



Orthopaedic Surgery Training on Personal Computer

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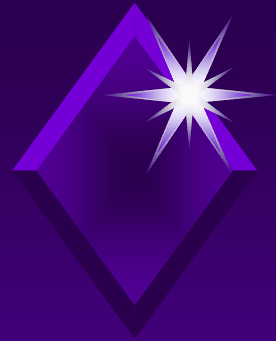
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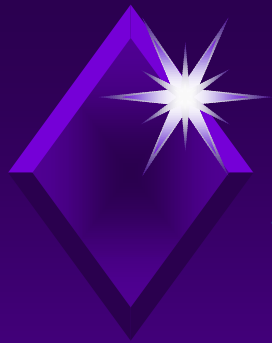
Background and Objectives

- ◆ Singapore General Hospital,
Department of Orthopaedics
- ◆ Existing training using synthetic bones
- ◆ Aim to virtual training using geometric models of the synthetic bones
- ◆ Further aim to orthopaedic surgery simulation using geometric models of the bones reconstructed from CT data



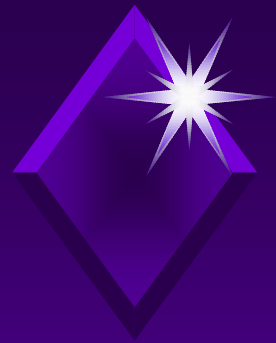
System Design

- ◆ Virtual Bonesetter
- ◆ MS Windows95, Criterion's Renderware
- ◆ Open VR system that includes the following objects:
 - ◆ Fractured bones
 - ◆ Implants
 - ◆ Surgical instruments
- ◆ Extendable set of models



Data Source

- ◆ Fractured bones
 - ◆ Reconstruction from CT data
 - ◆ Fracture modelling
- ◆ Implants and tools
 - ◆ Engineering drawings and data from the medical atlases and booklets
 - ◆ Software modelling and interactive design



Plastic Bones





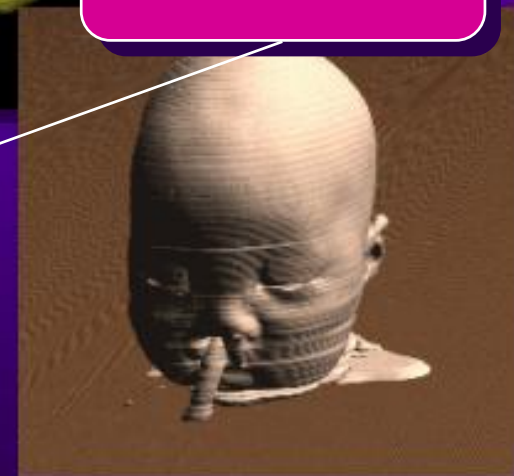
Reconstructed Bones

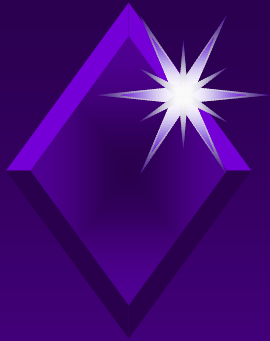


CT

Reconstruction

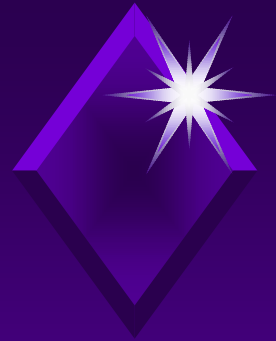
RWX





Fractured Bones

- ◆ Fractures exist in predictable shapes and can simply be modelled
- ◆ Special cases can be reconstructed from CT data



