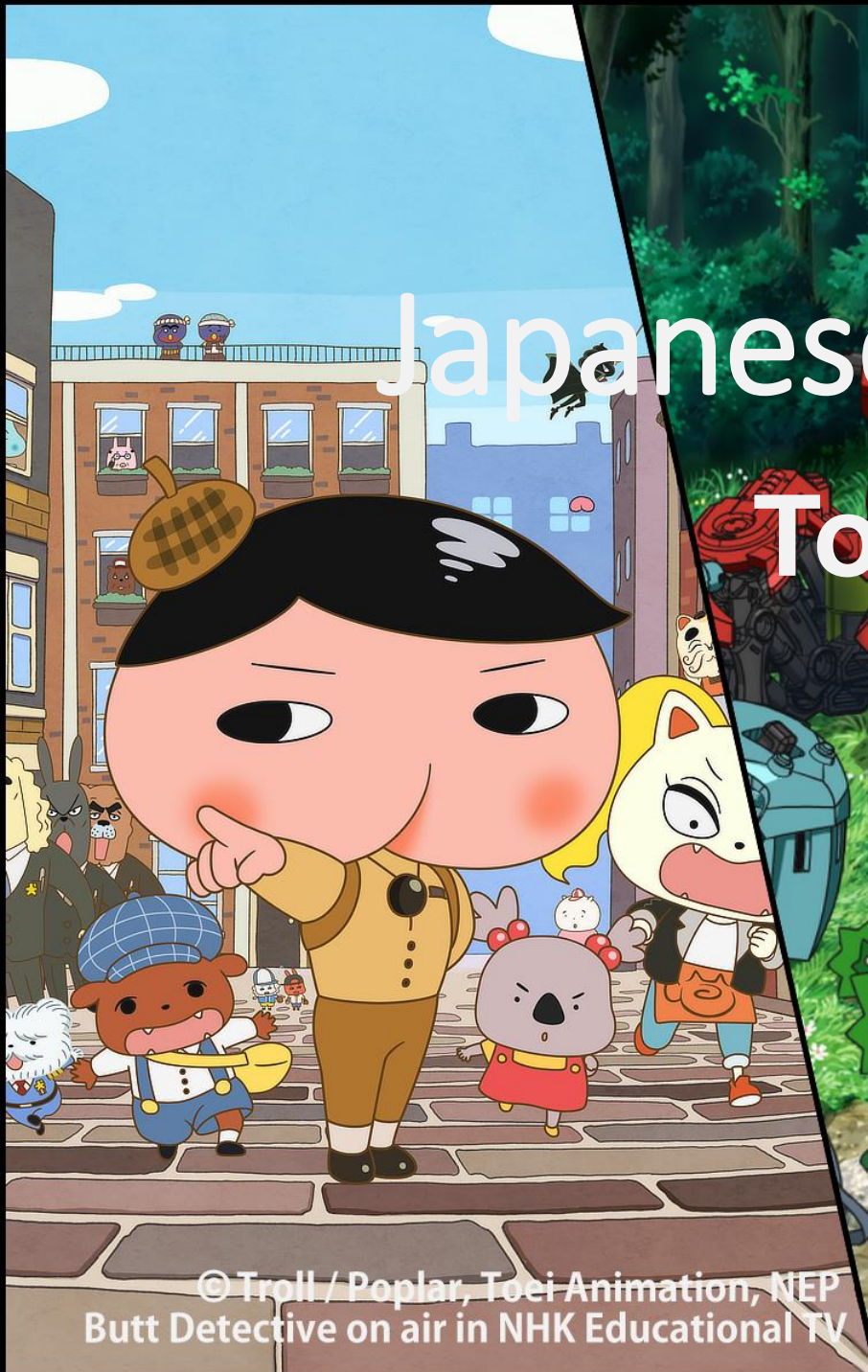Japanese Animation in 2021
To CG or not CG?

