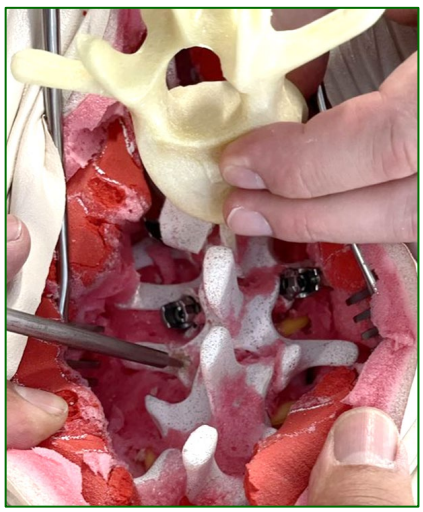
SYNBONE®
better education outcome

New Launch: Foamed-In Pathological Torsos

In summer of 2022, SYNBONE launched a foamed-in portfolio of Torsos, where Spine and Pelvis are covered with Soft Tissue & Skin to allow better experience while practicing various procedures for the dorsal access to the spine. The SYNBONE model can be used for external fixations, fusions, screwing, placing rods etc. under fluoroscopic or endoscopic conditions, as soft tissues are radiolucent, and bones are radiopaque.

LSS9311.10.FI LD9311.10.FI L3 – L5 intact	LSS9312.FI LD9312.FI L1 – L5 intact	LSS9313.FI LD9313.FI T10 – L5 intact	LSS9361.FI LD9361.FI T10 – L5 scoliosis





Screw placement on scoliosis

CT-Scans of SYNBONE Torso with Spine and Pelvis in Soft Tissue

Experts voice I

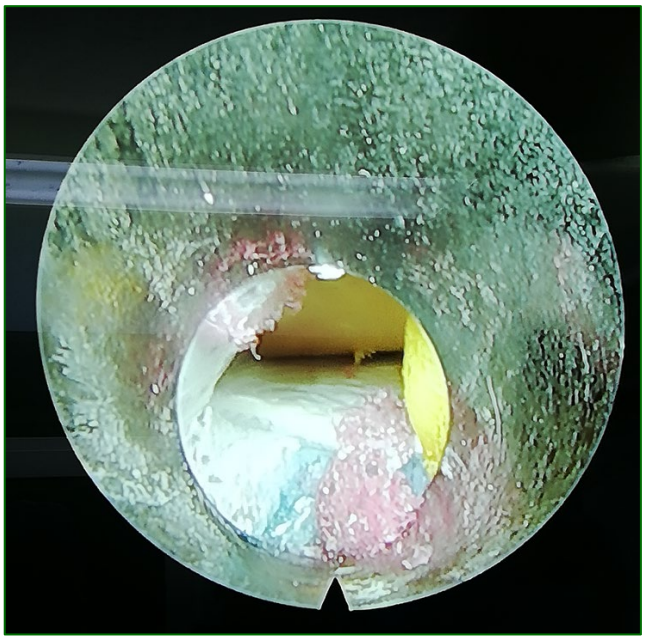
Soft tissue is realistic, it easy to cut and rigid to hold the Spine in place, allowing corrective movement. Spines retain SYNBONE's top class characteristics. Very nice to work with because it is odourless.

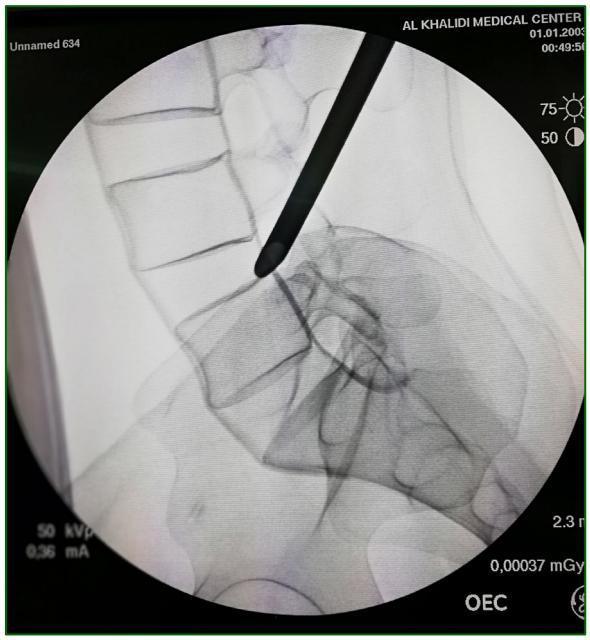
Statement of an anonymous Senior Spine Product Manager of a Global Organisation

Experts voice II

I would like to thank the SYNBONE team for the great effort you are doing in creating those outstanding models. We used the Torso with Spine and Pelvis covered with soft tissue and skin under x-ray guidance and with endoscopic instruments. The anatomy is very clear, precise, and accurate like human beings. You did a great job, thank you.

Dr. Rasha Mousa AL-Kanash
Neurosurgeon / Endoscopic Spine Surgeon
Razi Spine Clinic/ Amman /Jordan





Endoscopic images and CT-scans of SYNBONE Torso made at the Al Khalidi Hospital and Medical Center, Amman / Jordan

SYNBONE Spine Models

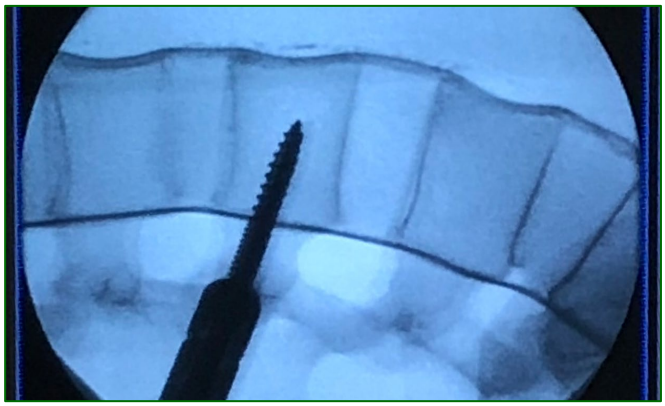
SYNBONE Spine Models are produced with specially designed polymers mimicking ***SYN****thetic* ***BONE*** for a better education outcome during trainings. The material behaviour and the haptic feeling is one of the closest to a real spine compared to other dry material models options available in the domain.

SYNBONE's spine portfolio includes lumbar, thoracal, cervical, and entire spine models with or without Skull, Occiput and Sacrum. The models can optionally be ordered with Spinal Cords, Muscles, Nerves, Arteries, Flava, Dura, Radiolucent Skin and Radiopaque coating, with densities as per customer specific requirements.

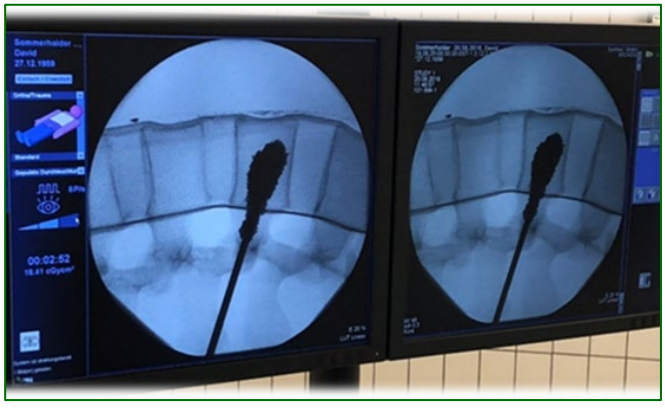
Benefits

- Humanlike feeling
- Very good screwing results
- Compact cortical bone structure
- Crispy feeling of cancellous bone
- Efficient educational spinal trainings
- No breaking through the cortical layer
- Can be used for augmentation trainings

Surgeons performing navigation based posterior approach with SYNBONE PR1329 Spine Bed and SYNBONE lumbar spine with Pelvis LSSPR1335.



Fluoroscopic image – insertion of pedicle screw in SYNBONE LSS model

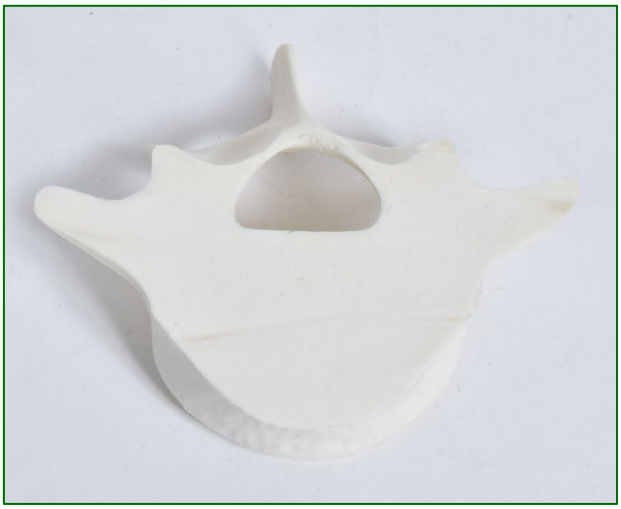


Fluoroscopic image – cement augmentation with SYNBONE LSS model

SYNBONE materials LSS versus LD

LSS series:

- Thin outer cortical layer
- Porous cancellous bone structure
- Almost human-like feeling
- No cracking, no bristling during hands-on
- Ideal for augmentation and vertebroplasty
- Visible under CT-scans



LD series:

- Compact structure
- Cortical layer
- Solid foam

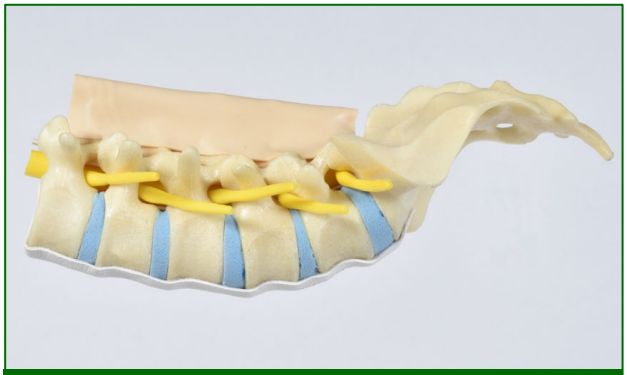
Experts voice

"The behaviour of the new models with the new material is very realistic. It needs very little effort to insert a pedicle screw or a Jamshidi needle.

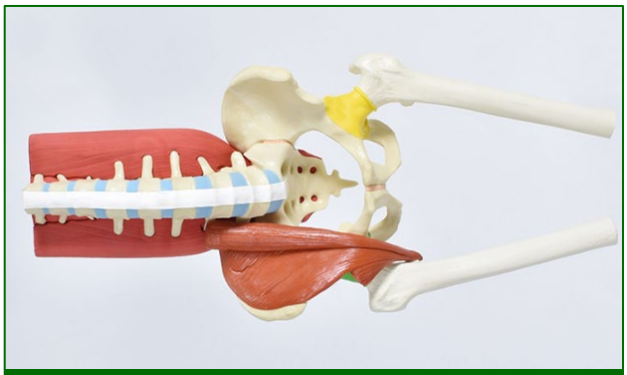
The cancellous bone is slightly crispy and on the opposite side, you can feel a slight cortical layer before breaking through.

The material of the new LSS spines is human like. More realistic than anything before. The models can even be used for augmentation. The cement enters easily into the vertebrae."

Prof. Lorin M. Benneker
MD, Head of Spine Unit
Inselspital Berne, Switzerland

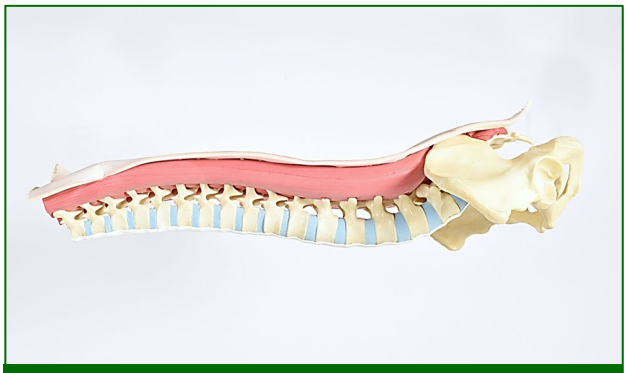


LSS9351 Spine L1-L5 with contin. supra interspinous ligaments and lordosis deformity



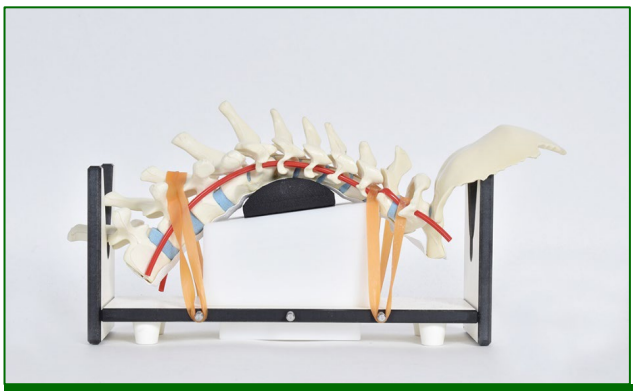
LSS9307.0 Spine L1-L5 with Pelvis, Femur, Muscles, Spinal Cord and Nerves for lateral approach

PR1329 Spine Bed
Spine L1 – L5 w/ Pelvis a/ Sacrum
PR1501.10 Muscle L1 – L5 a/Sacrum

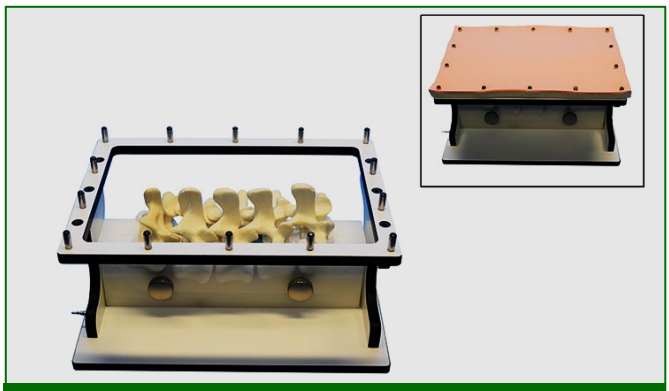


LSS9308.2 Spine T2-L5
with Pelvis, Muscles and Soft Tissue

SPINE Holders



0029 Spine Holder Compact



PR1232 Spine Holder for MIS Approach

Spine Beds

SYNBONE Spine Beds are available in various sizes to perform exercises in anterior, posterior, or lateral positions and can be used for CT scanning.

Customized Spine Beds can be produced on request.

14 different Spine Beds available

for posterior and anterior access

holds lumbar spine with pelvis

holds cervical spine with occiput

SYNBONE®
better education outcome

Contact us

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Come and visit us next time when you are at AO offices in Zizers/Landquart.
SYNBONE is next door from the AO office.

e-shop

➔ **Scan QR-Code and visit our e-shop:**

go to SYNBONE e-shop

➔ **Find all SYNBONE SPINE models here:** [SYNBONE e-shop / Spine portfolio]

➔ **For worldwide orders:** [sales@synbone.com]

SurgiSTUD™

BUILD A SPINESTUD

SpineSTUD®

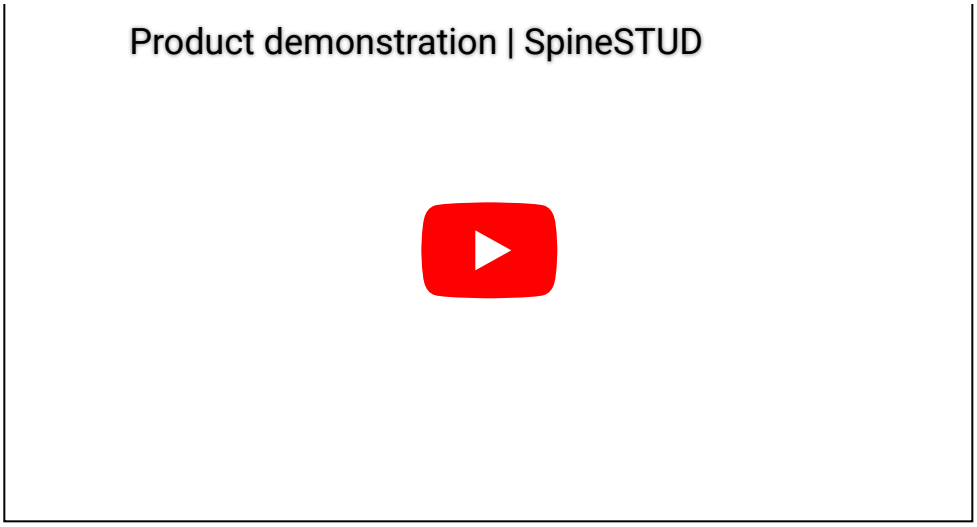
What is a SpineSTUD

SurgiSTUD™ training models are biofidelic training platforms of real human pathology, better preparing surgeons for the OR. Customized to the specific needs of the surgeon, the models provide a superior training platform at significant cost-savings over cadavers.

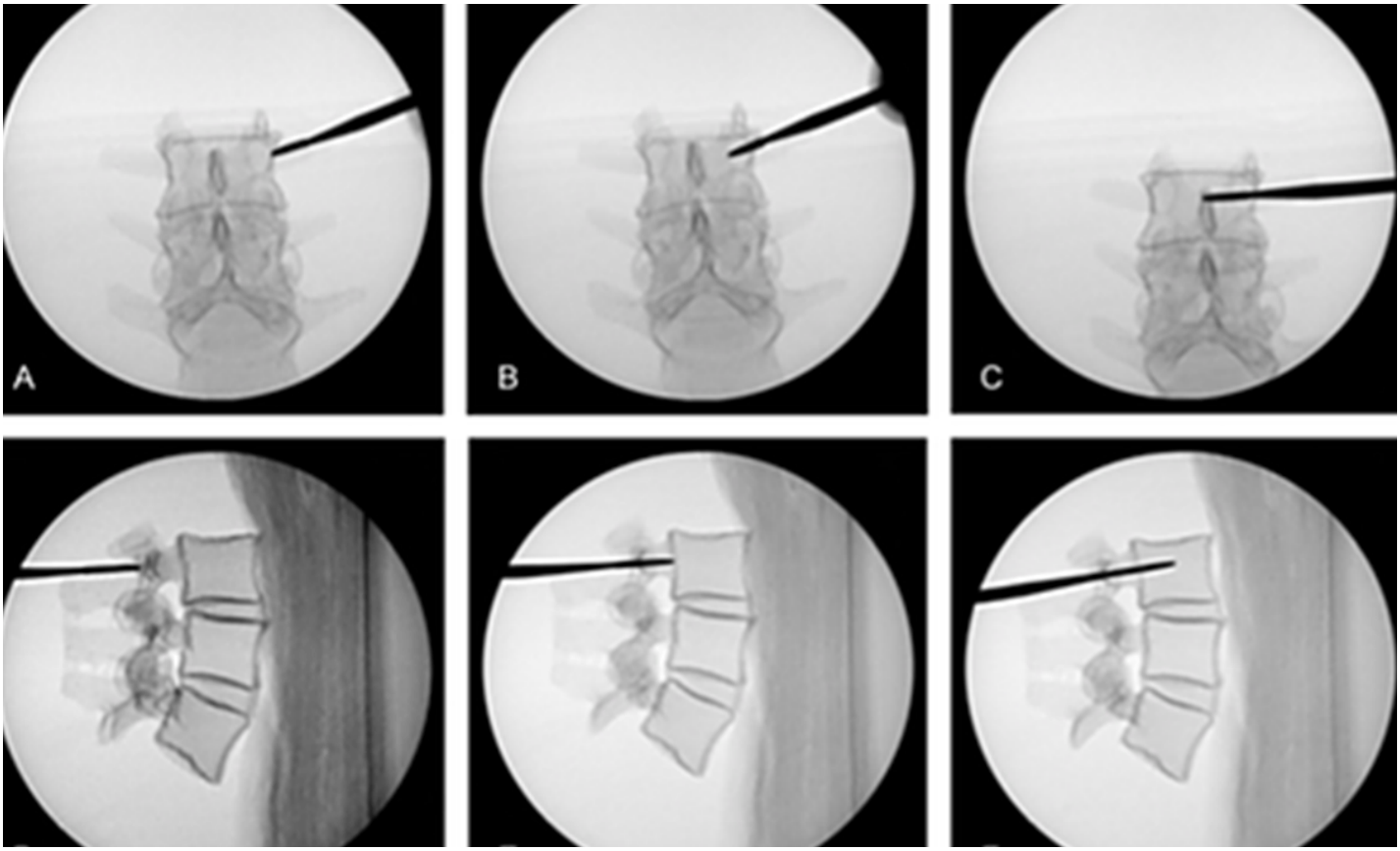
Unique Features of a SpineSTUD:

- SpineSTUD was our pilot product. We have over 90 different anatomy types within our library of available models that can be used independently or mix and matched to create "Franken-Spines" to fit your model needs.
- Our SpineSTUD platform offers models with the largest range of different instrumentation techniques. From open posterior approaches, to MIS lateral, anterior cervical, tethering, etc., we can provide consistencies to your training course that are not seen in cadaveric based training.
- Every model is 100% made to order and is designed to enhance your training goals. From the anatomy and boney quality, to the types of add-ons, and even patient age, our engineers will work with you to provide a comprehensive model to fit your different training levels and engage your surgical or surgeon rep audiences.
- We have different body cast types that allow you to fully vary the patient size, weight, and age. This obscures key anatomical features while retaining tension on instrumentation toolsets and surgical depth during different correction techniques.