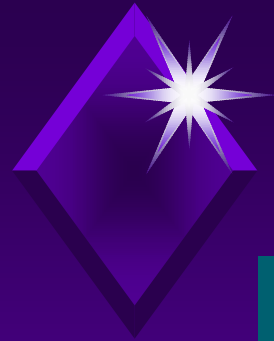
Standard Fractures. Example

◆ Femur

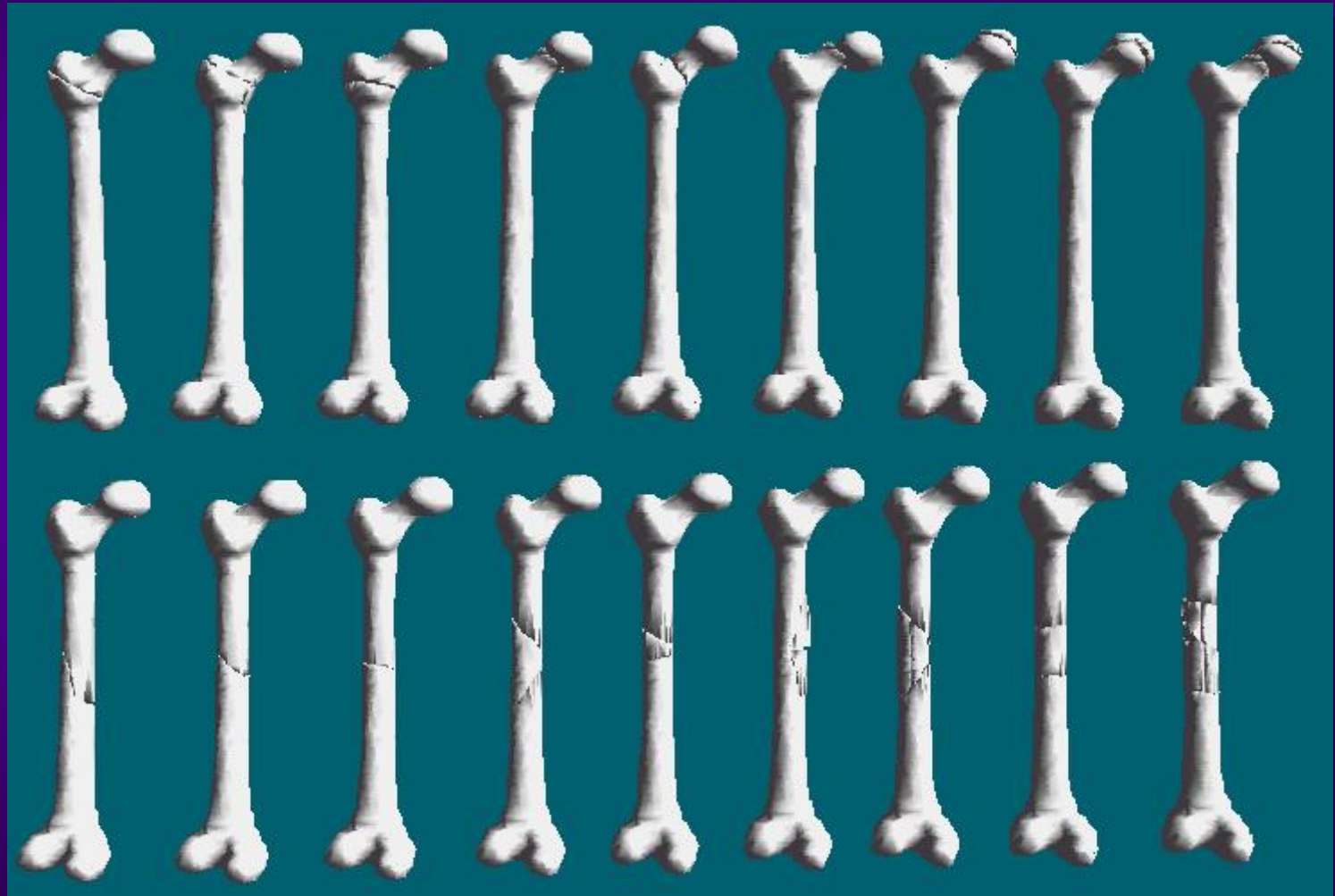
- ◆ Proximal femur - 9 types
- ◆ Femoral shaft - 9 types
- ◆ Distal femur - 9 types

◆ Pelvis

- ◆ Stable fractures - 3 types
- ◆ Rotationally unstable fractures - 3 types
- ◆ Totally unstable fractures - 3 types

