



OrthoCAD Network Research Cell

संगणक सहायित विरुपशोधन जालक्रम अनुसंधान कक्ष

Low-cost Mega Implants for Orthopaedic Reconstructive Surgery by Computer-aided Development, Testing and Surgery Planning

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R&D Partners

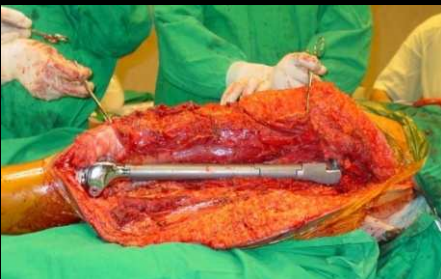
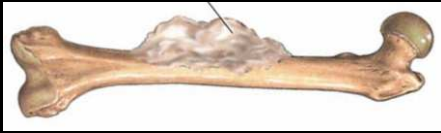
NFTDC



Supported by the
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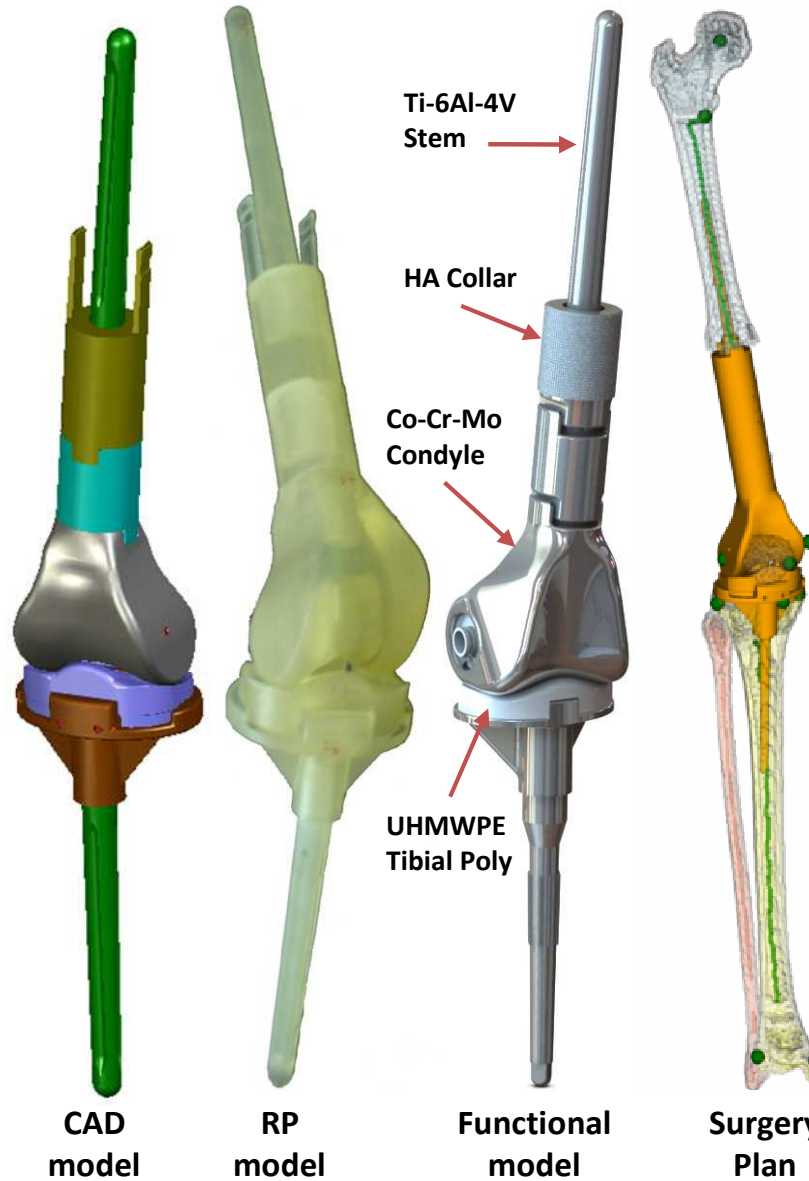
Total Knee Prosthesis System

