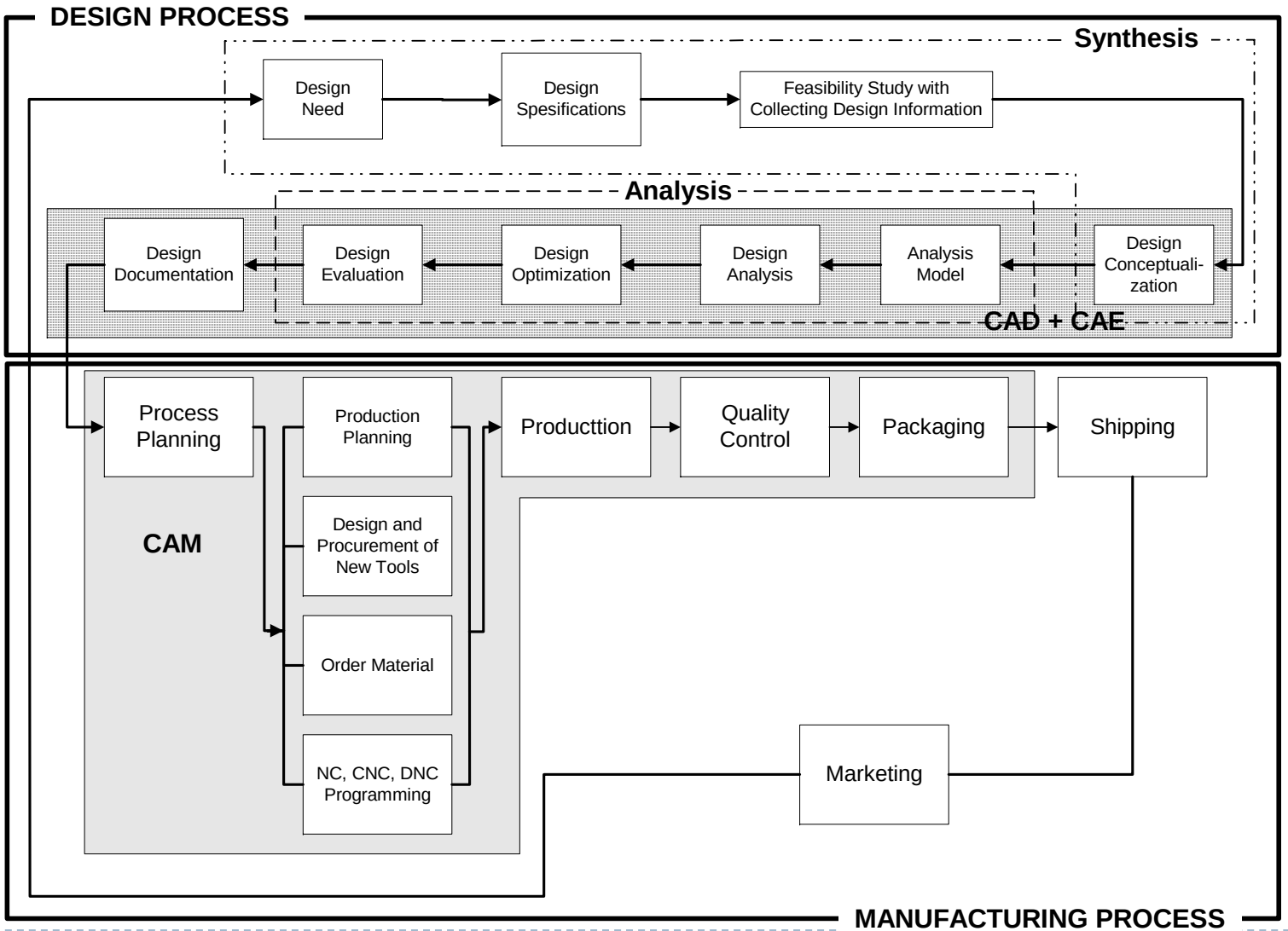
Introduction to CAD/CAM/CAE

Human-Centered CAD Lab.

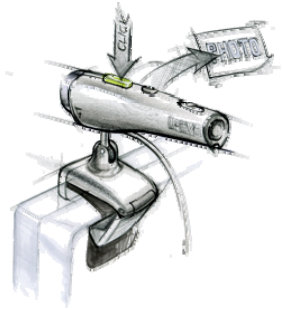
Introduction

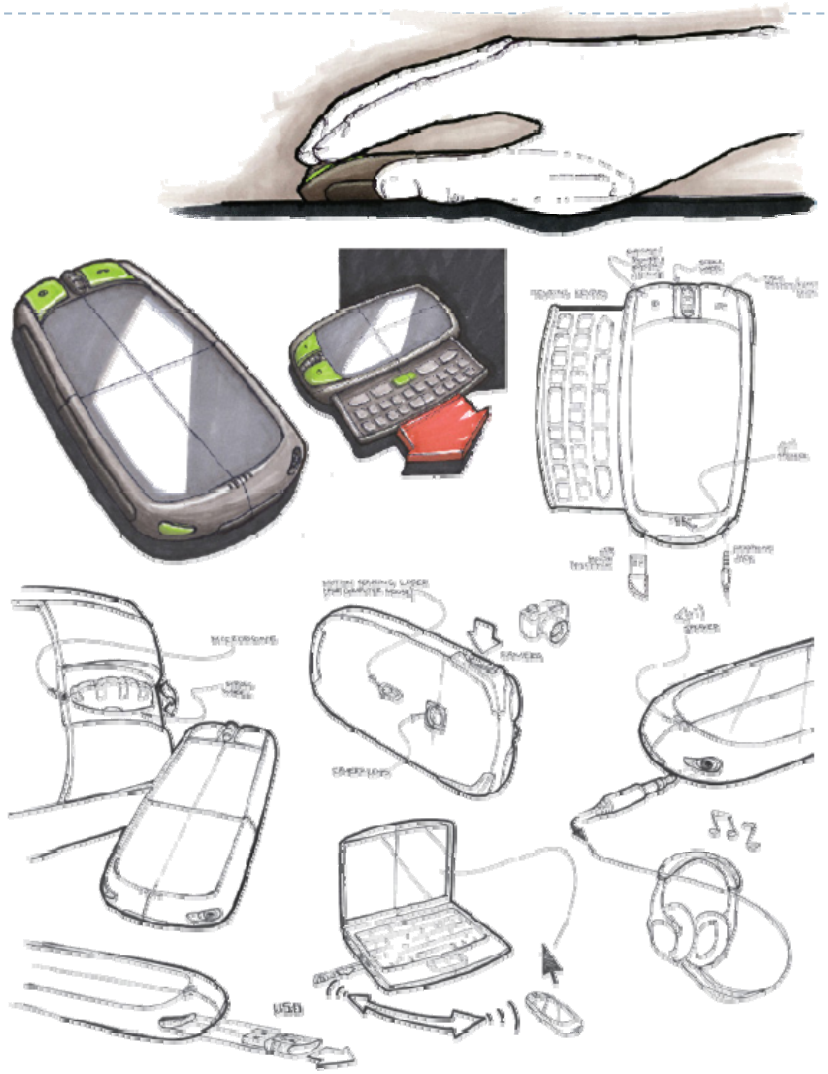
- CAD(Computer Aided Design)
- CAM(Computer Aided Manufacturing)
- CAE(Computer Aided Engineering)
  - Memory capacity, processing speed,
  - Interactive graphics
- Quality, Cost, Delivery

