Study Plan — Hughes/Computer Graphics (CGPP 3/e)

User Story Template & Cards

Version October 20, 2025

How to Use This Template

This document turns each chapter of *Computer Graphics: Principles and Practice (3/e)* into an actionable user story. Every card has the same sections: Business Value, Priority/Estimate, Persona, Dependencies, Assumptions/Risks, the Story statement, Non-Functional tags, Acceptance Criteria (BDD), and a checklist of Tasks.

Writing Effective User Stories

A good story is **concise, testable, and valuable**. Use the format:

> **As a** <*persona*>, **I want** <*capability*>, **so that** <*benefit*>.

Examples:

- **Weak:** "Learn cameras."
- **Better:** "As a graphics engineer, I want to implement perspective and orthographic camera models so that screen-space depth and composition are predictable across scenes."

Acceptance Criteria should follow BDD:

> **Given** preconditions, **When** the hands-on objective is executed, **Then** measurable outcomes are observed.

Non-Functional Tags (suggested)

Performance	Security	Reliability	Accessibility	Privacy	i18n

Card Anatomy (Story Card Definition)

The following sections are expected in every card. Adapt language to your organization.

- **Epic / Feature** — the broader capability this chapter contributes to.
- **Business Value** — the reason the capability matters (why now).
- **Priority / Estimate** — e.g., Priority: Must/Should/Could; SP: 1–5.
- **Persona** — primary actor (e.g., Student, Graphics Engineer).
- **Dependencies** — pre-reads, libraries, or tools required.
- **Assumptions / Risks** — environment or scope caveats.
- **Story** — one sentence using the template above.
- **Non-Functional** — select relevant quality attributes as pills.
- **Acceptance Criteria (BDD)** — Happy-path Given/When/Then.

- **Tasks** — a short checklist that delivers the outcome.

CH-01 — Introduction

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Introduction* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance | Reliability | Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Sketch the full rasterization pipeline and label each stage.
- ☐ Pick your stack (OpenGL 3.3+ / WebGPU) and create a skeleton app.
- ☐ Write a glossary of 25 core terms (frame, clip space, NDC, BRDF, etc.).
- ☐ Set up project structure with per-chapter folders and a common math lib stub.
- ☐ Commit a README listing success metrics for this study plan.

CH-02 — Intro to 2D Graphics (port from WPF)

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Intro to 2D Graphics (port from WPF)* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance | Reliability | Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement a minimal retained-mode 2D scene graph (groups, transforms).
- ☐ Render lines, paths, fills, alpha; support z-order and DPI scaling.
- ☐ Create 3 demo scenes testing blending and overdraw cases.
- ☐ Add hot-reload for assets/shaders; show a frame-time HUD.
- ☐ Document differences from WPF concepts (dependency properties, layout).

CH-03 — An Ancient Renderer Made Modern

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *An Ancient Renderer Made Modern* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance | Reliability | Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement polygon scanline fill with winding / even-odd modes.
- ☐ Show painter's algorithm vs depth ordering on stacked quads.
- ☐ Add front/back-face culling toggles and visualize overdraw heatmap.
- ☐ Export reference images for 5 tricky concave cases.
- ☐ Write property-based tests for edge walking and fill parity.

CH-04 — A 2D Graphics Test Bed

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *A 2D Graphics Test Bed* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Create a test harness with scene switcher and screenshot capture.
- ☐ Add perf counters (FPS, frame time p95) and input capture/logging.
- ☐ Build regression tests that compare images with SSIM/PSNR thresholds.
- ☐ Package three ‘golden’ scenes that stress blending and alpha.
- ☐ Wire a CI job that runs image-diff tests on PRs.

CH-05 — Intro to Human Visual Perception

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Intro to Human Visual Perception* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement interactive demos for Mach bands and contrast sensitivity.
- ☐ Add a tone-mapping panel (exposure, white balance, filmic).
- ☐ Measure perceived banding before/after dithering at 8-bit output.
- ☐ Compare perceived sharpness across MIP levels and anisotropic filtering.
- ☐ Write a short memo mapping perception to sampling choices.

CH-06 — Fixed-Function 3D & Hierarchical Modeling

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Fixed-Function 3D & Hierarchical Modeling* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Build a node hierarchy with parent/child transforms and local/global frames.
- ☐ Create a solar system demo (orbit + spin) with per-node pivots.
- ☐ Render with a basic Phong-like approximation as a placeholder.
- ☐ Toggle wireframe and bounding boxes per node.
- ☐ Document how modern shaders replace fixed-function equivalents.