Bone tumour in children



Leg amputation can be avoided by resecting only bone tumour and reconstructing the joint using a mega-knee prosthesis

High-quality low-cost modular rotating hinge total knee prosthesis for Indian population



Testing, Instruments, & Planning



Knee simulator & testing machine



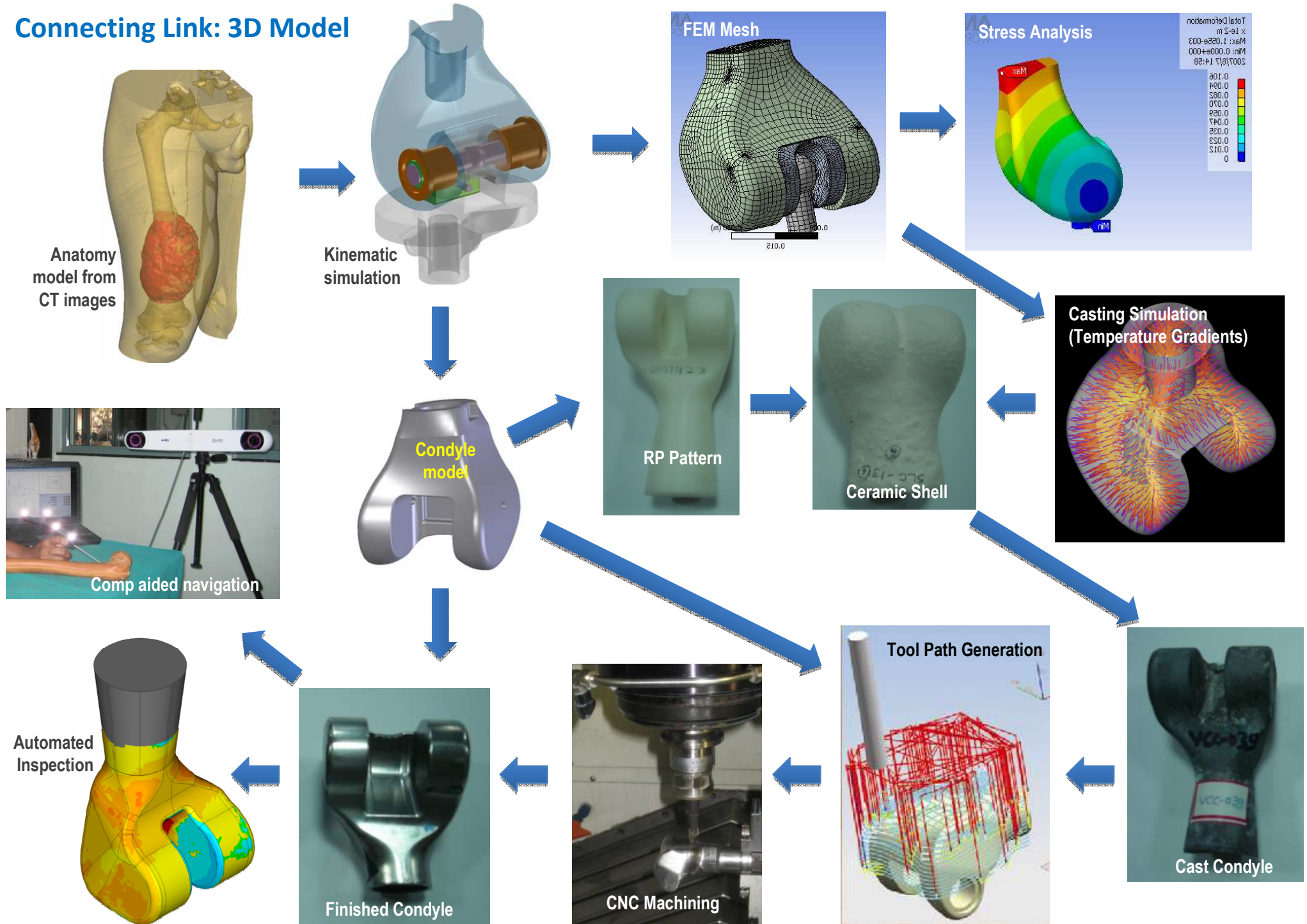
Surgical instruments (armamentarium)



