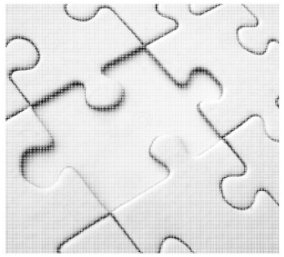
Tecnologie avanzate di progettazione e produzione Protesi e Ortesi

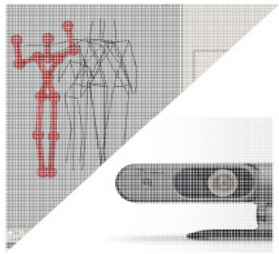
Known_How

Approccio artigianale

Operazioni Manuali

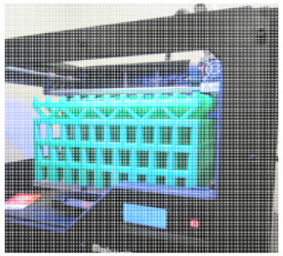


Carenza di metodi standard



Acquisizione dati

Modellazione 3D Avanzata

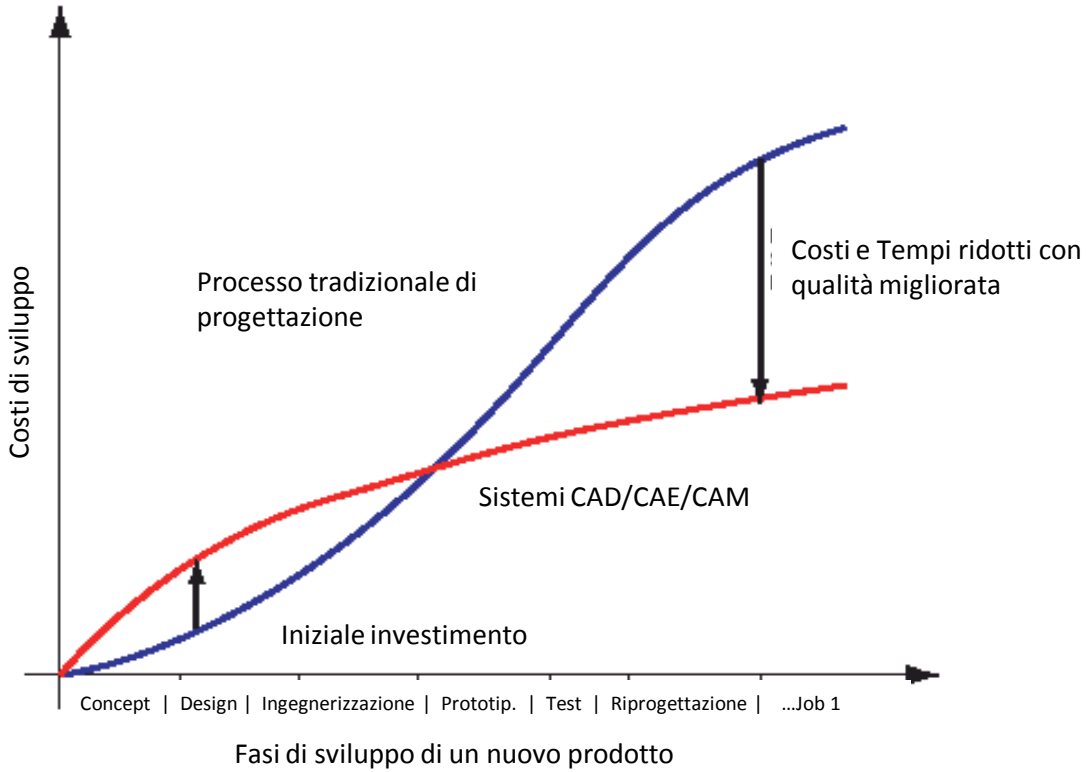


Tecnologie produzione innovative

Marco Cavallaro

Introduzione a dei sistemi CAD/CAM

Settori Industriali: Automotive



Settore Industriale: Automotive

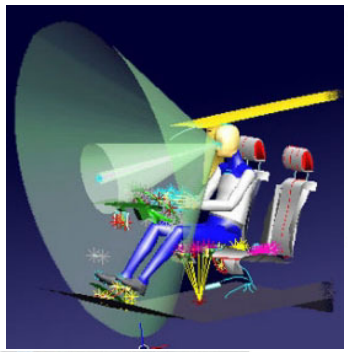
Anni 60/70
Primi CAD a 500’000 $

Anni 80/90
-50 % tempo sviluppo in 5 anni

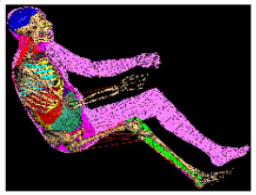
Oggi
Applicazioni CAD/CAE/CAM molteplici. Produzione ‘snella’ e abbattimento tempi di sviluppo

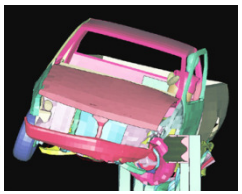
Tecnologie tradizionali del passato, lavoro manuale con imperfezioni

Evoluzione tecnologica con massima corrispondenza tra progettazione ed esecuzione

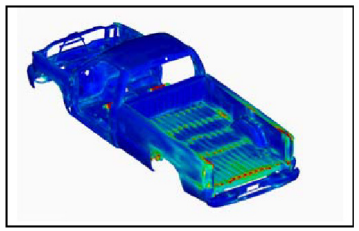


Analisi ergonomica



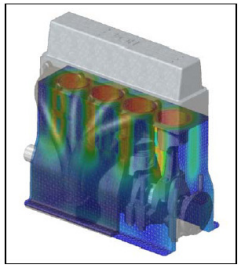


Analisi dinamiche



Stress Analysis

FEA (Finite Element Analysis)



Analisi termiche

Settore Clinico: Dentale

Apparecchi dentali

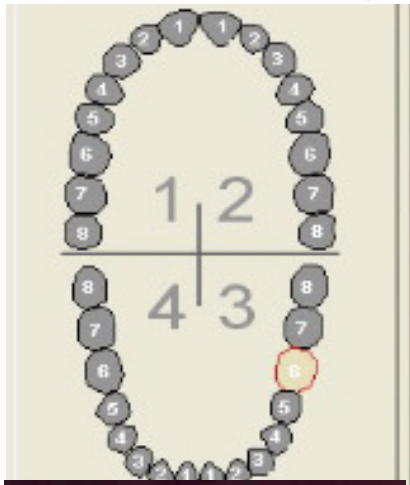
- Allineatori Custom made
- Stampi rapidi e/o tecniche additive
- Progettazione e pianificazione trattamento

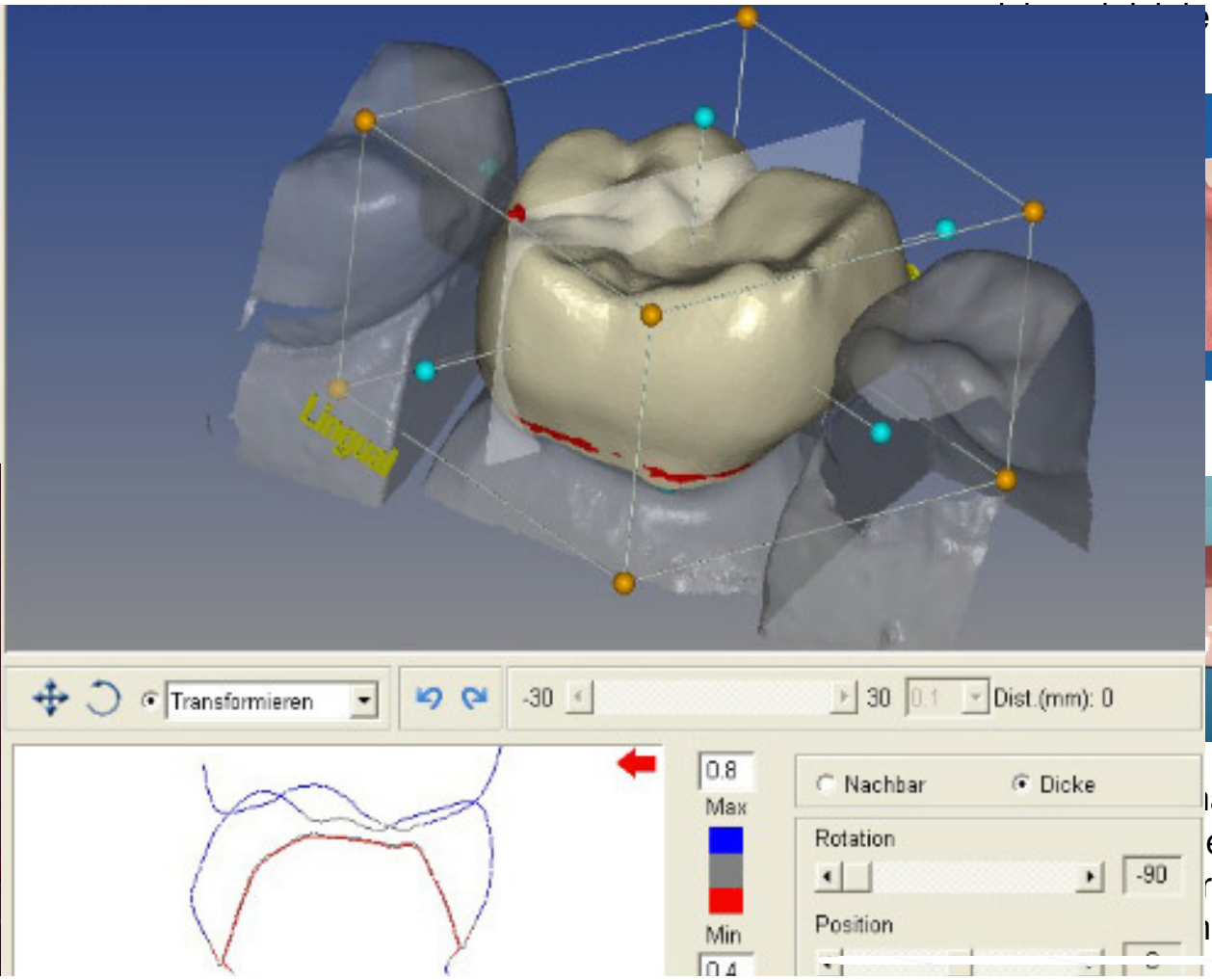
Settore Clinico: Dentale

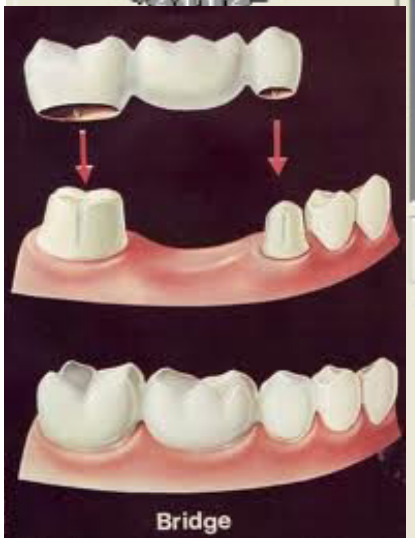
Il medico prende l'impronta dei denti direttamente con scanner o indirettamente con presa