© Troll / Poplar, Toei Animation, NEP
Butt Detective on air in NHK Educational TV

© TOMY／ZW製作委員会・MBS

Pacific Rim: The Black
© Courtesy of Legendary
A Netflix Original anime series

Syllabus

- Introduction (5 min)
- An Overview of The Japanese Animation Production Workflow (1h)
    - 2D workflow
    - 3D workflow
    - 2D/3D hybrid workflow
- Robots in Japanese Animation (1h)
    - Concept and modeling
    - Animation
    - FX, look and lighting
- The Challenges Adapting Hand-drawn Designs To 3D CG (1h)
    - Contours
    - Hair
    - Eyes
    - Rim lights
    - Shadows
- Discussion and Questions (30min)

SIGGRAPH Asia 2021

OVERVIEW OF JAPANESE ANIMATION WORKFLOW

- The 3 workflows of Japanese animation production
  - 2D
  - 3D
  - 2D+3D (hybrid)

- For each animation production workflow
  - The 3 stages
  - Roles of each department
  - Case study

- Conclusion
  - Japanese animation workflow VS abroad
  - The future of Japanese animation

Japanese Animation Specificities

- Set 60 years ago
- Ongoing digital shift
  - Still using paper
- Importance of Time sheets
  - Defines characters motion and timing
  - Helps communication between staffs
- Managed using "shot envelopes"
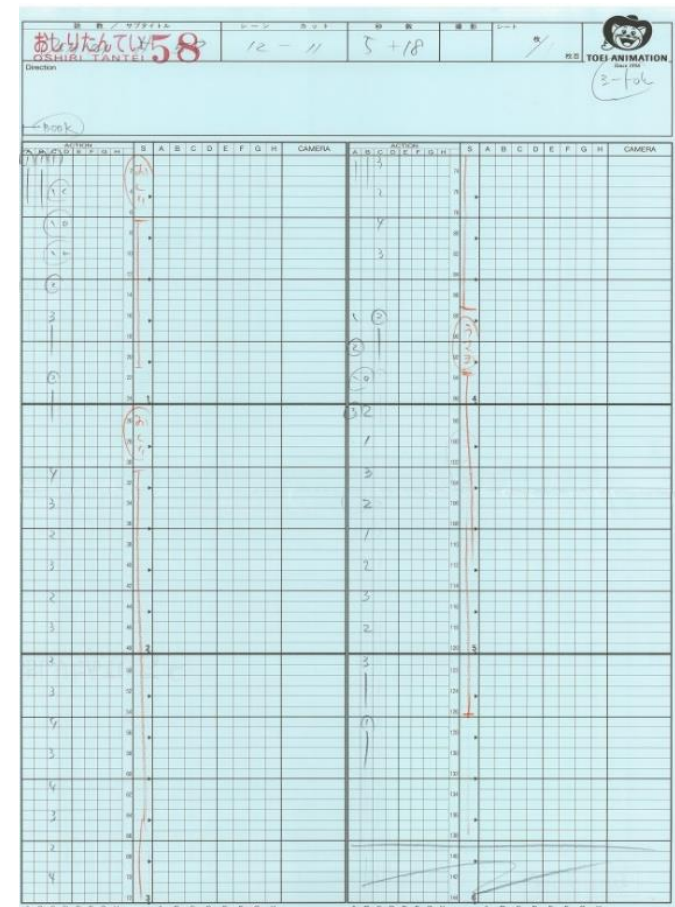
Time sheet
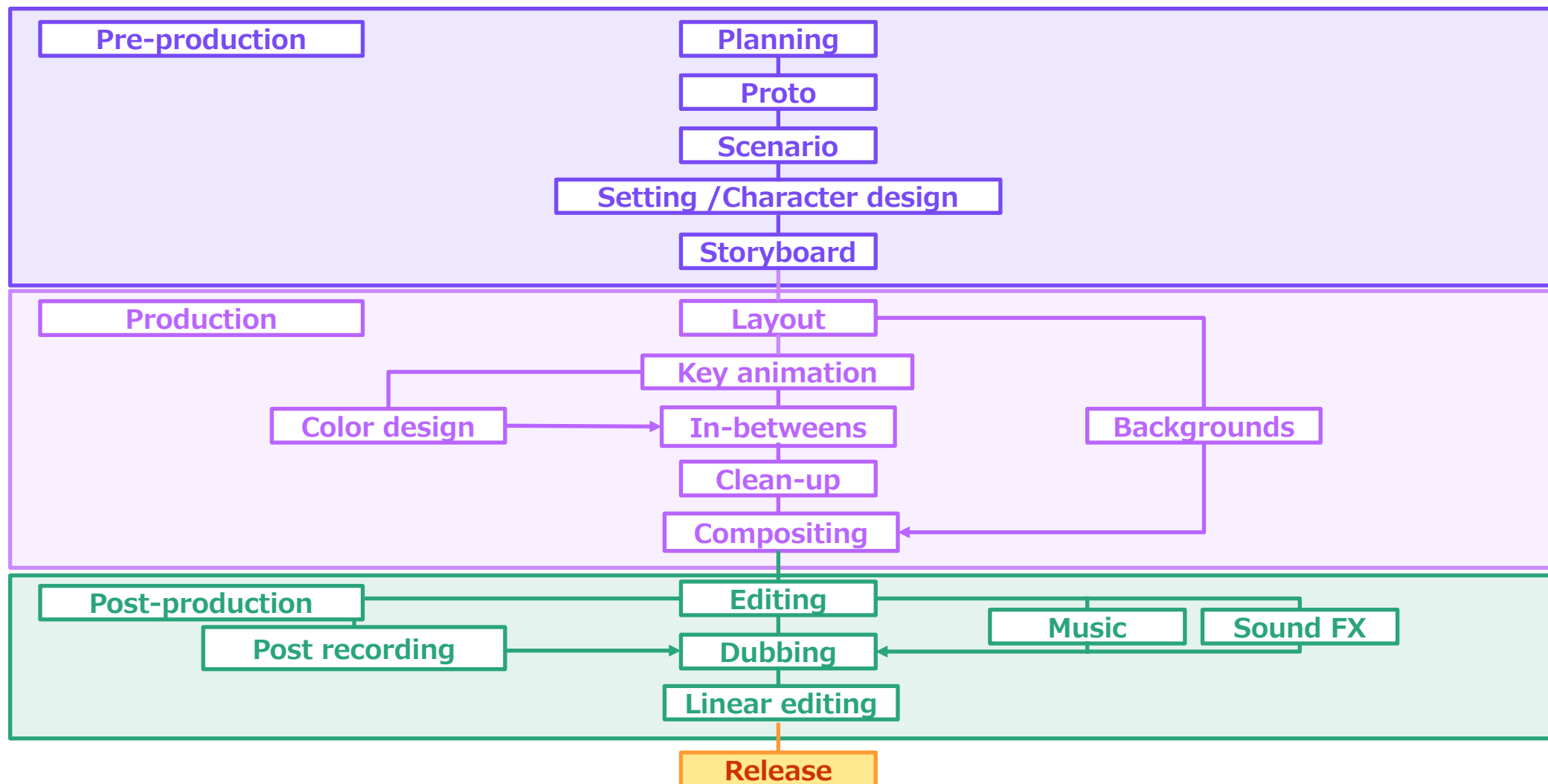©Troll / Poplar, Toei Animation, NEP

