Study Plan — Computer Animation (3rd ed.)

User Story Template & Chapter Cards

How to Use This Document

Each chapter of Rick Parent's *Computer Animation, 3rd Edition* is represented as a **user story card**. Cards include the business value, persona, dependencies, acceptance criteria, and a concrete **Tasks** checklist. Duplicate a card when you need variants (e.g., an advanced path using C++/OpenGL instead of Python/Blender). Compile with `pdflatex` (no special packages beyond those in this file).

Required Data for a Good Story

- **ID & Title** (e.g., `CA-03 -- Interpolating Values`).
- **Epic/Feature** the story rolls up to (e.g., "Animation Core").
- **Business Value** stated in stakeholder language.
- **Priority & Estimate** (e.g., Must/Should + story points).
- **Persona** performing the work (e.g., "technical animator").
- **Dependencies** (tools, rigs, prior chapters).
- **Assumptions/Risks** that might affect scope or timing.
- **Story sentence**: *As a persona, I want capability so that value.*
- **Non-Functional tags** (performance, reliability, security, ...).
- **Acceptance Criteria** in *Given–When–Then* form.
- **Tasks** as a bite-size, checkable list.

User Story Template (Example)

Epic / Feature	Production Foundations
Business Value	Shared understanding of scope and success criteria to reduce rework.
Priority / Estimate	**Priority:** Must **SP:** 2
Persona	developer on a new repo
Dependencies	build tooling, unit test framework
Assumptions / Risks	schedule risk if team lacks a common story format; ambiguity risk

Story *As a developer, I want a consistent user story template so that the team can plan and verify work objectively.*

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Acceptance Criteria (BDD)
Scenario Happy path
Given the repository with this LaTeX template is available
When the author completes the *Tasks* below
Then the stated Outcomes/Deliverables for this chapter are produced and verifiable.

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

Tasks

- ☐ Fill in ID/Title, Business Value, Persona, Dependencies, Assumptions/Risks.
- ☐ Draft the story sentence using "As a … I want … so that …".
- ☐ Write 1–3 *Given–When–Then* acceptance criteria.
- ☐ Break work into 4–7 tasks (each 15–90 minutes).
- ☐ Review with a peer; commit the story card to the project docs.

Epic / Feature	Orientation & Pipeline
Business Value	Establish shared understanding of modern CG animation workflow and course outcomes.
Priority / Estimate	**Priority:** Must **SP:** 2
Persona	student/TD onboarding to the course plan
Dependencies	Blender or equivalent DCC; Python 3.x; Git repo for notes/clips
Assumptions / Risks	time-boxed to one week; risk of tool setup delays

Story *As a learner, I want to map the CG animation pipeline and pick a final-shot concept so that weekly work aligns to a coherent end goal.*

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Acceptance Criteria (BDD)
Scenario Happy path
Given the toolchain installs successfully
When the learner produces a brief animatic and a pipeline diagram
Then the stated Outcomes/Deliverables for this chapter are produced and verifiable.

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

Tasks

- ☐ Sketch the pipeline: assets → rig → animation → sim → lighting/render → comp.
- ☐ Create a 10–15s animatic (stepped keys or storyboard with timing).
- ☐ Set up project repo folders for `notes/`, `clips/`, `refs/`.
- ☐ Write risks & constraints for your capstone shot (1 page).

Epic / Feature	Math & Transforms
Business Value	Reliable transforms/orientations prevent gimbal issues and rig instability.
Priority / Estimate	**Priority:** Must **SP:** 3
Persona	technical animator / TD
Dependencies	Python notebooks or C++ utility library; test meshes
Assumptions / Risks	numeric instability if conventions (handedness, units) are inconsistent

Story *As a TD, I want robust transform/orientation utilities so that rigs and cameras behave predictably.*

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Acceptance Criteria (BDD)
Scenario Happy path
Given reference tests are available
When matrix/quaternion conversions and parent/child transforms pass unit tests
Then the stated Outcomes/Deliverables for this chapter are produced and verifiable.