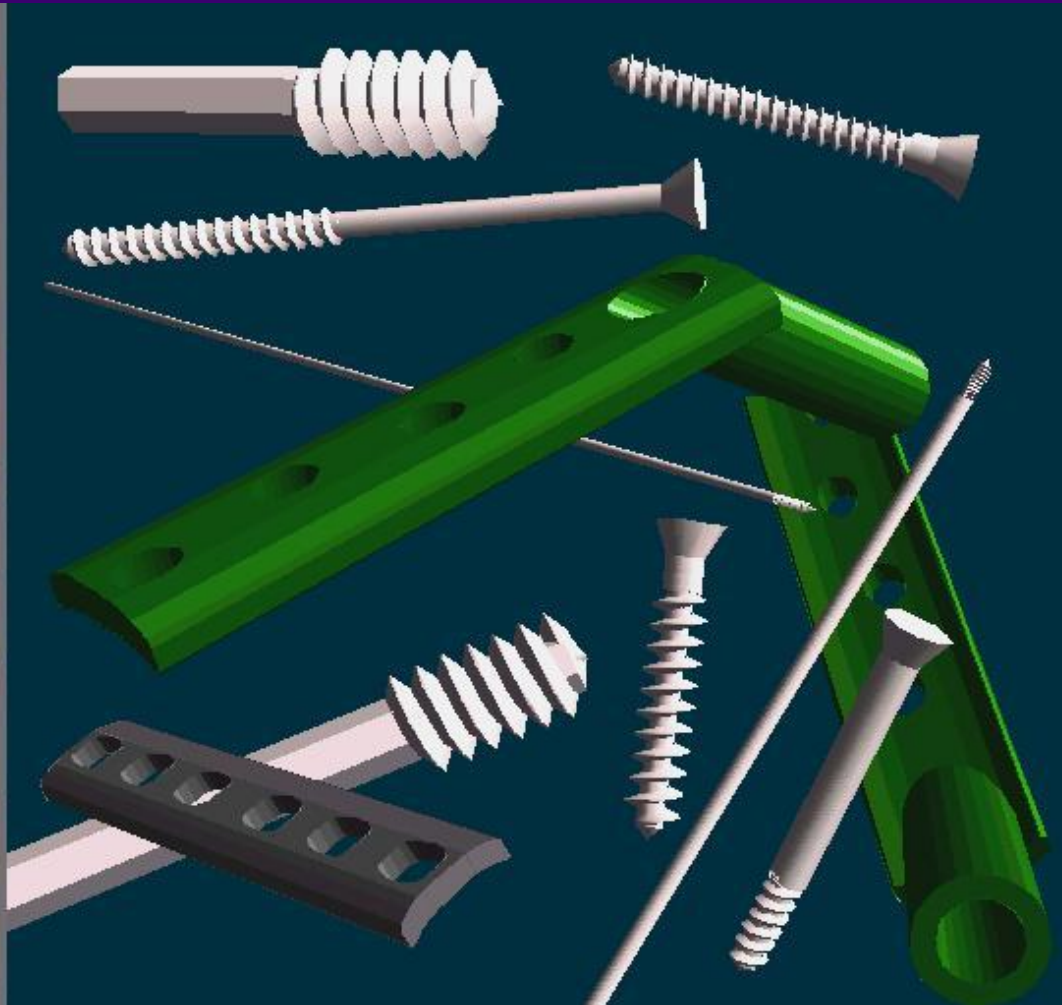


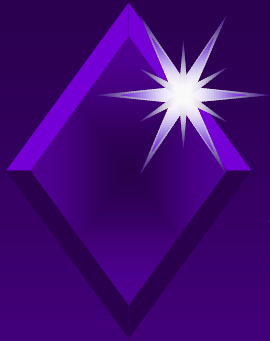
Femoral Standard Fractures





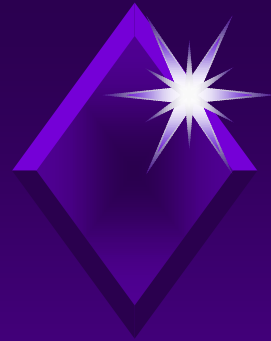
Real and Virtual Implants





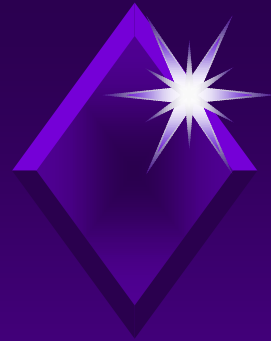
Basic Procedures Groups

- ◆ Application of the instruments and insertion of the implants in place
- ◆ Viewing the objects through “the image intensifier”
- ◆ Rotating and zooming the scene and objects in the scene
- ◆ Walk through the bone canal
- ◆ Reverse process
- ◆ Setting the multiple lights
(point light sources and spot-lights)
- ◆ Setting the backdrop