The 3 Workflows

- 2D
  - Anything you can draw
  - Can start with paper and camera
- 3D
  - Not a lot of success of Japanese animation in 3D
  - Robots, mechanical parts, complex camera work
  - Requires software and large range of skills
- 2D + 3D
  - Try to get best of both world
  - Complex to manage

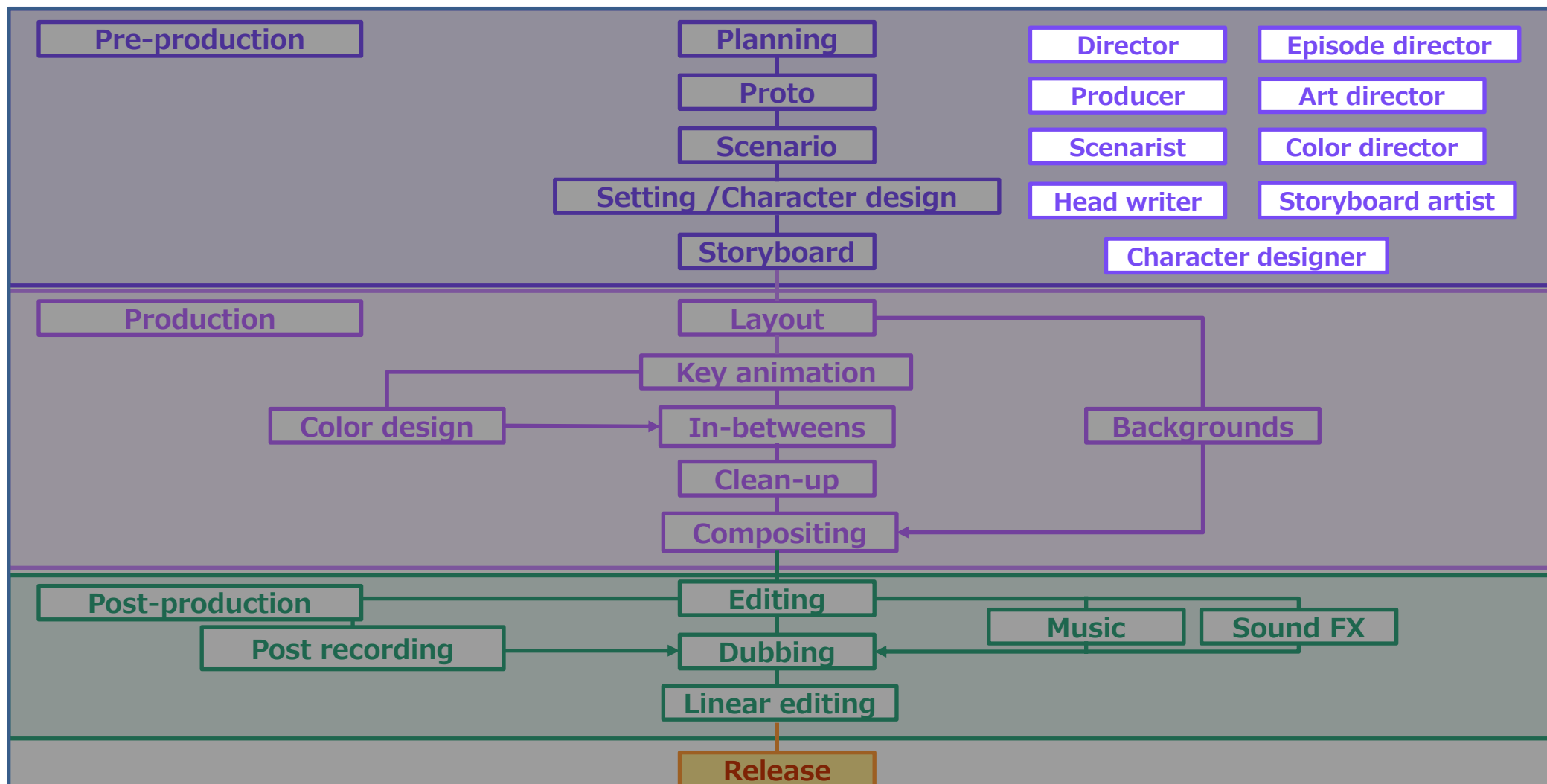# The 2D Anime Production Workflow

Overview of the 2D Anime Production Workflow

- Specificities
  - Typical workflow for more than 30 years
  - Conversions from analog to digital world
  - Produce the footage first then record the voice over (Post-recording)
- Pros
  - Easy to handle irregular cases
  - Can reproduce wide range of visual expression
    - Anything can be drawn
  - Low initial cost
- Cons
  - Scheduling is difficult