Product Development Cycle



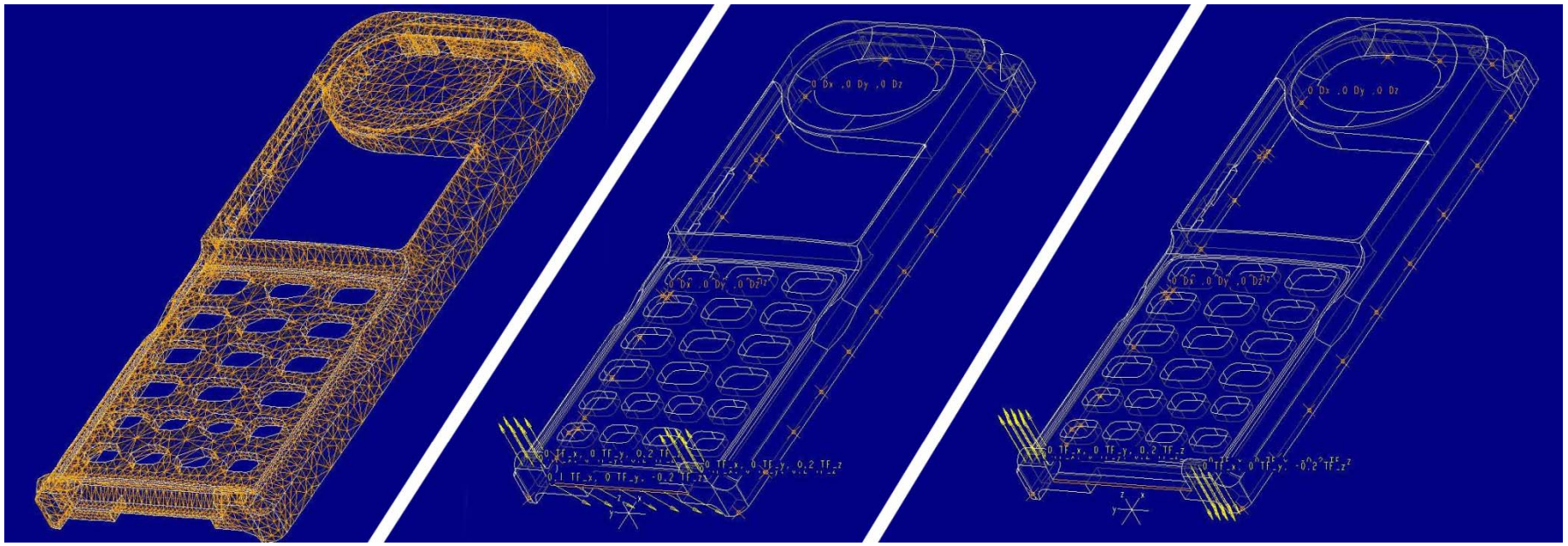
Conceptual Design





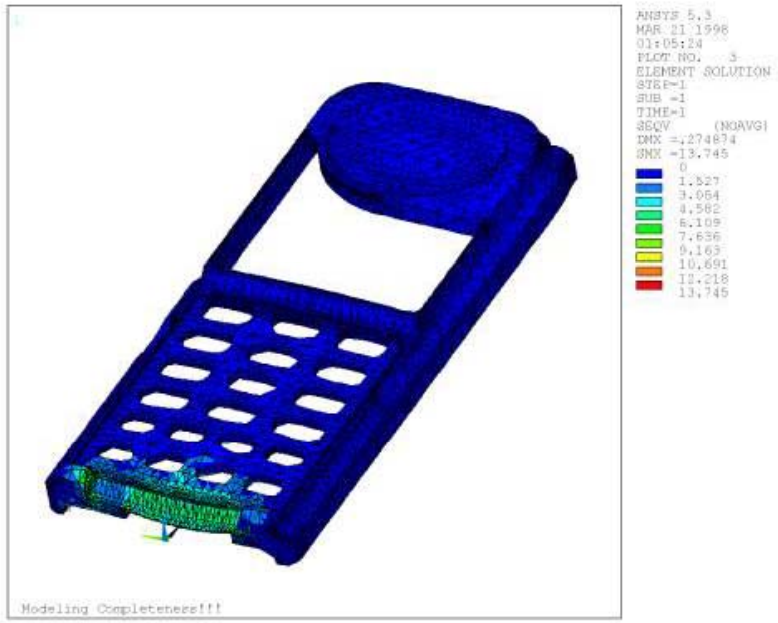
Solid model of example part

Finite element analysis model of example part