CH-07 — Essential Math & Geometry of 2- and 3-Space

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Essential Math & Geometry of 2- and 3-Space* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance | Reliability | Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement vec2/3/4 and mat3/4 with affine helpers and unit tests.
- ☐ Write robust segment/triangle intersection predicates.
- ☐ Implement barycentric coordinates and point-in-triangle test.
- ☐ Add coordinate-space converters (object/world/view/clip/NDC).
- ☐ Benchmark numeric stability with randomized stress tests.

CH-08 — Describing Shape in 2D & 3D

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Describing Shape in 2D & 3D* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Load OBJ/PLY; compute per-face and per-vertex normals.
- ☐ Add manifold checks and simple weld/merge operations.
- ☐ Implement wireframe/solid toggles and normal visualization.
- ☐ Export a repaired mesh after hole-filling and deduping vertices.
- ☐ Write a short note on manifoldness and rendering implications.

CH-09 — Functions on Meshes

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Functions on Meshes* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement barycentric interpolation for scalar fields on triangles.
- ☐ Visualize a temperature field with color ramps (linear vs diverging).
- ☐ Add UV lookup and bilinear filtering on a textured mesh.
- ☐ Compare per-vertex vs per-pixel interpolation artifacts.
- ☐ Create tests that compare analytic vs sampled values at random points.

CH-10 — 2D Transformations

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *2D Transformations* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance | Reliability | Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement 3x3 homogeneous matrices for 2D TRS.
- ☐ Build interactive 2D camera (pan/zoom) and transform gizmos.
- ☐ Demonstrate window-to-viewport mappings with aspect correction.
- ☐ Create a scripted animation that composes multiple transforms.
- ☐ Write unit tests for composition associativity and inversion.

CH-11 — 3D Transformations

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *3D Transformations* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance | Reliability | Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement axis-angle, Euler, quaternion conversions and SLERP.
- ☐ Build an arcball camera with constraints and damping.
- ☐ Visualize gimbal lock with labeled axes and keyframes.
- ☐ Add right-/left-handed toggles and verify against test scenes.
- ☐ Document numerical pitfalls of quaternion normalization.

CH-12 — 2D & 3D Transformation Library

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *2D & 3D Transformation Library* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance | Reliability | Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Ship look-at, orthographic, and perspective constructors.
- ☐ Add covector/normal transformation (inverse-transpose) helper.
- ☐ Cache and invalidate matrices inside a Transform component.
- ☐ Benchmark transform throughput on CPU and GPU instancing.
- ☐ Write API docs with examples and edge cases.

CH-13 — Camera Specifications & Transformations

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Camera Specifications & Transformations* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement perspective/orthographic cameras mapped to clip/NDC.
- ☐ Add dolly/orbit/FPS rigs and near/far UI with reversed-Z option.
- ☐ Plot z-buffer precision across depth for different n/f settings.
- ☐ Capture mismatches between math and raster outputs and fix them.
- ☐ Create camera presets and a compare view.

CH-14 — Standard Approximations & Representations

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Standard Approximations & Representations* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Model a scene graph with materials and lights as first-class nodes.
- ☐ Demonstrate image-based vs geometric vs volumetric approximations.
- ☐ Build a blending showcase (premultiplied vs straight alpha).
- ☐ Profile overdraw and propose mitigation steps per scene.
- ☐ Create a decision table for representation choices by use-case.

CH-15 — Ray Casting & Rasterization

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Ray Casting & Rasterization* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement a CPU ray caster for spheres/triangles.
- ☐ Implement a minimal triangle rasterizer with barycentric interpolation.
- ☐ Render the same scene both ways and compare correctness/perf.
- ☐ Visualize aliasing differences and sampling strategies.
- ☐ Write a post-mortem on trade-offs and when to choose each.

CH-16 — Survey of Real-Time 3D Platforms

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Survey of Real-Time 3D Platforms* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Create a matrix of features across OpenGL, Vulkan, D3D, WebGPU.
- ☐ Identify the minimal cross-platform subset for this study repo.
- ☐ Build a portability checklist for shaders, textures, and buffers.
- ☐ Run a smoke test on at least two platforms (desktop + web).
- ☐ Document driver quirks encountered and workarounds.

CH-17 — Image Representation & Manipulation

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Image Representation & Manipulation* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement image I/O, mipmap generation, and premultiplied alpha.
- ☐ Build a compositor supporting over/atop/in operators.
- ☐ Create a CLI tool for format conversion and alpha premultiplication.
- ☐ Add sRGB↔linear conversions and verify with unit tests.
- ☐ Create regression images for edge cases (alpha fringes).