  - Hard to keep consistent quality between shots
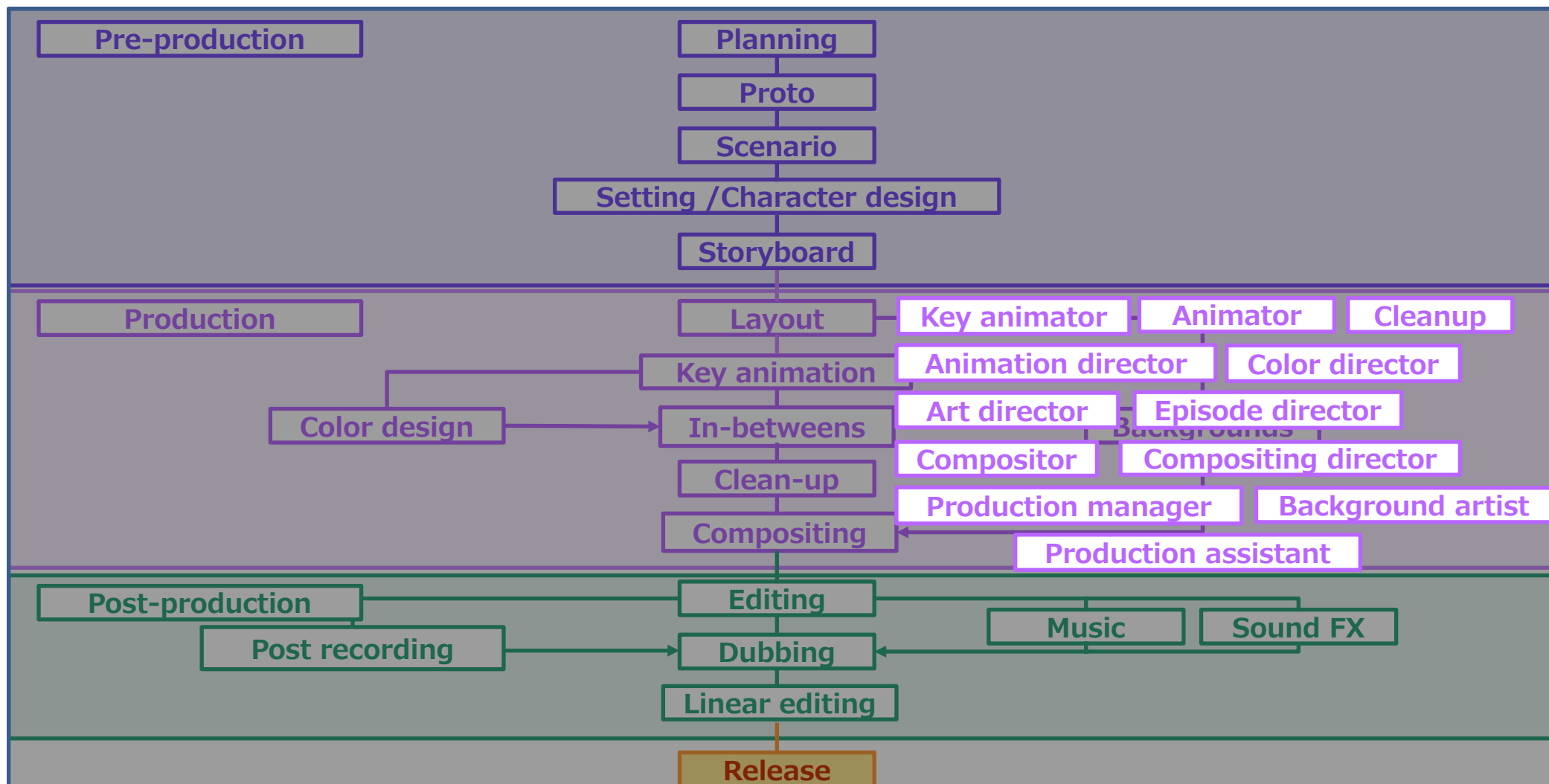
Workflow Overview

Pre-production

- Planning
- Proto
- Scenario
- Setting /Character design
- Storyboard

Production

- Layout
- Key animation
- Color design → In-betweens
- Backgrounds
- Clean-up
- Compositing

Post-production

- Editing
- Music
- Sound FX
- Post recording → Dubbing
- Linear editing

Release

The Staff Involved in Pre-Production

Pre-production

- Planning
- Proto
- Scenario
- Setting /Character design
- Storyboard

Director   Episode director
Producer   Art director
Scenarist   Color director
Head writer   Storyboard artist
Character designer

Production

- Layout
- Key animation
- Color design
- In-betweens
- Backgrounds
- Clean-up
- Compositing

