Introduction to Computer Graphics

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Introduction to Computer Graphics

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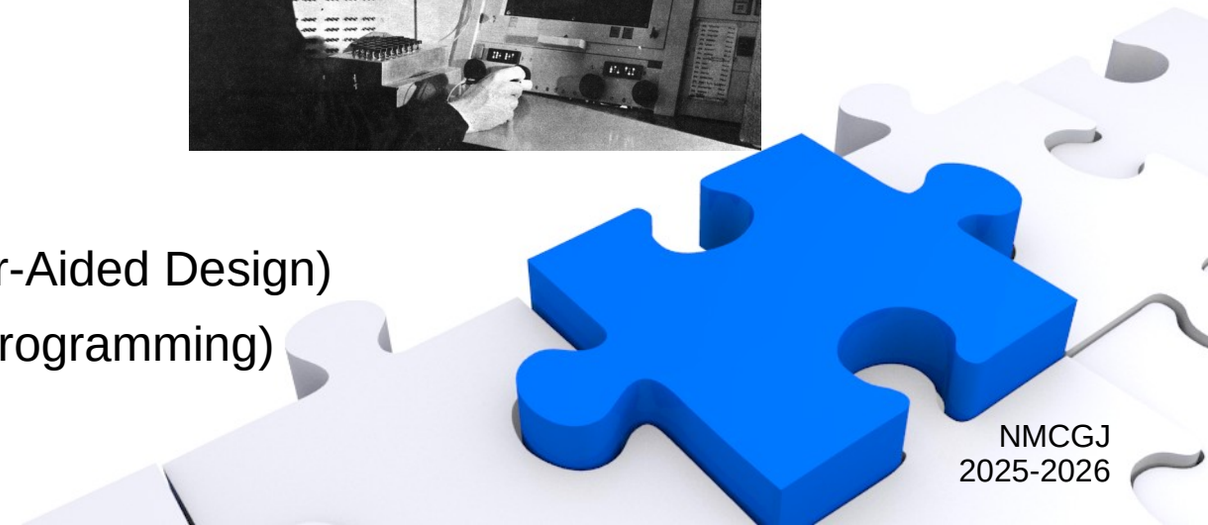
- What is computer graphics?
  - Creation, storage, manipulation and rendering of models and images
  - Models come from various sources
    - Art, mathematics, biology, physics, …
  - Two basic paradigms
    - 2D images and 3D graphics
  - SKETCHPAD (Ivan Sutherland, 1963)
    - First (interactive) graphics system
    - Ancestor of modern CAD systems (Computer-Aided Design)
    - Ancestor of modern OOP (Object-Oriented Programming)



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- 2D images
  - Discrete samples (= pixels, picture elements) describe virtual information
  - Pixels are created by
    - Paint programs, scanners, cameras, …
  - Images can be manipulated once the pixels are known
    - Recoloring, contrast, superposition, restoration, …
  - Some disadvantages
    - No depth
    - No different viewpoints

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- 2D images
  - Painterly rendering
    - How to make a painting from a photograph?
    - Examine neighborhood of each pixel
    - Define brushstroke for pixel
      - Length, thickness, direction
    - Apply strokes in random order
  - Example

    (Aaron Hertzmann)

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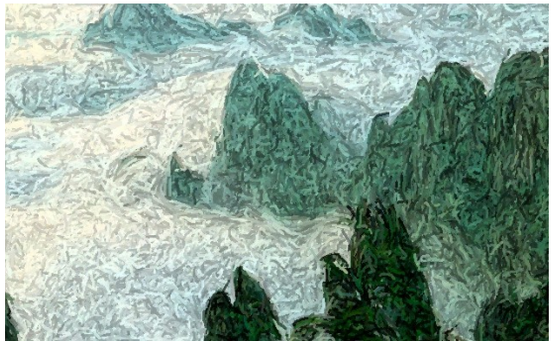
- 2D images
  - Painterly rendering: change the painting style by changing the parameters

source

“impressionist”

“expressionist”



“pointillist”

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- 3D graphics
  - Modeling
    - Creation of a geometric model (= scene)
  - Rendering
    - Creation of a 2D image of the scene
    - Different viewpoints possible
  - Animating
    - Creation of movement

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- 3D graphics
  - Modeling of the scene
    - How to represent real environments?
      - Geometry: modeling of surfaces and volumes
      - Photometry: light, color, reflectance
    - How to build these representations?
      - Manual in CAD software
      - Sculpting a small physical model (e.g., clay model)
      - …
    - Geometric building blocks
      - Polygons (hardware supported)
      - Advanced CAD tools: spline surfaces, subdivision surfaces, ...

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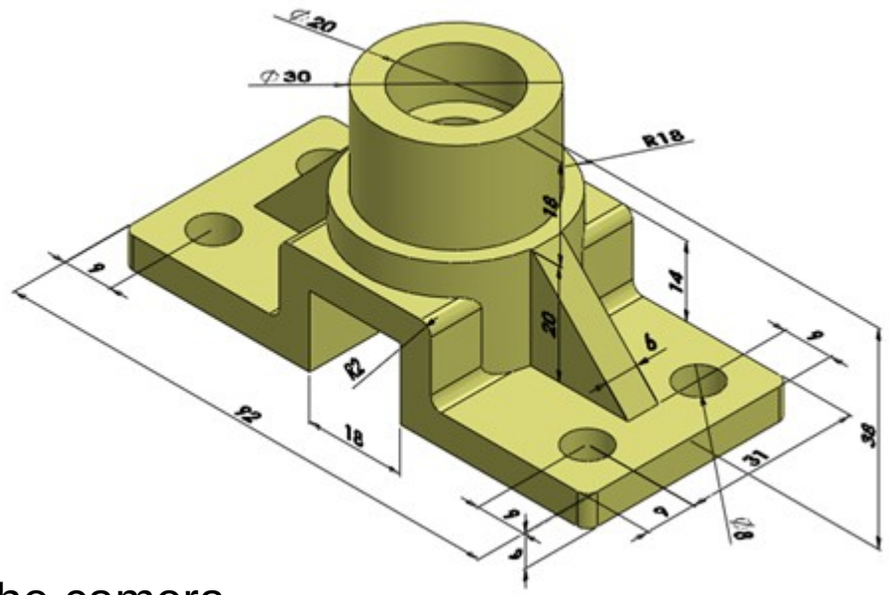
- 3D graphics
  - Rendering of the scene
    - Non-photorealistic rendering
      - Artistic drawings
      - Technical drawings



    - Photorealistic rendering
      - Light travels from light sources to the camera
      - Simulation of physical behavior of light in a 3D environment
      - Given
        - Geometry + material
        - Light sources + camera

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- 3D graphics
  - Behind the scenes of short animation movie “One more beer!” (Pedro Conti)

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- 3D graphics
  - Animation of the scene
    - Different techniques
      - Manual update of models
      - Physics-based model generation (following some physical laws)
      - Motion capture (recording actions of human actors)
  - Graphics hardware
    - Development started in 70s
    - Efficient transformation of a polygon-based model into an image
    - Matrix operations in homogeneous coordinates