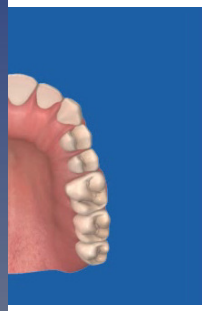
Attraverso la digitalizzazione e la modellazione 3D, la posizione e l'allineamento dei denti viene

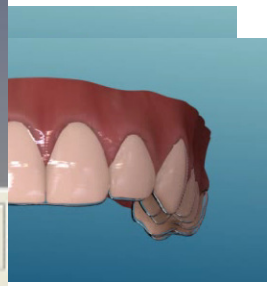
Viene creato la sequenza che riproduce fedelmente il movimento dei denti dalla a quella finale.





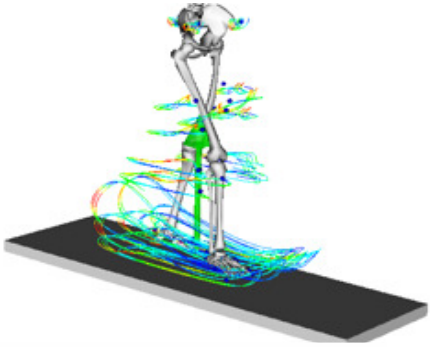


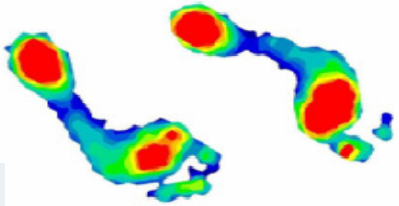


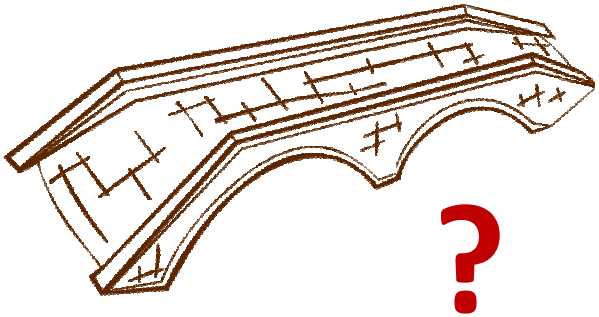


a e approva o
etto secondo
rescritto nel
ento.

Settore Ortopedico







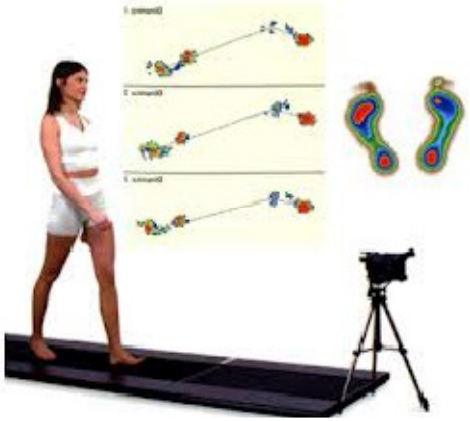
?

Diagnostica:
Diverse Tecnologie e Know-How
clinico e biomeccanico

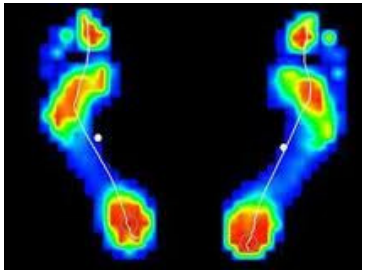
Fabbricazione:
Procedure Manuali e
Stilizzazione qualitativa

Settore Ortopedico: diagnosi

Sistemi Baropodometrici

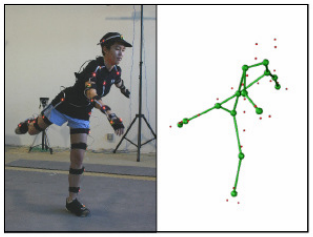


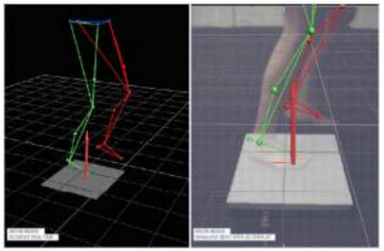
Pressione

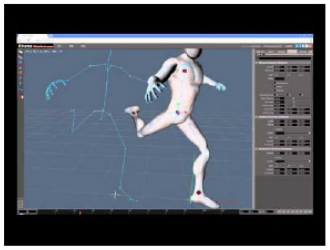


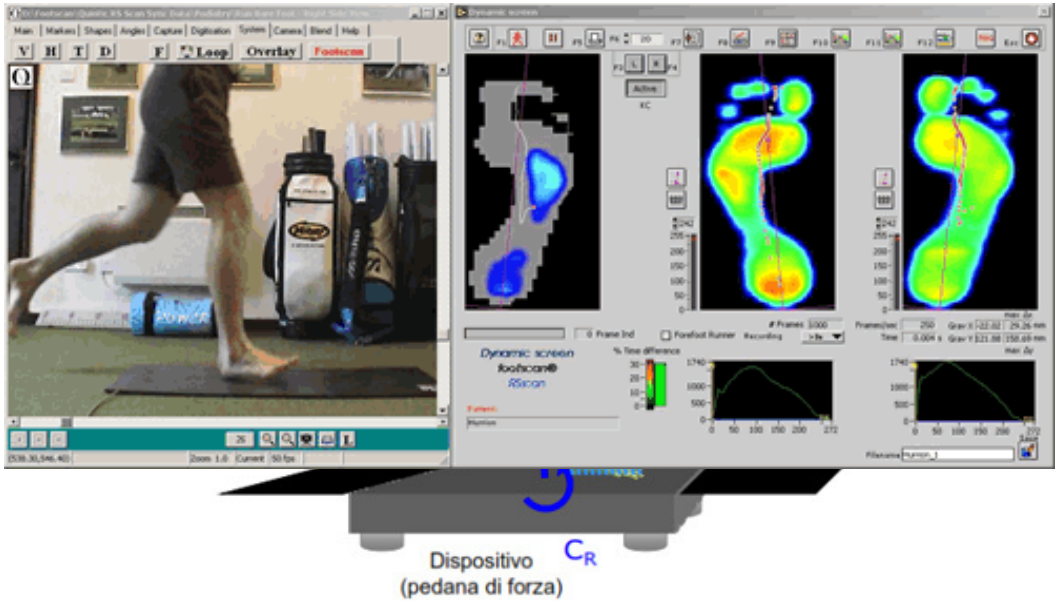
Sistemi di Cinematica

Movimento



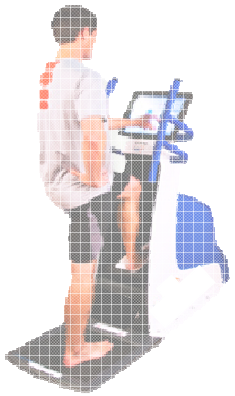


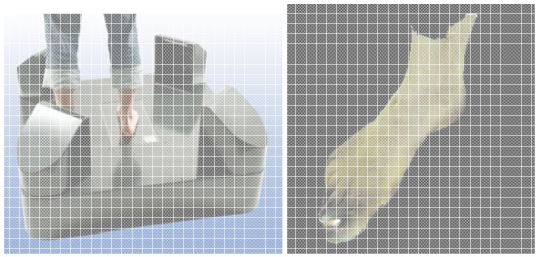




Sistemi di Scansione 3D

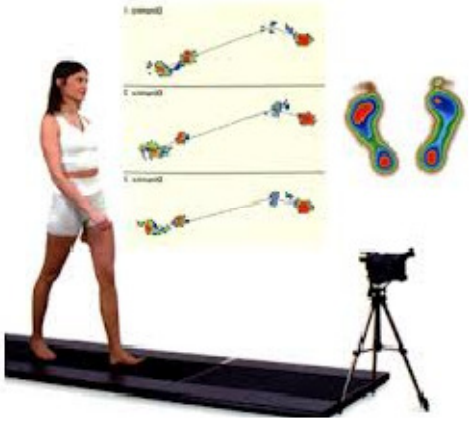
Forma



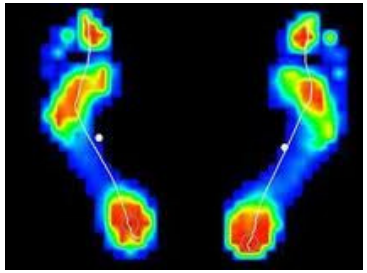


Settore Ortopedico: diagnosi

Sistemi Baropodometrici

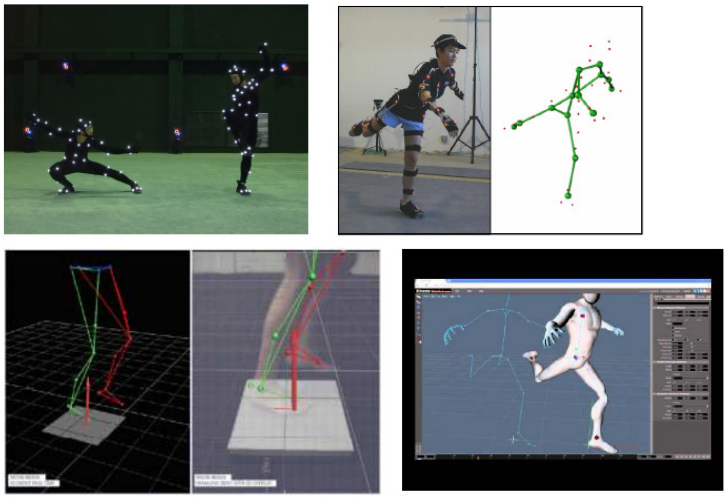


Pressione



Sistemi di Cinematica

Movimento



Tipologia di sensori:
- Resistivi;
- Capacitivi;
- Risonanti.