Product demonstration | SpineSTUD



Build A SpineSTUD »



Synthetic Bone Architecture

The synthetic bone of a STUD is made with a corticocancellous architecture that mimics human bone. This architecture provides excellent radiographic anatomy and permits the use of injectable bone cements.

High-Fidelity Segmental Range Of Motion

Medability

“We create innovative solutions transforming surgical professionals’ competencies to provide the best patient care.”

Information for AO SPINE

Medability

Game changer for MISS and Interventional procedures

Best-in-class medical imaging

SimBone™

Realistic
Radiation-Free
Imaging

Real Instruments

Easy Plug & Play
No calibration required

AO SPINE

Information for

2022

Medability

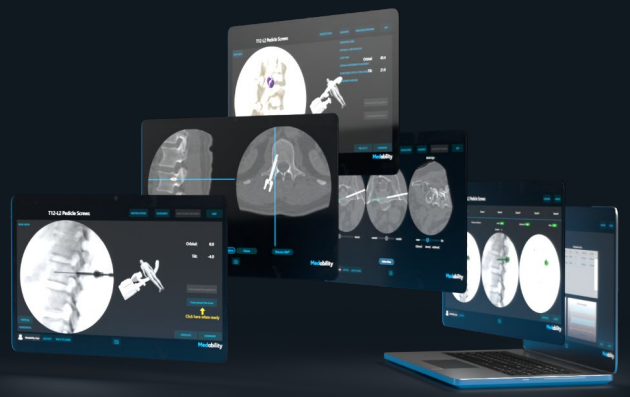
AO SPINE

Information for

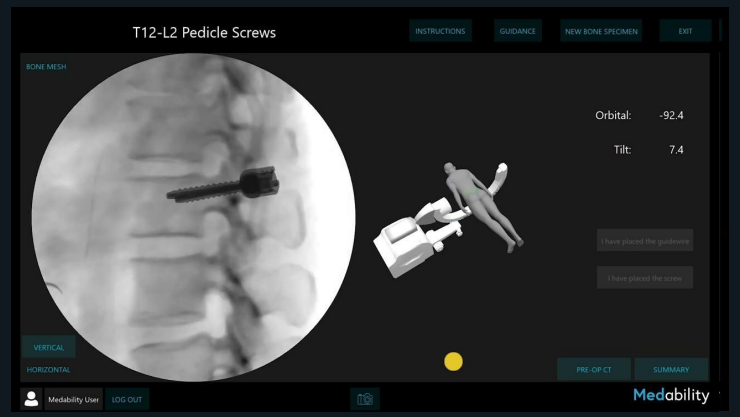
2022

“The best simulated medical imaging I can get”

Switch between different modalities to better understand imaging and anatomy

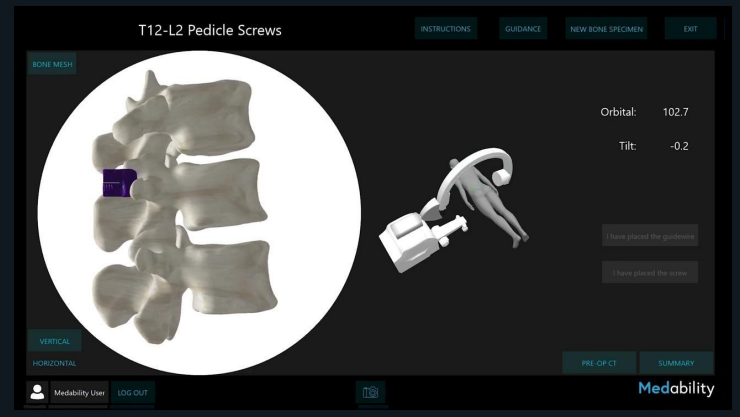


X-Ray: https://youtu.be/xQgjLqGUaNY
3D: https://youtu.be/c_zxDEwfdnc
CT: https://youtu.be/ag0qhO7PYkM
Navigation: https://youtu.be/XUKOExx1zGc

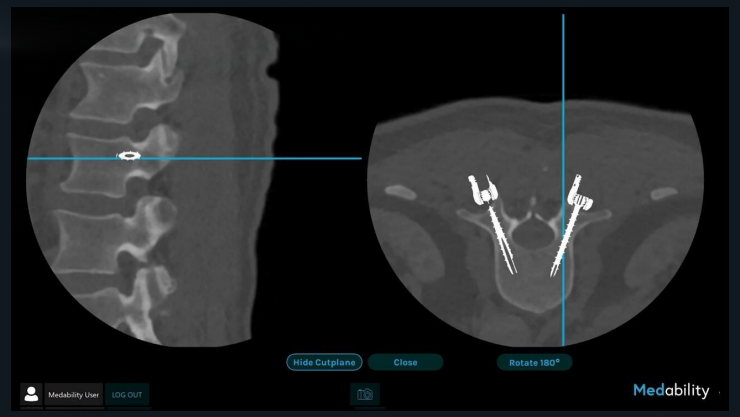


X-Ray

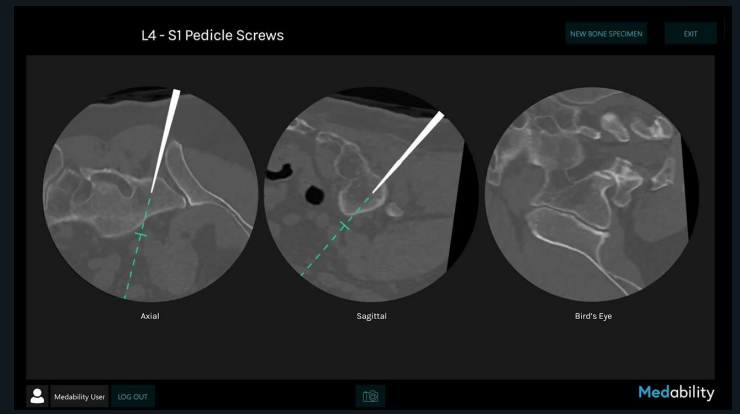
+



3D



CT



Navigation

Medability

Information for AO SPINE

2022

Interchangeable vertebral segments

Cervical

Anterior,
Posterior

Thoracolumbar

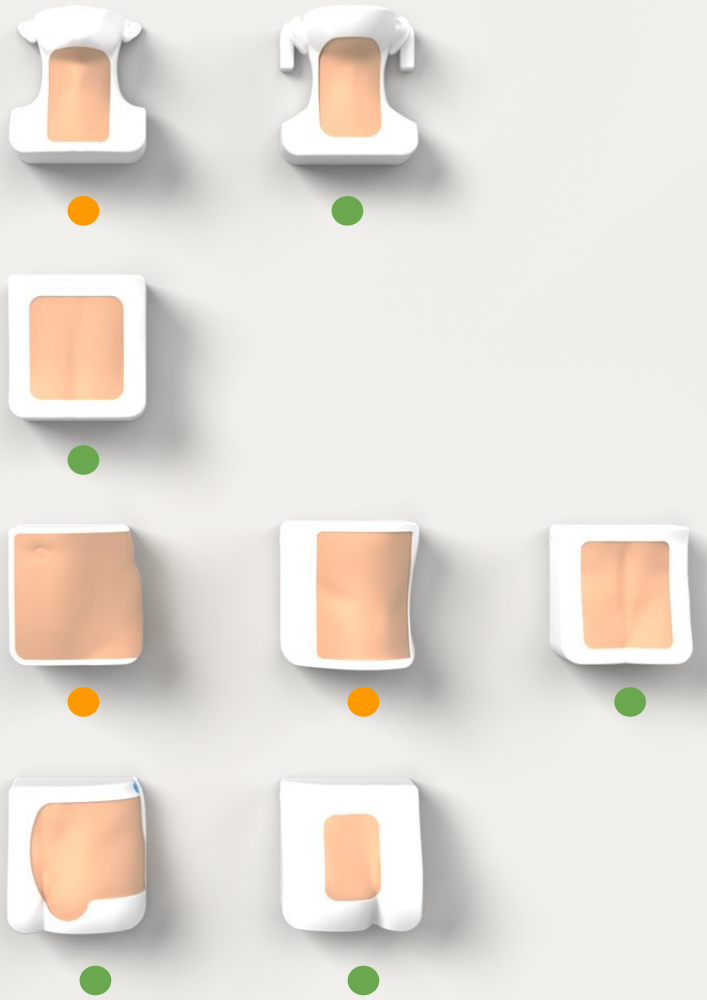
Posterior

Lumbar

Anterior, Lateral,
Posterior

Spinopelvic

Lateral,
Posterior



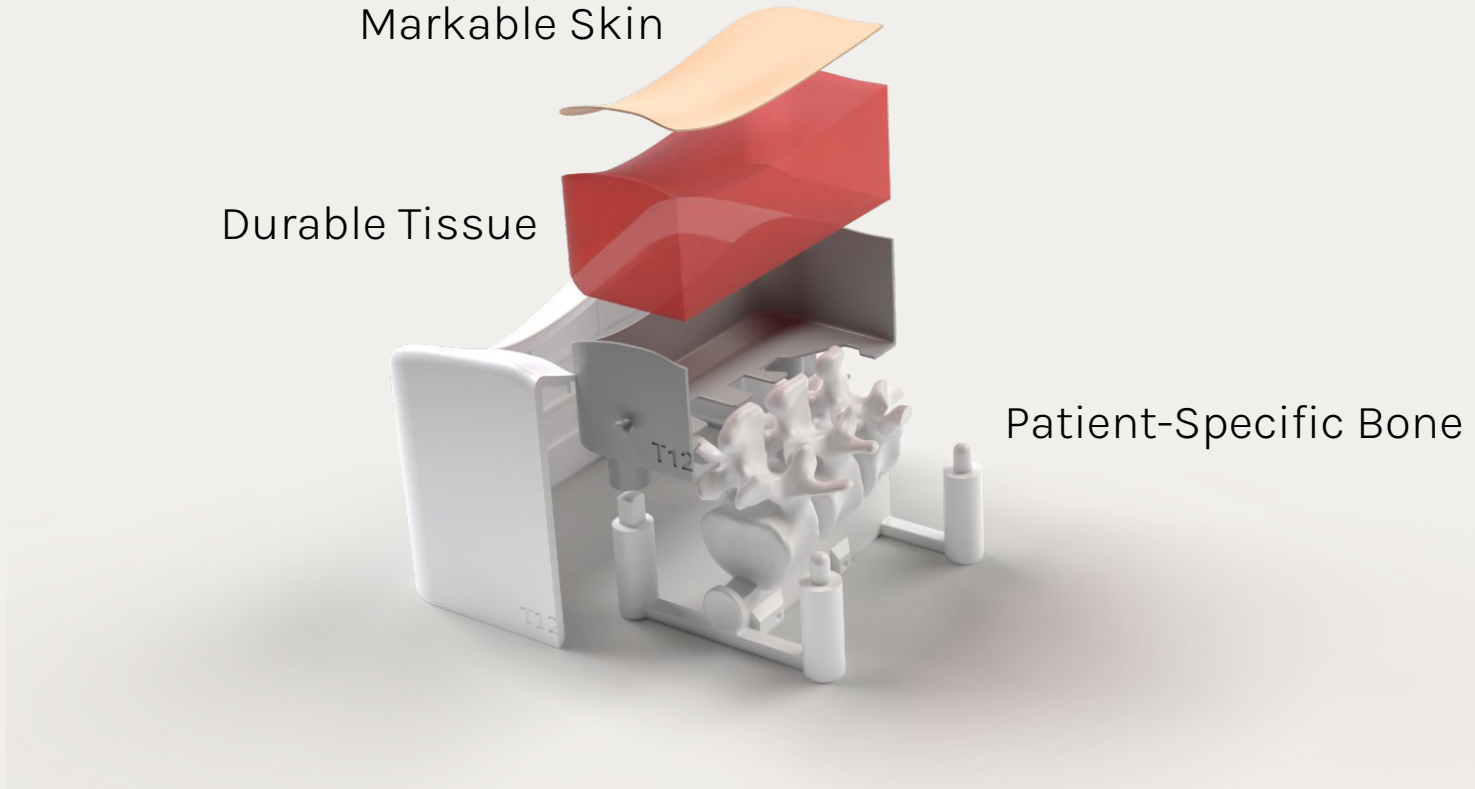
Available

Coming soon

Medability

Realistic hands-on experience surgeons love

Using 3D printing to recreate actual anatomy from CT scans



AO SPINE

Information for

2022

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AO SPINE

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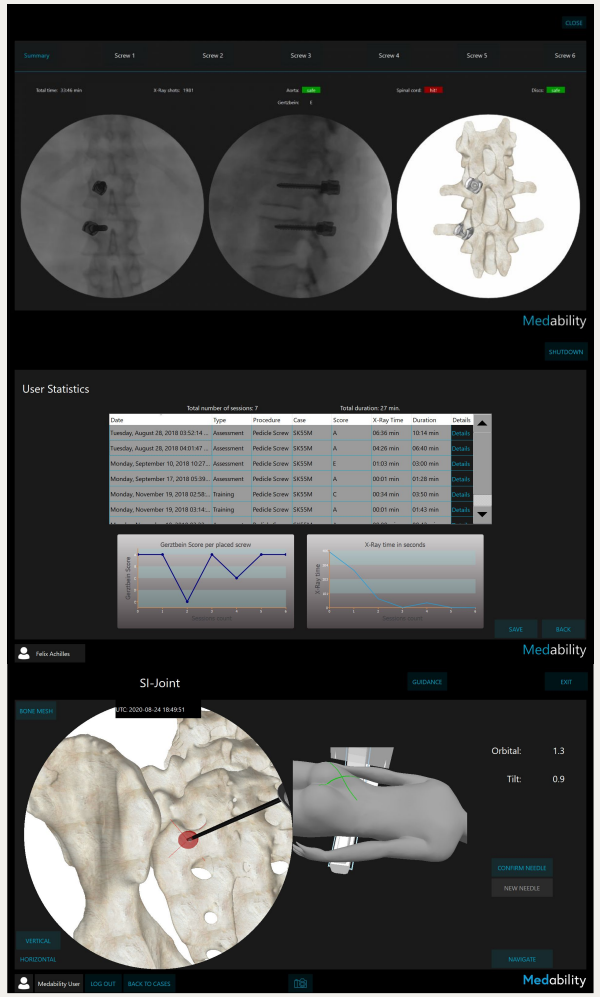
2022

Guidance and performance insights

Improving skills by well-considered educational features



Procedure performance metrics

Real-time and post-procedure surgical performance review with trainee on SimBone™

Performance analysis over time

Trainee’s detailed statistics on e.g. radiation and learning curve

Guidance

Hints for trainee e.g. where to insert needle into joint during training.

SimBone in Action

Link: https://youtu.be/tYQ3Vqk34AI

Medability

Information for AO SPINE

2022

Hands-on: Spinal Infiltration

Course format (example)

- ✓ Courses at congresses or in hospitals in North America, Europe, UK
- ✓ 3 faculty members for 20 trainees

Basic

120 min

- ✓ C-arm projections
- ✓ Needle control
- ✓ Radiation safety
- ✓ Infiltrations:
  - Lumbar medial branch blocks
  - Lumbar facet joint injections
  - SI joint injections
  - TFESI, ILESI

Advanced

2-day course

- ✓ Theory: Foundations
  - Background
  - Risks & Complications
  - Pain generators
  - Infiltrations
  - Ablative techniques
- ✓ Theory: Techniques
- ✓ Hands-on (see slide 4)

Modules

Occipitocervical
C0-C3

Cervical posterior
C1-C7

Thoracic
T5-T9

Thoracolumbar
T12-L2

Lumbar L3-S1

SI-joint

Medability

Hands-on: Image-guided MIS Pedicle Screw Placement

Course format (example)

- ✓ Courses at congresses or in hospitals in North America, Europe, UK
- ✓ 3 faculty members for 20 trainees

Basic

120 min

- ✓ C-arm X-ray projections
- ✓ Trocar and Awl control
- ✓ Radiation safety
- ✓ Basic skills:
  - Lumbar and thoracolumbar C-arm projections
  - Lumbar/ thoracic perc pedicle screws

Advanced

2-day course

- ✓ Theory: Foundations
  - Background & Instrumentations
  - Biomechanics & Anatomy
  - Medical Imaging & Navigation
- ✓ Theory: Techniques
- ✓ Hands-on (see slide 5)

AO SPINE

Information for

2022

2-day Course Content: Infiltration

2021 GSC Paris Course - Infiltration

Available now

✓ C-arm projections: cervical, thoracic, lumbar and pelvic
✓ Needle control techniques
✓ Radiation safety

Procedures

✓ Cervical/Lumbar
  - facet joint injections
  - medial branch blocks
  - TFESI and SNRBs, ILESI
✓ SI joint injections
✓ Costotransverse joint injections
✓ Intercostal injections
✓ RFA of lumbar, SI-joint and cervical medial branches

Medability

Information for AO SPINE

2022

2-day Course Content: Hands-On MIS Pedicle Screw Placement

2021 AO Spine Davos - Spinal fusion

Available now

✓ C-arm projections for screw placement
✓ Computer navigation assistance
✓ Radiation safety

Procedures

✓ Cervical pedicle screws and lateral mass screws
✓ Magerl transarticular screws
✓ C2 pars screws
✓ Thoracic pedicle screws (+in-out-in technique)
✓ Lumbar pedicle screws
✓ Lumbar cortical bone trajectory screws

Coming soon

★ Laminar/sacral/Ileum screws
★ S1 pedicle screws
★ S2 ala screws
★ S2 ala ileum screws
★ Lateral SI-screws / transsacral screws

Publications

The "unfair advantage" of hybrid spine surgery simulation for percutaneous pedicle screw placement makes it as effective as training on a cadaver: a prospective randomized study with novice volunteers.

https://www.researchgate.net/publication/344097637_Der_unfaire_Vorteil_des_Hybrid_Wirbelsaulen-OP_Simulators_macht_ihn_beim_Erlernen_von_perkutaner_Pedikelschraubenplatzierung_so_effektiv_wie_den_Kadaver_eine_prospektiv_randomisierte_Studie_mit_freiwi[accessed Sep 29 2022].

AO Spine Evaluation

Evaluation of the simulation exercise during the AO Spine Pedicle Screw and Injection Techniques under Simulated X-ray Guidance course (Baden, 2018)

AO Spine Courses

2021 AO Spine Davos Course - ViperPrime (JnJ - DepuySynthes) - Spinal fusion

2021 GSC Paris Course - Infiltration

Medability

Information for AO SPINE

2022

Please contact sales@medability.de

medability.de | Medability | Medability GmbH

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Subsidiaries
Medability USA Inc. | Medability Canada Inc.