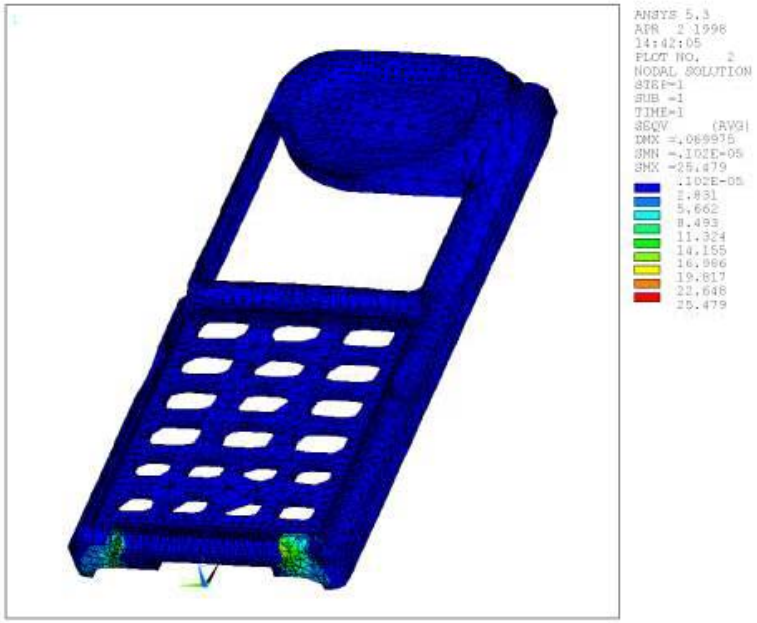


Finite element meshes	Load condition: case 1	Load condition: case 2

Stress distribution on example part

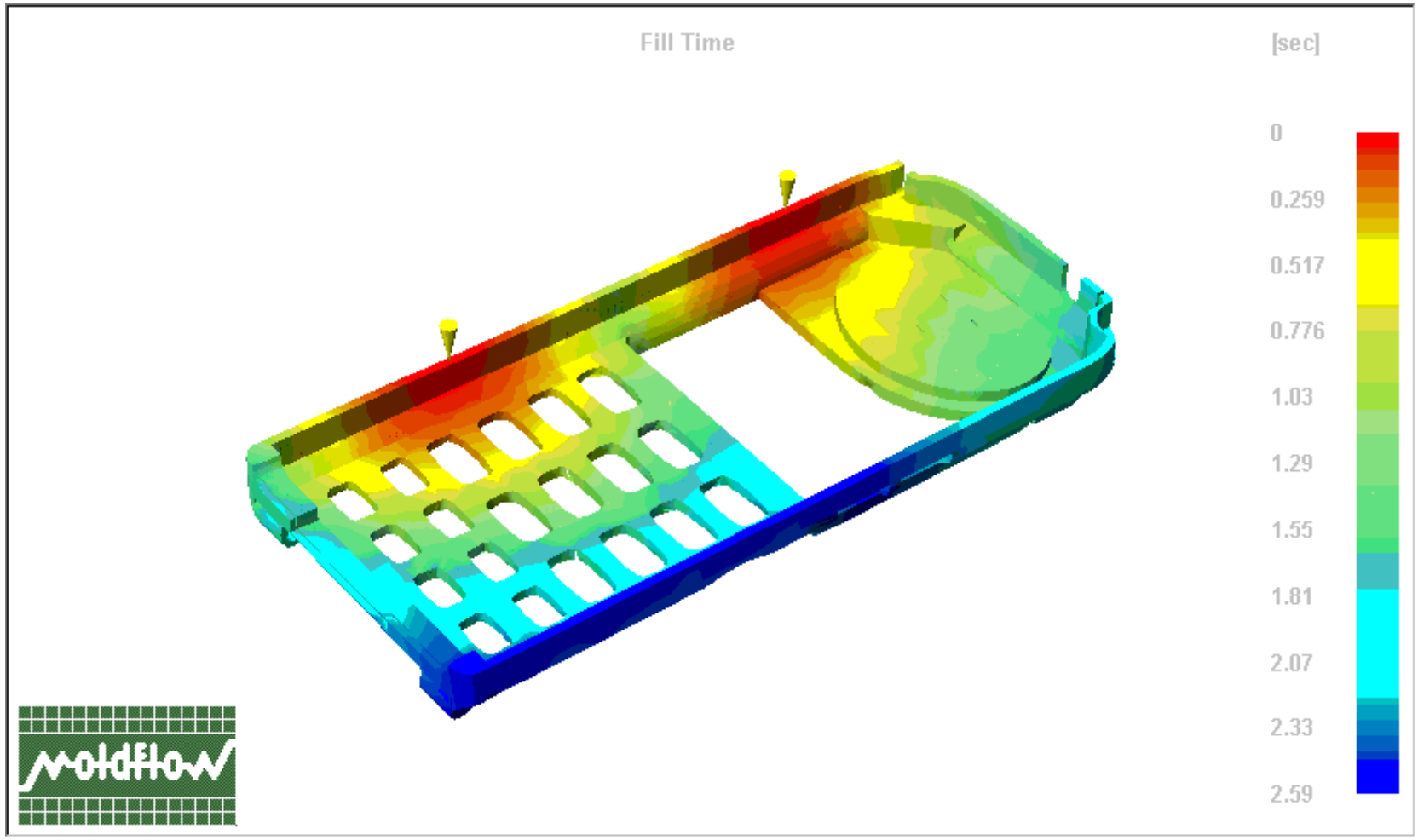