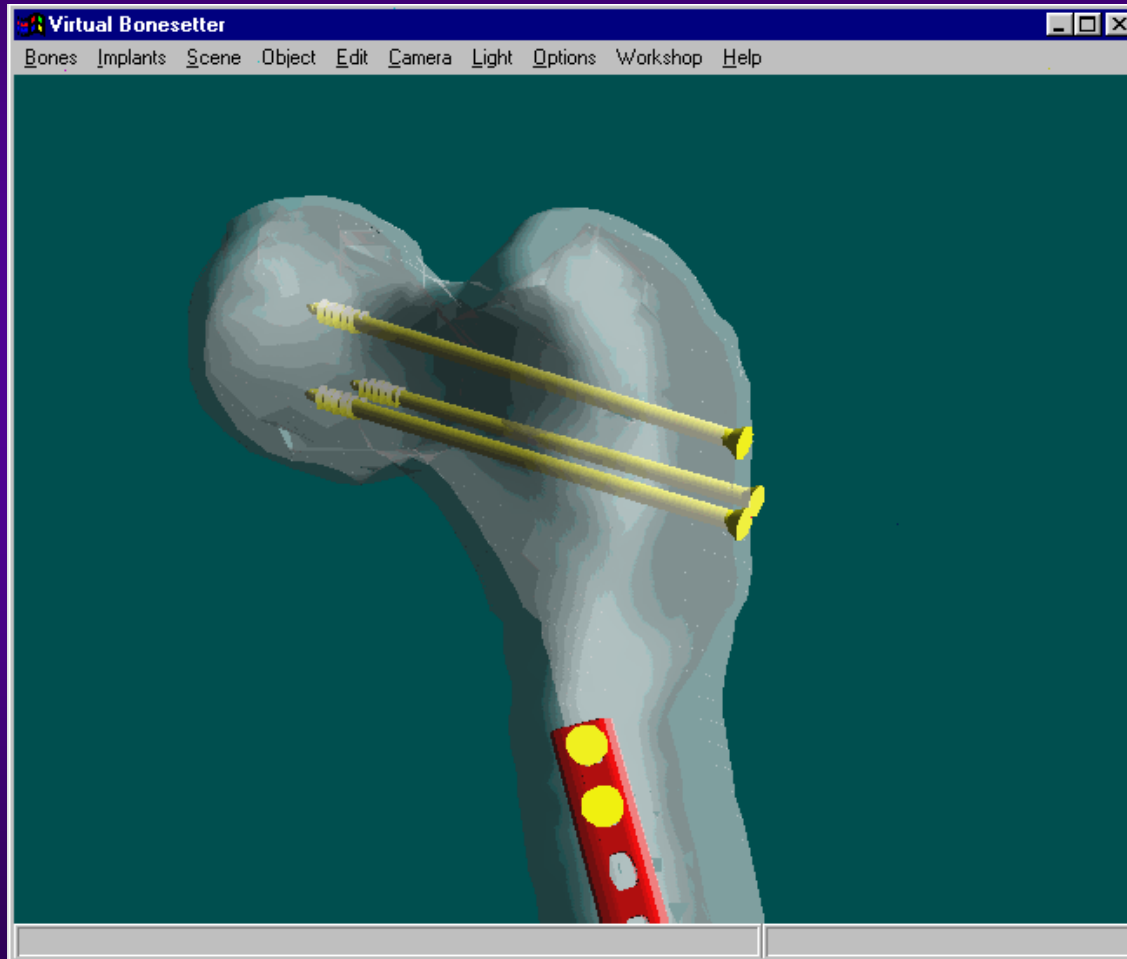


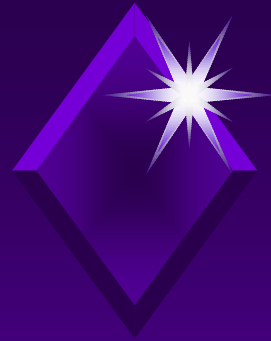
Example of Virtual Surgical Procedures

- ◆ Locate the bone in front of the user
- ◆ Insert threaded guide wire
- ◆ Insert pin
- ◆ Remove threaded guide wire
- ◆ Remove pin
- ◆ Insert multiple guide wires
- ◆ Measure for screw length
- ◆ Insert screw
- ◆ Seat plate
- ◆ Insert nail