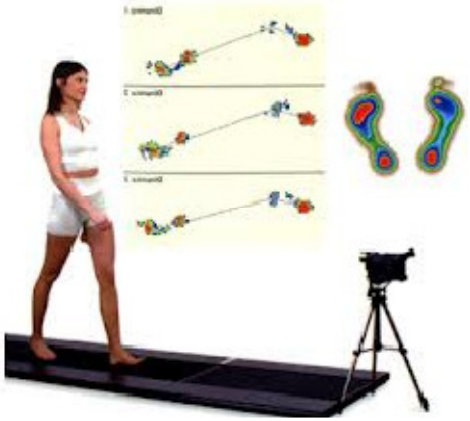
Tipologia di soluzione:
- Pedane e/o moduli;
- Solette sensorizzate;
- Sensori applicabili.

Tipologia di acquisizione:
- Diretta;
- Inversa.

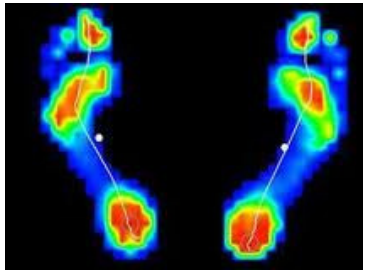
Tipologia di sistema:
- Meccanica, Inerziale;
- Ottica;
- Elettromagnetica;
- Acustica.

Settore Ortopedico: **tendenze**

Sistemi Baropodometrici

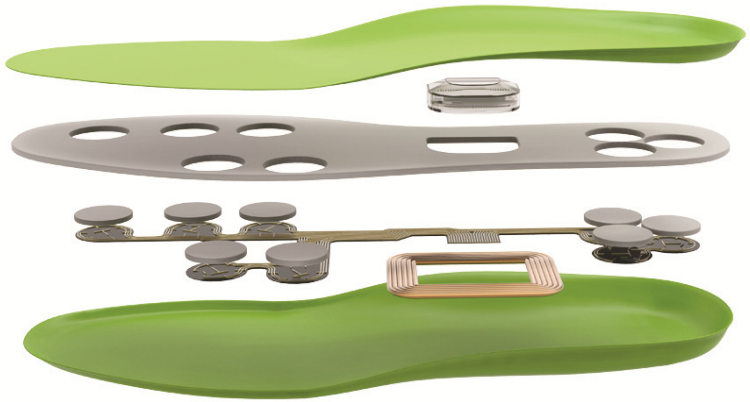


Pressione



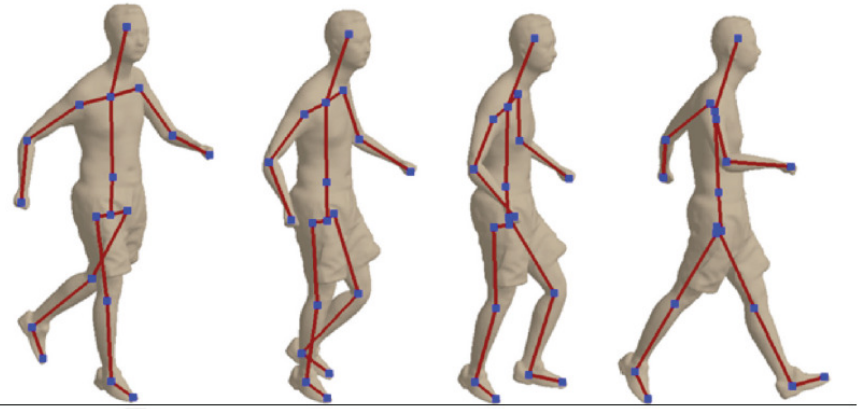
ADD · FACTOR

M WEAR



Settore Ortopedico: **tendenze**

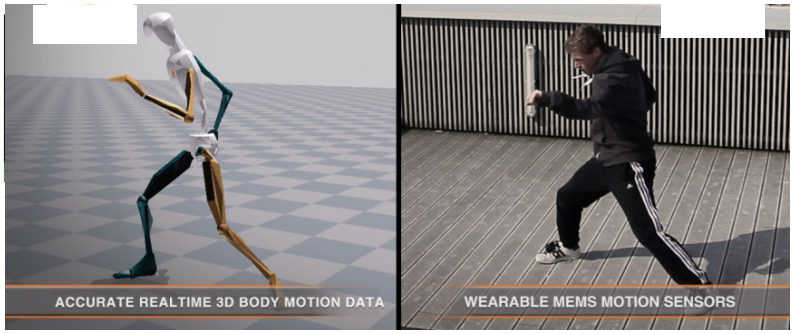
ADD · FACTOR

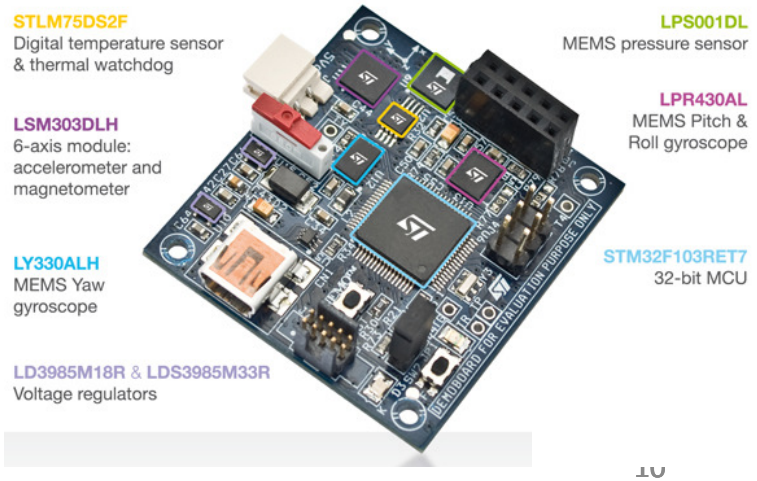


Skeleton tracking

Sistemi di Cinematica

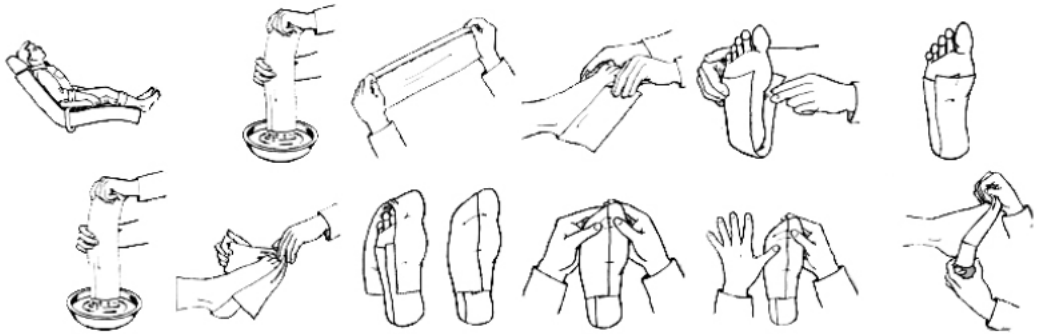
Cinematica





Settore Ortopedico: realizzazione

Acquisizione



Stilizzazione

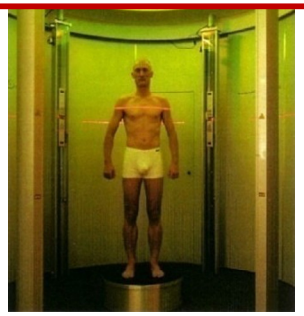
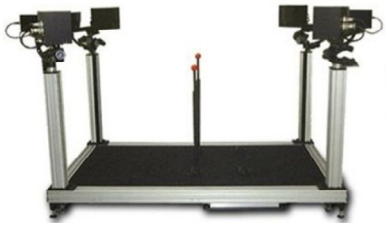
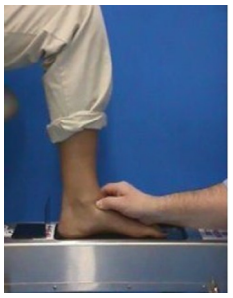
Finitura

Sistemi Acquisizione

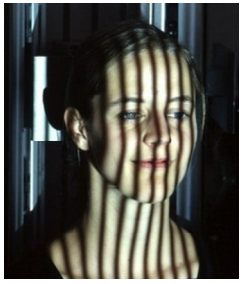
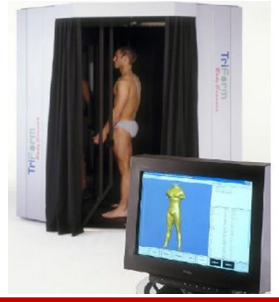
Sistemi di scansione

Sistemi Attivi

Triangolazione Laser

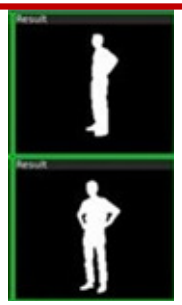





Luce Strutturata

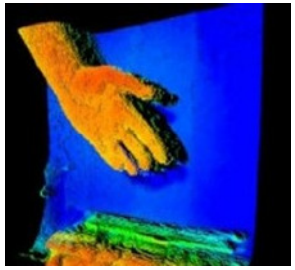
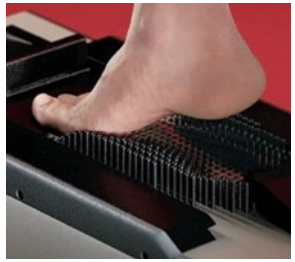
Sistemi Passivi