Research Institute Davos

DEHST - Digitally enhanced hands-on surgical training

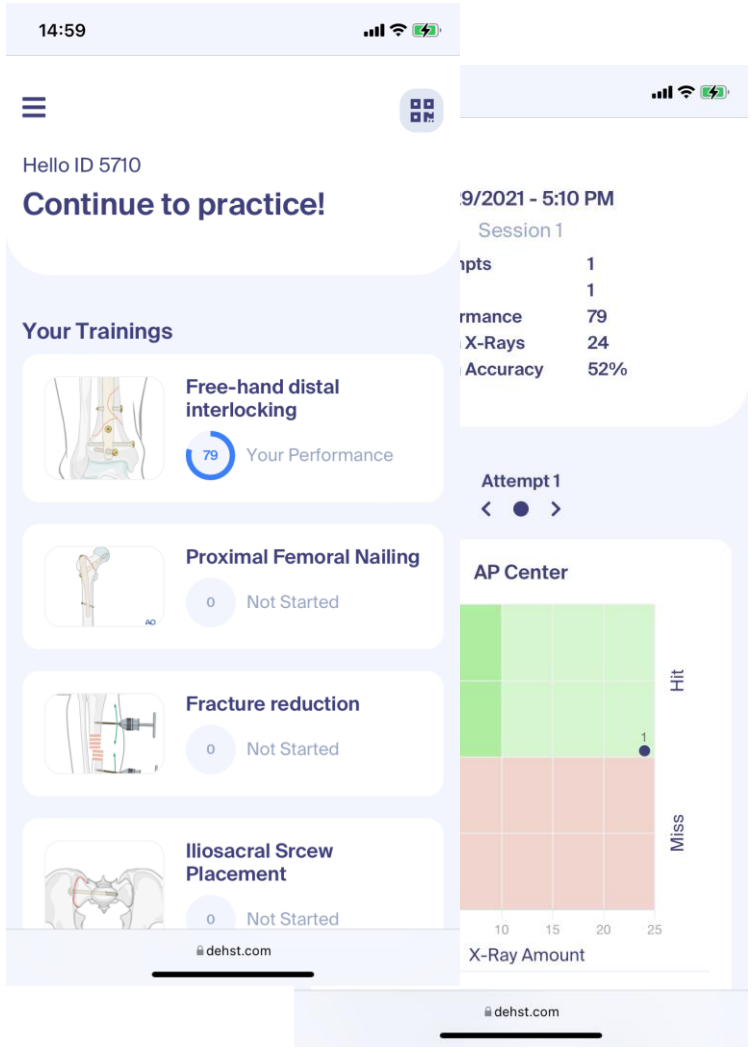
J Buschbaum & M Windolf
Concept Development (ARI)

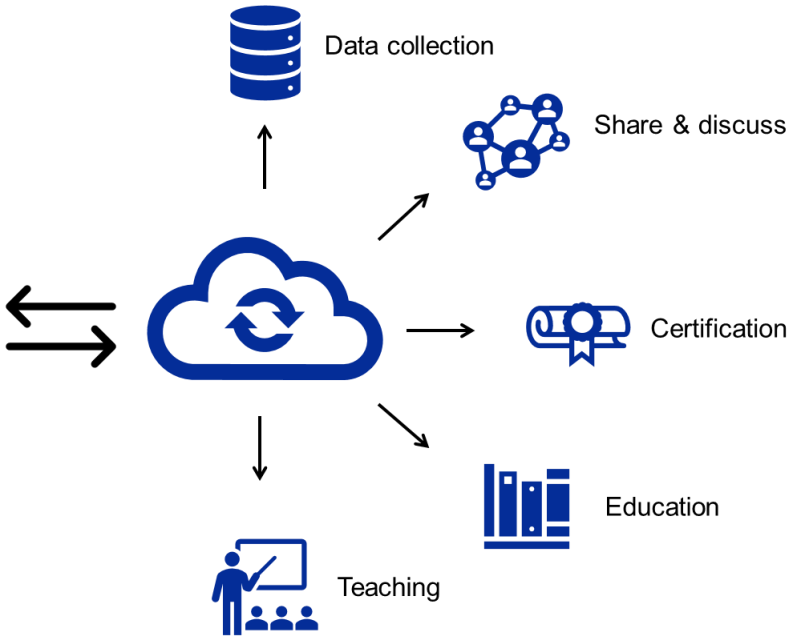
Introduction

Digitally Enhanced Hands-on Surgical Training

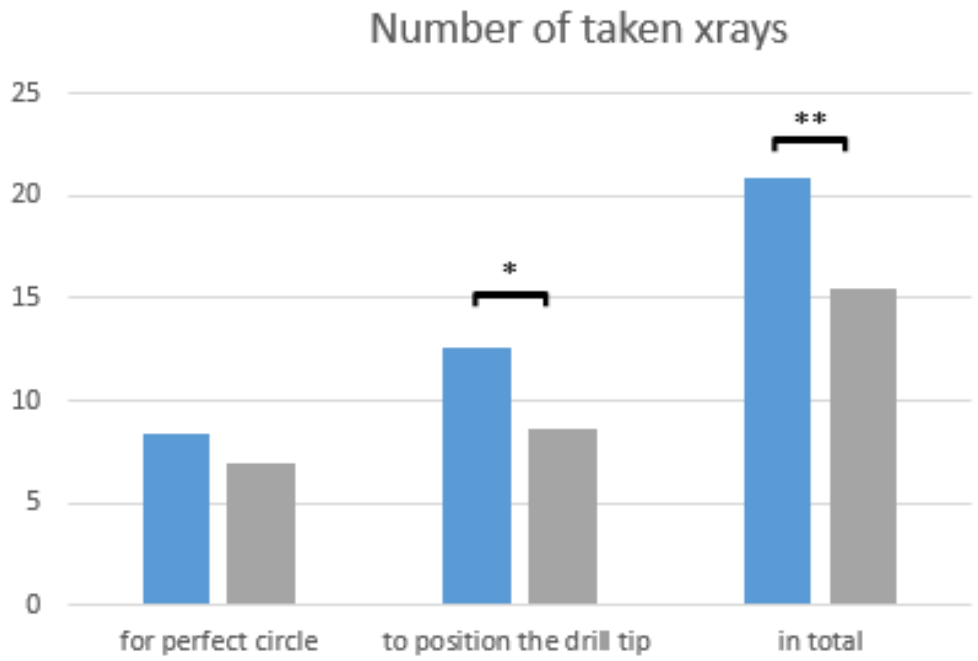
- Real hands-on experience combined with digital technologies
- Skill station product line targeting the relevant operational skills

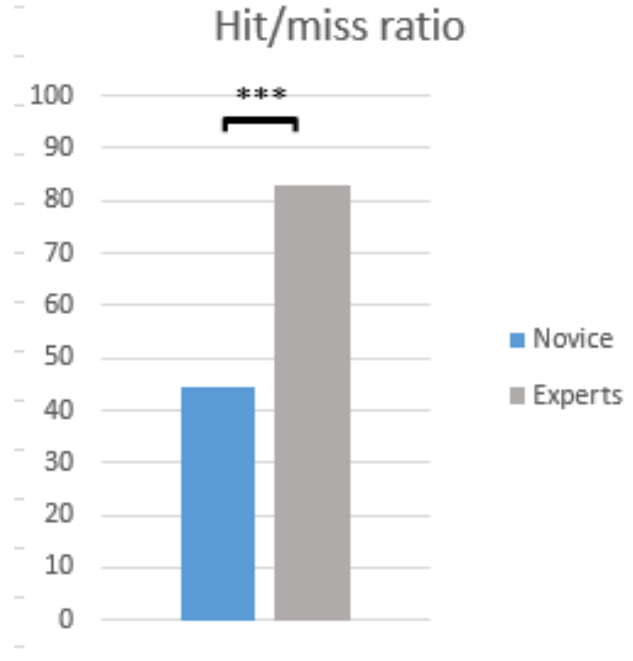
Web-APP for analytics and interaction





Construct Validity study
Evaluation of AO Davos Courses





*/**/*** statistically significant difference

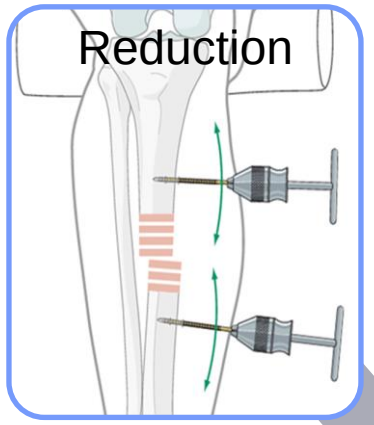
medicina
MDPI

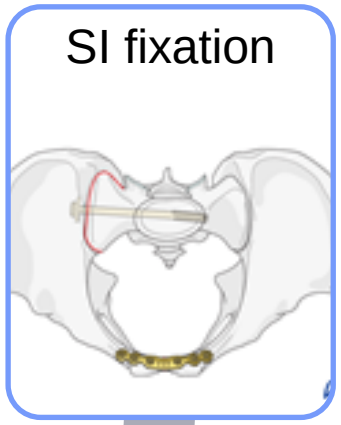
Type of the Paper (Article)

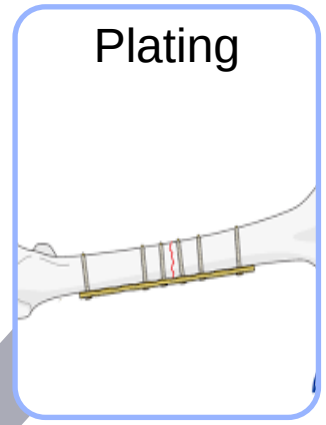
Validity of a novel digitally enhanced skills training station for freehand distal interlocking

Torsten Pastor [1,2,*], Tatjana Pastor [3], Philipp Kastner [1,4], Firas Souleiman [1,5], Matthias Knobe [2,6,7], Boyko Gueorguiev[1], Markus Windolf[1] and Jan Buschbaum[1]

Further modules



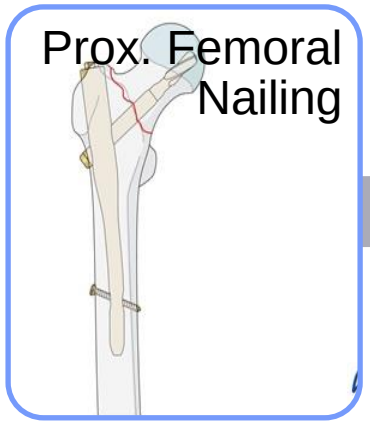




Nailing package (under development)

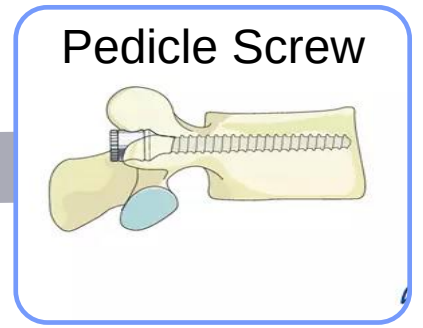
Training modules

- Fracture reduction
- Finding entry point
- Nail Insertion and insertion of Cephalic component
- Distal Locking



Development Plan

- Prototype package (Dec 2022)
- Product 0-series (Oct 2023)



Thank you for your attention!

- Cost-effective, transportable, de-centralize training concept
- Real hands-on experience
- Augmented by digital technology
- Enhanced user experience and training scope
- Comprehensive training assessment and feedback
- Measurable training success

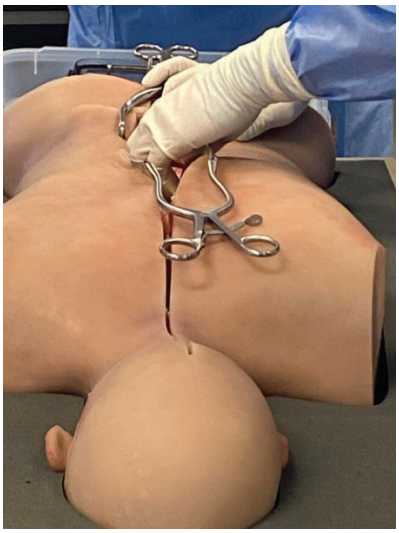
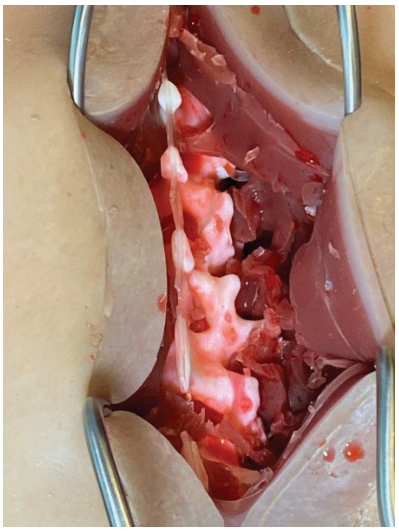
Spine Model

Fusetec has developed surgical training models for the spine, including a spine base with thorax and abdomen with interchangeable cassettes. Fusetec has developed several options which include the posterior and anterior approach with fully operable soft tissue and pathologies are available, with blood flow and a pulse, upon request. Models are transported globally, in a hard case and are Xray compatible.

Spine Base are non-operable and interchangeable spine cassettes are inserted. Models have been designed to consist of a minimal cost consumable.

Model and Procedures

- Full Base – fully operable Occiput to Sacrum (posterior and anterior approach)
- Half Base – Fully operable L1 to Sacrum (posterior and anterior approach)
- Full Base – Non- operable with interchangeable operable cassettes
- Cassettes – Operable from posterior approach.
- Cervical Occiput to T3
- Thoracic T4 to T12
- Lumbar L1 to Sacrum
- Blood pump with pulse (optional)
- Interchangeable Pro-sections: Cervical, Thoracic and Lumbar
- Pathologies as requested.
- Other sized pro-sections are available if required


Fusetec 3D Pty Ltd
25 Marlborough Street
Adelaide SA 5000
ABN 35 618 746 875

Contact Details:
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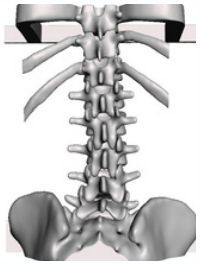
www.fusetec.com.au
P +61 8 7200 2413

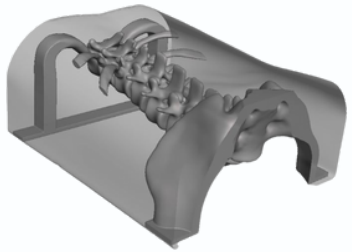
VIOMERSE™

The Leaders in Immersive Training

SPINE TRAINING PHANTOMS

THORACOLUMBAR PHANTOM

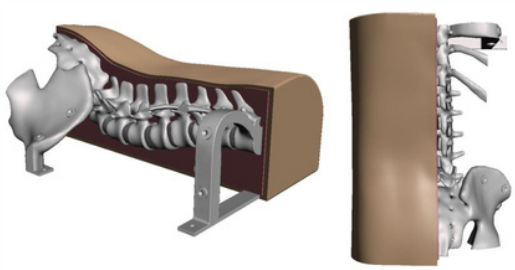




Thoracolumbar Spine Phantoms:

- T8 - pelvis synthetic vertebrae (radiopaque cancellous and cortical bone) embedded in a synthetic torso.
- Includes skin, fascia, muscle, and synthetic discs.
- Ideal for teaching placement of pedicle screws and other implants.
- CT DICOM file provided with each phantom.

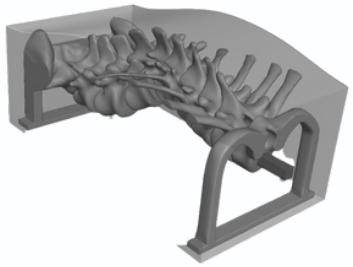
THORACOLUMBAR CUTAWAY PHANTOM



Thoracolumbar Spine Phantoms:

- T10 - pelvis synthetic vertebrae (radiopaque cancellous and cortical bone) embedded in a synthetic torso.
- Includes skin, fascia, muscle, and synthetic discs.
- Half of the spine along the sagittal plane is exposed to open air, which is ideal for basic demonstration and navigation.
- The closed side is intended for full procedural workflow.
- CT DICOM file provided with each phantom.

CORONAL DEFORMITY/ SCOLIOSIS PHANTOM



Thoracolumbar Spine Phantoms:

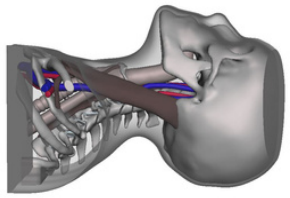
- T10 - pelvis synthetic vertebrae (radiopaque cancellous and cortical bone) embedded in a synthetic torso.
- Includes skin, fascia, muscle, and synthetic discs.
- Severe deformity requiring correction.
- Phantom compatible with multiple approaches (TLIF, OLIF, etc).
- CT DICOM file provided with each phantom.

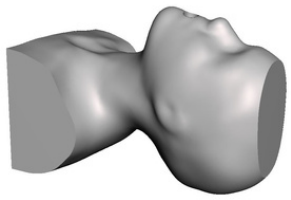
VIOMERSE™

The Leaders in Immersive Training

SPINE TRAINING PHANTOMS

MULTI-APPROACH CERVICAL SPINE PHANTOM

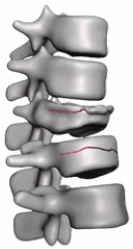


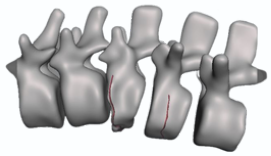


Cervical Spine Phantom:

- Synthetic spine consisting of occiput - T2 embedded in hydrogel.
- It includes dura, nerve roots, discs, muscle, fascia, and epidural fat.
- Ideal for posterior or anterior open procedures.
- CT DICOM files provided with all phantoms.

VERTEBRAL COMPRESSION FRACTURE PHANTOM

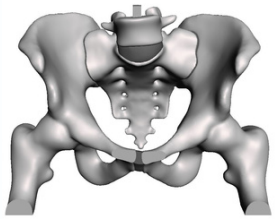


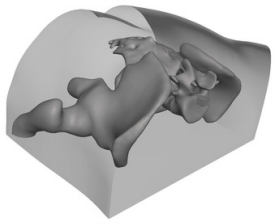


VCF Spine Phantoms:

- 5 vertebrae embedded within a hydrogel block.
- Contains multiple fractured vertebrae and simulated osteoporotic bone.
- Ideal for hands-on training with vertebral body augmentation equipment.
- Radiopaque phantom requires radiographic imaging.

SACROILIAC PHANTOM





Sacroiliac Phantom:

- Synthetic spine consisting of L4 - pelvis embedded in hydrogel.
- Includes skin, fascia, muscle, and synthetic sacroiliac joint.
- Ideal for SI joint implants.
- CT DICOM file provided with each phantom.

Realists

Product Presentation

Jan 2023

Revolutionize your surgical training with the game-changing realism from RealSpine

Our Portfolio

Complete solutions for spine surgery training

RealSpine

Basic MISS

- For a basic decompression of the lumbar spine
- Endoscopic / microscopic approaches

Advanced MISS

- For advanced decompression of the lumbar spine
- Endoscopic / microscopic approaches

Spondy X

- For Lumbar pedicle screw fixation
- Compatible with X-ray, surgical navigation and robotics

Spondy

- For decompression and stabilization of the lumbar spine
- Compatible with surgical navigation and robotics

SI

- For sacroiliac joint fusion
- Compatible with X-ray and surgical navigation

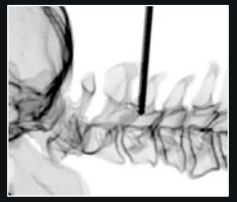
Lateral

- For lateral lumbar spine surgery
- ATP and Transpsoas approach

Myelopathy

- For decompression and stabilization of the cervical spine
- Compatible with surgical navigation and robotics

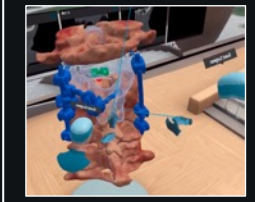
RealImaging



Radiation-free fluoroscopy

- Radiation-free X-ray simulation for surgical training with Realists products.
- Movement of instruments and implants in real-time
- Compatible with all instruments needed for a surgical procedure
- Portable, flexible and adaptable to any space.

Realists VR



Pre- and post-op in virtual reality

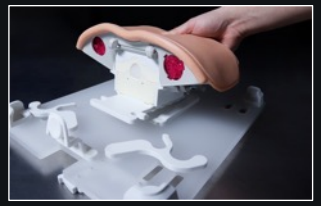
- Complement your hands-on RealSpine training with a pre- and post-operative case study setup in virtual reality.
- 3D paintable anatomical models, 3D segmented patients, DICOM viewer, sample procedures, measurements, videos and more.
- Single or online multiuser sessions

RealSpine | Basic MISS

For basic endoscopic / microscopic decompression training of the lumbar spine

Life-like simulation of key anatomical structures and tissues.