Result for case1

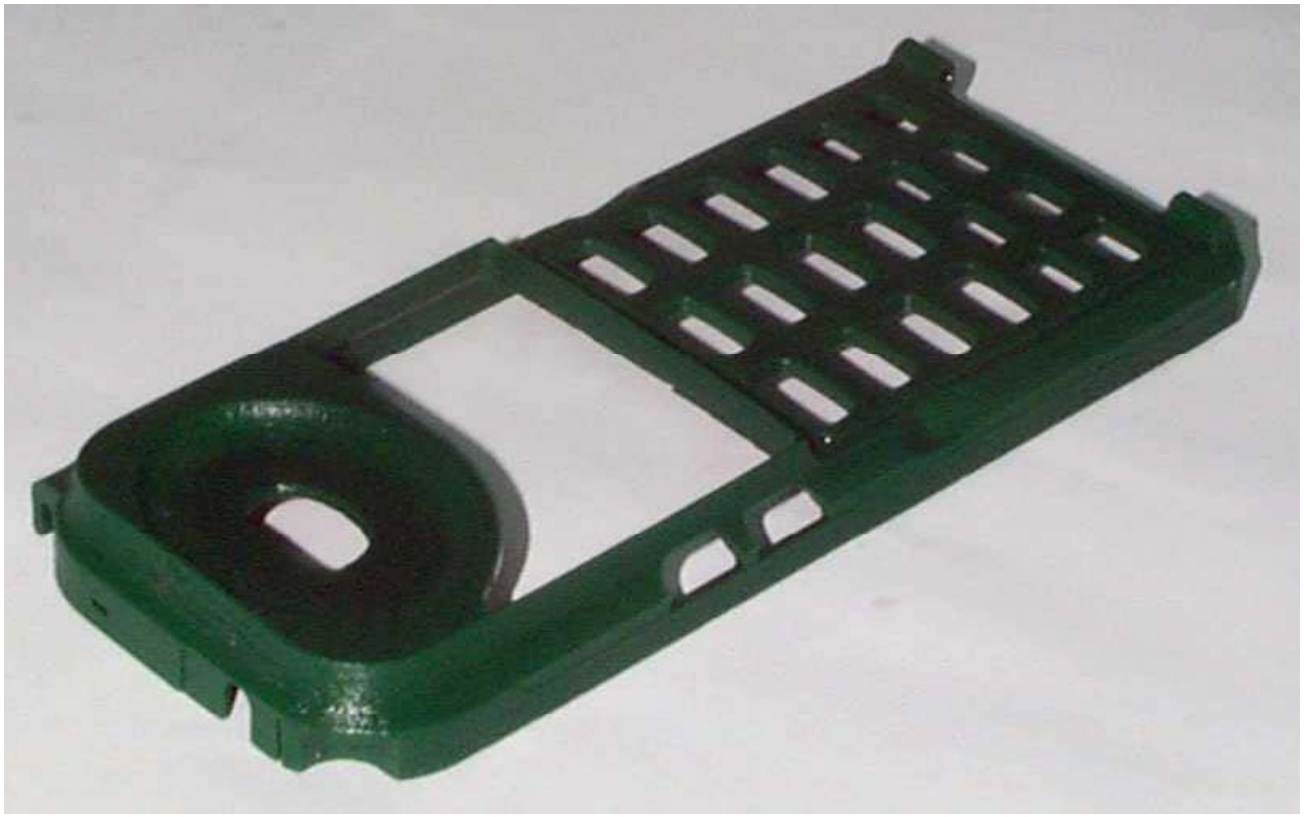


Result for case2

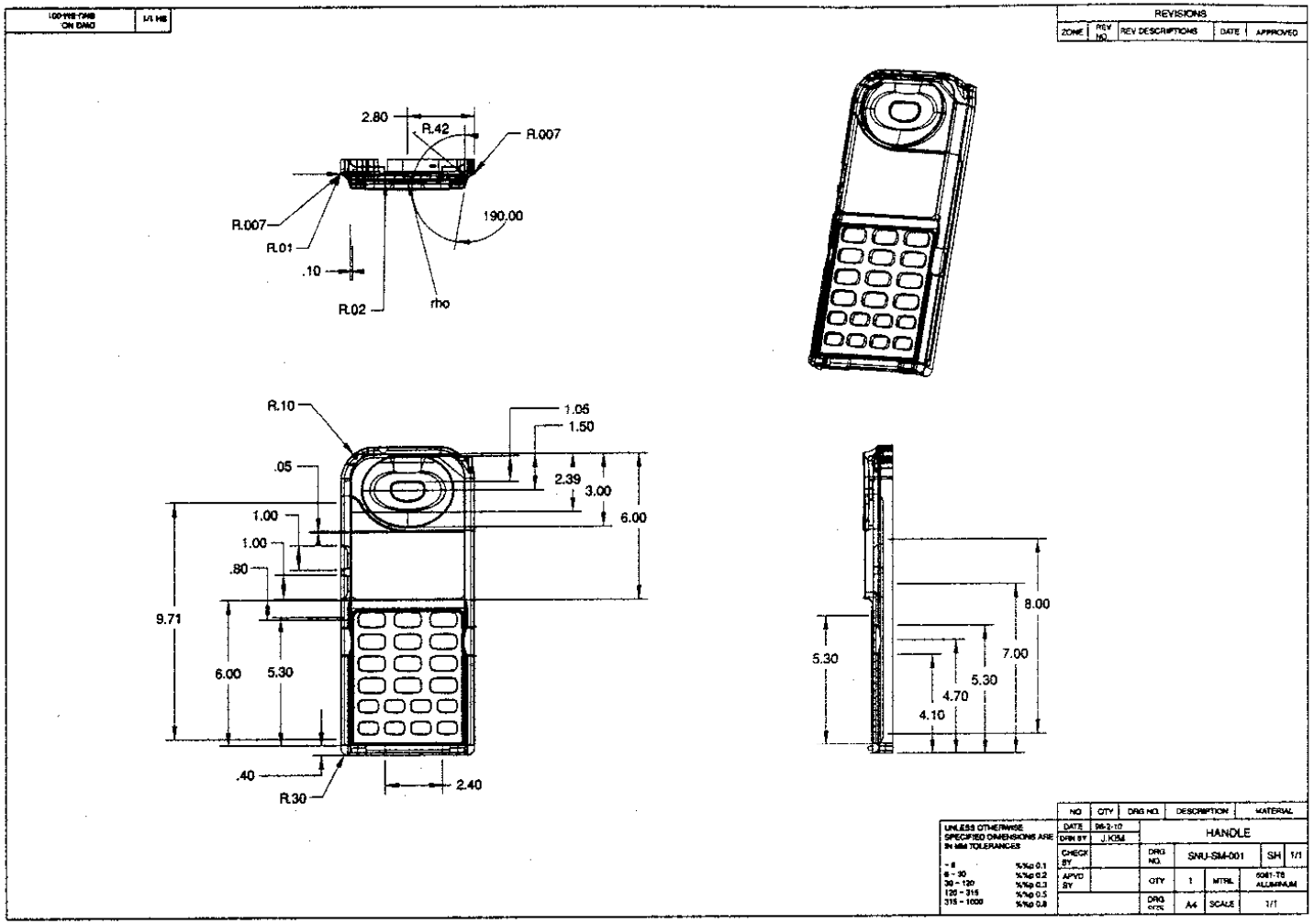
Fill time distribution for example part



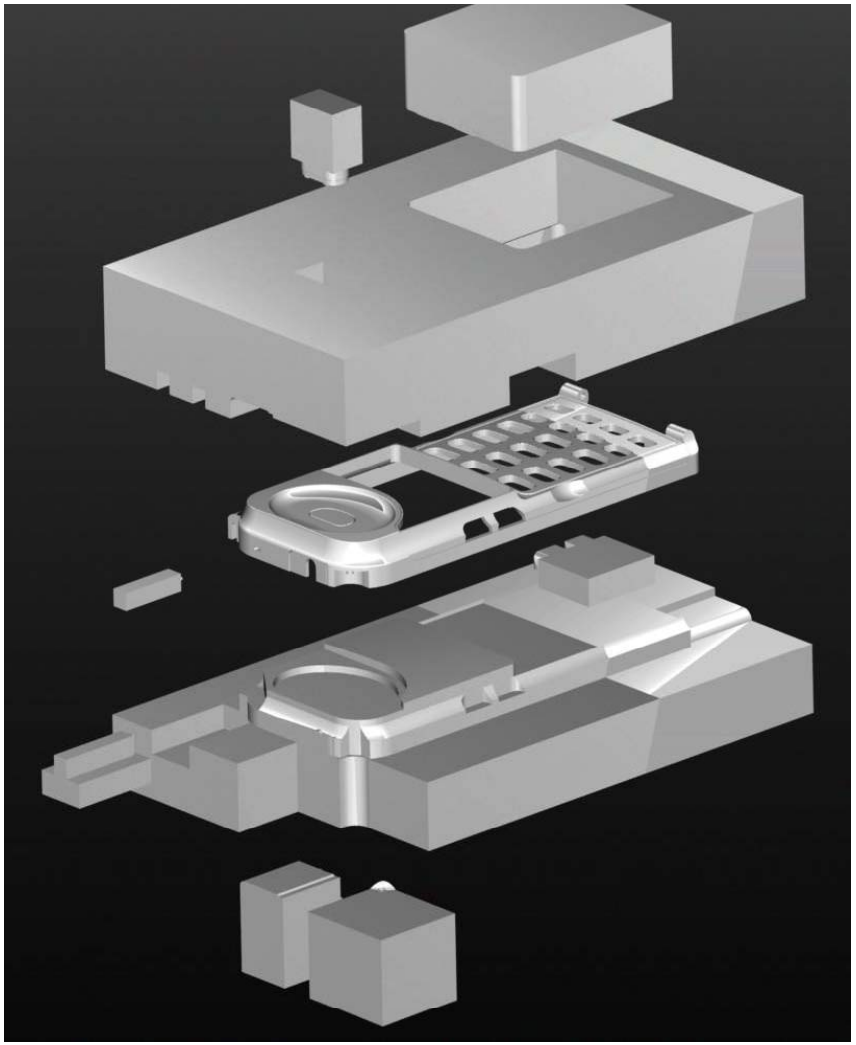