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

Tasks

- ☐ Implement 4x4 homogeneous transforms; verify inverse and composition.
- ☐ Implement quaternion ↔ matrix / axis-angle; add unit tests.
- ☐ Build a demo rig (2-bone chain) to visualize local vs world transforms.
- ☐ Document conventions (axes, degrees/radians, units).

Epic / Feature	Curves & Timing
Business Value	Smooth, controllable motion and camera paths with consistent speed profiling.
Priority / Estimate	**Priority:** Must **SP:** 3
Persona	animator / tools engineer
Dependencies	curve evaluation utilities; plotting
Assumptions / Risks	time slippage from arc-length reparametrization if not cached

Story *As an animator, I want spline and orientation interpolation so that paths and rotations are smooth and predictable.*

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Acceptance Criteria (BDD)
Scenario Happy path
Given test paths and keyframes exist
When constant-speed motion along a spline and correct SLERP orientation
Then the stated Outcomes/Deliverables for this chapter are produced and verifiable.

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

Tasks

- ☐ Implement Cubic Hermite, Catmull–Rom, and B-spline evaluation.
- ☐ Implement SLERP; compare with normalized LERP (error plot).
- ☐ Reparametrize a path by arc length; demonstrate constant-speed fly-through.
- ☐ Render a 5s camera move before/after reparam (side-by-side).

Epic / Feature	Keyframing & Shape Interp
Business Value	Artist-friendly controls for timing and deformations.
Priority / Estimate	**Priority:** Should **SP:** 3
Persona	animator
Dependencies	blendshape targets; keyframe editor
Assumptions / Risks	topology mismatch breaks shape interpolation

Story *As an animator, I want a keyframe editor and blendshape mixer so that I can sculpt timing and shape changes.*

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Acceptance Criteria (BDD)
Scenario Happy path
Given targets and rig are available
When morph and keyed timing match the reference beat sheet
Then the stated Outcomes/Deliverables for this chapter are produced and verifiable.

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

Tasks

- ☐ Build a mini keyframe editor (stepped/linear/bezier tangents).
- ☐ Create 3–5 blendshape targets; implement normalized weight mixing.
- ☐ Animate a 10s morph sequence with clean in-betweens.
- ☐ Export a turntable clip of neutral vs extreme shapes.

Epic / Feature	FK/IK Rigs
Business Value	Fast posing with constraints to reduce foot sliding and joint breakage.
Priority / Estimate	**Priority:** Must **SP:** 4
Persona	rigger / animator
Dependencies	test character; solver utilities
Assumptions / Risks	solver divergence near singularities

Story *As a rigger, I want stable FK/IK with joint limits so that animators can reach targets without artifacts.*

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Acceptance Criteria (BDD)
Scenario Happy path
Given rig joint limits are set
When IK solver reaches target within tolerance and without popping
Then the stated Outcomes/Deliverables for this chapter are produced and verifiable.

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

Tasks

- ☐ Implement CCD and Jacobian-transpose IK; log iteration counts.
- ☐ Add joint limits, pole vector, preferred angles.
- ☐ Animate a 5–10s reach-and-grasp on a moving object.
- ☐ Plot end-effector error over time; ensure monotonic convergence.

Epic / Feature	MoCap Pipeline
Business Value	High-fidelity base motion retargeted to house rigs with minimal cleanup.
Priority / Estimate	**Priority:** Should **SP:** 4
Persona	motion TD
Dependencies	BVH/FBX clips; OpenCV; retarget tool
Assumptions / Risks	foot drift and scale mismatches require cleanup

Story *As a motion TD, I want to retarget and blend MoCap so that I can quickly block complex performances.*

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Acceptance Criteria (BDD)
Scenario Happy path
Given calibration data and clips exist
When retargeted animation passes foot-contact checks and timing constraints
Then the stated Outcomes/Deliverables for this chapter are produced and verifiable.