Post-production

- Editing
- Post recording
- Music
- Sound FX
- Dubbing
- Linear editing

Release

The Staff Involved in Pre-Production

- Producer
  - Planning
  - Recruit the main staff
  - Budget / Sales
  - Final delivery
- Director
  - In charge of the final quality
  - From pre to post-production
- Head writer
  - Look over the whole TV series
  - Head of scenarist team
  - Does not exists in movies
- Scenarist
  - Scenario for each episode

- Character designer
  - Create the character settings
- Art director
  - Backgrounds
  - Art / concept board
- Color director
  - Color charts for cels
- Episode director
  - Guarantees episodes quality
- Storyboard artist
  - Storyboard for each episode

The Staff Involved in Production

Pre-production
- Planning
- Proto
- Scenario
- Setting /Character design
- Storyboard

Production
- Layout — Key animator - Animator — Cleanup
- Key animation — Animation director — Color director
- Color design → In-betweens — Art director - Episode director
- Backgrounds
- Clean-up — Compositor — Compositing director
- Compositing ← Production manager — Background artist
- Production assistant

Post-production
- Editing — Music — Sound FX
- Post recording → Dubbing ←
- Linear editing

Release

The Staff Involved in Production

- Key animator
  - Layout and scenery
  - Key animation (Character, FX …)
- Animator
  - In-betweens of key animation
  - Cleanup
- Clean up
  - Clean up animation
  - Paint color
- Animation director
  - Look over the key animators
  - Quality and characters details consistency in the show
- Background artist
  - Draw backgrounds

- Art director
  - Guarantees backgrounds quality
- Compositing director
  - Create the final look
  - Guarantees compositing quality
- Compositor
  - Per shot compositing
- Production manager
  - Overall schedule
  - Overall staff management
- Production assistant
  - Per episode staff management
  - Per episode schedule management