Physical prototype of example part



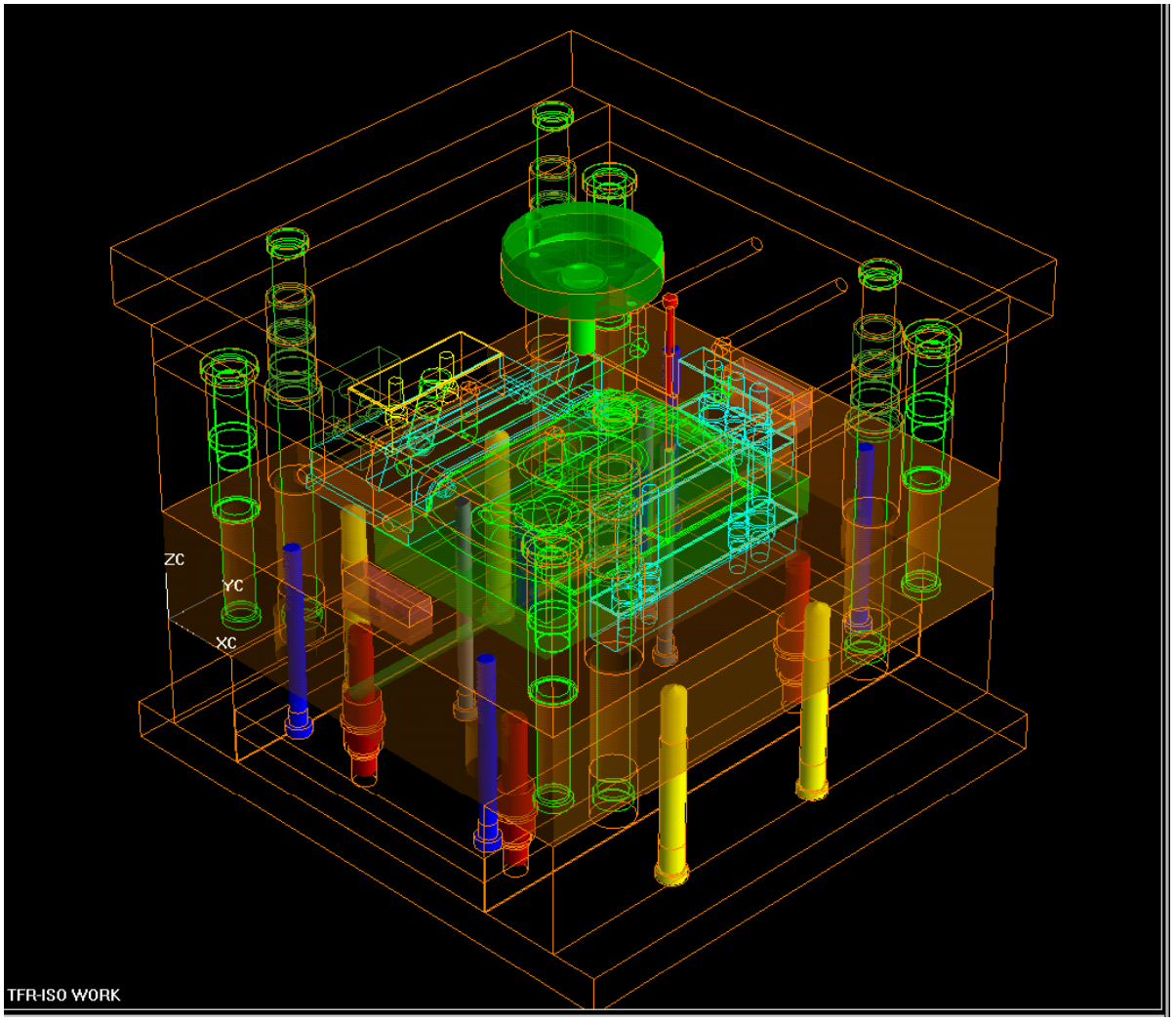
Part drawing of example part



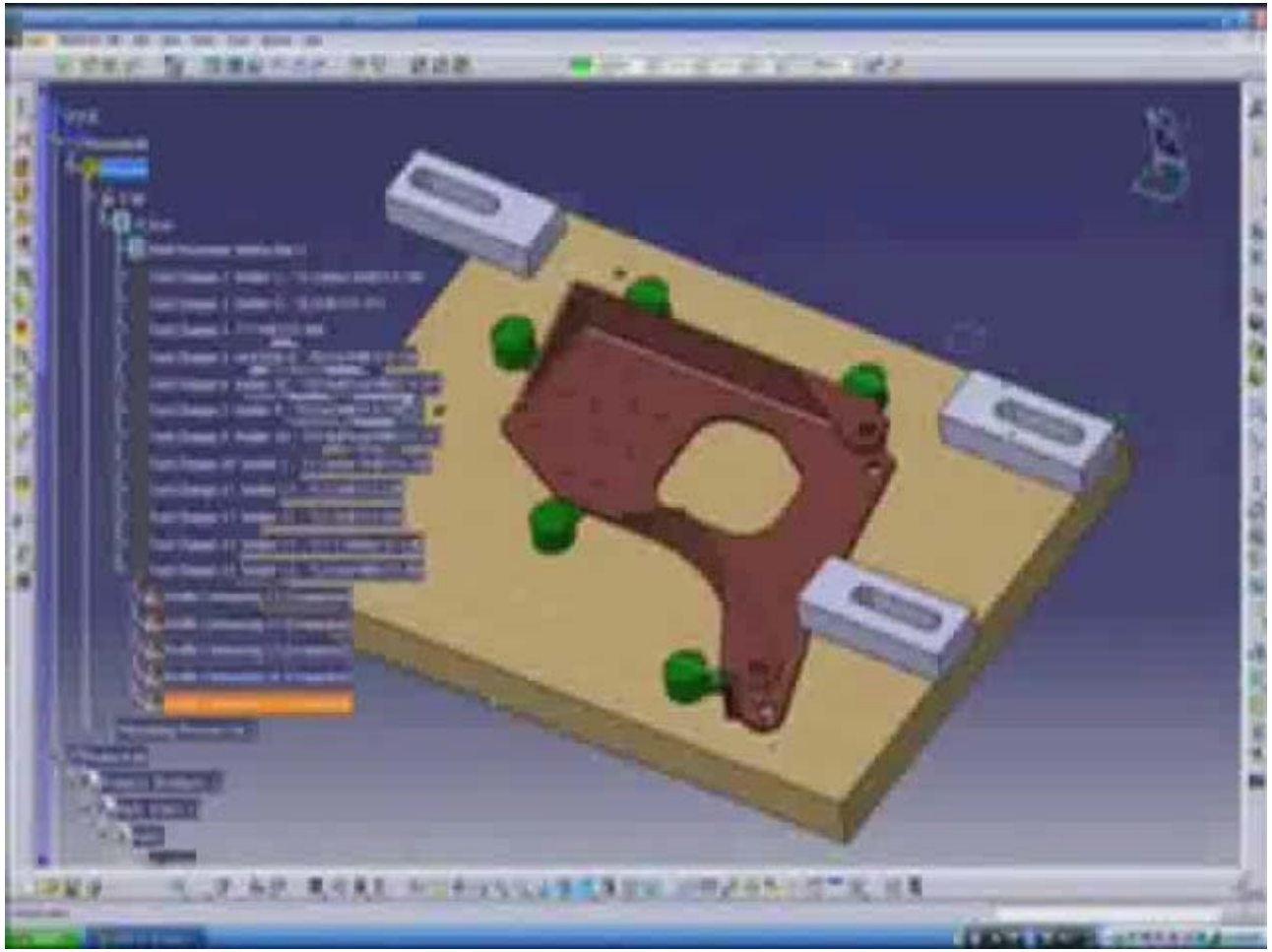
Core, cavity and side cores for example part