3D surgery planning software

Integrated Design, Manufacturing, Testing and Surgery Planning

Connecting Link: 3D Model



OrthoCAD Network Research Cell at IIT Bombay

Facilities

- Computer-aided Design (CAD): HP XW 8600 workstation with SolidWorks, Hypermesh and Radioss.
- Computer-aided Manufacture (CAM): HP 4400 work-station with AutoCAST-X and UG NX + CAM.
- Computer-aided Surgery (CAS): Quad-Core workstation with MIMICS and FreeForm
- Rapid Prototyping (RP): Solidimension SD300, with build size of 220x120x160 mm
- Knee Walking Simulator: Loading capacity of 4500 N and cycle time of 2-3 seconds
- Microscope: Meiji Stereo microscope
- Weighing Balance: Sartorius balance, 0.1 mg accuracy
- Universal Testing Machine: Instron system with special-purpose attachments for implant testing
- Photo-elastic Stress Analysis: Vishay Polariscope with laser direction indicator and coating kit
- Surgery Navigation Camera: NDI Polaris Vectra system with 1.5x3x2.4 m volume

Manufacturing facilities at NFTDC Hyderabad.

Summary and Lessons

- **Medical implant development- need to consider all lifecycle issues:**
Functionality, bio-compatibility, anatomical suitability, surgical suitability, manufacturability, revision surgery affordability...
- **Close collaboration between multiple disciplines and institutes:**
face-to-face meetings on weekends, rest video-conferencing.
- **Partnership:**
 - ✓ Academic R&D: Indian Institute of Technology Bombay, Mumbai
 - ✓ Medical care: Tata Memorial Hospital, Mumbai
 - ✓ Manufacturer: Non Ferrous Materials Tech. Dev. Centre, Hyderabad
 - ✓ Government: Office of the Principal Scientific Advisor, New Delhi
 - ✓ Monitoring: AIIMS Delhi; SCTIMST Trivandrum, BARC Mumbai
- **Crossing individual comfort zones**
Mechanical, Medical, Materials, Manufacturing
- **Ground-up innovation based on requirements of local patients**
instead of reverse engineering of imported devices -> 80% cost reduction.

Facilities

• Computer-aided Design (CAD): 10 workstations with SolidWorks, Inventor and ProE.

• Computer-aided Manufacturing (CAM): 10 4400 work-station with AutoCAST-X and UG NX + CAM.

• Finite Element Analysis (FEA): Quad-Core workstation with MIMICS software.

• Rapid Prototyping (RP): Solidimension SD300, with build size of 220x120x160 mm

• Knee Walking Simulator: Load capacity of 500 N and cycle time of 2-3 seconds

• Microscope: Inverted Stereo microscope

• Weighing Balance: Sartorius balance, 0.1 mg

• Universal Testing Machine: Instron 1130 with special-purpose attachments for implant testing

• Photo-elastic Stress Analysis: Vishay Polariscopes with laser direction indicator and coating kit

• Surgery Navigation Camera: NDI Polaris

Manufacturing Facilities at NFTDC Hyderabad (Partner)