Perform endoscopic and microscopic decompression procedures on both sides of the L4-L5 vertebrae.



Lightweight and easy to set up and use, take your training anywhere you go.

When used in conjunction with our RealImaging, it provides an all-encompassing solution for introductory spine surgery education.

Pathology:
- Disc herniation L4-L5 Bilateral

RealSpine | Basic MISS

Anatomy

Bones	L4-L5
Skin	Closed
Muscle	Basic
Ligaments	Flavum
	Interspinal
	Posterior Longitudinal (PLL)
Dura & Nerve Roots	Dura & Nerve Roots
Disc	Disc L4-L5

Procedures

Incision	Basic incision
Flavectomy	
Laminectomy	
Bilateral decompression	
Sequestrectomy	
Discectomy	Basic haptic feedback
Facetectomy	

Compatible Technologies

Cages (TLIF/PLIF)	Basic haptic feedback
Drilling	

Approaches

Microscopic / Exoscopic
Tubular Endoscopic
Full Endoscopic

Access

Posterior
Interlaminar
Extraforaminal
Transforaminal
Percutaneous

https://vimeo.com/803458174

RealSpine | Advanced MISS

For advanced endoscopic / microscopic decompression training of the lumbar spine

High-fidelity simulation of all anatomical landmarks including tissues and fluids.

Designed to simulate the challenges and complexities of real-life endoscopic spine surgery.

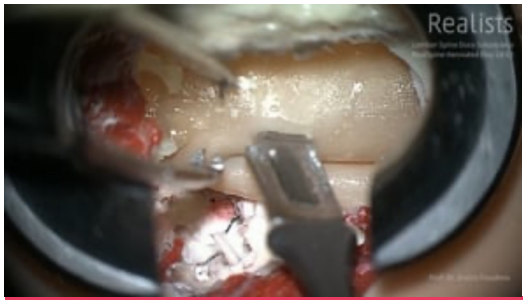
Specifically designed for endoscopic and microscopic spine surgery procedures

Customize your training. Choose from the pathologies and approaches available.

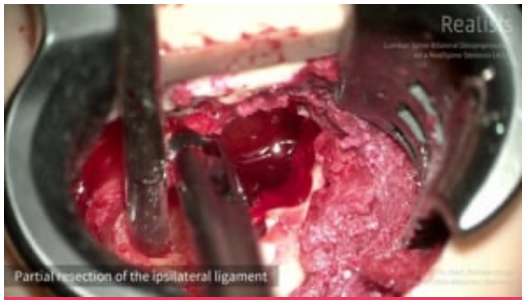
Compatible with RealImaging. Deliver a complete training experience with our x-ray free surgical navigation.

Pathologies available:

- Disc herniation L4-L5
- Extraforaminal disc herniation L4-L5
- Stenosis L4-L5
- Complex stenosis L4-L5



Dura Suture
https://vimeo.com/811308236

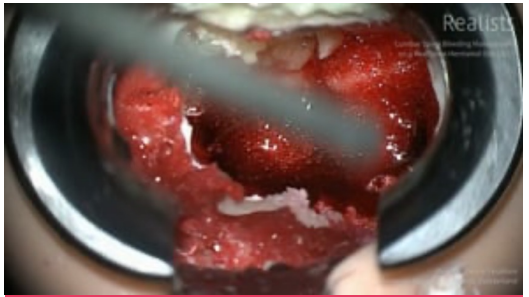


Bilateral Decompression
https://vimeo.com/811308074

Endoscopic Decompression
https://vimeo.com/811308291

TLIF Cage Insertion
https://vimeo.com/811308355

Discectomy
https://vimeo.com/811308191



Bleeding Management
https://vimeo.com/811308143

RealSpine | Advanced MISS

Anatomy

Bones	L4-L5
Skin	Incision, Closed
Muscle	Advanced haptic feedback
Ligaments	Flavum
	Facet Capsular
	Interspinal
	Supraspinous
	Posterior Longitudinal (PLL)
Dura & Nerve Roots	Dura & Nerve Roots
	Cauda Equina
	CSF
Disc	Disc L4-L5
	Anulus
	Nucleus
Fat	Epidural
Bleeding	Muscular
	Laminar
	Epidural

Procedures

Incision	Advanced haptic feedback
Flavectomy	
Laminectomy	
Bilateral decompression	
Sequestrectomy	
Discectomy	Advanced haptic feedback
Facetectomy	
Dura closure	
Bleeding management	

Compatible Technologies

Cages (TLIF/PLIF)	Advanced haptic feedback
Drilling	
Dura suture	
Water irrigation	
Bleeding management	Bone wax, coagulation agents

Approaches

Microscopic / Exoscopic
Tubular Endoscopic
Full Endoscopic

Access

Posterior
Interlaminar
Extraforaminal
Transforaminal
Percutaneous

RealSpine | Basic or advanced MISS? Which one best suits you?

Basic MISS

Advanced MISS

Anatomy		Basic	Advanced
Bones	L4-L5	✓	✓
Skin	Incision		✓
	Closed	✓	✓
Muscle	Basic	✓	
	Advanced haptic feedback		✓
Ligaments	Flavum	✓	✓
	Facet Capsular		✓
	Interspinal	✓	✓
	Supraspinous		✓
	Posterior Longitudinal (PLL)	✓	✓
Dura & Nerve Roots	Basic	✓	
	Advanced haptic feedback		✓
	Cauda Equina		✓
	CSF		✓
Disc	Disc	✓	✓
	Anulus		✓
	Nucleus		✓
Fat	Epidural		✓
Bleeding	Muscular		✓
	Laminar		✓
	Epidural		✓

Access	Basic	Advanced
Posterior	✓	✓
Interlaminar	✓	✓
Extraforaminal	✓	✓
Transforaminal	✓	✓
Percutaneous	✓	✓

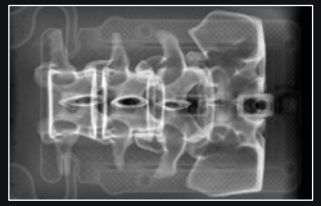
Procedures		Basic	Advanced
Incision	Basic incision	✓	
	Advanced haptic feedback		✓
Flavectomy		✓	✓
Laminectomy		✓	✓
Bilateral decompression		✓	✓
Sequestrectomy		✓	✓
Discectomy	Basic	✓	
	Advanced haptic feedback		✓
Facetectomy		✓	✓
Dura closure			✓
Bleeding management			✓

Compatible Technologies		Basic	Advanced
Cages (TLIF/PLIF)	Basic	✓	
	Advanced haptic feedback		✓
Drilling		✓	✓
Dura suture			✓
Water irrigation			✓
Bleeding management	Bone wax, coagulation agents		✓

Approaches	Basic	Advanced
Microscopic / Exoscopic	✓	✓
Tubular Endoscopic	✓	✓
Full Endoscopic	✓	✓

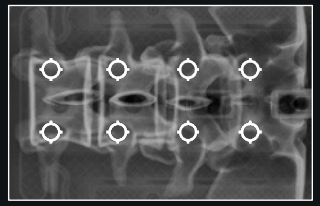
RealSpine | Spondy X

Radiolucent model for use with X-ray modalities
For lumbar pedicle screw fixation



Compatible with X-ray, surgical navigation and robotics

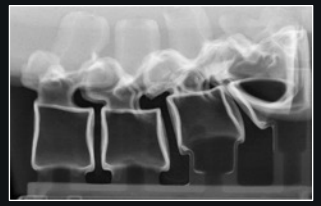
Leveraging the well-established bio-mechanical performance of RealSpine bones and muscles



Fusion (Screw Fixation) at L3, L4,L5, S1 pedicles

Lightweight and easy to set up and use, take your training anywhere you go.

When a C-arm is not accessible, use our product with RealImaging, X-ray free surgical navigation for training.



Pathology:
- Spondylolisthesis L4-L5

RealSpine | Spondy X

Anatomy

Bones	L3-S1
Skin	Closed
Muscle	Lumbar posterior closed

Procedures

Incision
Fusion (screw fixation)

Compatible Technologies

External Navigation
Pedicle Screws (Fusion)
X-Ray
Robotics

Approaches

Open

Access

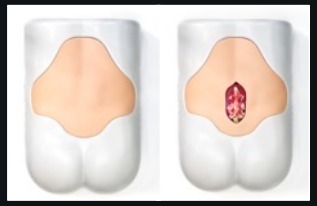
Posterior
Percutaneous

https://vimeo.com/769403992

RealSpine | Spondy

For decompression and stabilization of the lumbar spine
Covering a wide range of applications

Realistic simulation of all anatomical landmarks, including tissues and fluids.



For open, microscopic and percutaneous approach

Place up to 8 pedicle screws and operate up to 3 disc levels

The interchangeable cartridge includes all necessary tissues and fluids for a complete training experience.

Compatible with RealImaging. Deliver a complete training experience with our x-ray free surgical navigation.

Pathology:
- Spondylolisthesis L4-L5 + stenosis

RealSpine | Spondy

Anatomy

Bones	L3-S1
Skin	Closed / Open
Muscle	Lumbar posterior closed / open
Ligaments	Flavum
	Facet Capsular
	Interspinal
	Supraspinous
	Posterior Longitudinal (PLL)
Dura & Nerve Roots	Dura & Nerve Roots
	Cauda Equina
	CSF
Disc	Disc L3-L4, L4-L5, L5-S1
	Anulus
	Nucleus
Fat	Epidural
Bleeding	Muscular
	Laminar
	Epidural

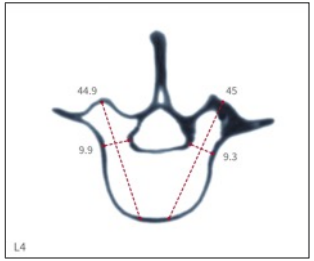
Procedures

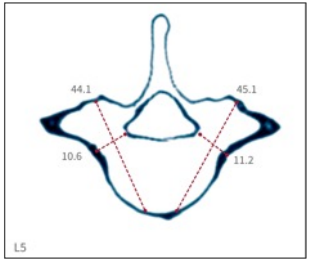
Incision
Flavectomy
Laminectomy
Bilateral decompression
Discectomy
Facetectomy
Fusion (Screw Fixation)
Dura closure
Bleeding management

Compatible Technologies

External Navigation
Cages (TLIF/PLIF)
Drilling
Pedicle Screws (Fusion)
Dura suture
Bleeding management
Robotics

Anatomical dimensions





Dimensions in mm

Approaches

Microscopic / Exoscopic
Tubular Endoscopic
Open

Access

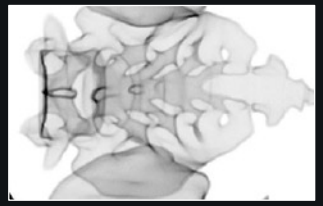
Posterior
Interlaminar
Extraforaminal
Percutaneous

Spondy – Set up
https://vimeo.com/688337433

RealSpine | SI

Radiolucent model for use with X-ray modalities
For sacroiliac joint fusion

Reduce the learning curve with our close-to-reality training experience



Compatible with different imaging systems, including X-ray, C-arm and navigation

Unmatched stability and accuracy to use instruments and equipment just like in real surgery

Training on the go – practical and cost-effective training wherever you need it.

When a C-arm is not accessible, use our product with RealImaging, X-ray free surgical navigation for training.

Ready, set, train! Our RealSpine model is ready for action right out of the box

Anatomy

Bones	S1-S3
	Iliums
Skin	Closed
Muscle	Posterior-lateral closed
Joints	Sacroiliac

Procedures

Incision
Pin insertion
Drilling
Fusion (implants / screws)

Compatible Technologies

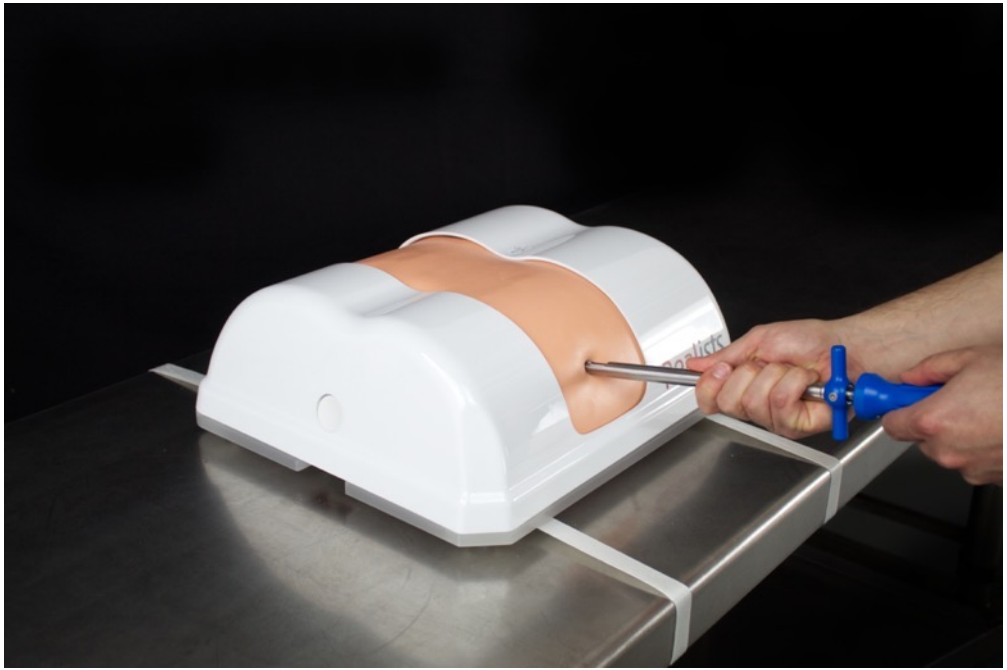
External Navigation
Implants / Screws (Fusion)
X-Ray

Approaches

Lateral
Posterior

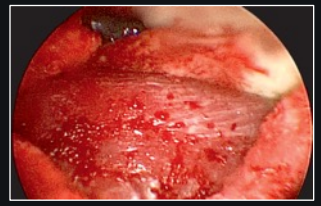
Access

Percutaneous



RealSpine | Lateral

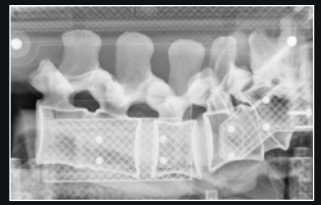
For training of lateral lumbar spine surgery
ATP and Transpsoas approach



Accurate representation of visual and haptical feedback from all anatomical structures.

Single or lateral-then-prone positioning for lateral interbody fusion and pedicle screw fixation

3 operable levels. Insertion of up to 3 cages. Placement of up to 8 pedicle screws



Compatible with X-ray and surgical navigation

Compatible with RealImaging. Deliver a complete training experience with our x-ray free surgical navigation.

Pathology:
- Spondylolisthesis L4-L5

RealSpine | Lateral

Anatomy

Bones	L3-S1
	Ribs
	Iliac Crest
Skin	Lateral closed
	Posterior closed
Muscles	Obliquus externus abdominalis
	Obliquus internus abdominalis
	Transversus abdominis
	Psoas major
	Fascia transversalis
	Posterior situs
Discs	Discs L2-L3, L3-L4, L4-L5
	Anulus
	Nucleus
Fat	Subcutaneous (Lateral)
Bleeding	Subcutaneous (Lateral)
Membranes	Peritoneum
Organs	Ureter
Vessels	Aorta Abdominalis
	Inferior Vena Cava

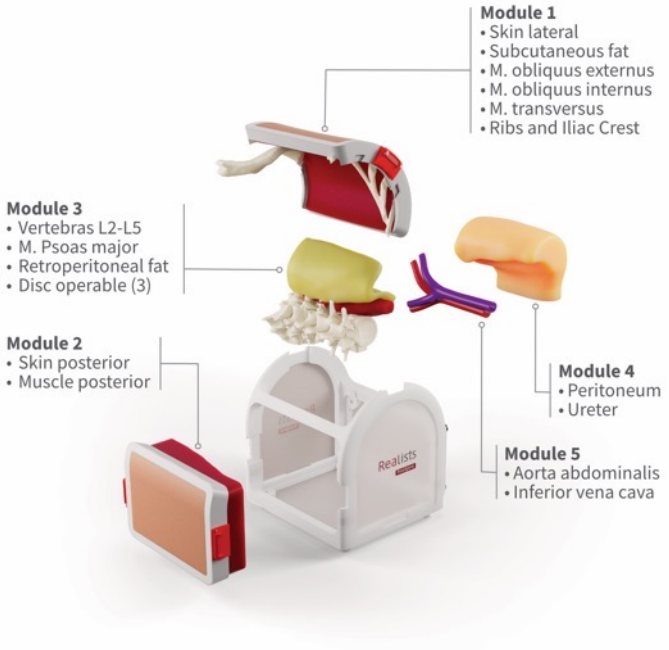
Approaches

Tubular Endoscopic
Open

Access

Posterior
Lateral
Percutaneous

Cost-efficient modular system, designed to replace only the modules used during training



Procedures

Incision
Discectomy
Fusion (Screw Fixation)
Transpsoas approach
ATP approach

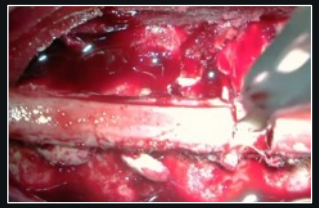
Compatible Technologies

External Navigation
Cages (LLIF)
Pedicle Screws (Fusion)
X-Ray

https://vimeo.com/realists/lateral

RealSpine | Myelopathy

For decompression and stabilization of the cervical spine



High-fidelity simulation of all anatomical landmarks including tissues and fluids.

Compatible with Lateral Mass, Pedicle and Laminar screws.

Compatible with Occipital fixation systems.

The interchangeable cartridge includes all necessary tissues and fluids for a complete training experience.

Compatible with RealImaging. Deliver a complete training experience with our x-ray free surgical navigation.

Pathology:
- Myelopathy in segment C3-C7

Anatomy

Bones	Occiput – C7
Skin	Open
Muscle	Cervical posterior open
Ligaments	Flavum
	Facet Capsular
	Interspinal
	Supraspinous
	Posterior Longitudinal (PLL)
	Nuchal
	Intertransverse
Dura & Nerve Roots	Dura & Nerve Roots
	Cauda Equina
	CSF
Fat	Epidural
Bleeding	Muscular
	Epidural
	A. Vertebralis
Vessels	A. Vertebralis

Procedures

Flavectomy
Laminectomy
Laminoplasty
Bilateral decompression
Facetectomy
Fusion (Screw Fixation)
Dura closure
Bleeding management

Compatible Technologies

External Navigation
Drilling
Pedicle Screws (Fusion)
Lateral Mass Screws (Fusion)
Dura suture
Bleeding management

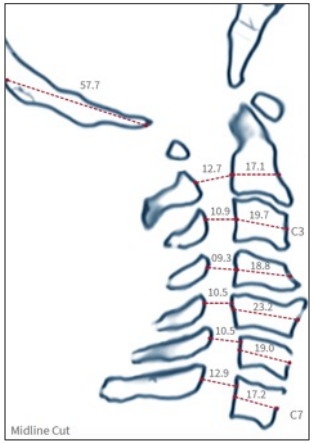
Approaches

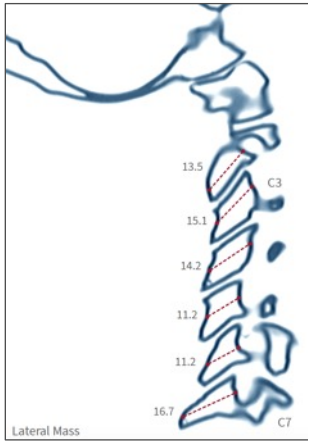
Microscopic / Exoscopic
Tubular Endoscopic
Open

Access

Posterior
Interlaminar

Anatomical dimensions





Dimensions in mm

Screw Fixation Compatibility

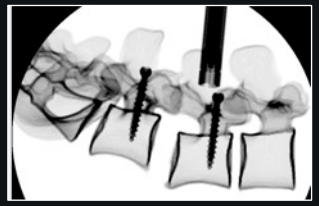
	Lateral Mass Screws			Pedicles Screws	Laminar Screws	Occiput Screws / Plate
	Magerl	Louis	Roy-Camille			
Occiput						✓
C1	✓	✓	✓	✓	✓	
C2	✓	✓	✓	✓	✓	
C3	✓	✓	✓	✓	✓	
C4	✓	✓	✓	✓	✓	
C5	✓*	✓	✓	✓	✓	
C6	✓*	✓	✓	✓	✓	
C7	✓*	✓	✓	✓		

* Possible but without cervical cover

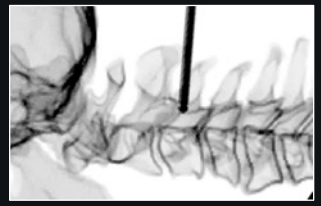
https://vimeo.com/773368101

RealImaging

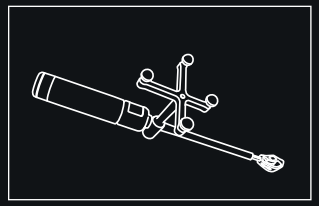
Radiation-free X-ray simulation for surgical training with RealSpine.