Completely designed mold base



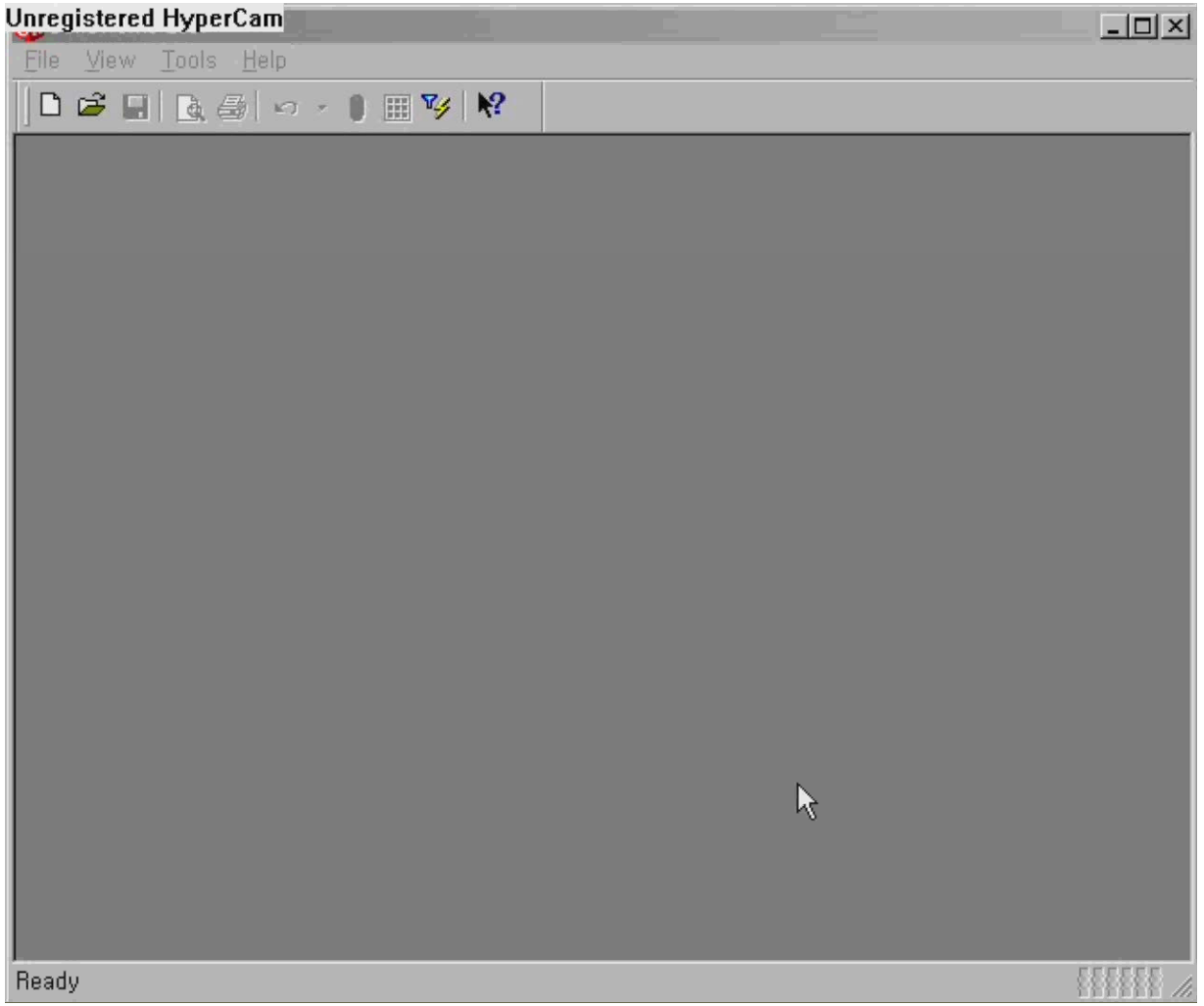
NC tool paths to machine part



Roles of Computer in Product Development Cycle

- Quick generation of design concepts
  - Computer aided drafting system
  - Geometric modeling system
  - Parametric modeling

Roles of Computer in Product Development Cycle – cont'



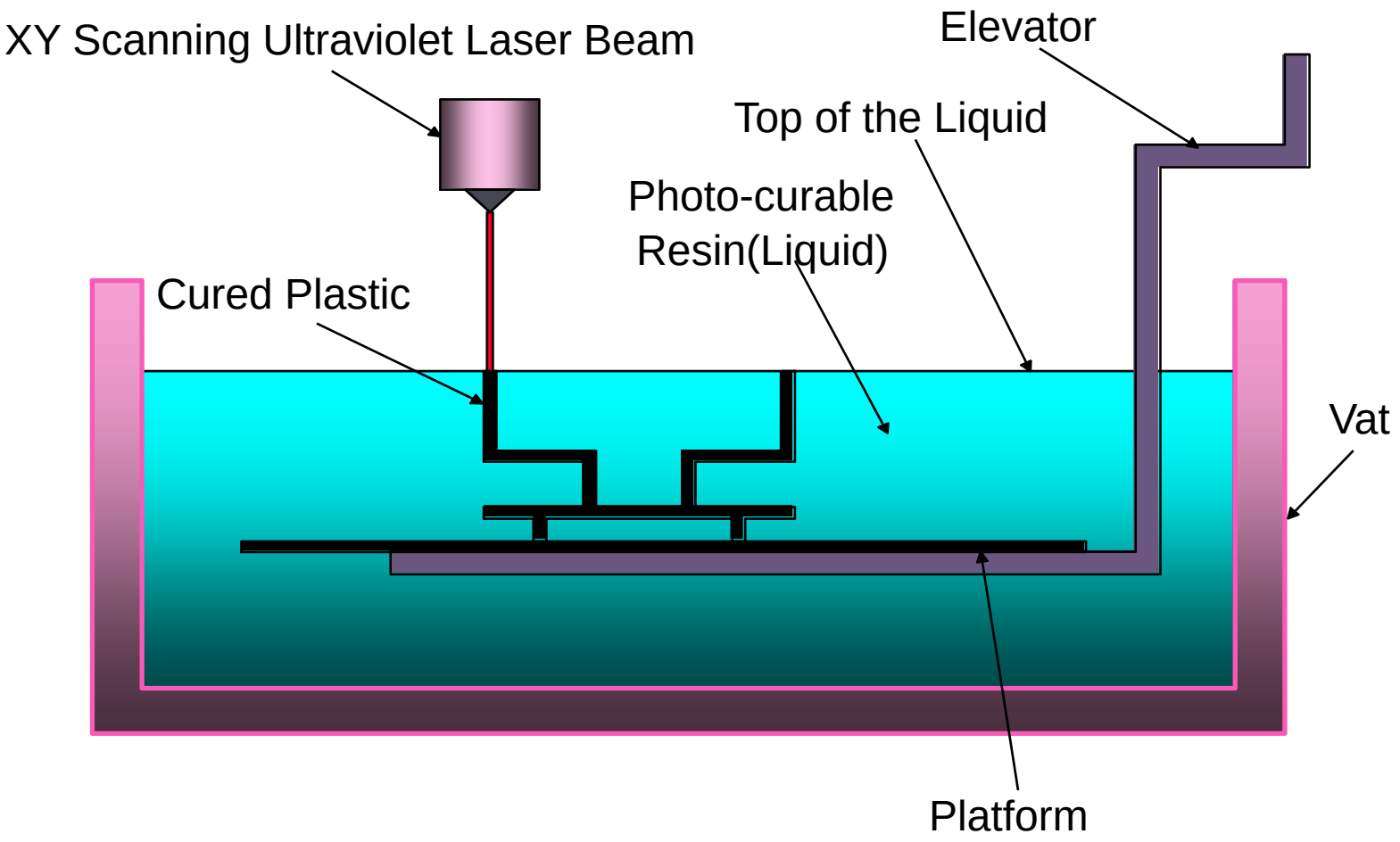
Roles of Computer in Product Development Cycle – cont'