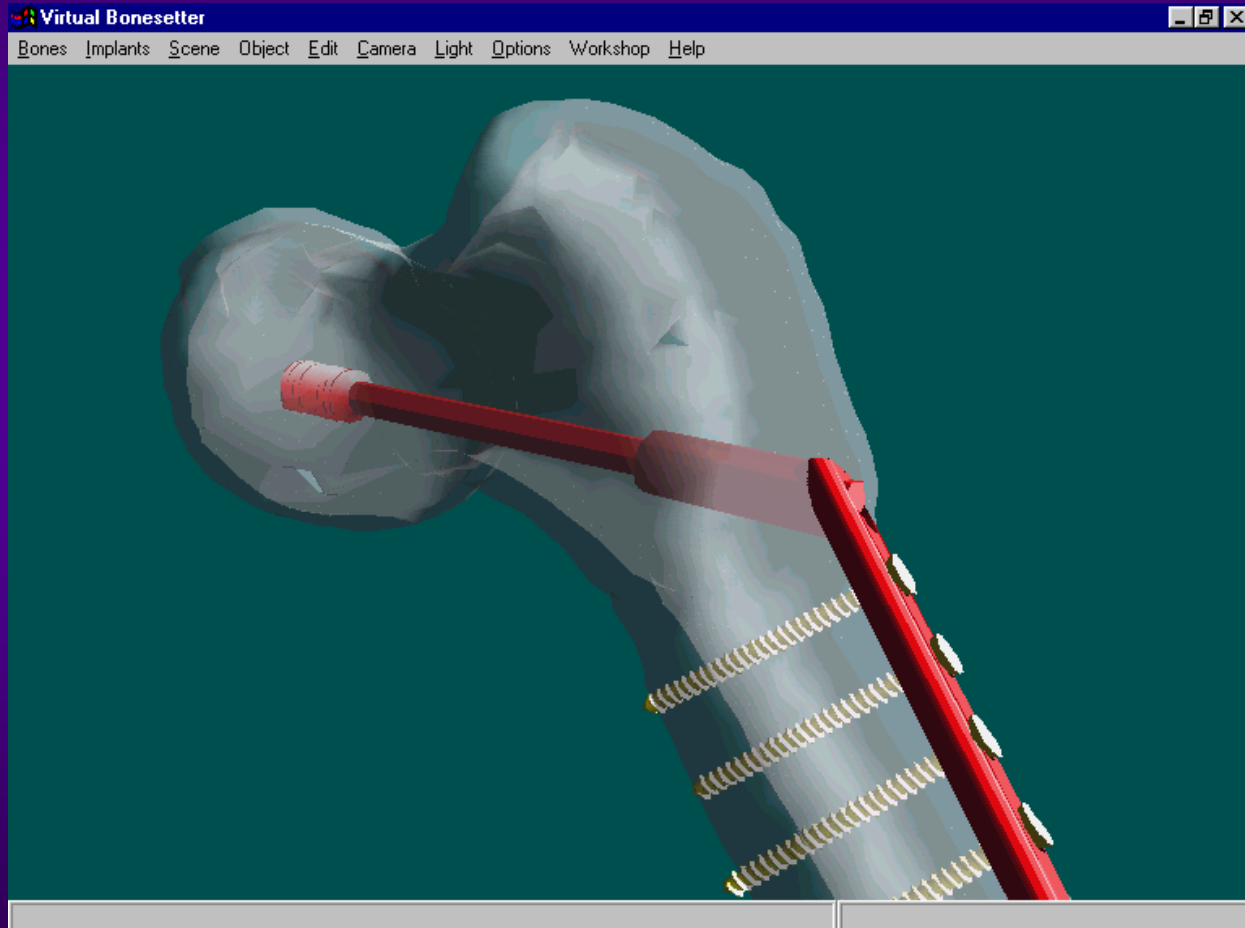


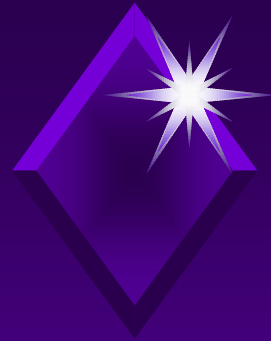
Femur Neck Fixation with Cancellous Screws