Real-time image-guided navigation of instruments, implants, screws, and more.



Accurate simulation (less than 0.5mm deviation).



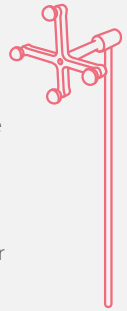
Compatible with all surgical instruments

Portable and flexible. Adaptable to any space. Use it anywhere.

RealImaging

Realists Reference Pointer

Realists' standard solution for precise guidance

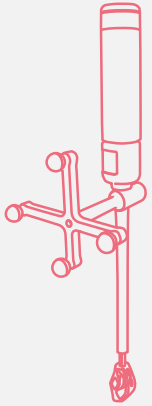


- Guidance for precise positioning of instruments and implants
- Reference marker for position control

Part of the RealImaging package

Use of Real Surgical Instruments

Use your own instruments and see them in RealImaging.



Instrument Adaptation Process

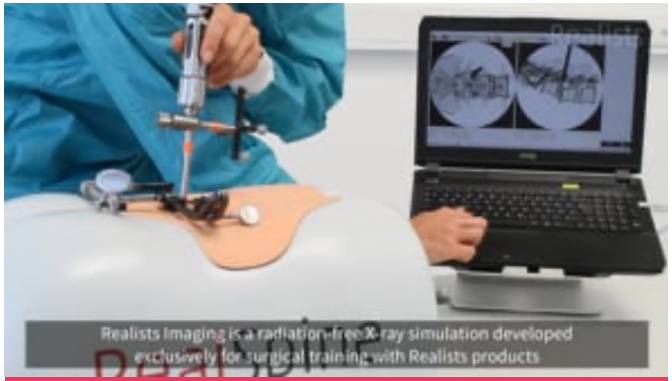
For new instruments with which RealImaging is not yet compatible:

1. Provide instruments to Realists.
2. Realists to customize RealImaging and create instrument specific trackers
3. Return of instruments incl. trackers (trackers belong to the customer)

Tracker Production

Production of trackers for instruments with which RealImaging is already compatible.

One-time investment

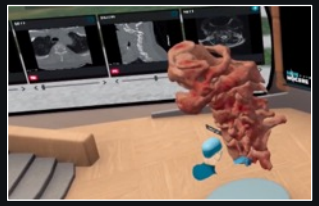


https://vimeo.com/441976473

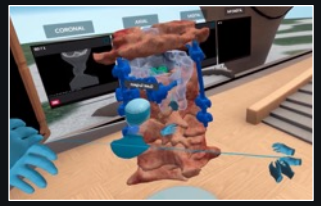
Realists VR powered by NON NOCERE

Virtual reality setup for pre- and post-operative case studies

Draw and paint over 3D anatomical models generated from real patient DICOM data.



View DICOMs of your selected cases and overlay images on 3D models to better understand the condition.



Accurately measure lengths, determine the size of tools or implants needed, compare pre- and post-operative conditions.

Deliver a more immersive experience by importing slide decks and video into the virtual setup.

https://vimeo.com/822041346

RealLab

Your partner in hands-on surgical training

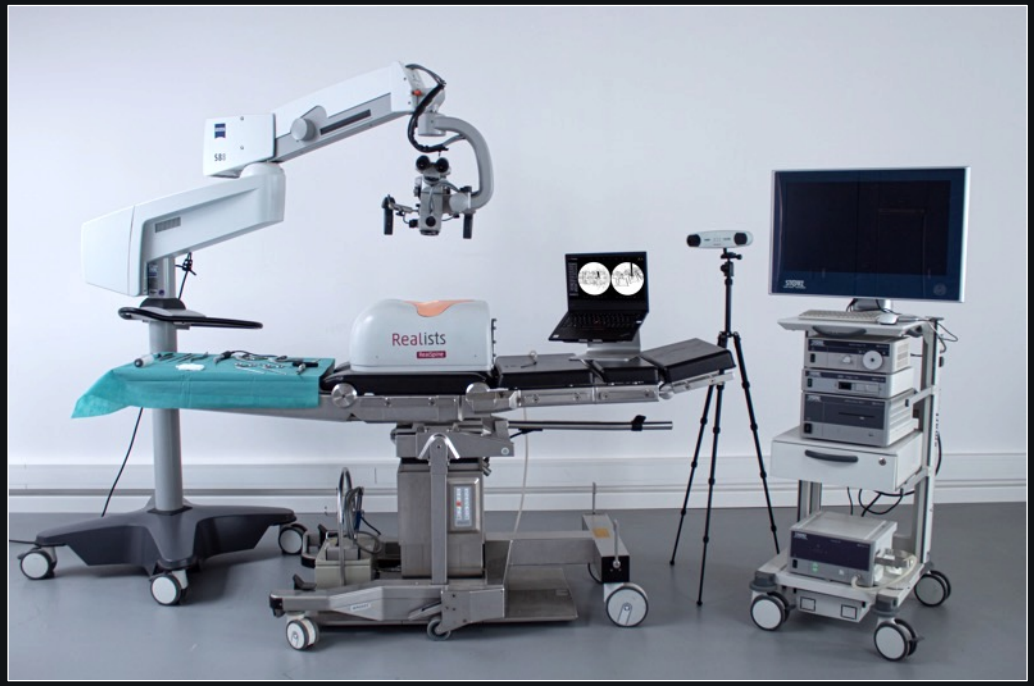
(in collaboration with the Leipzig University of Applied Sciences)

Located in Leipzig, a vibrant German city with rich history, culture and music.

Provided with all the necessary equipment to ensure a successful training experience.

Includes technical, logistical and educational support.

3 complete workstations for minimally invasive spine surgery



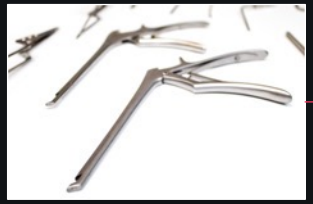
RealLab Your partner in hands-on surgical training

Location	Realists Training Technologies Headquarters Heinrich Heine Str. 35 04178 Leipzig, germany
Number of workstations	3
Equipment per Workstation	Microscope ZEISS S88
	Surgical drill
	Suction
	Instruments for microdecompression procedures
	Radiation-free X-ray simulation for surgical training (RealImaging)
	Surgical disposables (gloves, gauze, caps, gowns, face masks)
Additional spaces	Coffee station
	Conference Room

All-in-One

Spine surgical training – far beyond the ordinary

Surgical Instruments
Basic surgical instrument set



Realists Visualization
2D full-HD camera incl. LED illumination for visualization of the situs and co-observation

Training Support Services
Support in the organization and implementation of the training on site or remotely

Realists

Surgical Equipment
Suction devices, surgical drills and other disposable surgical supplies

Realists Training Concept
Didactic concept for efficient learning and best possible training outcomes

Logistic Services
Providing global access to top-notch spine surgery training

Our R&D team is operating at full capacity!

Jun 2023

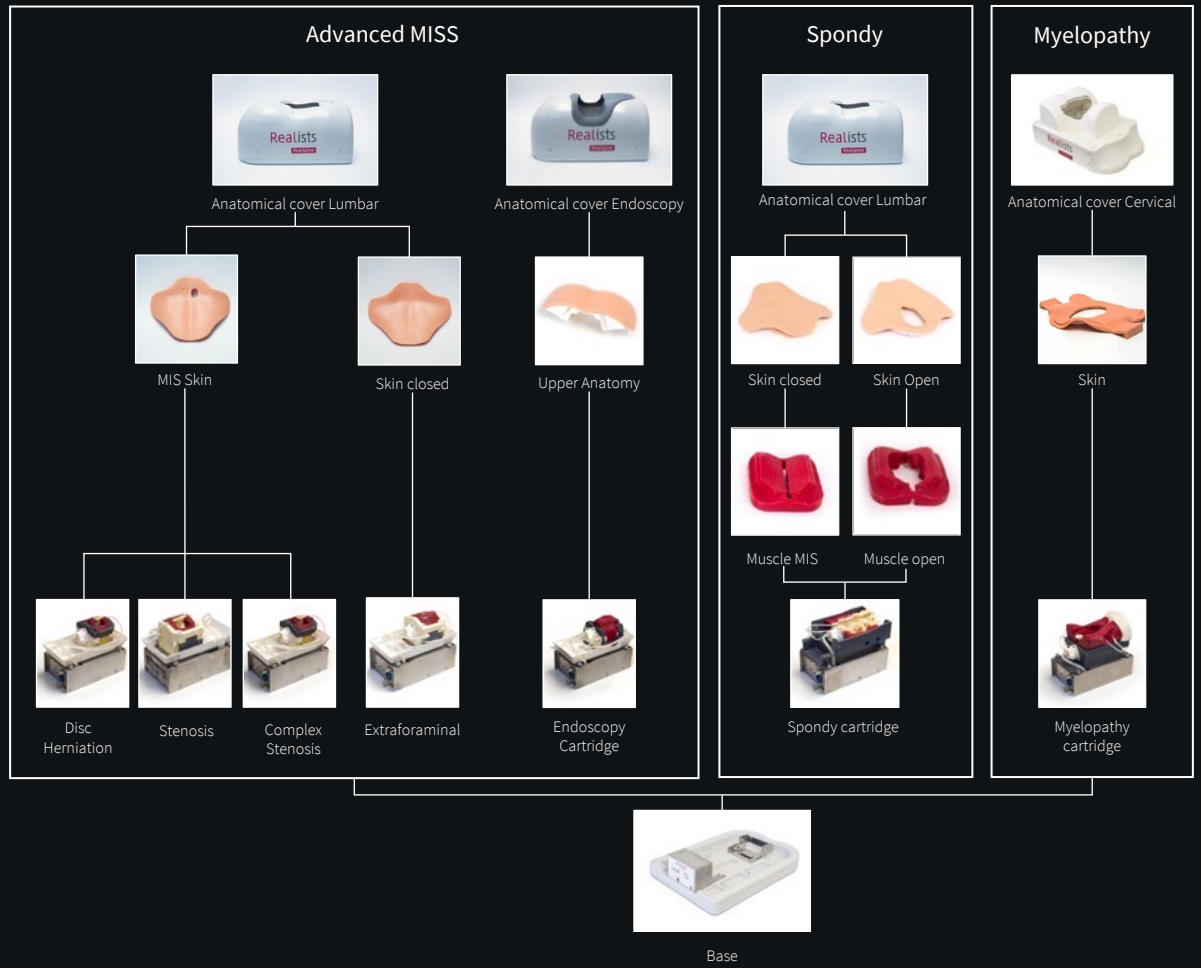
RealSpine
Anterior Cervical

October 2023

RealSpine
Anterior Lumbar

RealSpine
Cervical X-ray

RealSpine | System Compatibility



RealSpine | System Compatibility

Basic MISS

Cover Basic MISS +
Muscle container

Basic MISS Cartridge
+ skin + muscle

Spondy X

Cover Spondy X

Spondy X cartridge
+ skin + muscle

SI

Cover SI

Spondy SI cartridge
+ skin + muscle

Base plate

Lateral

Module 5

Module 3

Module 4

Module 1

Module 2

Base frame

Our Publications

Publication title	Thema	QR-Link
Melcher C, Hussain I, Kirnaz S, Goldberg JL, Sommer F, Navarro-Ramirez R, Medary B, Härtl R. Use of a High-Fidelity Training Simulator for Minimally Invasive Lumbar Decompression Increases Working Knowledge and Technical Skills Among Orthopedic and Neurosurgical Trainees.	Validity of RealSpine as training tool for spine surgery	
Adermann, J., Geißler, N., Bernal, L.E. et al. Development and validation of an artificial wetlab training system for the lumbar discectomy.	Validation of haptic and visual realism of RealSpine	
Fenyöházi E, Jarvers JS, Torres OA Adermann J, Voigtländer M, Selig C Schrempf A, Härtl R, Josten C, Bernal Vera LE, Korb W. Realitätsnahe chirurgische Trainingsumgebungen für die Wirbelsäulenchirurgie // Realistic surgical training environment for spinal surgery.	Effects on the learning curve based on pre post self assessment evaluations	
Mehren C, Korb W, Fenyöházi E, Iacovazzi D, Bernal L, Mayer MH. Differences in the Exposure of the Lumbar Nerve Root Between Experts and Novices: Results From a Realistic Simulation Pilot Study With Force Sensors.	Evaluation of our force sensors in the simulated dura	

Realists

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Leipzig, Germany

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realists_realspine

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@RealSpine

Realists GmbH

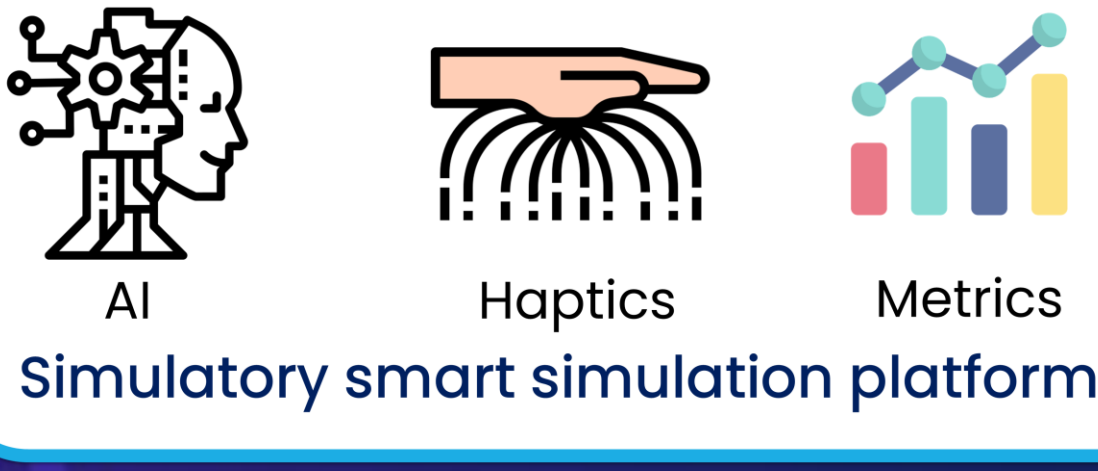
VRspine™

Smart Virtual Spinal endoscopy simulator for surgeons

Simulatory
Simulation Reimagined

Smart Virtual Spinal endoscopy simulator for surgeons

VRspine™ is a high-fidelity simulator built on top of Simulatory's Smart Simulation Platform that provides training to spinal surgeons on ultra-minimally invasive surgery techniques integrating virtual reality, sense of touch through true 3D haptic devices and AI (Artificial Intelligence) based scenarios.

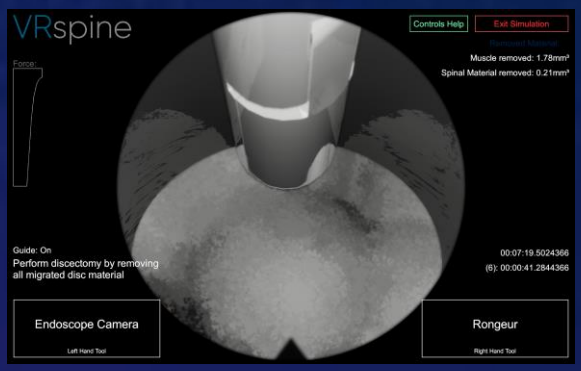


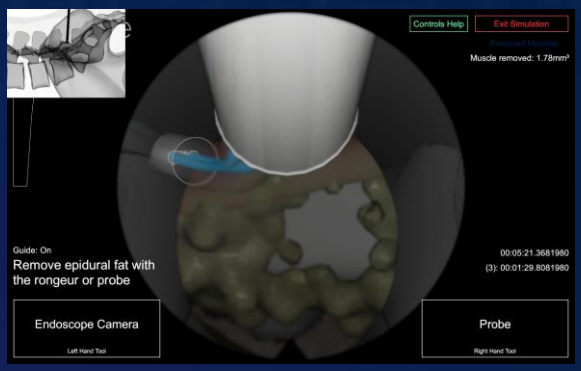
Highlights:

- Entry point to a spine surgeon's life
- Unique patient case on every trial
- Unlimited training for surgeons
- Kinesthetic haptic feedback
- 100% virtual simulation
- Automatic performance metrics

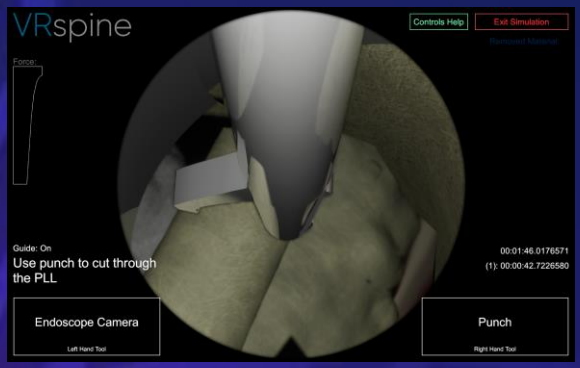
Library of modules: Endoscopic Monoportal

Interlaminar Discectomy

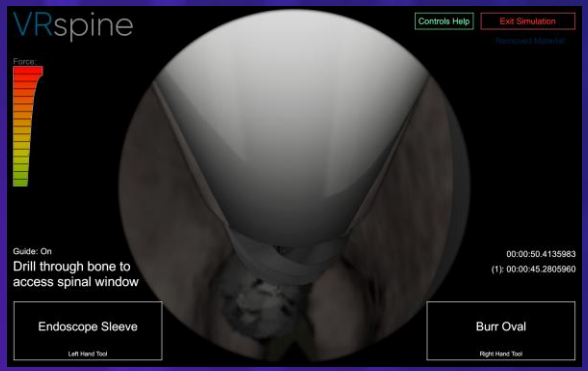


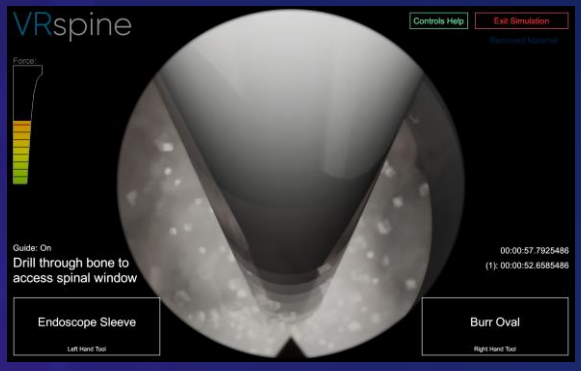


Transforaminal Discectomy



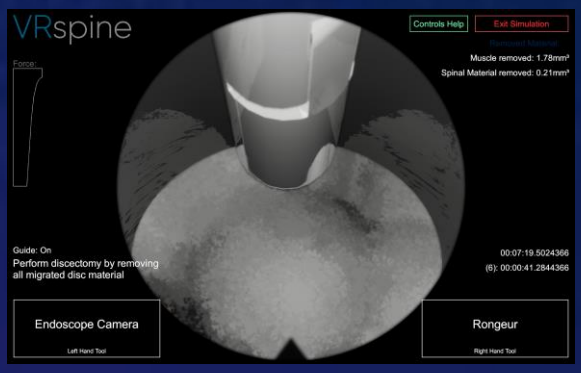
Spinal Stenosis

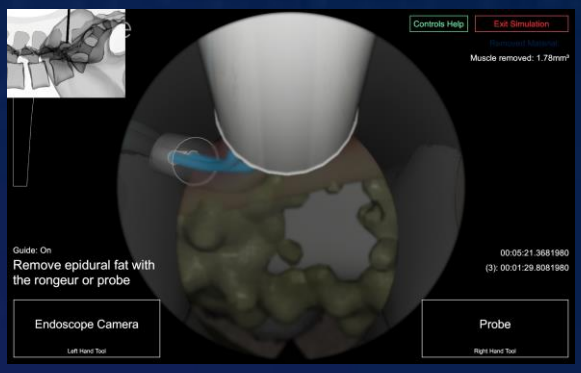




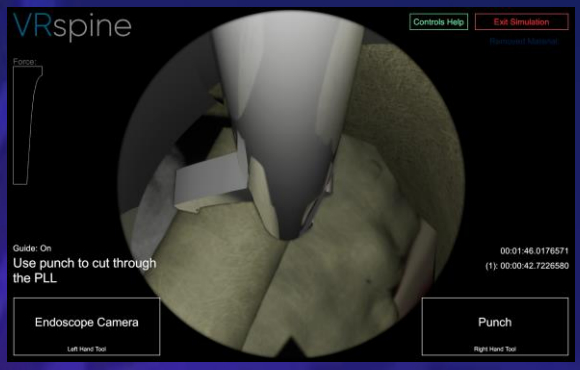
Library of modules: Endoscopic Biportal ★