Fotogrammetria

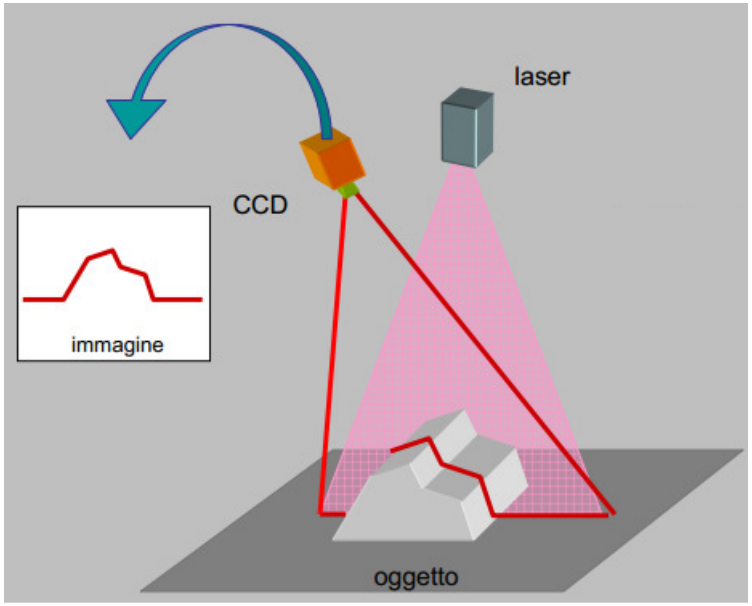



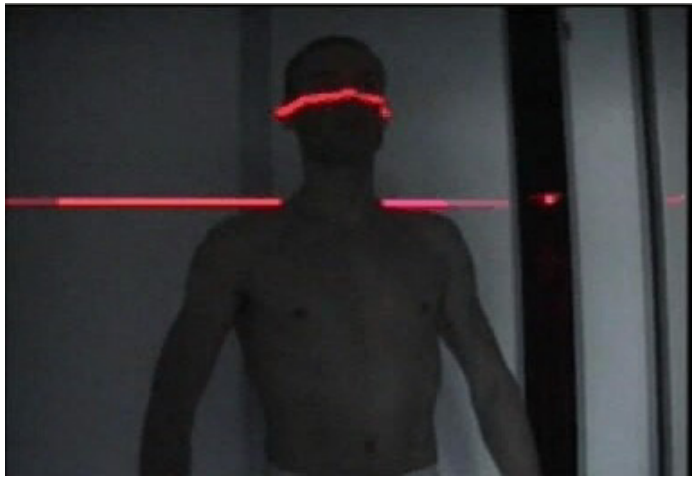

Altre tecnologie,
tra cui a contatto

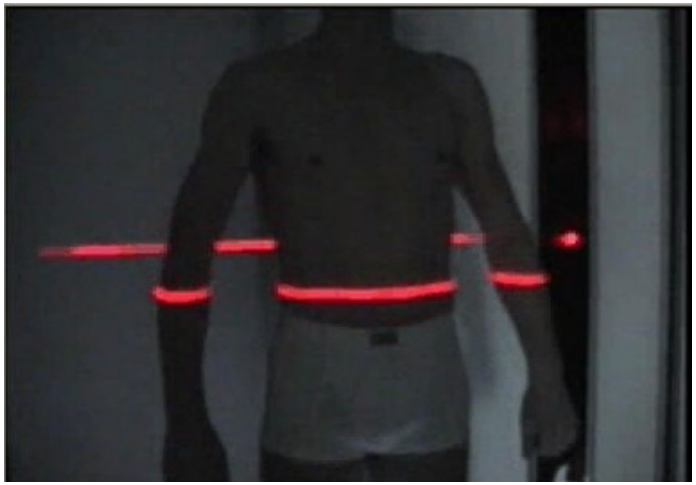


Sistema a Triangolazione Laser



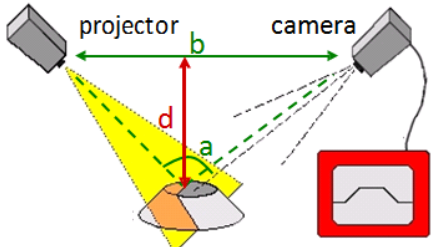


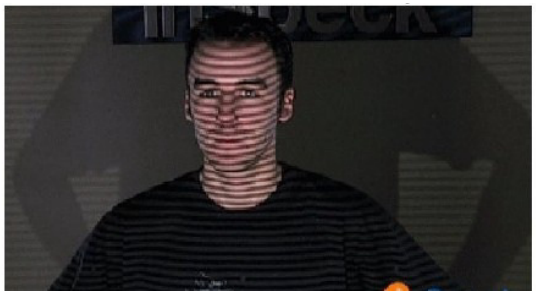


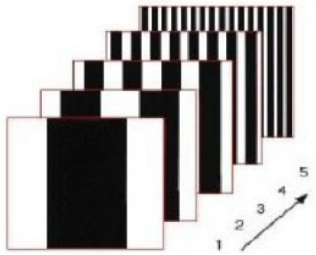
Sensori a lama laser:

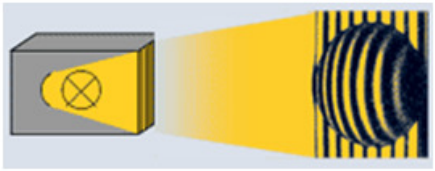
- L'oggetto viene scansionato mediante lama di luce ed una o più camere, registrandone il profilo da più punti di vista;
- La posizione spaziale dei punti sul profilo è ricavata per triangolazione;
- La linea viene mossa rispetto all'oggetto e viene registrato un insieme di profili.