The Staff Involved in Production

Pre-production

Planning → Proto → Scenario → Setting /Character design → Storyboard

Production

Layout

Color design

Post-production

Editing — Sound director | Sound FX editor

Post recording → Dubbing ← Music compositor = Music supervisor

Linear editing — Sound editor | Voice actor

Online editing | Editing

Release
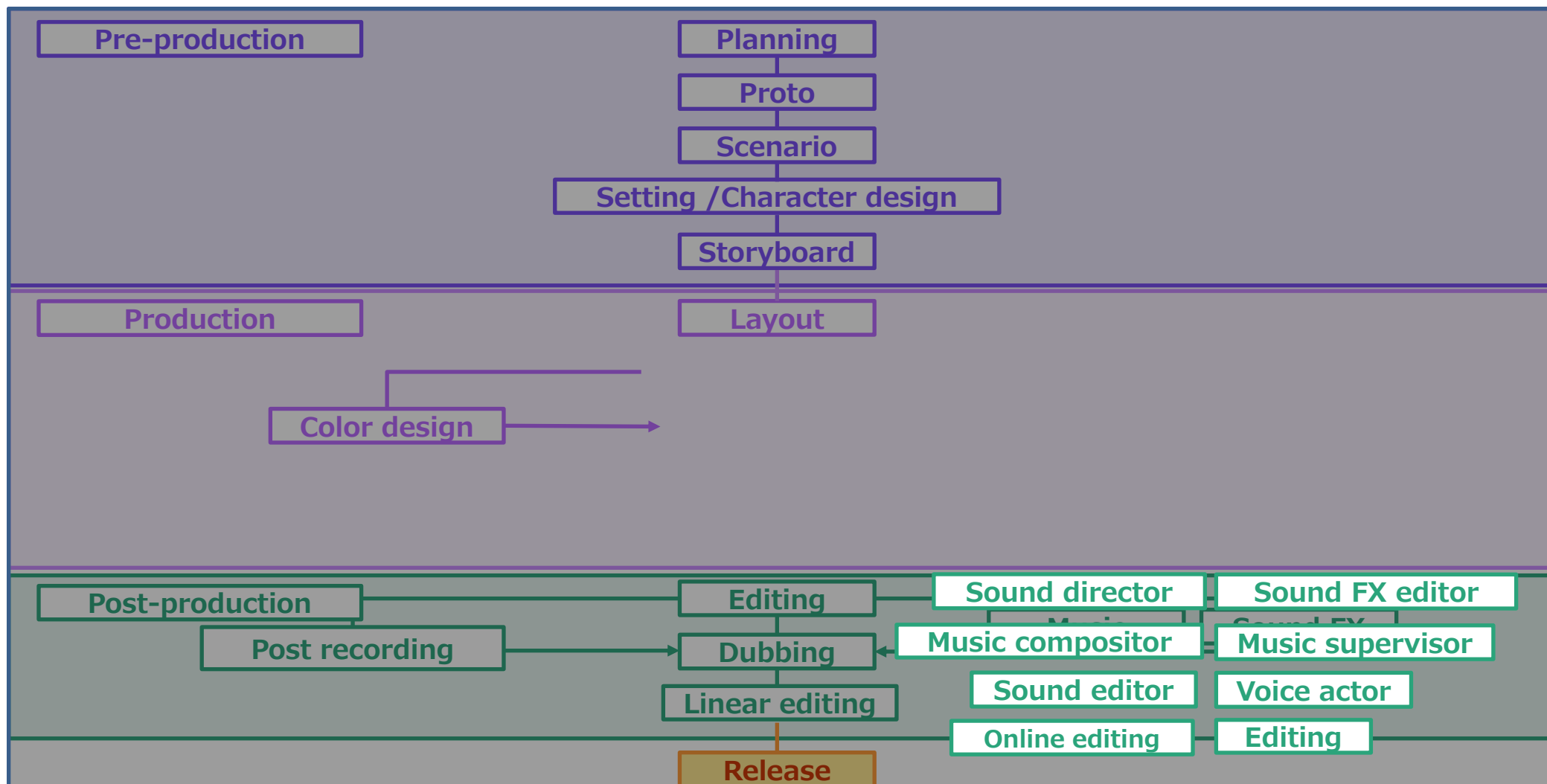
The Staff Involved in Post-Production

- ## Sound director
  - Direction of sound related staff / voice actors

- ## Sound editor
  - Voice and music editing

- ## Sound FX editor