CH-18 — Images & Signal Processing

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Images & Signal Processing* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement convolution filters and separable kernels.
- ☐ Demonstrate Nyquist sampling and aliasing with interactive sliders.
- ☐ Compare reconstruction filters (box, triangle, Lanczos).
- ☐ Add a frequency-domain view using FFT on test images.
- ☐ Write guidelines for choosing filters in the pipeline.

CH-19 — Enlarging & Shrinking Images

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Enlarging & Shrinking Images* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement nearest, bilinear, bicubic, and Lanczos resampling.
- ☐ Measure PSNR/SSIM on resized images vs high-res ground truth.
- ☐ Show ringing vs smoothing trade-offs and mitigation.
- ☐ Add a scaler demo UI with real-time comparisons.
- ☐ Document quality vs performance recommendations.

CH-20 — Textures & Texture Mapping

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Textures & Texture Mapping* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Compute tangents/bitangents and enable normal mapping.
- ☐ Demonstrate mipmapping, anisotropic filtering, and LOD bias.
- ☐ Compare atlas vs array textures and PBR texture sets.
- ☐ Implement texture address modes and gamma-correct sampling.
- ☐ Create a material preview scene with UI controls.

CH-21 — Interaction Techniques

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Interaction Techniques* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement picking and 3D gizmos (translate/rotate/scale).
- ☐ Add Unicam/multitouch gestures with constraints.
- ☐ Build a selection and manipulation system for scene nodes.
- ☐ Record usability notes from 3 tasks (position a light, orbit camera...).
- ☐ Log input events and edge cases; propose ergonomic defaults.

CH-22 — Splines & Subdivision Curves

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Splines & Subdivision Curves* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement Hermite, Catmull–Rom, and cubic B-splines.
- ☐ Reparameterize by arc length and compare uniform vs chordal.
- ☐ Build a path editor and animation along a curve.
- ☐ Show C^k continuity impacts on motion smoothness.
- ☐ Add unit tests for endpoint conditions and continuity.

CH-23 — Splines & Subdivision Surfaces

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Splines & Subdivision Surfaces* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement Bézier patches and Catmull–Clark basics.
- ☐ Compute limit positions and normals; visualize control mesh vs limit.
- ☐ Evaluate patches on GPU and compare tessellation levels.
- ☐ Export tessellated meshes for downstream rendering.
- ☐ Write a note on performance/quality trade-offs.

CH-24 — Implicit Representations of Shape

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Implicit Representations of Shape* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement signed distance fields and basic CSG (union, inter, diff).
- ☐ Polygonize with marching cubes and validate normals.
- ☐ Ray trace sphere/torus implicits analytically.
- ☐ Build an SDF modeling sandbox; export OBJ.
- ☐ Collect numerical issues and fixes (epsilon, band limits).

CH-25 — Meshes

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Meshes* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance | Reliability | Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Build a half-edge mesh library with adjacency queries.
- ☐ Implement LOD generation and vertex cache optimization.
- ☐ Add mesh repair: weld near-duplicates, fill small holes.
- ☐ Bench traversal and cache effectiveness.
- ☐ Ship a mesh viewer with toggles for topology overlays.

CH-26 — Light

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Light* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Summarize radiometry vs photometry and common units.
- ☐ Implement basic light types and sampling (point, area, env).
- ☐ Demonstrate Fresnel effects in a simple shader.
- ☐ Build a light sampling demo with PDFs and plots.
- ☐ Draft a unit cheat-sheet used across the repo.

CH-27 — Materials & Scattering

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Materials & Scattering* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement Lambert, Blinn–Phong, Cook–Torrance (GGX).
- ☐ Add importance sampling for GGX with visible normal sampling.
- ☐ Compare Disney principled parameters to microfacet terms.
- ☐ Visualize BRDF lobes and energy conservation numerically.
- ☐ Create a material inspector UI and presets.

CH-28 — Color

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Color* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance | Reliability | Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement CIE XYZ/Lab conversions and white-point adaptation.
- ☐ Build a color-management path (linear↔sRGB, display transform).
- ☐ Add filmic tone mapping with exposure/white-balance controls.
- ☐ Validate gradients for banding and add dithering.
- ☐ Write a color pipeline decision memo.