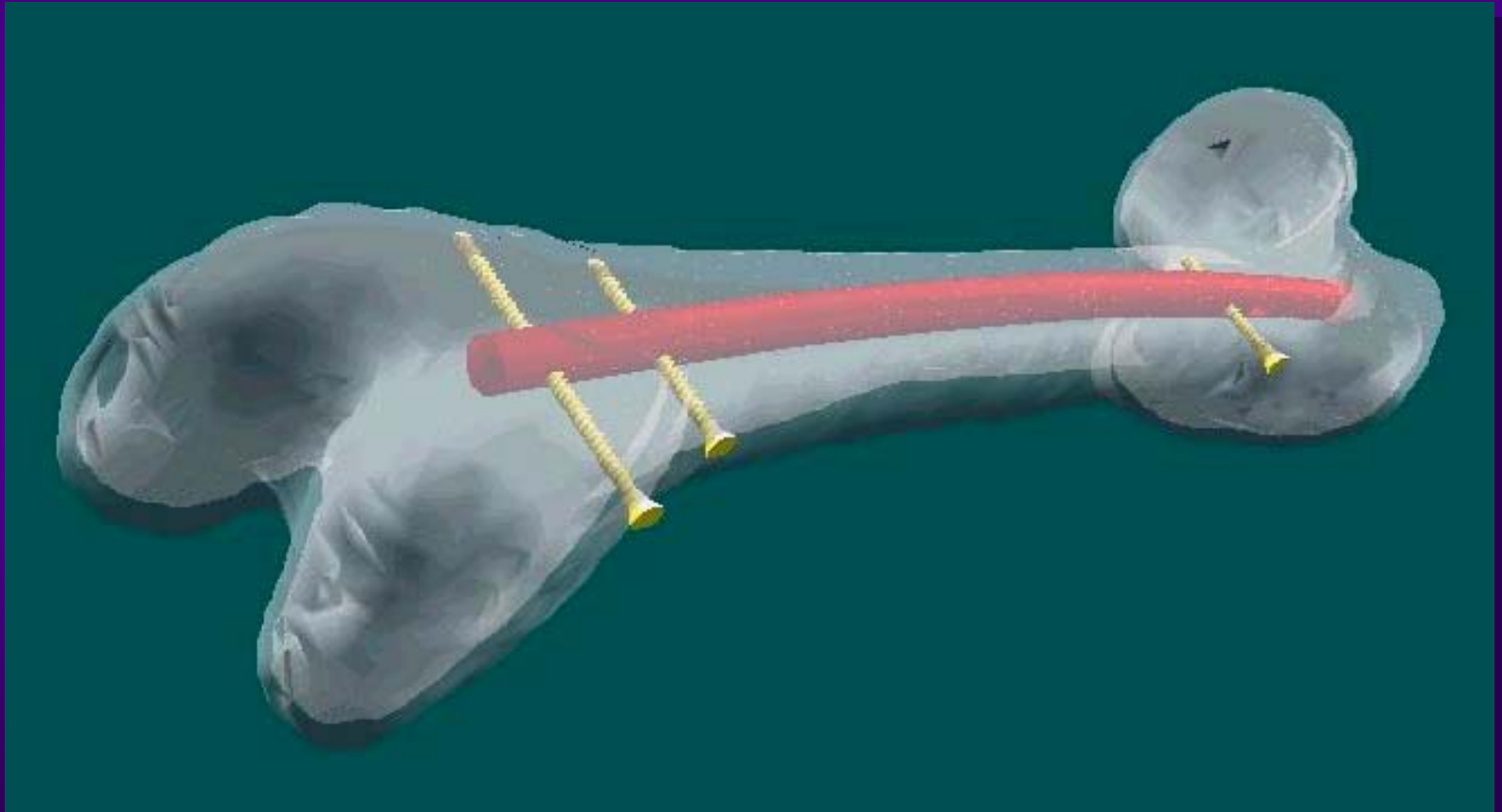


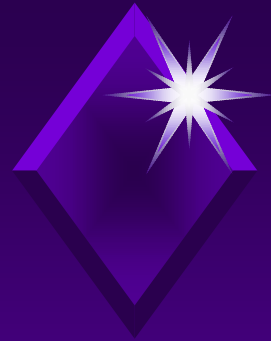
Femur Neck Fixation with the Dynamic Hip Screw System





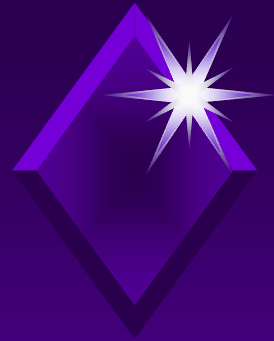
Femur Fixation with an Intra-medullary Nail