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

Tasks

- ☐ Calibrate camera(s) and reconstruct a simple 3D point set.
- ☐ Retarget BVH to course rig; fix contacts with constraints.
- ☐ Blend two clips; add time-warp to match beats.
- ☐ Produce an 8–12s walk-to-reach composite before/after cleanup.

Epic / Feature	Particles, Rigid, Cloth
Business Value	Realistic secondary motion increases production value.
Priority / Estimate	**Priority:** Must **SP:** 5
Persona	VFX TD
Dependencies	physics integrators; collision library
Assumptions / Risks	instability with large time steps; tuning time

Story *As a VFX TD, I want stable particle/rigid/cloth sims so that shots look physically plausible.*

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Acceptance Criteria (BDD)
Scenario Happy path
Given collision proxies exist
When sims run without explosion and meet timing budgets
Then the stated Outcomes/Deliverables for this chapter are produced and verifiable.

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

Tasks

- ☐ Implement particle forces and emitters; add lifetime and randomness.
- ☐ Build mass–spring cloth; compare explicit vs semi-implicit integration.
- ☐ Add rigid bodies with impulse collisions (restitution, friction).
- ☐ Render a 10s composite: ball hits boxes; cloth banner reacts.

Epic / Feature	Fluid Effects
Business Value	Believable smoke/water interactions for hero shots.
Priority / Estimate	**Priority:** Should **SP:** 5
Persona	FX artist / TD
Dependencies	grid solver (2D); SPH prototype; render volumes
Assumptions / Risks	cost constraints on resolution/time; coupling to colliders

Story *As an FX TD, I want smoke and liquid sims so that I can art-direct turbulent motion efficiently.*

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Acceptance Criteria (BDD)
Scenario Happy path
Given domain and sources are set
When smoke shows vorticity confinement and liquid shows plausible splashes
Then the stated Outcomes/Deliverables for this chapter are produced and verifiable.

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

Tasks

- ☐ Implement a 2D stable fluids grid (advect, diffuse, project).
- ☐ Prototype SPH for splashes; tune kernel radius/viscosity.
- ☐ Add collider coupling; emitters for smoke and pour.
- ☐ Render an 8–10s flipbook comparing parameter sweeps.

Epic / Feature	Virtual Humans
Business Value	Solid deformations and locomotion for character shots.
Priority / Estimate	**Priority:** Must **SP:** 5
Persona	character TD
Dependencies	skinned mesh; skin weights; terrain asset
Assumptions / Risks	skinning artifacts at joints; foot sliding on uneven terrain

Story *As a character TD, I want robust skinning and a walk cycle so that human motion reads believably.*

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Acceptance Criteria (BDD)
Scenario Happy path
Given weights and controls are defined
When walk cycle maintains COM over support polygon; no interpenetration
Then the stated Outcomes/Deliverables for this chapter are produced and verifiable.

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

Tasks

- ☐ Paint skin weights; test extreme poses; fix elbow/shoulder artifacts.
- ☐ Animate a gait cycle with contact and passing phases.
- ☐ Add simple garment (shirt/skirt) interacting with body.
- ☐ Render a 10s walk over uneven terrain; measure stride and cadence.

Epic / Feature	Face Rig & Lip-Sync
Business Value	Expressive dialogue and emotions for storytelling.
Priority / Estimate	**Priority:** Should **SP:** 4
Persona	facial rigger / animator
Dependencies	blendshapes or FACS AUs; audio clip
Assumptions / Risks	coarticulation timing; uncanny valley risk if eyes/eyelids misbehave

Story *As a facial animator, I want a viseme-driven rig so that lip-sync and expressions feel natural.*

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Acceptance Criteria (BDD)
Scenario Happy path
Given audio and transcript exist
When lip closures on labials are correct; eye focus is consistent; no popping
Then the stated Outcomes/Deliverables for this chapter are produced and verifiable.