Rapid Proto Machine



Investment Casting



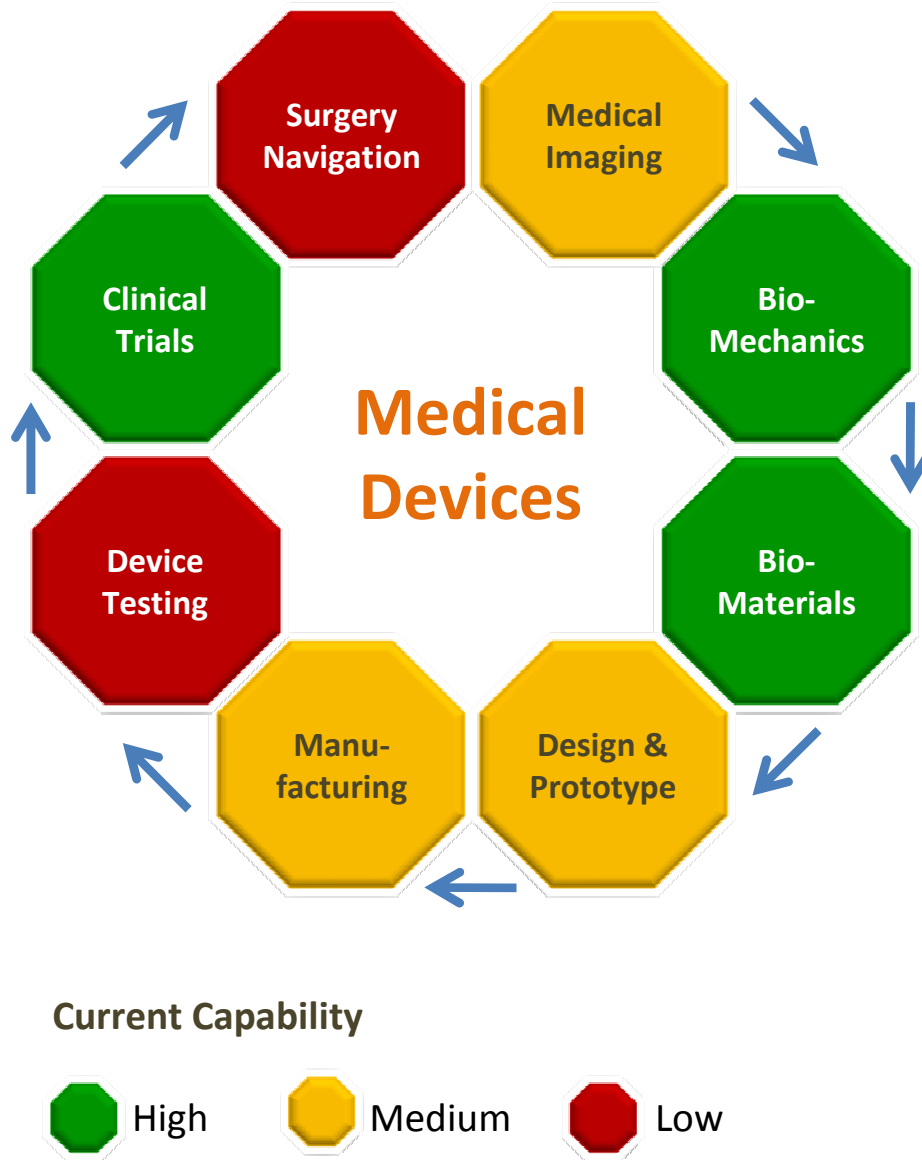
Centrifugal Casting



CNC Machining Centre



HA Coating



Future Directions:

- Other orthopaedic devices suitable and affordable for local population:
 - Hip, Shoulder, Elbow prostheses
 - Dental, Maxillofacial, Spinal...
 - Customised implants
 - Related instruments
- Medical implant testing:
 - Rapid & low-cost evaluation
 - Virtual testing methods
 - ✓ Kinematics
 - ✓ Indexes for life-cycle issues
 - ✓ Fatigue & Wear models
 - Validation using UTM & photostress analysis
- Low-cost systems for guided surgery and navigation.