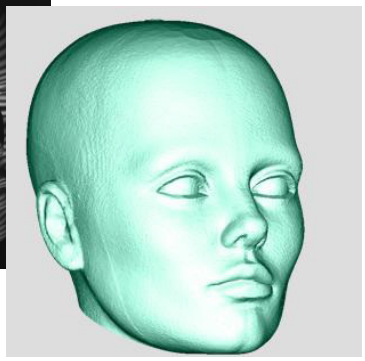
Sistema a Luce Strutturata

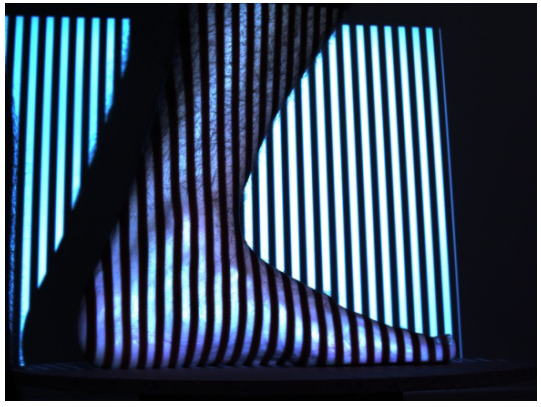




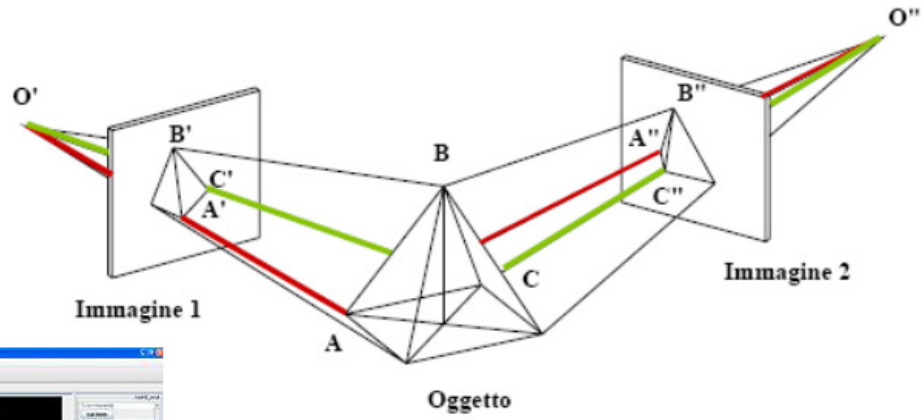


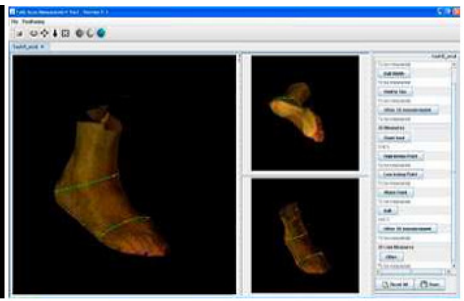


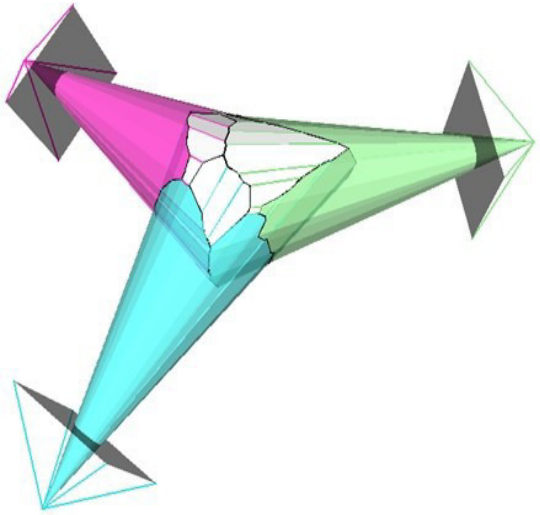




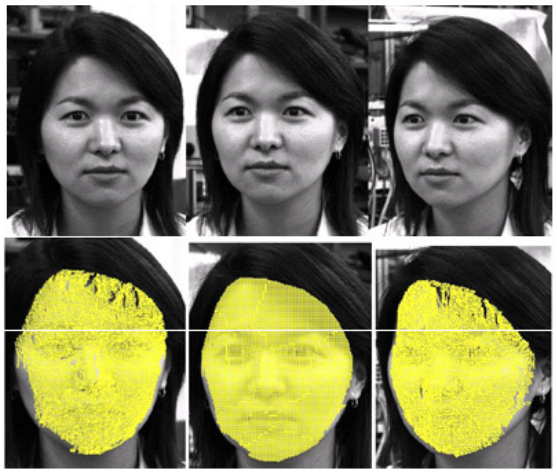
Sistema Fotogrammetrico

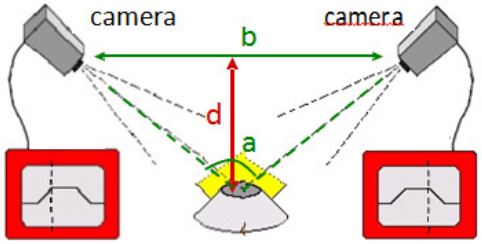


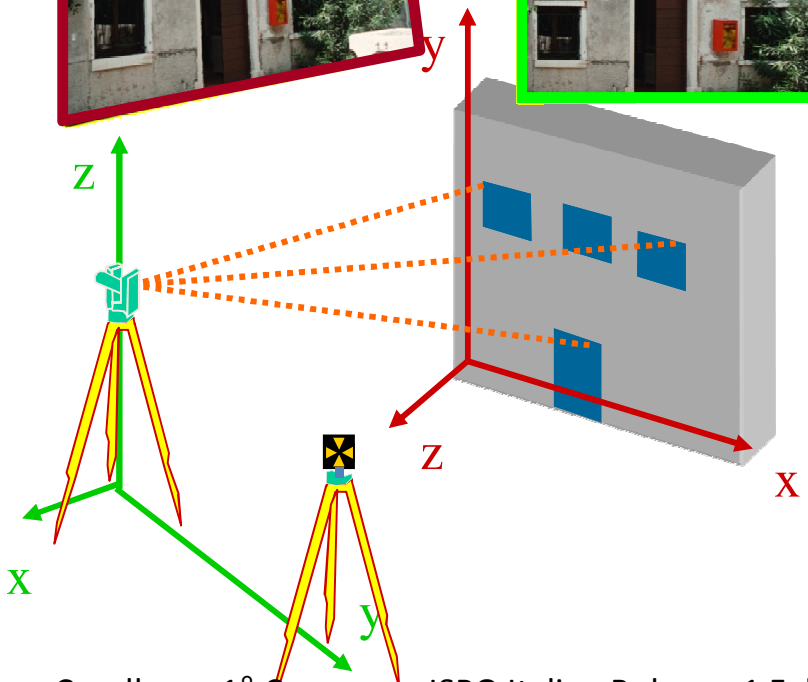


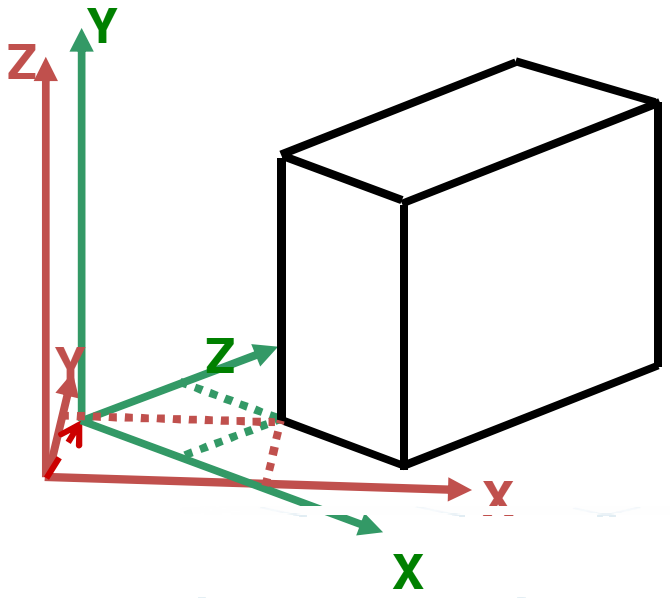


Sistema Fotogrammetrico





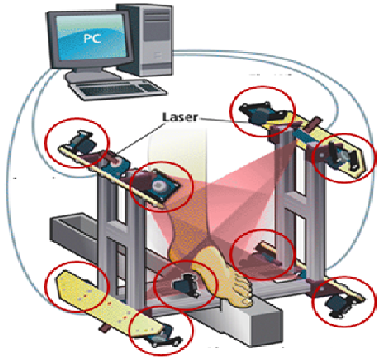


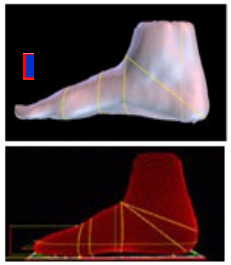


Configurazione sistemi ottici

Sensori posizionati in prestabiliti punti e ricostruzione 360°:

- Body scanner;
- Foot Scanner.



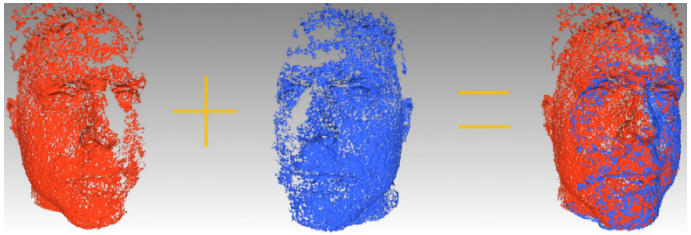


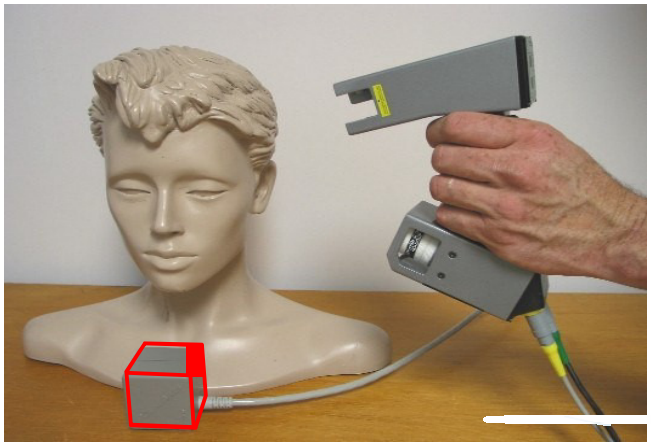
Sensore Unico:

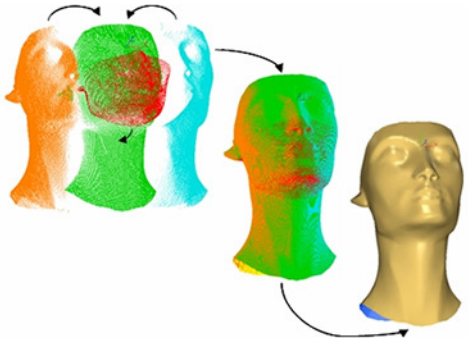
- Rotazione relativa (oggetto o sistema);
- Più scansioni e ricostruzione successiva.

Sensori portatili a mano:

- Ricostruzione automatica possibile mediante marker o riconoscimento overlap;
- Individuazione del sensore nello spazio grazie ad un sistema di tracking.