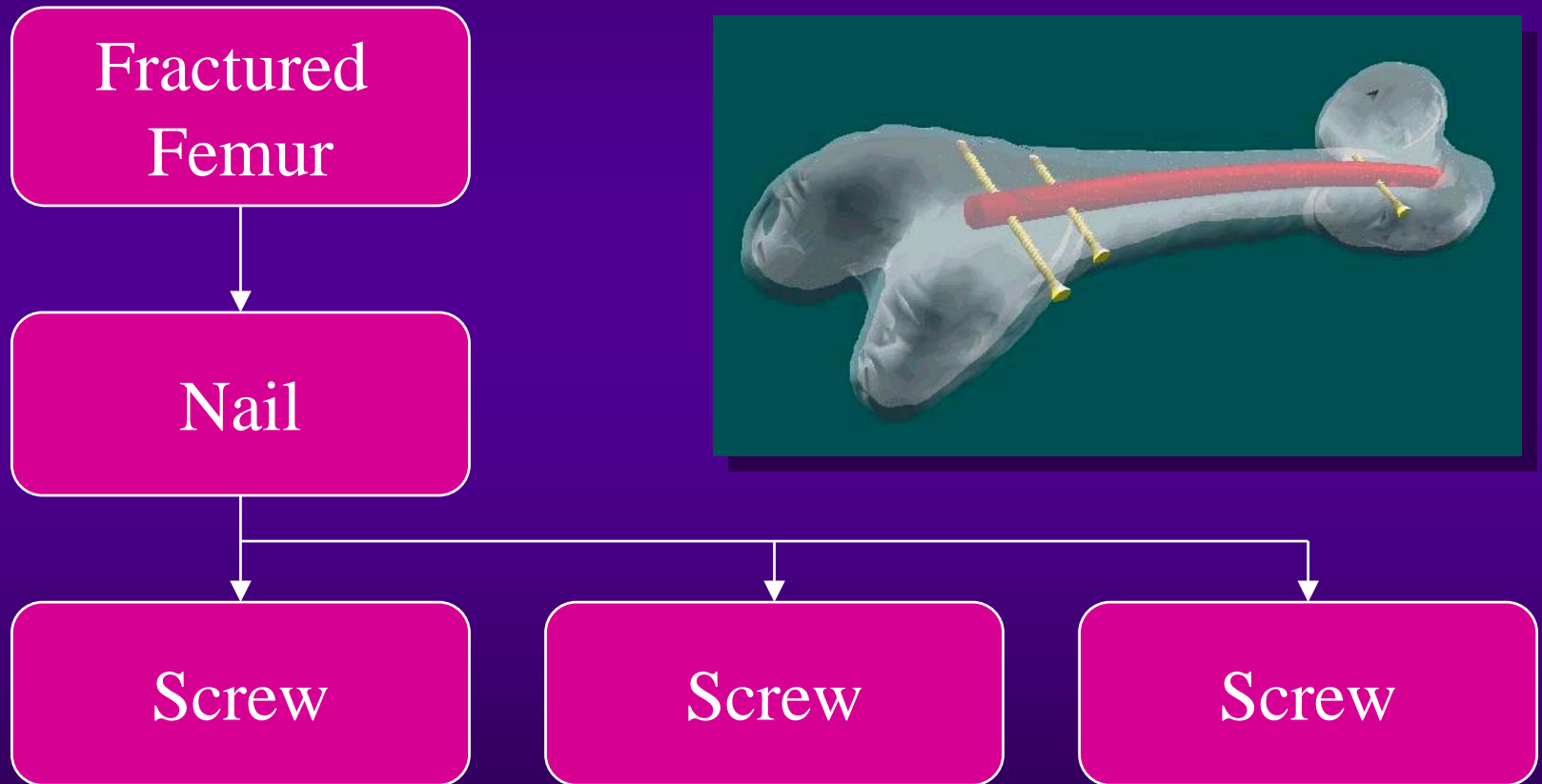


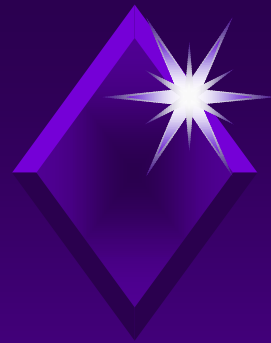
Hierarchical Geometric Database

- ◆ Fractured Bone or Implant
 - ◆ Unique ID
 - ◆ Shape - polygonal mesh
 - ◆ Graphics attributes
 - ◆ Extra geometric information used for pseudo-physical collision detection and/or insertion/seating
 - ◆ Parent reference