- Powerful analysis capability
  - Stress analysis, interference checking
  - Kinematic analysis, etc.
  - Analysis model with proper abstraction
  - Interactive generation of analysis model

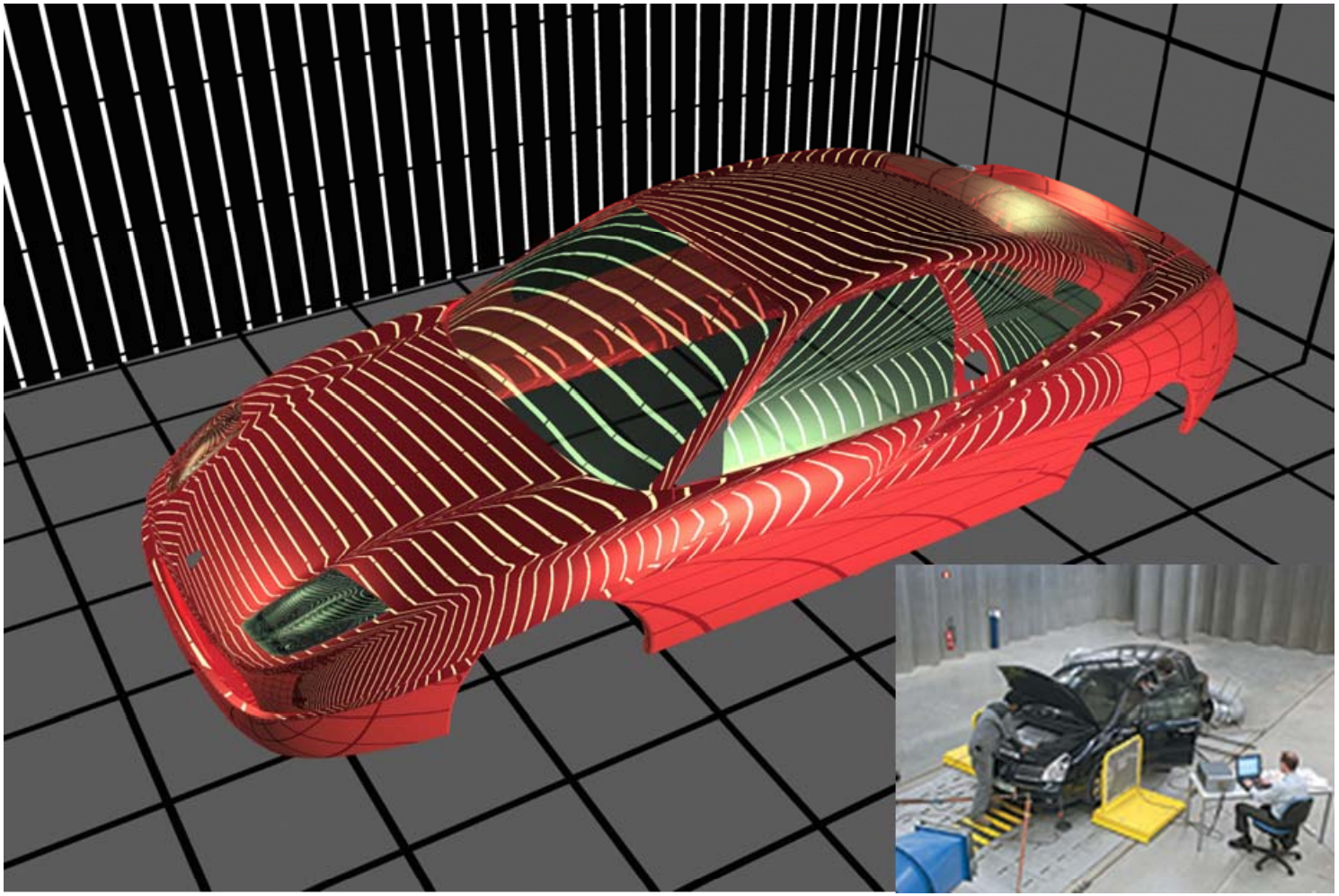
Roles of Computer in Product Development Cycle – cont'

- Easy prototyping for design evaluation
  - Rapid Prototyping (RP)
  - Virtual Prototyping (VP)