Sistemi Produttivi

Settore Ortopedico: realizzazione

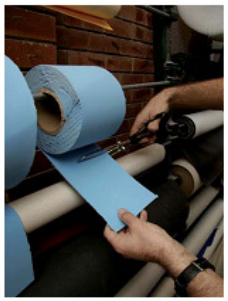
70% in Europa è prodotto a mano

Presa Impronta

Colata Gesso o Resina

Stilizzazione

Essicazione

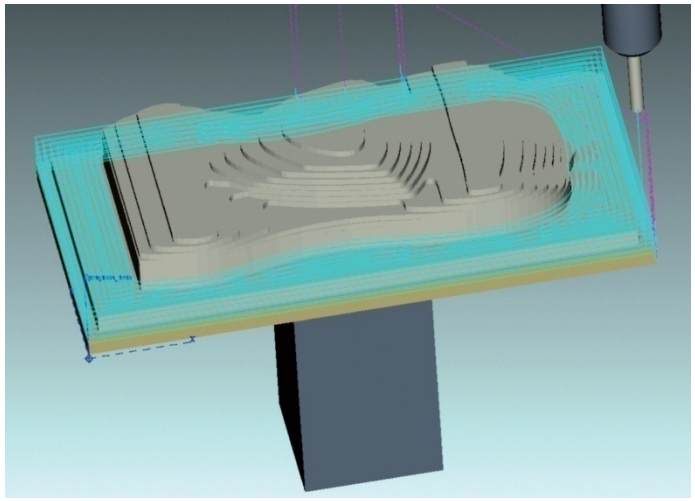


Termoformatura

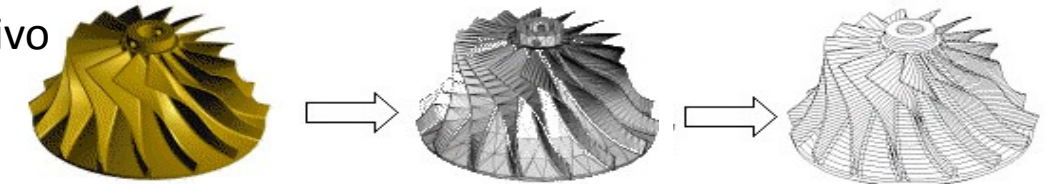
Finitura

Tecnologie CAD/CAM

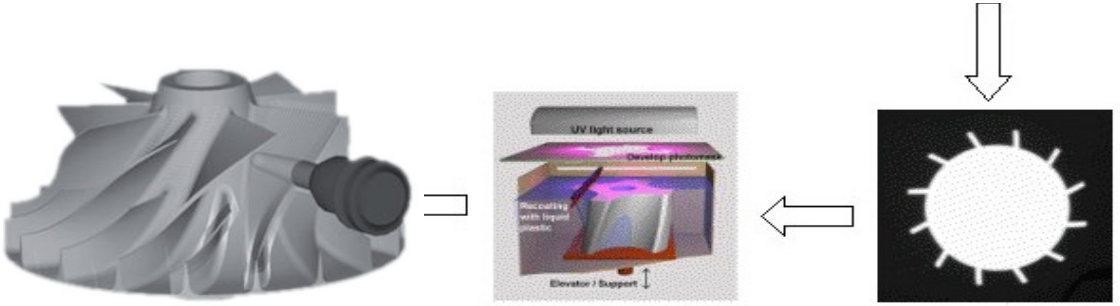
CAM: sottrattivo



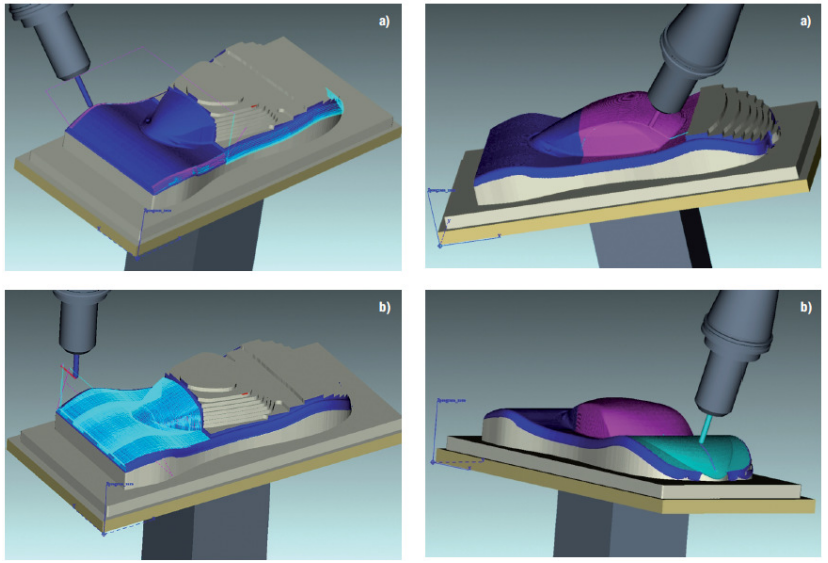
CAM: additivo

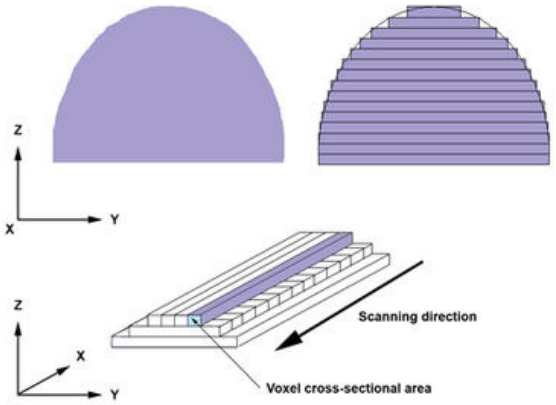


3D model STL Slicing



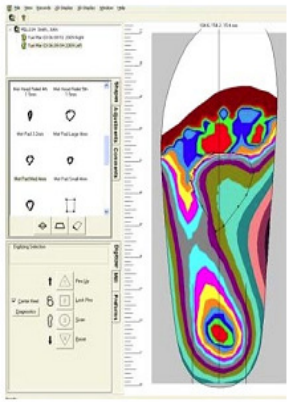
Product Process Layer



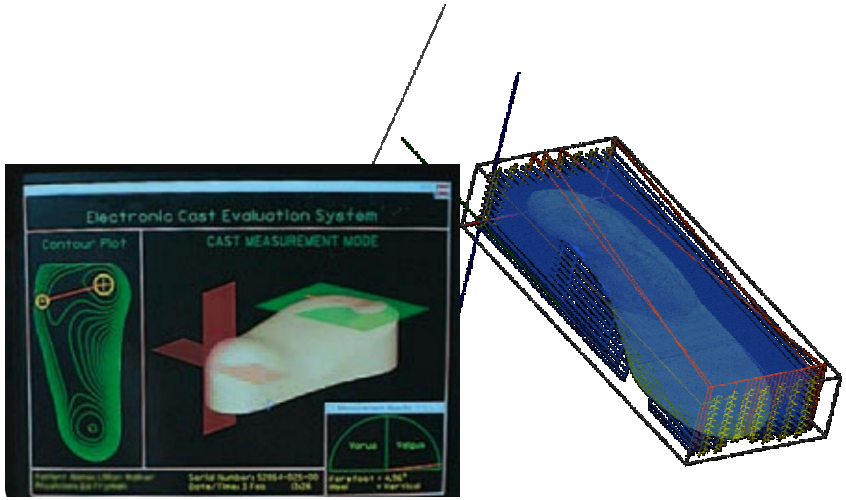


Fresatura

Acquisizione Digitale

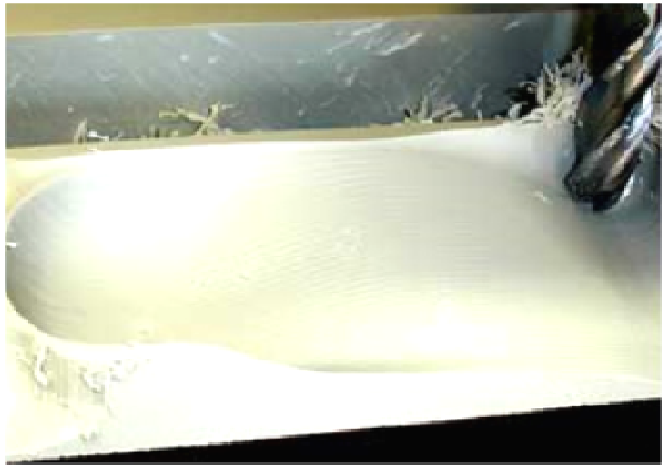


CAD Stiliz.Correz.