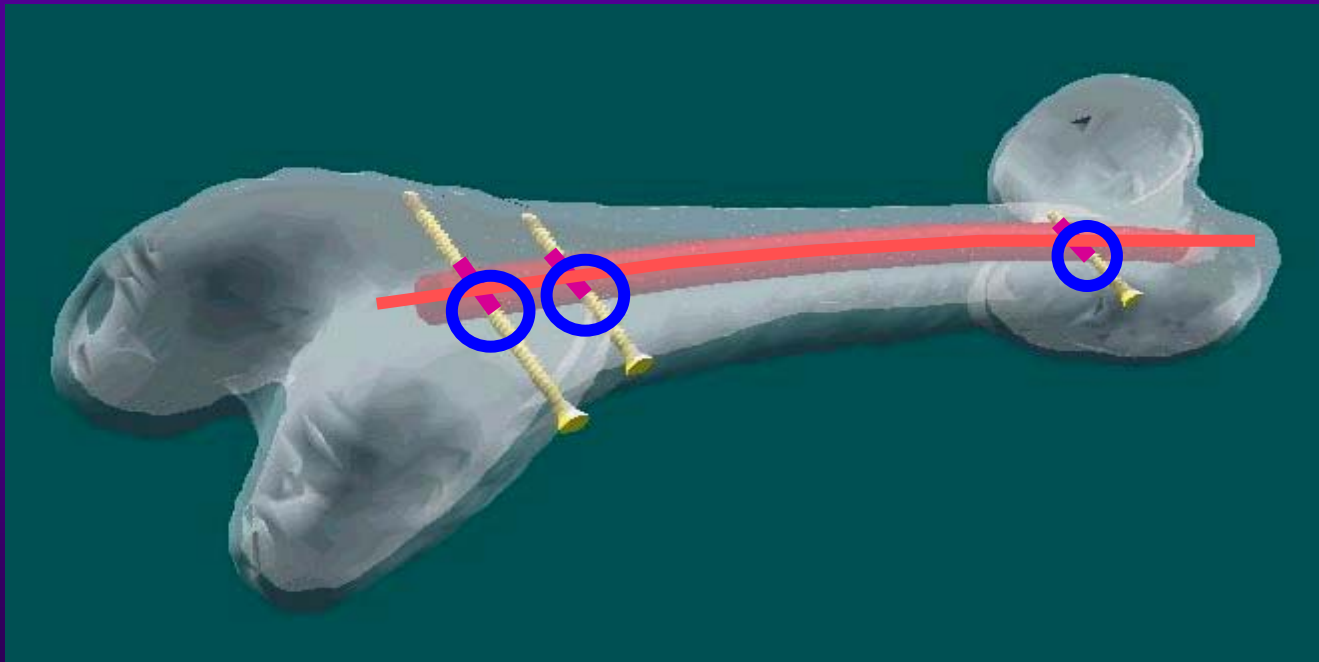
Example of Hierarchy

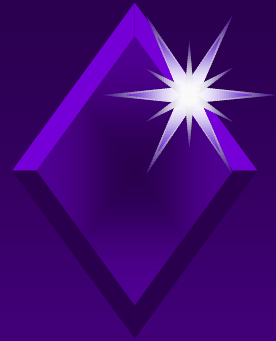




Example of Collision Detection

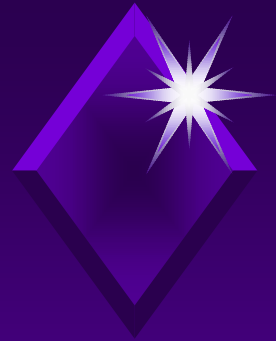
- ◆ Geometric attractive field + axis or centre point(s)





Further Development

- ◆ To extend the library of tools and implants
- ◆ To develop a geometric library of fractured bones
- ◆ To add other specific surgical procedures
- ◆ To incorporate video of actual surgery procedures



Conclusion

- ◆ VB provides the capability to combine 3-D visual imagery of bones with interactivity in support of a realistic surgical simulation.
- ◆ The system could offer many attractive possibilities: lower risk training for students, fewer risks for patients, better scenario-based practice, and minimized cost of training.