RP - Stereolithography Process

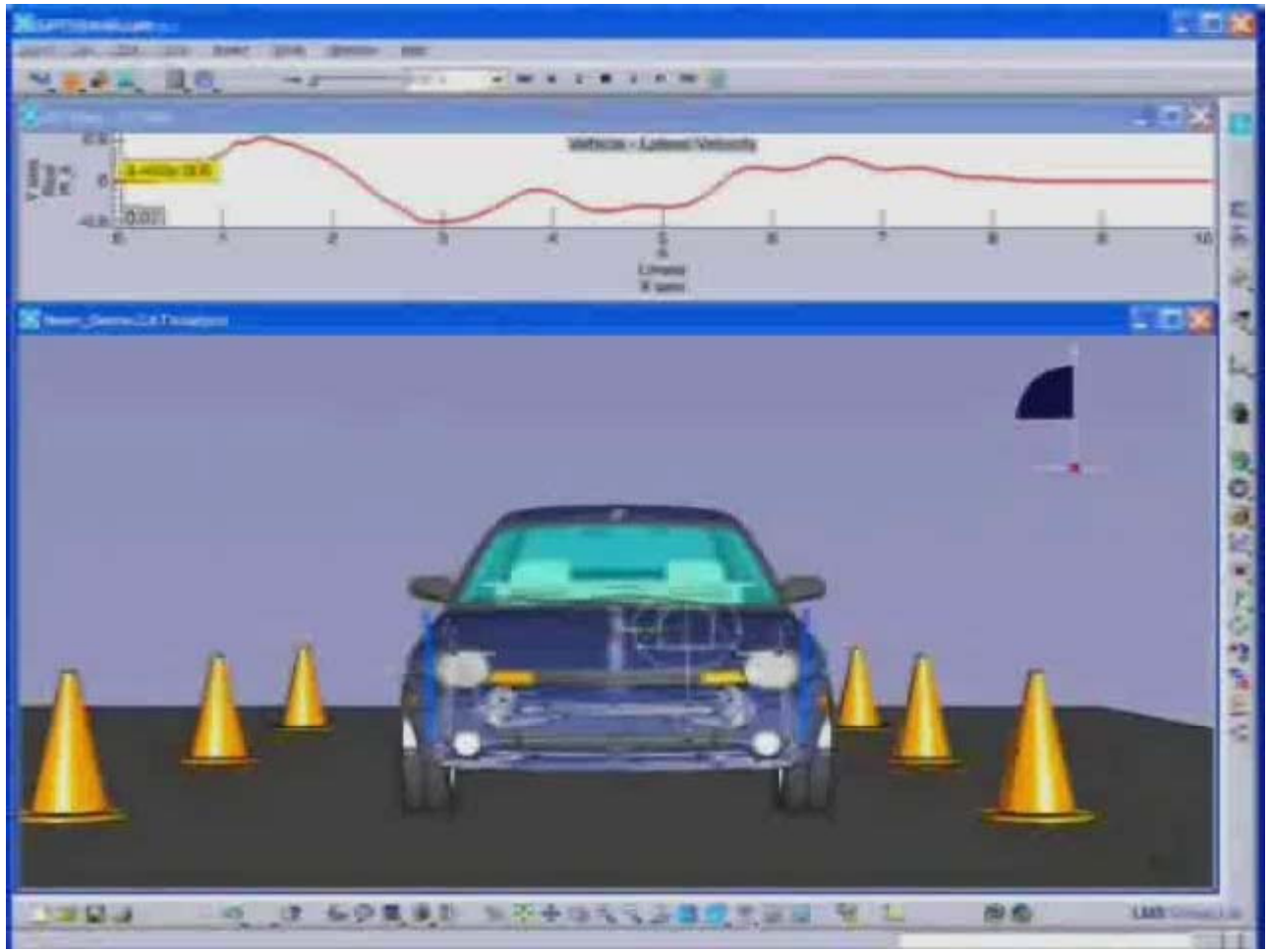


Virtual Prototyping of Car Body



Simulation for Testing Product

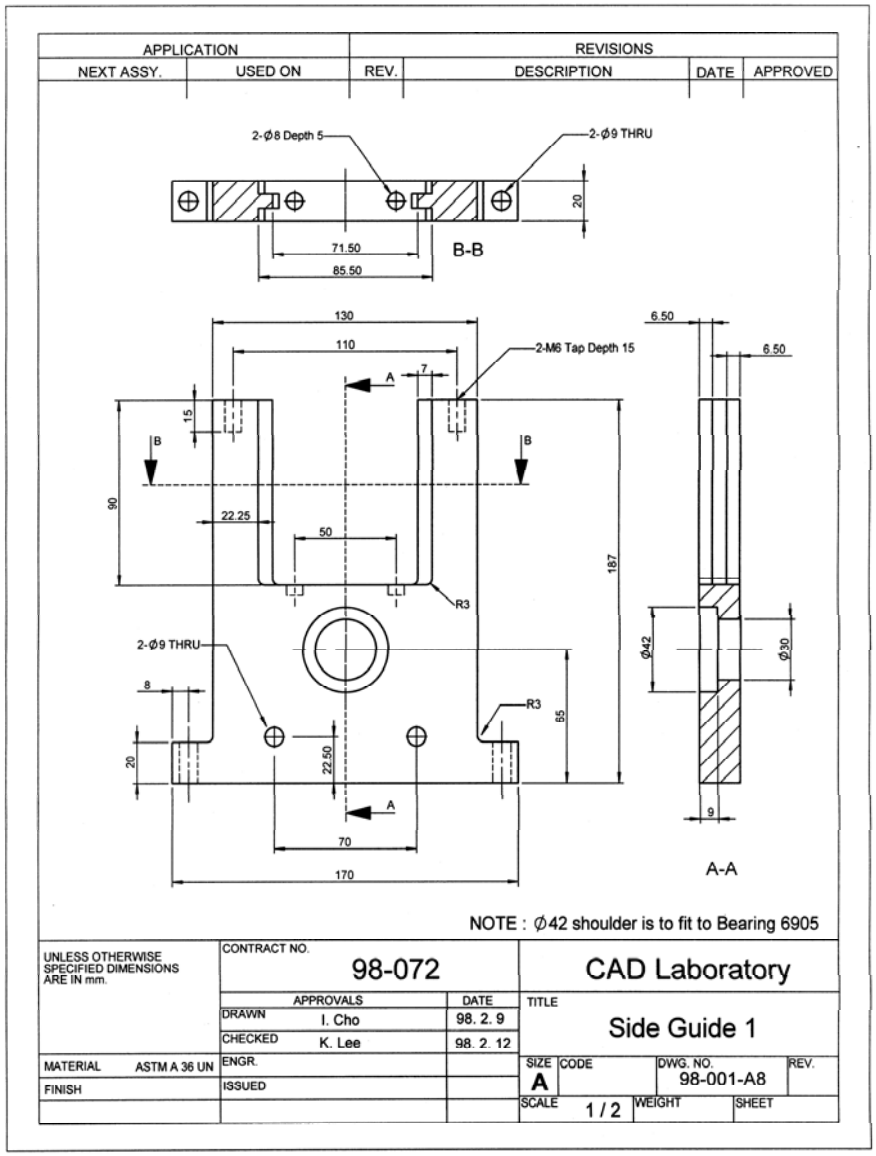
- Car Motion Test



Roles of Computer in Product Development Cycle – cont'

- Easy design documentation
  - Computer aided drafting system
  - Automatic drafting program

Roles of Computer in Product Development Cycle – cont'



Roles of Computer in Product Development Cycle – cont'

- Automatic generation of process plan
- Automatic generation of NC program
- Automatic generation of program for Robot, CMM

Definitions of CAD, CAM and CAE

- CAD
  - Creation, modification, analysis, optimization
  - Computer graphics + application program for design
  - Tolerance analysis, mass property calculation, interference checking

Definitions of CAD, CAM and CAE – cont'

- CAD – cont'
  - Basic function is to define design geometry
  - Computer aided drafting system or geometric modeling system is the key element of CAD system
  - Design geometry is the core in the product development cycle and stored in the database by CAD system

Definitions of CAD, CAM and CAE – cont'

- CAM
  - Plan, manage, control of manufacturing operations
  - CAM module for NC programming is the most popular
  - Robot programming for material handling, welding, assembling, etc.
  - Programming for CMM

Definitions of CAD, CAM and CAE – cont'

- CAM – cont'
  - Automatic Process planning
    - Group technology
    - Feature recognition or feature based modeling
  - MRP(Material Requirement Planning)

Definitions of CAD, CAM and CAE – cont'

- CAE
  - Simulation of designed product
  - Simulate, refine and optimize the design
  - Kinematic program, large-displacement dynamic analysis, etc.

Definitions of CAD, CAM and CAE – cont'

- CAE – cont'
  - FEM is the most typical CAE software
  - Stress, deformation, heat transfer, fluid flow, magnetic field, continuous field problem
  - Meshing, easy input of BC and loads are required – Preprocessor
  - Display of computed result – Postprocessor

Definitions of CAD, CAM and CAE – cont'

- CAE – cont'
  - Need to delete details or reduce the dimension for computational efficiency
  - Often FEM is combined with optimization
  - Used to detect design flaws at the initial design stage (e.g. CosmosWorks, AnsysWorks)