  - Sound FX creation / editing

- ## Music compositor
  - Music composition / recording direction

- ## Music supervisor
  - Choose/edit music according to the content

- ## Voice actor
  - Play the lines from the scenario

- ## Editing
  - Adjust final timing and FX

- ## Online editing
  - Release format, final adjustments

Overview of Pre-Production Steps

- Preparation
- Small staff
- 3 months to 1 year
- The core structure of the project

| Planning |
| Proto |
| Scenario |
| Settings / Character design |
| Storyboard |
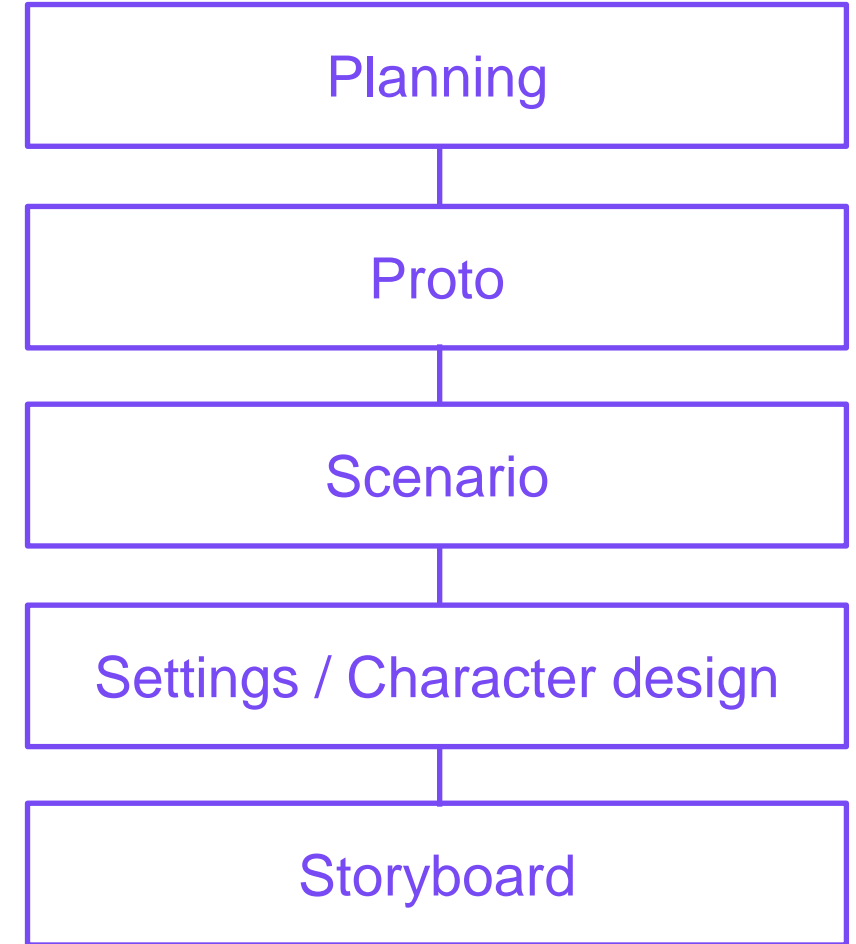
Planning