CAM Elaborazione

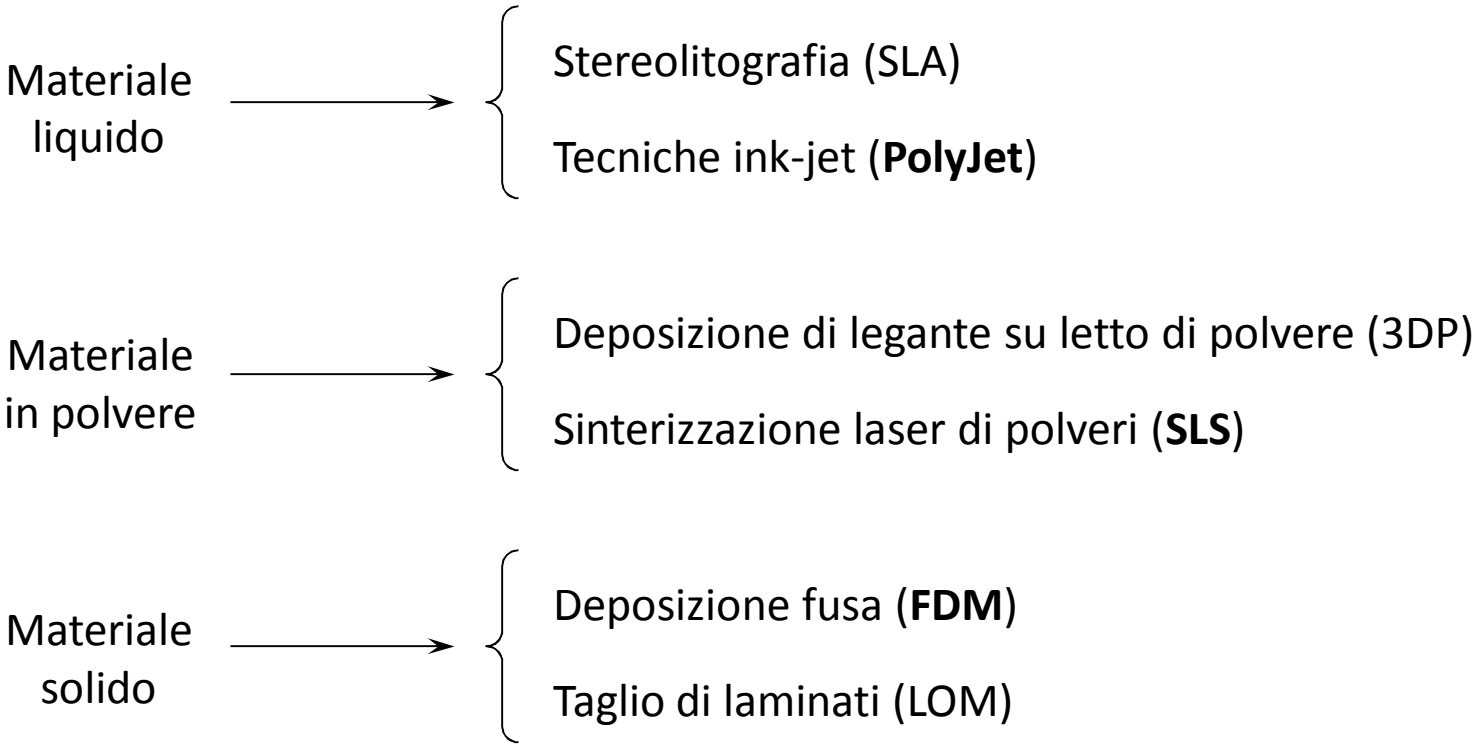
Finitura



CNC Machining

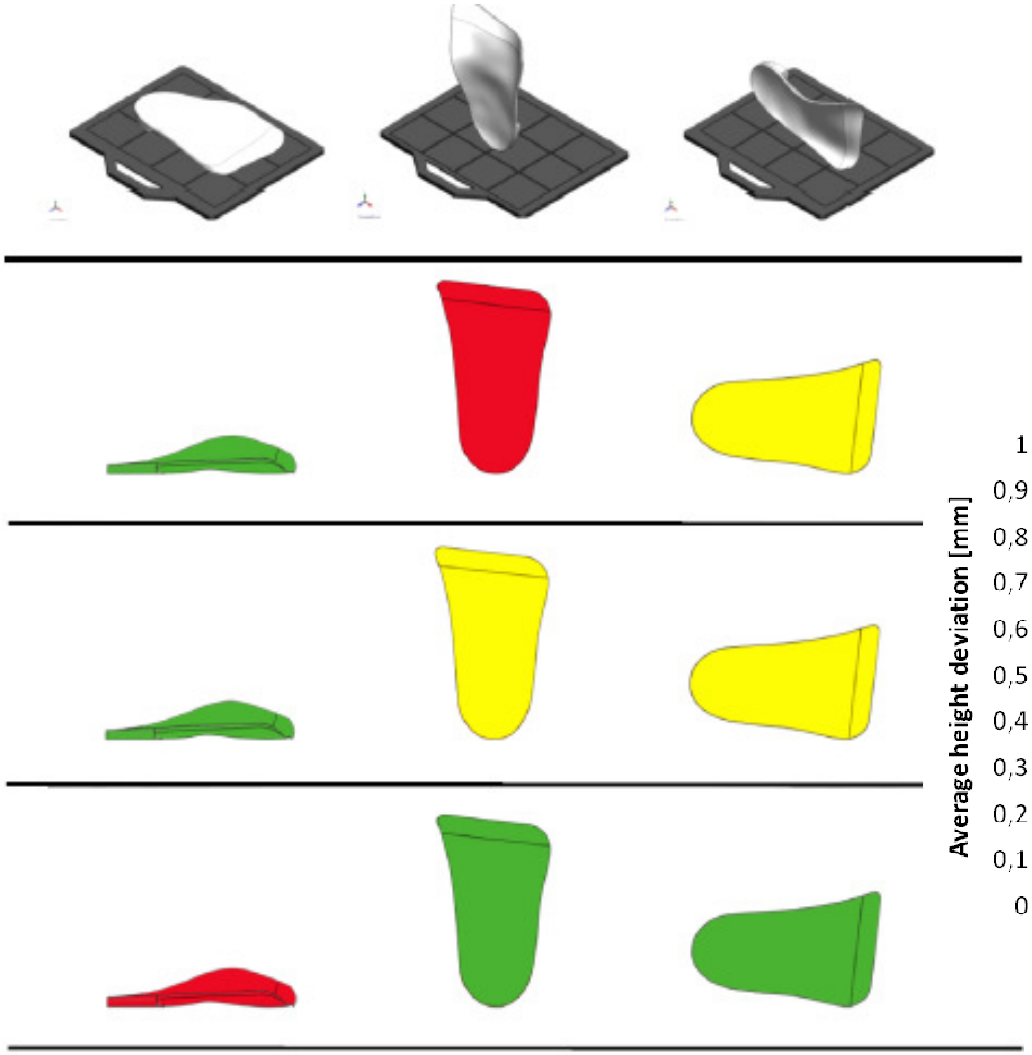
Classificazione delle Tecniche AM

- Tecniche principali (in base al materiale di partenza):



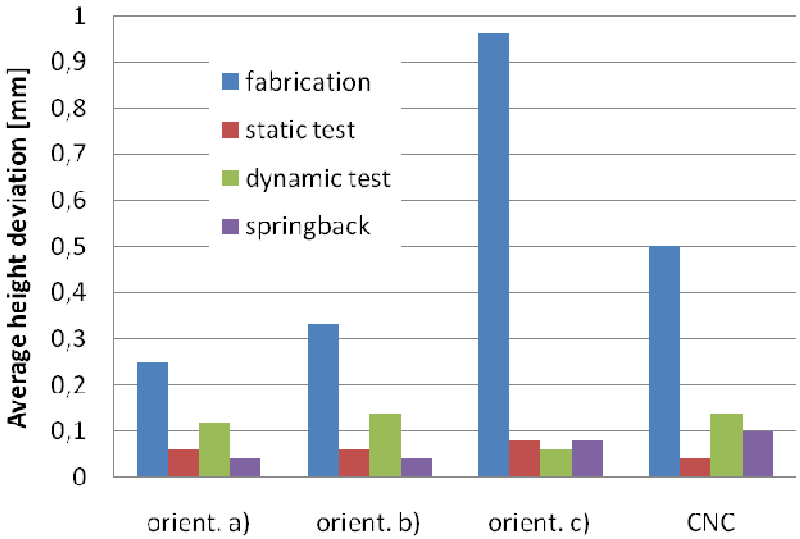
3D printing: maggior controllo

- Orientamento di deposizione e risposte relative



Strategia di deposizione

Resistenza meccanica



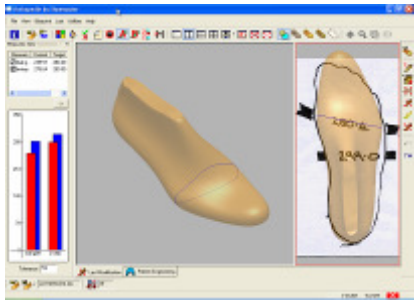
M. Cavallaro, A. Armillotta (2012). **Additive Manufacturing as a potential and functional alternative in Foot Orthotics production.**

Sistemi industriali per migliorare qualità e ripetibilità dei prodotti

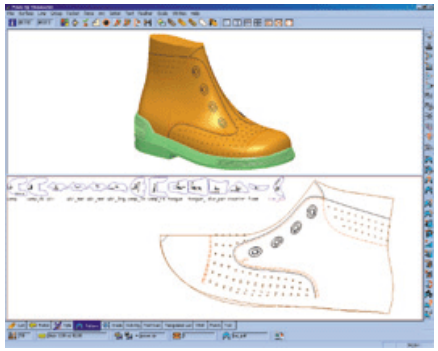
Da Tecnologia a Sistema Industriale

IPP - Lab Vigevano

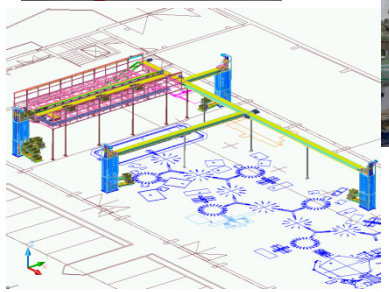
Acquisizione Consumatore



Progettazione Customizzata del Prodotto

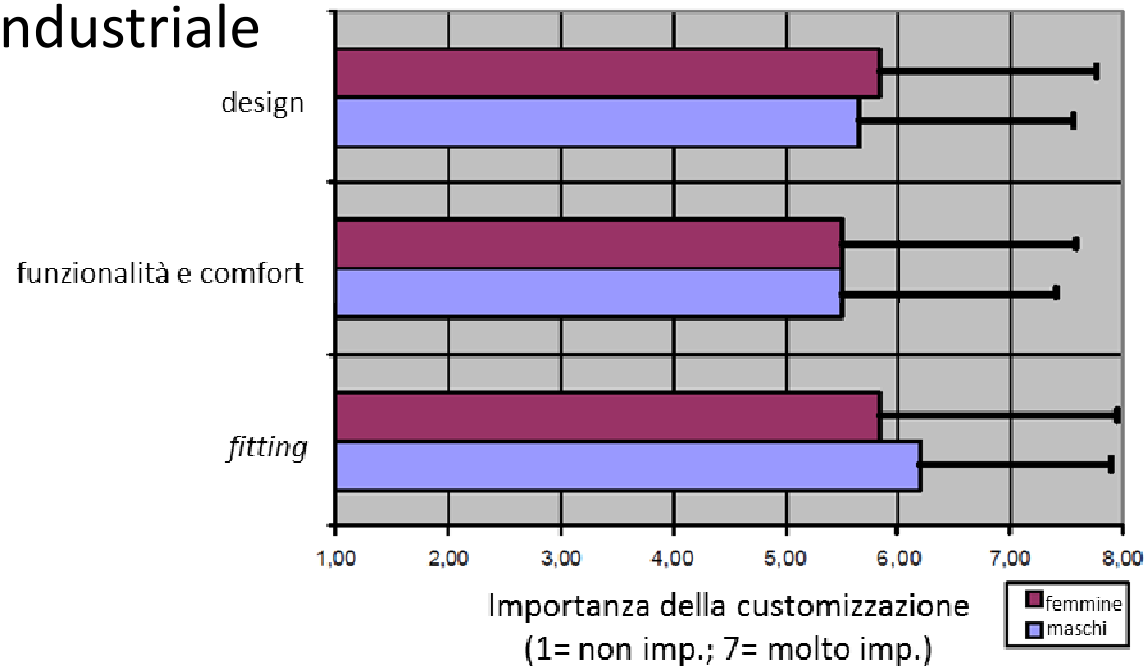


Sistemi produttivi altamente automatizzati



Da Tecnologia a Sistema Industriale

Scarpe Personalizzate

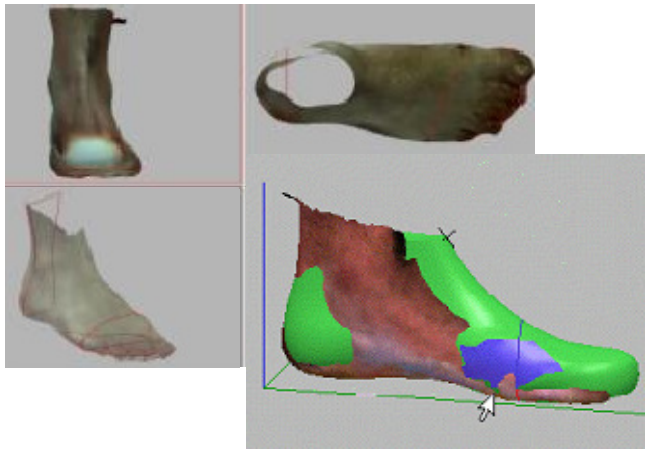


Scarpe predisposte e sovradimensionate

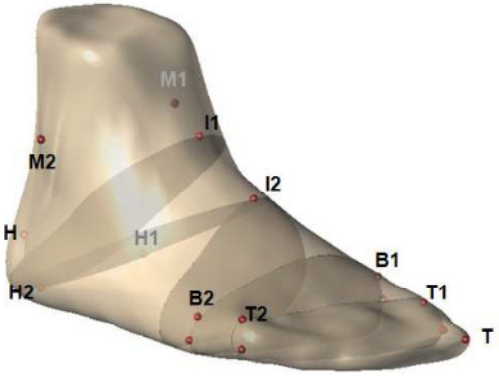
- Differenti livelli di personalizzazione:
  - Forma
  - Funzionalità
  - Comfort
  - Specifiche estetiche

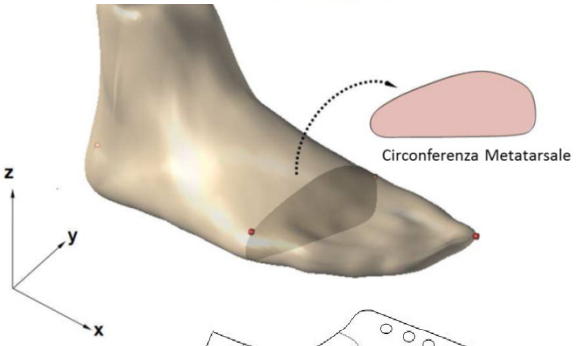
Scarpe personalizzate da sistema industriale