Disc Herniation

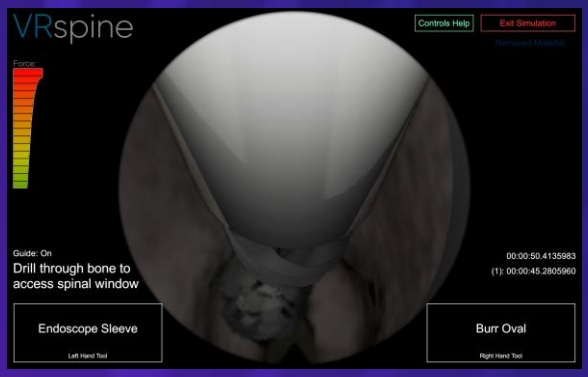




Spinal Stenosis



Endoscopic fusion: TLIF/ PLIF



★ Under development

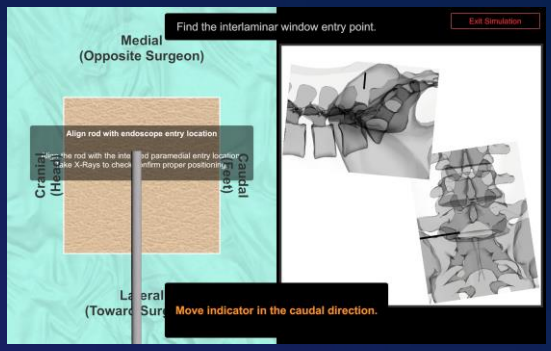
Features and Benefits:

Realistic Haptics

Integrated high-fidelity haptic feedback. Mimic the real experience of operating on surgical anatomy.

X-ray navigation

Simulates realistic X-Ray and teaches the trainee to perform successful X-ray navigation.



Surgical drilling

Simulates surgical drilling with realistic force feedback and teaches the trainee to use different drill-bits.

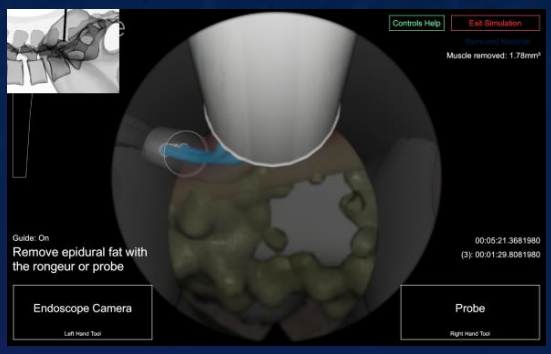
Metrics

Intelligent performance metrics of the trainee that shows skills development over time.

Features and Benefits

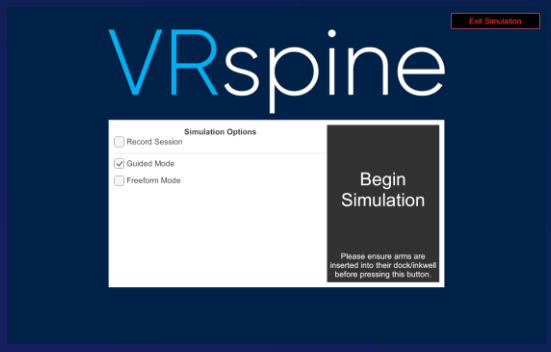
AI-based training

Simulates unique scenarios for every trial of the trainee based on our AI platform.



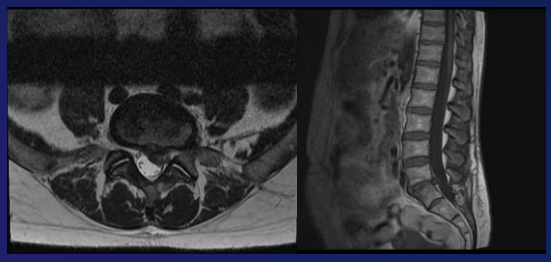
Expert Mode

Freeform mode that allows for expert users to train without any guidance or hints on real cases.



Train on synthetic patient data

Enables training on hundreds of different patient cases.



Contact information:

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Europe: +41792188596
www.thesimulatory.com

Proximie

Saving lives by sharing the world's best clinical practice

"It's as though you are there in person, in the middle of the operating theatre"

PROXIMIE.COM

What is Proximie?

Proximie is a software platform that allows physicians and medical device experts to virtually scrub-in to any operating room or cath lab, from anywhere in the world.

Every Proximie assisted procedure can be recorded, analysed and leveraged for future use to help inform best practice. By empowering physicians to share skills in real-time - before, during and after surgery - Proximie is helping to reduce variation in care and help to save lives.

Proximie was built to be light, easily deployed on low bandwidth, and therefore as usable in austere environments as it is in a high-end hospital. The platform has been used in every surgical specialty and is currently being used in more than 50 countries, over 300 hospitals worldwide, and by over 35 medical device organisations.

What makes it different?

APPLICATIONS

- Live remote or support
- Live remote proctorship
- Live remote preceptorship
- Expanding service capacity

MAIN FEATURES

- Video and audio communication
- Up to 4 Low Latency HD Camera Views
- Utilize Existing Hardware
- Picture in Picture Video Display
- Library of sessions
- Overlay of 2D images & 3D models
- Secure and compliant
- Phone, tablet and desktop compatible
- Face to Face Video

OTHER HIGHLIGHTS

- Analytics and insights
- Calendar with Session Scheduling
- Localized privacy policy
- Post Case Review Functionality
- Moderated participants
- Live participant chat
- Live user support

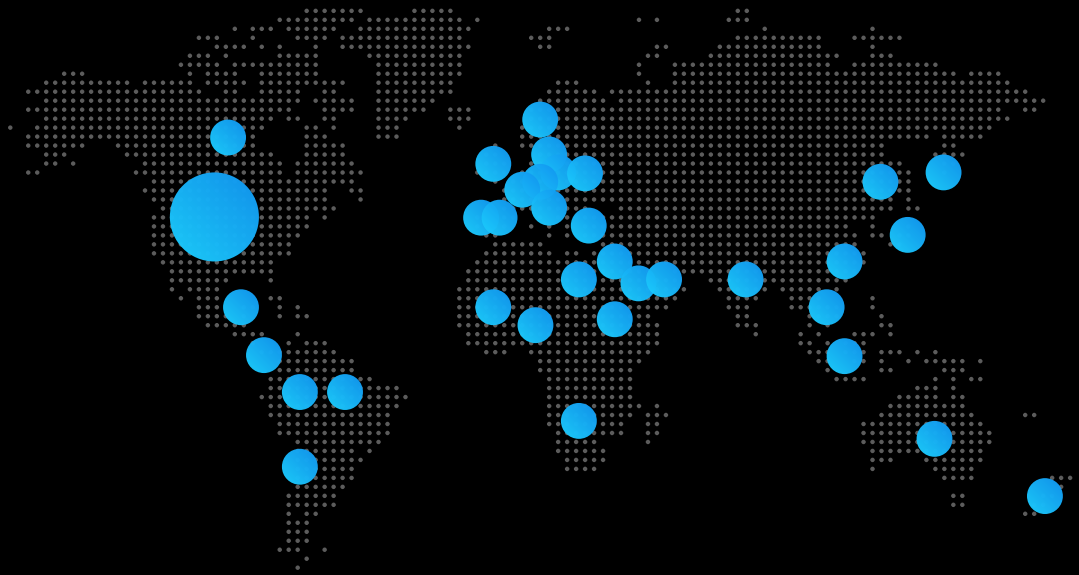
What is Proximie?

WHY WAS PROXIMIE FOUNDED

As a practicing surgeon, having worked across the world,

DR. NADINE HACHACH-HARAM,

witnessed first hand that both here and abroad there is considerable variation in surgical care which drives up cost and results in poor patient outcomes.



500+ locations

50+ countries

35+ medical device companies

20+ clinical publications

Founded in **2016**

Commercialized in **2019**

120+ employees

31% female

40% BAME

Privacy & security

HIPAA & GDPR

compliant and adhere to local regulations with data privacy and security

Proximie

A Learning Experience Platform Powered by Smart Simulation

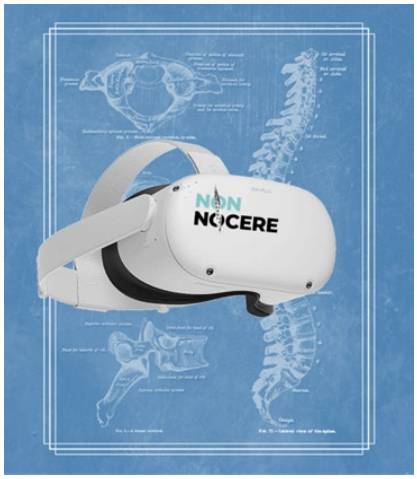
There is a paradigm shift in medical training.

Traditional Training

Watch & learn method.
Centralized, not accessible.
No standardization.
Mistakes create complications.

VR Training

One-to-one training with prominent experts.
Continuous training with no boundaries.
Training remotely as a team.
Ability to learn from mistakes.
Practicing on rare pathologies.
Standardized metrics which lead to objective evaluation.
Undisrupted training during the pandemic.



We created a virtual training center.

We have created a multi-layered teaching tool powered by a virtual classroom, designed by surgeons for the needs of **decentralized modern medical education**. The platform enables the faculty and the learners to interact directly in the virtual classroom.

Our system utilizes a series of tools that allows the blending of traditional teaching with advanced 3d visualization, creating "an unparalleled learning experience." Asking immediate questions, correcting mistakes, **peer-to-peer discussions**, and real-time observation creates an ideal environment for **knowledge transfer** and evaluation.

This interactive, multi-user teaching environment with **remote training** capability utilizes two different implementations of virtual reality:

A virtual anatomy and pathology lab.

Teaching and/or exploring anatomy with various pathologies.

Teaching pre-operative planning: Assessing clinical information to determine/confirm diagnosis and appropriateness of procedure.

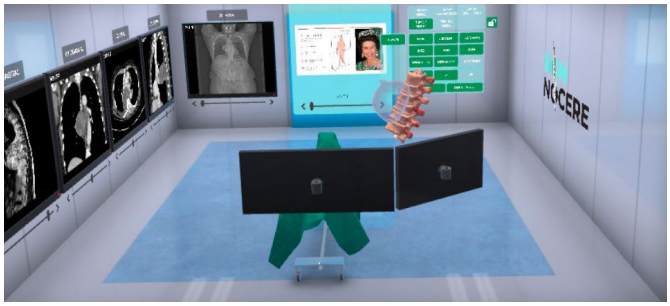
Teaching basic procedural know-how: Teaching steps, potential risks, and how to overcome them.

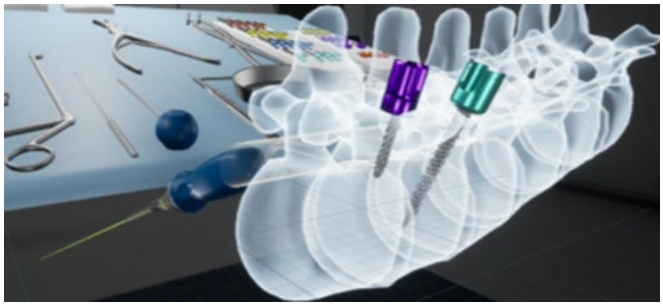
An immersive virtual OR.

Case preparation: Positioning the patient correctly, understanding the approach and required instruments, and being prepared to deal with probable complications.

Efficiency and flow: Demonstrating the planned course of the procedure.

True imaging.





Real patient data in simulation.

We are retrieving data from actual radiology scans, **quickly importing this data into the VR environment**, rendering the tool useful for **real-time teaching, surgical planning, and M&M rounds**. This makes it possible for the learners to work on various actual pathologies hence increasing their experience and ability to adapt to different situations they may encounter in real life.

Learning experience design.

We aim to create novel learning pathways and experiences for trainees and trainers. We work with surgeon-guided editorial teams from our partner institutions to develop VR-specific EPAs for a competency-based curriculum. We use a novel backward planning approach and competency & **problem-based design** to ensure making the procedural learning paths most relevant in translating knowledge, so learners can fill their competency gaps more efficiently and effectively.

NonNocere backward planning

- What is the desired outcome in engaging in learning?
- What are the gaps in a surgeon's performance?

A great tool to teach & evaluate.

Multiplayer
The users can join from all around the world. Remote mentoring and monitoring are possible.

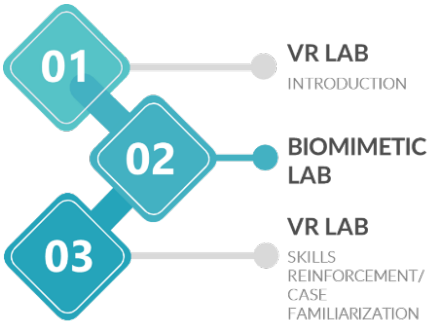
Teaching mode
For the professor to show anatomy in VR to better explain the details of the procedure and anatomical landmarks.

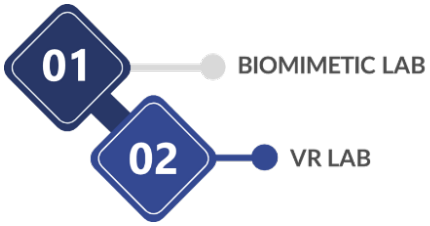
Learning mode
A self paced environment where the user can go through different levels of learning material and practice a surgical procedure.

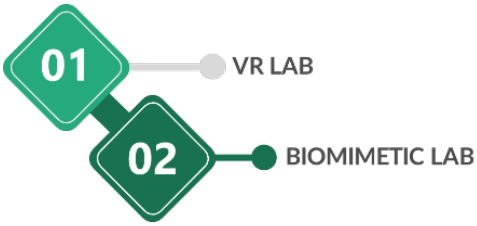
Assessment
The assessment mode is where the trainee performs their best and their metrics are recorded.

Dual Learning.

VR & biomimetic simulators/cadavers can be used together for 360° learning. Our VR simulator supports procedural learning. It ensures an understanding of human anatomy and different pathologies. Limitless repetition of mission-critical steps is possible. At the same time, Biomimetic simulators enable psychomotor skill development. They make using real surgical tools on a responsive synthetic cadaver possible.







VR lectures & case discussions library.

Our feature which enables us to record lectures and case discussions helps create a library for the user institutions. Learners can watch previous sessions and case discussions involving rare pathologies as needed at their own time in VR. Such a library would be a great add-on to the teaching institution's toolbox meshing perfectly with any competency-based curriculum.

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7. März 2020

Precision OS delivers accredited curriculum for orthopedic surgical training in VR

Blueprints (/de/feed/all/Blueprints) Medical (/de/feed/all/Medical) Precision OS (/de/feed/all/Precision%20OS) Simulation (/de/feed/all/Simulation) VR (/de/feed/all/VR)

Von Sébastien Lozé

Orthopedic surgery is no game. Get it right, and a patient's life can be transformed for the better. Get it wrong, and they could end up worse off than before you started. So how are two former game developers and an orthopedic surgeon working together to more effectively train practitioners?

A very random meeting

Formed in a Vancouver basement two years ago, Precision OS (https://www.precisionostech.com/) is now a flourishing business that provides orthopedic surgical training in virtual reality. Two of its three founders, CTO Colin O'Connor and Chief Creative Officer Roberto Oliveira, had both worked in the video game industry for decades. After years at Radical Entertainment, Black Box Games, and industry giant Electronic Arts (https://www.ea.com) they helped co-found United Front Games together, where they had critical and commercial success with titles like ModNation Racers and Sleeping Dogs.

In 2016, the pair were looking for something new to get their teeth into when they had what Oliveira describes as "a very random meeting" with orthopedic surgeon Dr. Danny Goel, now CEO of Precision OS. After a get-together at a local pub which included a demo from O'Connor of the newly released HTC Vive, the team started building a VR training platform for orthopedic surgery. Initial feedback from surgeons, residents, and device companies was positive, and the three went all-in

and started the business.

Rethinking surgical training

Traditionally, surgeons have trained using plastic models and actual cadavers. As Goel—who continues to practice as a surgeon—explains, neither of these "simulates" real conditions accurately enough. In the case of cadavers, the condition of the specimen can negatively impact the experience; although variation is at the heart of medicine, the actual core of the simulation should be consistent. Similarly, plastic models lack the contextual aspects of real-life surgery. The same is true of medical reference books, which can't deliver the experiential nature of surgery.

"The interesting part about anatomy is when you look in one of these medical books, everything's clean and broken apart and you see bones that are white and muscles that are very well defined," says Oliveira. "And then when you go into surgery and you look into the approach or the incision, it's completely different than what you would expect."

For Precision OS's VR training, the goal is to simulate the real environment as closely as possible, enabling students to experience what surgery looks and feels like. They encourage trainees to make mistakes in simulation—without putting patients at risk. To familiarize themselves with the procedures and thereby recreate them as closely as possible, Oliveira and O'Connor physically stand behind Goel and watch him operate. They also study medical books and actual cadavers.

And then it's a case of recreating what they have witnessed in a real-time VR environment. Having had experience with several game engines in the past, including writing their own at United Front, Oliveira and O'Connor chose Unreal Engine.

"I know for a fact that Unreal supports more things out of the box than any other engine out there," says O'Connor, explaining the choice. "And I wanted to make sure that we hit that triple-A fidelity mark right from the outset."

With his rendering engineering background, the openness of the Unreal Engine platform was also a key factor for O'Connor. "I also wanted to make sure that I had access to the code (https://docs.unrealengine.com/en-US/GettingStarted/DownloadingUnrealEngine/index.html) and could go right down to the hardware layer and internal GPU submission calls, to edge every single bit of performance out of the VR experience," he says.

Recreating operating theater reality

To create the virtual patient, the team initially purchased an anatomy model set, but quickly found the limitations of that, so they started modeling their own. Recently, in a bid to increase the authenticity, they had a patient scanned. In selecting their candidate, they ensured that, unlike the stock model, he was of the typical age and physique of someone needing the operation—that is to say, an older person with a common body habitus.

The accuracy of the simulation is particularly important when dealing with surgery, where a misrepresentation could have significantly grave consequences. Oliveira and O'Connor use every trick they've ever learned in game development to make sure they are able to represent each step as faithfully as possible, and Unreal Engine's deep and broad feature set is part of the solution.

"With the power behind the Blueprint (https://docs.unrealengine.com/en-US/Engine/Blueprints/index.html) system, the animation (https://docs.unrealengine.com/en-US/Engine/Animation/Overview/index.html) system, support for morph targets (https://docs.unrealengine.com/en-US/Engine/Animation/Persona/MorphTargetPreviewer/index.html), vertex animation (https://docs.unrealengine.com/en-US/Engine/Animation/Tools/VertexAnimationTool/index.html)...Unreal just gives us an array of technology that we can hook into to solve these problems of recreating a medical environment," says O'Connor.