CH-29 — Light Transport

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Light Transport* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Derive the rendering equation in notes; enumerate path types.
- ☐ Implement path enumeration stubs and debug visualizations.
- ☐ Map rendering choices to transport assumptions.
- ☐ Create sanity scenes to exercise different transport effects.
- ☐ Document insights that guide solver choices.

CH-30 — Probability & Monte Carlo Integration

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Probability & Monte Carlo Integration* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement RNG, stratified sampling, and alias tables.
- ☐ Estimate integrals with different estimators and compare variance.
- ☐ Implement MIS on simple integrands; visualize variance reduction.
- ☐ Build plots of convergence vs samples per pixel.
- ☐ Write rules-of-thumb for sampler selection.

CH-31 — Solving the Rendering Equation (Theory)

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Solving the Rendering Equation (Theory)* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement a radiosity toy on a Cornell box.
- ☐ Compare with a simple path tracer result.
- ☐ Discuss finite elements vs stochastic estimators trade-offs.
- ☐ Add toggles to inspect form factors and basis choices.
- ☐ Summarize applicability per scene class.

CH-32 — Rendering in Practice

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Rendering in Practice* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement a minimal path tracer with next-event estimation.
- ☐ Add photon mapping or bidirectional variant for comparison.
- ☐ Integrate false-color and heatmap debugging views.
- ☐ Build a scene loader and CLI renderer entry point.
- ☐ Write a renderer troubleshooting checklist.

CH-33 — Shaders

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Shaders* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance | Reliability | Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Create a shader playground with live GLSL/WGSL editing.
- ☐ Implement Phong, environment mapping, and toon shading.
- ☐ Add a compute shader for an image-processing task.
- ☐ Set up shader compilation diagnostics and includes.
- ☐ Document style guidelines for shader code.

CH-34 — Expressive (NPR) Rendering

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Expressive (NPR) Rendering* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement edge/feature extraction and quantization shading.
- ☐ Design a stroke/mark pipeline with parameter controls.
- ☐ Add salience-guided stylization toggles.
- ☐ Build before/after gallery scenes.
- ☐ Summarize NPR use-cases for real-time apps.

CH-35 — Motion

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Motion* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance | Reliability | Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement skeletal animation and pose interpolation.
- ☐ Add camera path editing with splines.
- ☐ Demonstrate motion blur considerations.
- ☐ Stress-test stability with long sequences.
- ☐ Document interpolation pitfalls and fixes.

CH-36 — Visibility Determination

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Visibility Determination* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement depth buffering and backface/frustum culling.
- ☐ Prototype occlusion queries and compare methods.
- ☐ Benchmark visibility methods on different scenes.
- ☐ Create failure-case gallery (precision, temporal).
- ☐ Write guidance for algorithm selection.

CH-37 — Spatial Data Structures

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Spatial Data Structures* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Implement BVH and KD-tree builders (basic SAH).
- ☐ Benchmark ray/frustum traversal performance.
- ☐ Visualize tree depth and node usage statistics.
- ☐ Swap structures at runtime and compare.
- ☐ Draft a tuning guide for builders.

CH-38 — Modern Graphics Hardware

Epic / Feature	Chapter Mastery
Business Value	Build demonstrable skill aligned to this chapter; produce a small artifact and tests.
Priority / Estimate	**Priority:** Must SP: 3
Persona	Graphics engineer / student working through CGPP 3/e
Dependencies	Toolchain (C++17 + modern OpenGL or WebGPU), build scripts, test harness.
Assumptions / Risks	Numeric stability and platform differences may affect outputs; allow time for debugging.

Story As a learner of computer graphics, I want to complete *Modern Graphics Hardware* so that I can apply its concepts in a working demo with tests.

Non-Functional Performance Reliability Accessibility

Acceptance Criteria (BDD)

- **Scenario** Happy path
- **Given** the chapter pre-reads and starter code are available
- **When** the hands-on objectives are implemented and tests run in CI
- **Then** artifacts (demo + notes) and a summary of outcomes are committed to the repo

Definition of Ready: Persona clear; AC drafted; Dependencies known; Estimate set. • *Definition of Done:* All ACs pass; Tests green; Security/a11y checks; Docs updated; Deployed/flagged.

Tasks

- ☐ Summarize GPU execution/memory models and latency hiding.
- ☐ Build microbenchmarks for vertex transform and texturing.
- ☐ Profile a shader and identify stalls vs occupancy.
- ☐ Experiment with buffer update strategies (streaming, persist).
- ☐ Write a post-mortem on performance lessons.