Forma

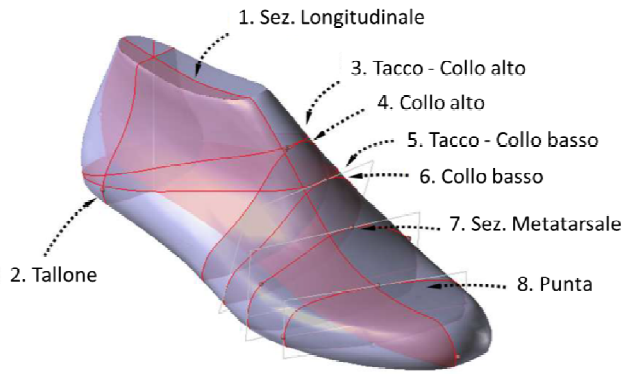


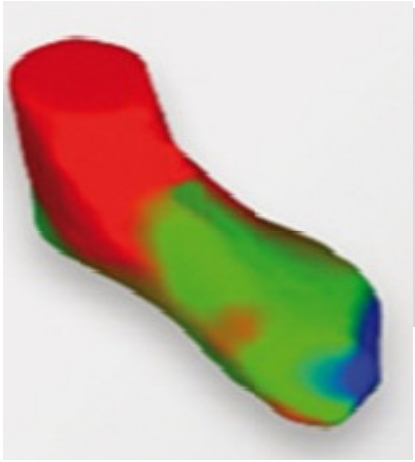
[PIEDE]



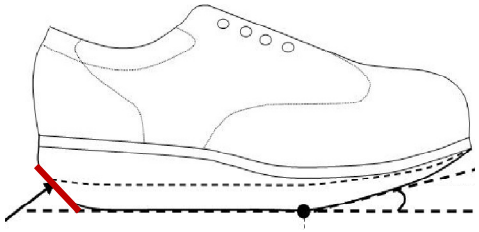


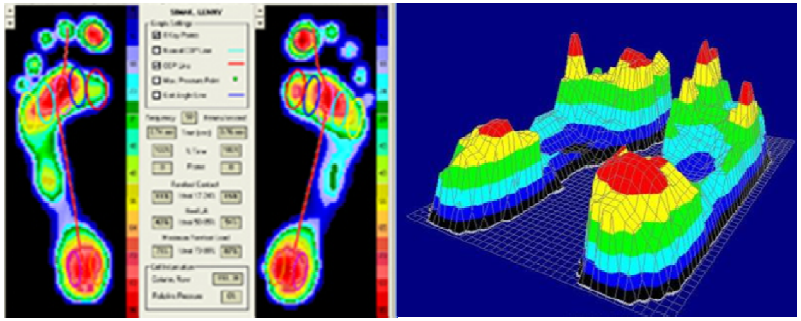
[PARAMETRI FORMA]

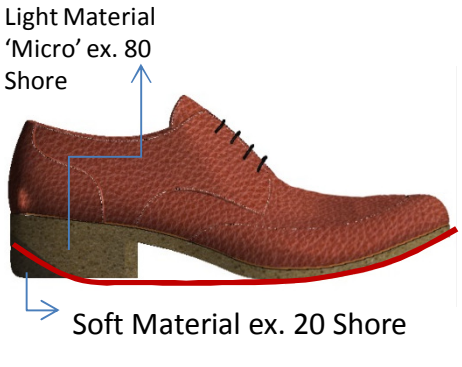


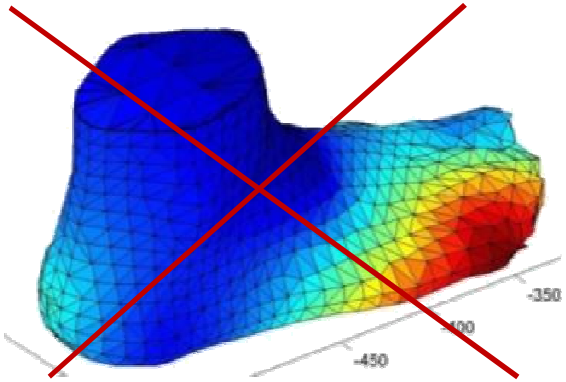


Funzionalità



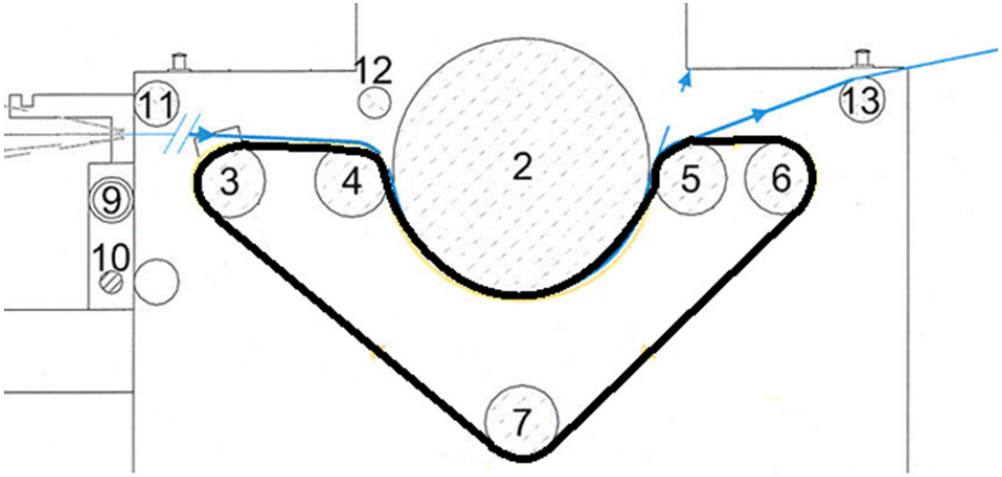


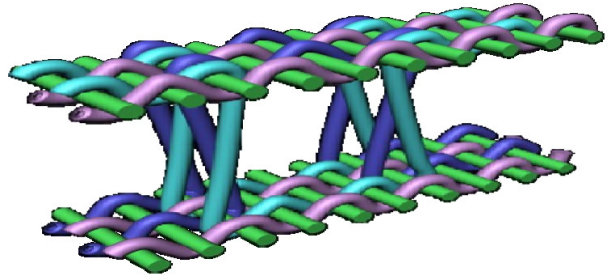


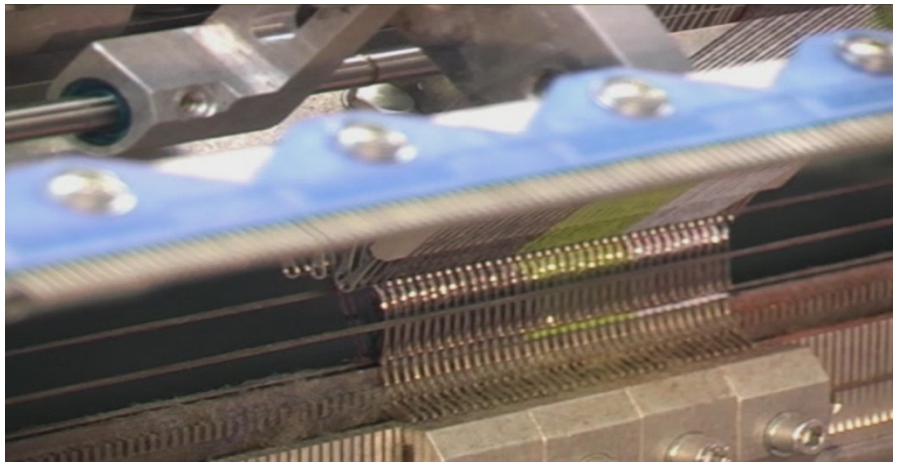


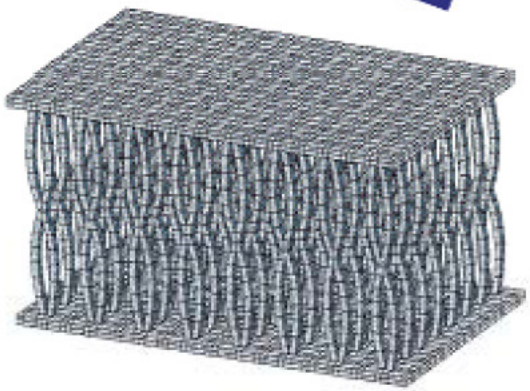
Comfort

[MATERIALI]





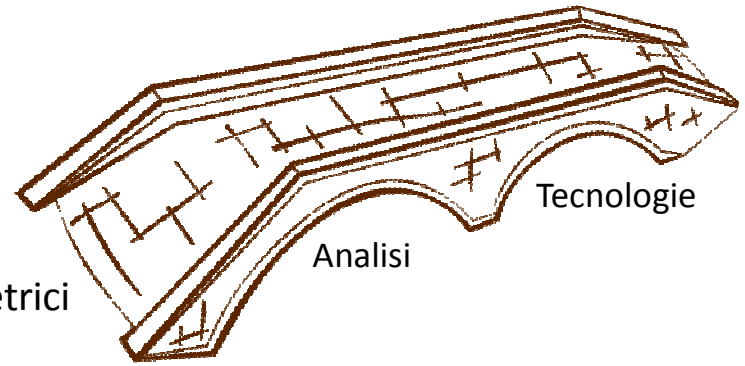




Specifiche estetiche

[Design Estetico]

Conclusione



- L'alta ripetibilità dell'approccio digitale può migliorare la qualità finale e media dei prodotti…

- Le procedure accurate e razionali consentono un maggior controllo e relativa gestione delle patologie nel tempo → miglioramento continuativo dei protocolli di trattamento…

- La progettazione ottimizzata, i materiali e le tecnologie possono insieme creare prodotti avanzati capaci di tenere conto quantitativamente e non solo qualitativamente dei dati biometrici come la morfologia statica e dinamica, cinematica inversa, distribuzione delle pressioni, biomeccanica del gesto…