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

Tasks

- ☐ Build facial controls (brows, lids, lips, jaw); map visemes to shapes.
- ☐ Time-align phonemes; add coarticulation smoothing.
- ☐ Animate 10–15s dialogue with micro-motions (eye saccades, blinks).
- ☐ Export with audio waveform overlay for review.

Epic / Feature	Agents & Crowds
Business Value	Scalable background motion and intelligent navigation.
Priority / Estimate	**Priority:** Could **SP:** 4
Persona	gameplay/AI engineer
Dependencies	navmesh; pathfinding; steering behaviors
Assumptions / Risks	congestion at bottlenecks; performance drops with agent count

Story *As an AI engineer, I want steering and pathfinding so that crowds navigate scenes convincingly.*

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Acceptance Criteria (BDD)
Scenario Happy path
Given map and obstacles are defined
When agents reach goals with low collision rate and stable frame time
Then the stated Outcomes/Deliverables for this chapter are produced and verifiable.

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

Tasks

- ☐ Implement seek/arrive/wander and obstacle avoidance; blend behaviors.
- ☐ Build a navmesh; pathfind with A*; add local avoidance.
- ☐ Simulate 50–200 agents through a choke point; measure throughput.
- ☐ Render a 15s crowd flow; record collision metrics.

Epic / Feature	Procedural Models
Business Value	Quickly generate complex detail (plants, blobs, smooth surfaces).
Priority / Estimate	**Priority:** Could **SP:** 4
Persona	look-dev / TD
Dependencies	metaball/implicit surface tools; L-system module
Assumptions / Risks	temporal coherence during deformation; performance

Story *As a look-dev TD, I want implicit surfaces and plant growth so that I can generate rich motion without manual modeling.*

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Acceptance Criteria (BDD)
Scenario Happy path
Given procedural modules are wired
When garden growth is temporally coherent and controllable
Then the stated Outcomes/Deliverables for this chapter are produced and verifiable.

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

Tasks

- ☐ Implement metaballs and preview via marching cubes/squares.
- ☐ Build an L-system with stochastic rules; add wind sway.
- ☐ Apply subdivision (Catmull–Clark/Loop) with crease control.
- ☐ Render a 10s procedural garden pullback (wireframe + shaded passes).

Epic / Feature	Rendering & Delivery
Business Value	Predictable render times and delivery-ready media.
Priority / Estimate	**Priority:** Must **SP:** 2
Persona	lighting/compositing TD
Dependencies	render farm or local batch; FFmpeg
Assumptions / Risks	render time vs quality trade-offs

Story *As a lighting TD, I want sampling/motion-blur controls so that finals balance quality and cost.*

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Acceptance Criteria (BDD)
Scenario Happy path
Given scenes are renderable
When finals and preview renders differ only in controlled quality parameters
Then the stated Outcomes/Deliverables for this chapter are produced and verifiable.

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

Tasks

- ☐ Compare sample counts and reconstruction filters; enable motion blur.
- ☐ Batch-render best shots at “preview” and “final” settings; log timings.
- ☐ Package output with correct color space and bitrate using FFmpeg.

Epic / Feature	Math Companion
Business Value	Faster debugging and verifiable numerics across chapters.
Priority / Estimate	**Priority:** Should **SP:** 2
Persona	TD / engineer
Dependencies	Jupyter or C++ test harness
Assumptions / Risks	overfitting tests to specific scenes

Story *As a TD, I want a math/test companion so that I can validate formulas and catch regressions quickly.*

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Acceptance Criteria (BDD)
Scenario Happy path
Given reference equations are captured
When unit tests for each formula pass and are linked to chapter cards
Then the stated Outcomes/Deliverables for this chapter are produced and verifiable.

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

Tasks

- ☐ Create a notebook per chapter; derive and validate key equations.
- ☐ Add finite-difference checks for Jacobians and gradients.
- ☐ Track assumptions (units, handedness, conventions) alongside tests.