"There are ethical considerations to what we are building," says Goel. "Misrepresentations and over-optimism of VR are critical elements when creating something with consequences to actual patients. We are sensitive to both and are researching all aspects of virtual reality. A second and important element to also consider is the point about empathy. It is important for the trainees to remember how their practice has implications to patient lives."

Teaching illustrative anatomy

Goel also wants to ensure that the module teaches anatomy illustratively, learning he values in his own work on the operating table.

"During surgery, although you can't see each and every muscle, an experienced surgeon understands the anatomical landscape very well," he says, "During surgery, I see surgical anatomy but I am thinking about illustrative anatomy. Although you never fully see certain nerves, vessels, and muscles in my mind I am imagining where these structures are, to avoid a

misplaced retractor or inadvertent injury.

“Anatomy is a three-dimensional concept that we learn in two dimensions. Unless I have regular unencumbered access to a cadaver, how do I learn and reinforce my anatomical learning? This point is really important to us here at Precision OS, where we focus on recreating as much of the realistic illustrative anatomy as possible in 3D. Having a deep understanding and appreciation for anatomy is the foundation of surgery in all specialties.”

Beyond the visual

As well as the visual aspect, the application features auditory feedback, so that you can hear the anesthetic machine, or the sound of a drill or mallet as you use it. And haptics are also employed, but only where they are critical to support the training. Goel explains that it’s the ability to make decisions during the training, and to make mistakes, that forms their double-loop simulation experience (https://www.teachthought.com/learning/learning-theories-double-loop-learning/) inherent in what Anders Ericsson has coined “deliberate practice” (https://www.businessinsider.com/anders-ericsson-how-to-become-an-expert-at-anything-2016-6).

“The decisions you make prior to and during surgery are how we impact patient outcomes,” he says. “This decision-making process is what we embed within our simulation modules.”

Selecting the hardware

When discussing haptics, both the cost and the portability of the hardware required to support them are also factors in the extent to which they are used. Many of their customers travel with the educational gear, and need to be able to quickly set it up and tear it down. And the team is keen to decrease the disparity in health care that exists in different parts of the world.

“Adding more complex hardware restricts who could have access,” says Goel. “Impacting the health care disparity that exists in certain parts of the world is a major consideration for us at Precision OS. We have therefore maintained our focus and dedication to creating the most impactful educational software while using the most portable hardware, permitting global distribution.”

Increased portability is also a goal so that student doctors can consume the training at their convenience, in their own home, office, or school. Currently the hardware implementation is a laptop tethered to a headset, which adds an element of friction

for transportation, but the team is moving to mobile VR devices and devices like the Oculus Quest within the next year.

Training the next generation of surgeons

So has there been resistance to using this kind of technology for training?

“It's quite interesting,” says Oliveira. “We see slight resistance sometimes where we don't expect to see it, like in younger students or younger doctors, and then sometimes we expect to see it in the older generation and sometimes we get an incredible reaction there. We’ve never really had to push the technology. People seem to understand this is the future of surgical training. Most organizations are just trying to figure out the best way to introduce it.”

Overall, as the technology becomes more affordable, accessible, and portable, it is seeing wide acceptance. The fact that the system can also be used to collect performance data and provide metrics for the students on the backend is another clear benefit to those whose mandate it is to train and educate the next generation of surgeons.

Today, Precision OS modules are in use by hundreds of residents in the ten North American universities and institutions that were their original partners, and, in conjunction with their other customers, are also available in in countries as far apart as Japan, Switzerland, France, and Australia. With their product for the international organization known as the AO Foundation (https://www.aofoundation.org/) and a new preoperative planning tool, they plan to educate thousands of people from North America, and then tens of thousands globally.

In May of 2019, Precision OS received accreditation (https://medicalsimulation.training/technology/precision-os-canadian-accreditation/) from a provider to the Royal College of Physicians and Surgeons of Canada (http://www.royalcollege.ca/rcsite/cpd/accreditation/cpd-accreditation-simulation-based-learning-activities-e), enabling their training to be used as the performance appraisal component of continuing medical education (CME) for surgeons. This accreditation, coming as it does from a highly regarded organization, is a validation of the company’s efforts to achieve the highest-quality training through VR.

The marriage of medicine and technology is disrupting the well-entrenched methods to educate physicians and surgeons. Understanding this, the whole team at Precision OS creates content with a heightened sense of social responsibility. “As an operating surgeon, I know the time and energy we spend on the details above could have significant implications,” says Goel. “What and how the trainees learn is of the utmost importance to us. The trust our partners and users have placed in us is reflected in our content for a single reason—for them to practice with purpose in virtual reality, so they may operate with precision, and truly impact patient care worldwide.”

Interested in finding out how you could use Unreal Engine 4? Get in touch (mailto:simulation@epicgames.com) and we’d love to start that conversation.

AKTUELLE POSTS

(/de/blog/winning-epic-s-megajam-was-the-spark-that-ignited-the-creation-of-

(/de/blog/two-falls-represents-two-different-cultures-with-contrasting-art-styles)

(/de/blog/inside-kingdoms-reborn-s-game-dev-s-journey-of-discovery-and-city-building)

ue5-powered-platformer-boti-byteland-overclocked)
29. Juni 2023

Der Sieg beim Epic MegaJam war der Zündfunke für die Entwicklung des UE5-Plattformers Boti: Byteland Overclocked. (/de/blog/winning-epic-s-megajam-was-the-spark-that-ignited-the-creation-of-ue5-powered-platformer-boti-byteland-overclocked)

Dank Lumen in der Unreal Engine 5 konnte das Team atemberaubende Bilder von...

28. Juni 2023

Two Falls repräsentiert zwei Kulturen mit sehr verschiedenen künstlerischen Stilen (/de/blog/two-falls-represents-two-different-cultures-with-contrasting-art-styles)

Entwickler Unreliable Narrators erzählt von der Zusammenarbeit mit authenti...

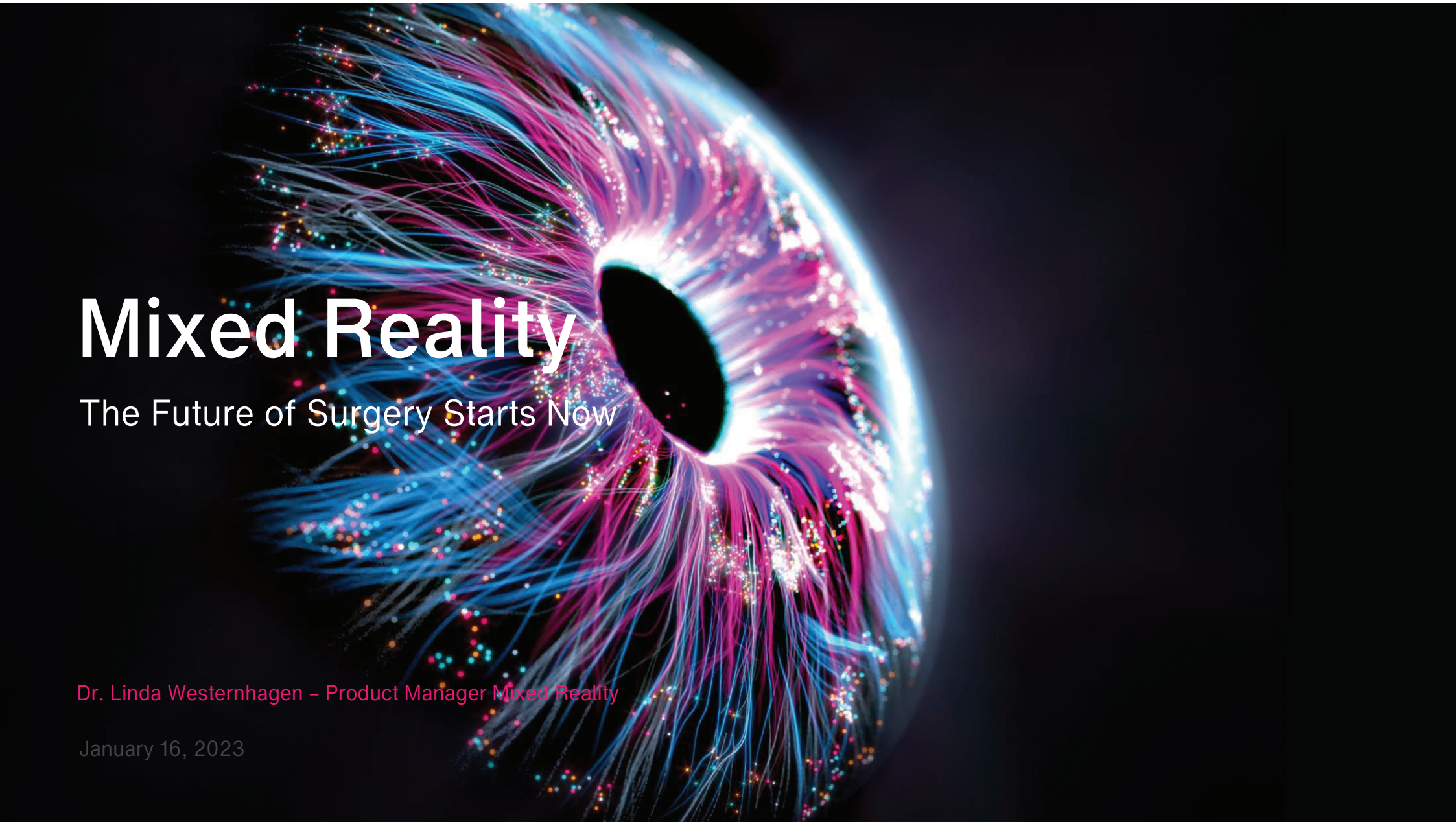
27. Juni 2023

Einblicke in die Entdeckungs- und Städtebaureise des Spielentwicklers von Kingdoms Reborn (/de/blog/inside-kingdoms-reborn-s-game-dev-s-journey-of-discovery-and-city-building)

Die Performance-Priorisierung der Unreal Engine half bei der Entwicklung vo...

(/de/feed)

Service-Partner



Mixed Reality

The Future of Surgery Starts Now

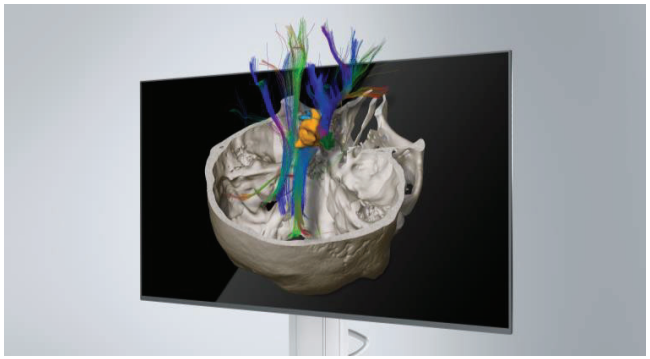
Dr. Linda Westernhagen – Product Manager Mixed Reality

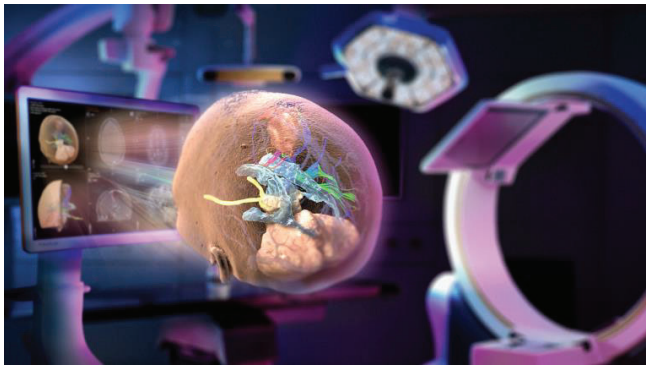
January 16, 2023

Free Patient Data from the Barriers of a 2D Screen

3D Visualization: From Screens to Reality

For an optimal understanding of your patient‘s anatomy





2009
3D VISUALIZATION

2016
3D STEREOSCOPIC DISPLAY

2019
MIXED REALITY

Many Different Types of Reality

What's the difference?

Virtual Reality

Immerses the user in an entirely digitally generated, interactive world

https://www.ossovr.com/

Augmented Reality

Enhances the real-world environment with digital objects

https://www.medgadget.com/2013/08/augmented-reality-ipad-app-guides-surgeons-during-tumor-removal.html

Mixed Reality

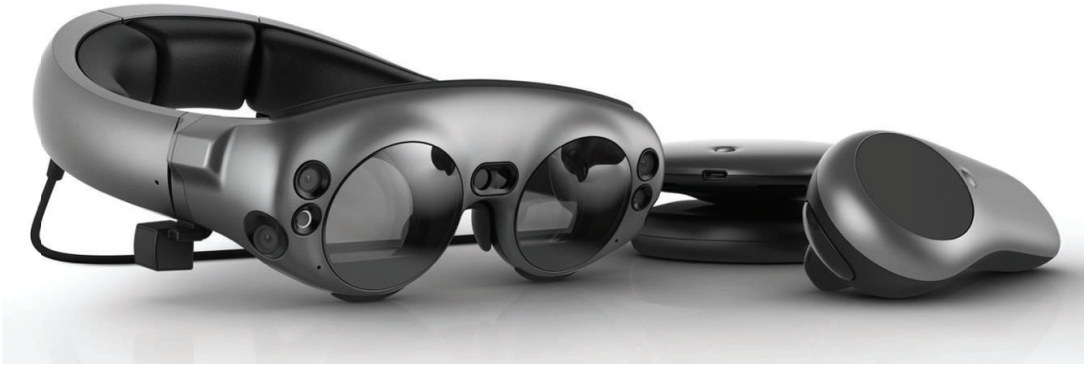
Merges the real and virtual worlds so that digital and physical objects interact in real time

Mixed Reality Viewer

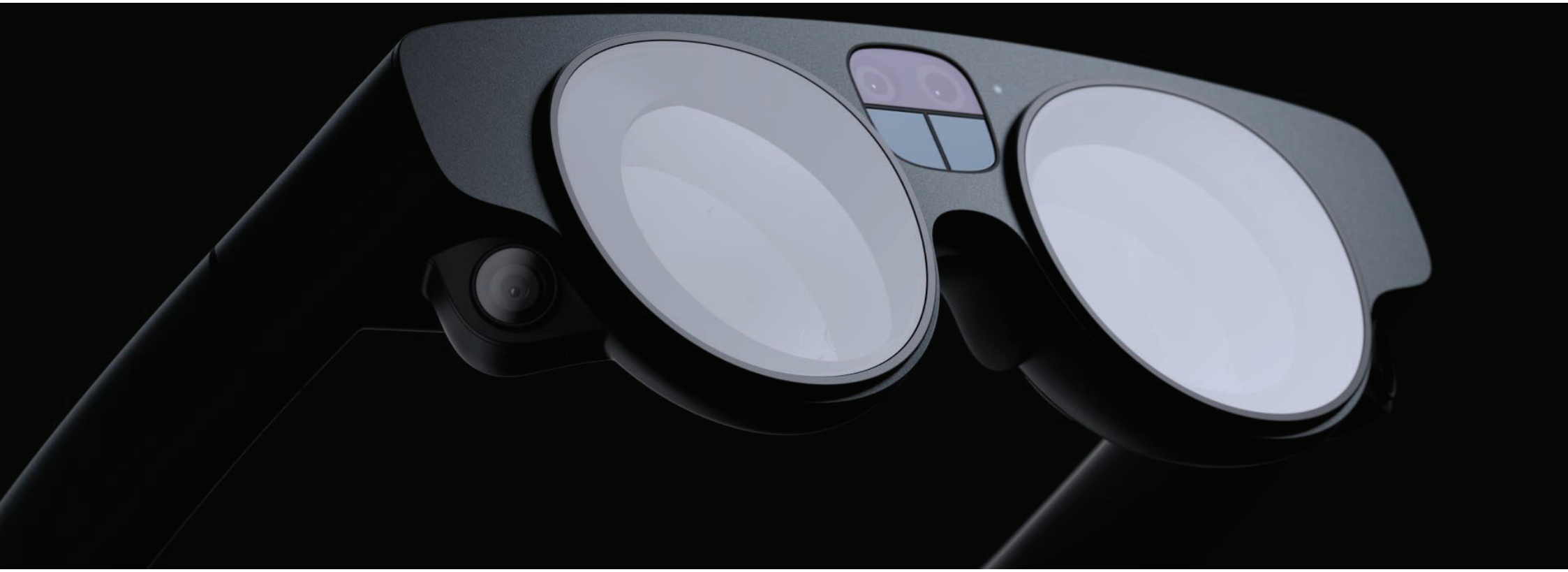
Brainlab product enabled by Magic Leap

Mixed Reality Viewer

- CE and FDA cleared



Magic Leap 1



Magic Leap 2

the most immersive AR device on the market

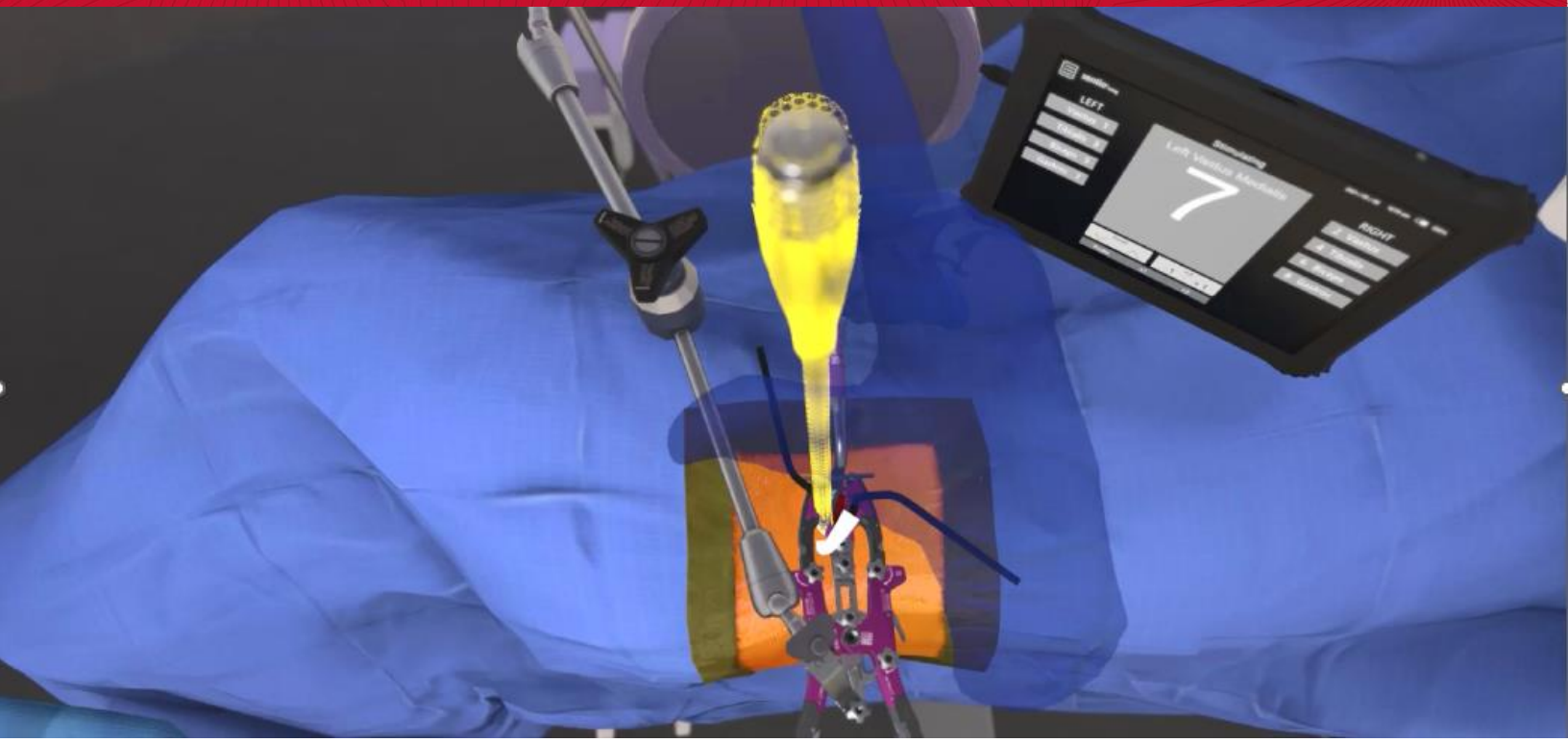
- 50% smaller
- 20% lighter
- 100% bigger FOV
- Industry-first global and segmented dimming

Johnson & Johnson INSTITUTE

Johnson & Johnson Institute's

Virtual Reality offerings for

DePuy Synthes Spine



UNLEASH® Single Position Lateral Procedural Solution (US Only)

Single Position Lateral interbody fusion procedure for L4/L5 disc degeneration using UNLEASH® Lateral portfolio.

Showcasing all key procedural steps including:

- **Patient positioning** and set up with SENTIO™ MMG,
- **Access** with SENTIO™ MMG and Phantom XL3™ Lateral Lumbar Access System,
- Lateral **discectomy**,
- CONDUIT™ **Lateral implant placement,**
- **Supplemental fixation** with VIPER PRIME™ Screw System.

DePuy Synthes
THE ORTHOPAEDICS COMPANY OF Johnson & Johnson

Johnson & Johnson
INSTITUTE

UNLEASH® Single Position ATP Procedural Solution (Global Release – December 2022)

Single Position Anterior to Psoas interbody fusion procedure for L4/L5 disc degeneration using UNLEASH® ATP portfolio.

Showcasing all key procedural steps including:

- **Patient positioning** and taping,
- **Access** with INSIGHT™ Lateral Access System,
- Lateral **discectomy**,
- CONDUIT™ **Lateral implant placement,**
- **Supplemental fixation** with VIPER PRIME™ Screw System.

Ask your sales consultant, scan the QR code, or visit jnjinstitute.com to learn more about VR

DePuy Synthes
THE ORTHOPAEDICS COMPANY OF Johnson & Johnson

VR station for ALIF, AO Spine course in Switzerland

Moritz C. Deml

2022

What was done? (what new educational technology was included in the event?)

- What was integrated?
  - ALIF L5/S1 – virtual reality provided by Depuy Synthes

- Learning objectives?
  - Principles of anterior lumbar ALIF
  - Anatomical landmarks on the way to L5/S1 retroperitoneal
  - Identify the anatomical landmarks accessing L5/S1
  - Describing procedure related complications
  - Outline advantages and disadvantages of the ALIF-procedure
  - List differences between ALIF and TLIF-Procedures

What was done? (what new educational technology was included in the event?)

- Participant:faculty ratio?
  - 2 : 1

- Any other important information?
  - Depuy Synthes is developing a new VR platform which should be even more realistic. But at the moment, to present the theoretical steps of an ALIF, the system is good and ready to use.

Photo of a station (and description)

- Two Laptops with VR equipment and a big screen.

Photo of a station (and description)

AO Spine Latin America experience report

SurgiSTUD and Realspine 2021

Luiz Gustavo Dal Oglio da Rocha

What was done? (what new educational technology was included in the event?)

- What was integrated?

Cervical spine simulation and 3D bone model

- Learning objectives?

Cervical spine simulation: develop surgical skills for fixation and decompression procedures for posterior cervical. Using microscopes and tubular decompression system

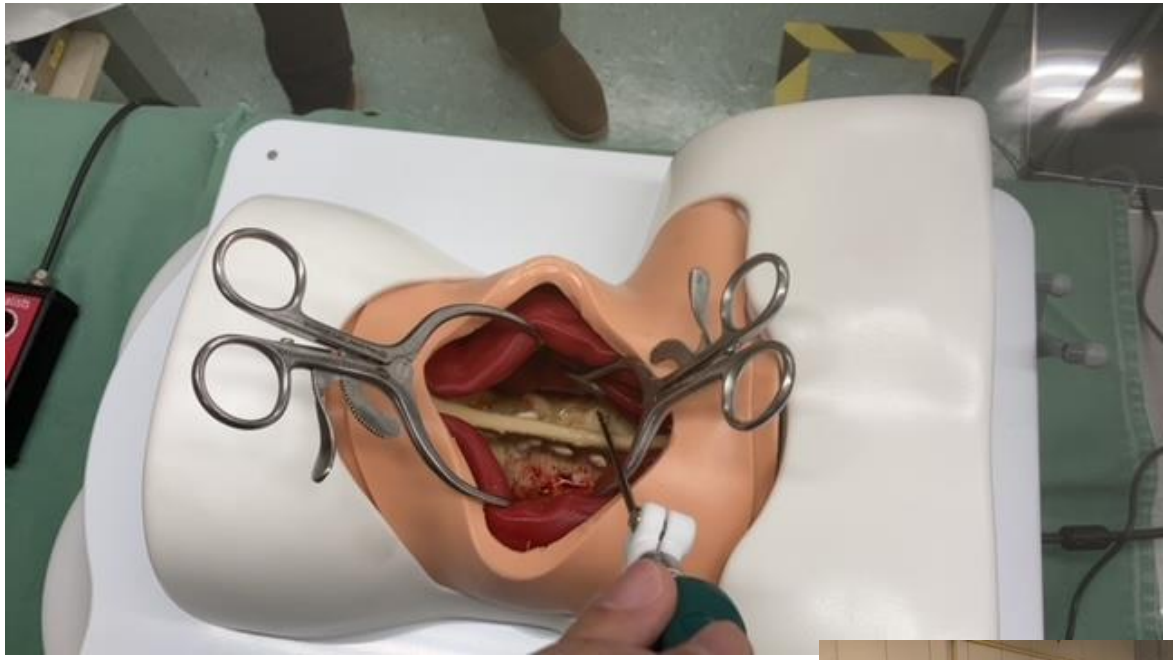
3D Bone model: facultys evaluated a thoracolumbar deformity model to feel if it is interesting to implement in our courses. This was just a pilot

- Partner providing the system?

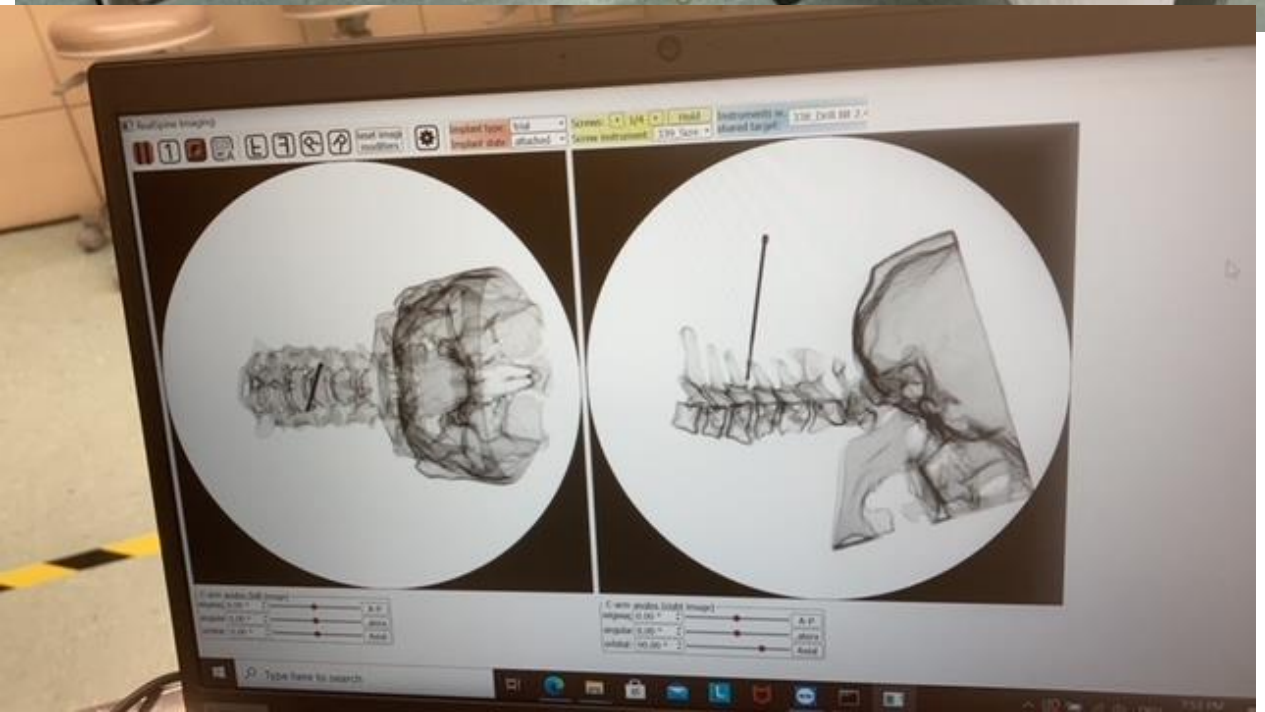
Simulation: Realists

3D bone model: surgistud

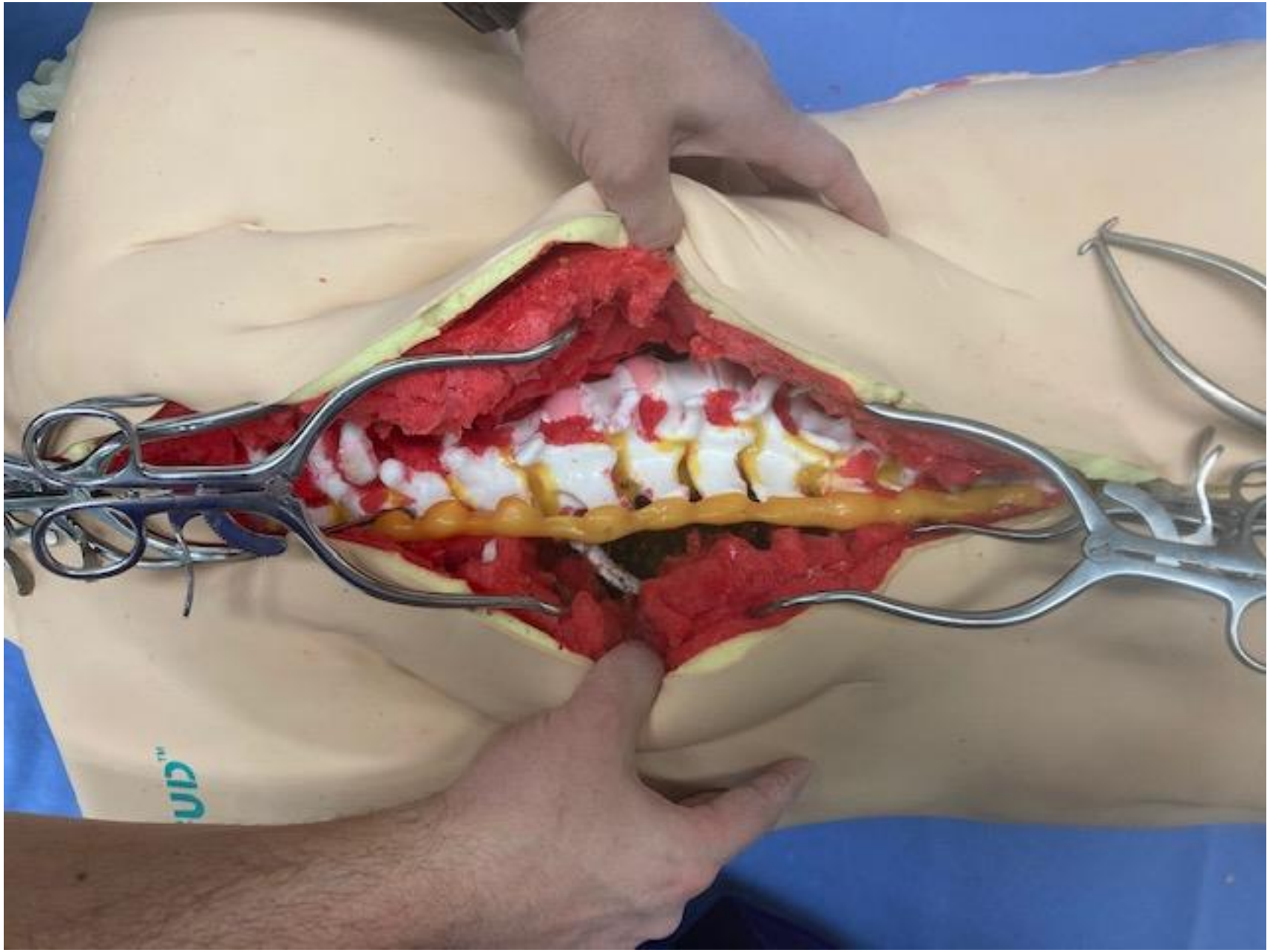
Photo of a station (and description)




Realists




AO
SPINE



Surgistud 3D bone model

What was the feedback and evaluation data?

- Very positive feed back from participants and faculty about the simulators
- Negative feedback from participants regarding the registration fee

- 3D bone model needs to evolve… but is fairly adequate for special activities

AO SPINE

Case Based 3D Bone Model Webinar

Asia Pacific

Lifelong learning and professional development at home

From wide touchpoints remote Online learning to Offline F2F courses with engaging content and practical exercises

Adaptive learning tool – 3D patient specific bone model, complimentary to Cadaver

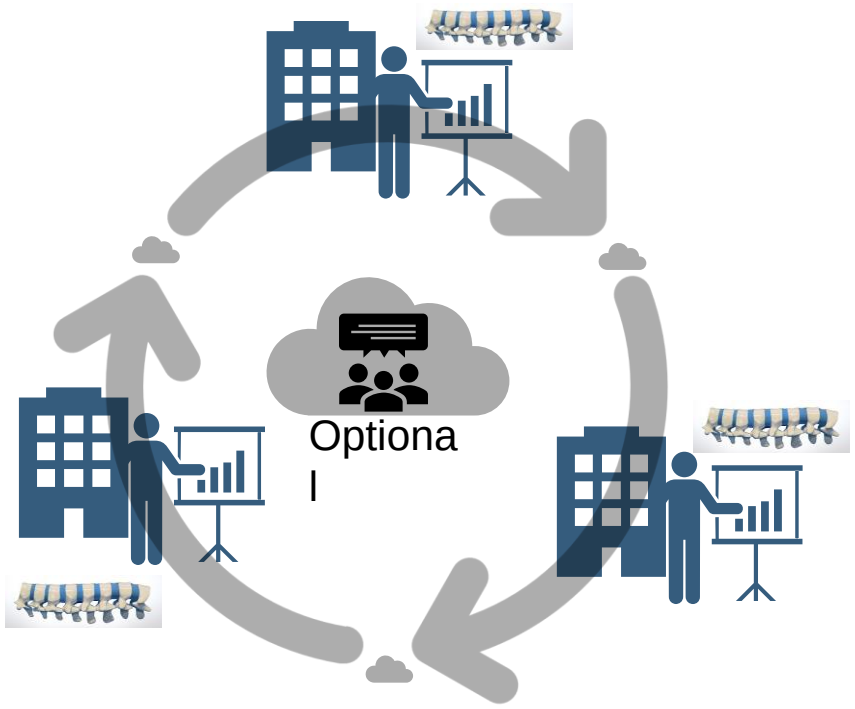
Councils faculties overcame travel restrictions

Case Based 3D Bone Model Webinar – 3 Phases Models

Gradually move to more interactive education if control of COVID-19 advanced

Model 1

Case-based 3D printing online education discussion Seminar models

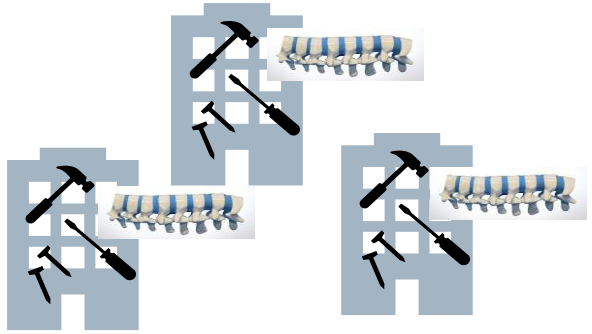


Model 2

Case-based 3D printing online and hands-on education discussion Course models

Model 1

+

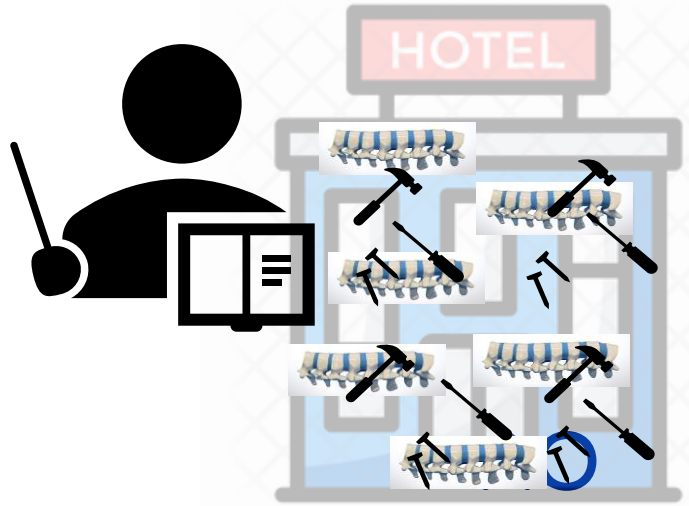


Model 3

Case-based 3D printing online and F2F hands-on blended learning education Discussion Course models

Online D2L +
50% Model 1

+



Case Based 3D Bone Model Webinar – 3 Phases Models

Gradually move to more interactive education if control of COVID-19 advanced

Model 1

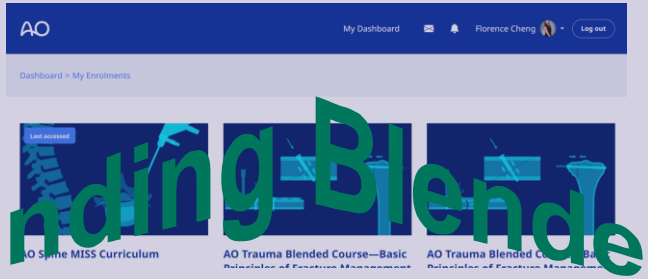
Case-based 3D printing online education discussion Seminar models

Model 2

Case-based 3D printing online and hands-on education discussion Course models

Model 3

Case-based 3D printing online and F2F hands-on blended learning education Discussion Course models



Pending-Blended Content AO

Adaptation of Technology to the whole world

Why do you recommend it?

How could you support the implementation in the other regions?

Cadaver

3D Bone Model

Oversea travel

Tele-mentoring

Case Based 3D Bone Model Webinar : More advanced phases

Why do you recommend it?

Model 1

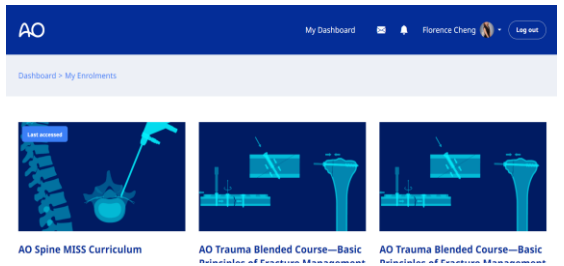
Case-based 3D printing online education discussion Seminar models

Model 2

Case-based 3D printing online and hands-on education discussion Course models

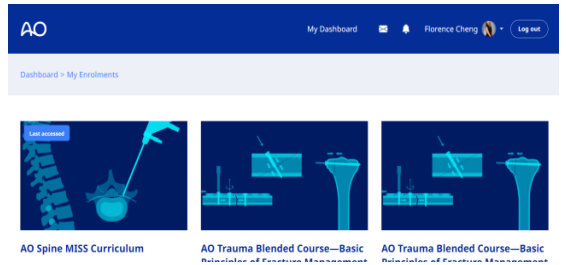
Model 3

Case-based 3D printing online and F2F hands-on blended learning education Discussion Course models



Model 4

- **Online Case-based 3D printing**
- **F2F hands-on blended learning**
- **Tele-mentoring**
- **education Discussion Course models**



✓ What was the main barriers to have this project running?

Benefits:

- Well-accepted by the participants
- Participants from the entire region of AP
- Good to have regional and local faculties for participants
- More teaching opportunities for young active surgeons
- No restrictions of online events under COVID-19 pandemic

Difficulties:

- Overall design of education contents: from beginners to experts
- Good only for small group teaching
- Limited models or simulators: good for deformity correction
- Different from cadaver workshop and hospital visit
- Costs for models