- ## Concept
  - Reason of the project
  - Content of the project
  - Production companies and main staff
  - Targeted media
  - Release date
- ## Gather the production budget
  - Production board members

Planning

Proto

Scenario

Settings / Character design

Storyboard
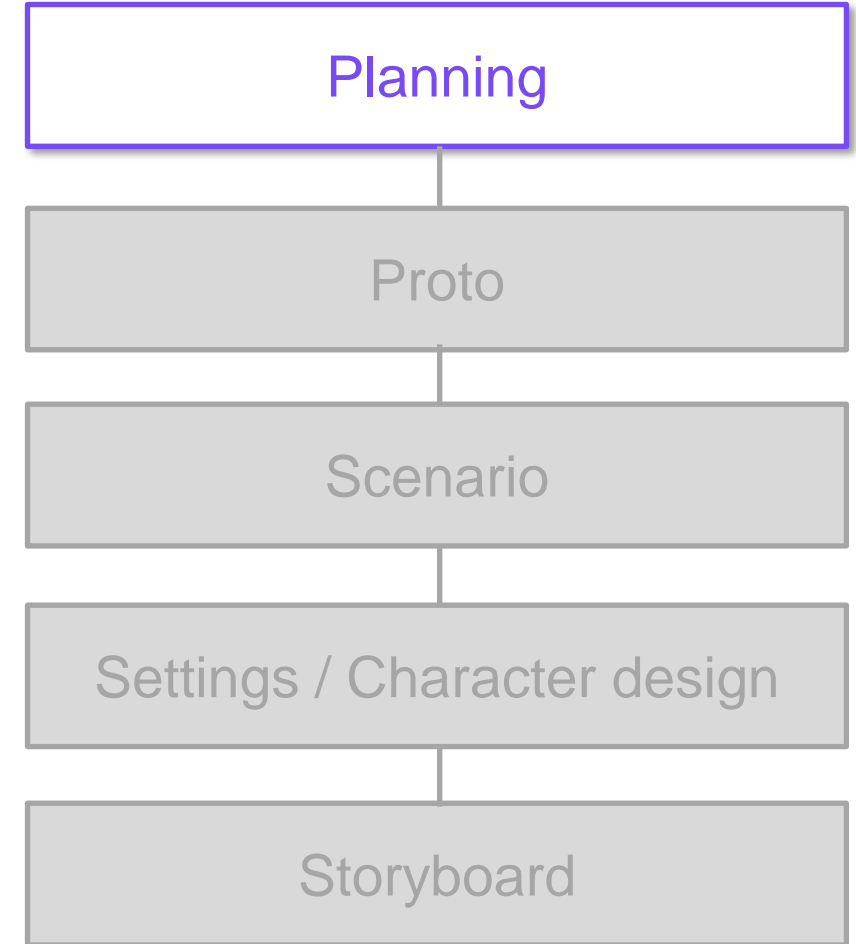
Proto

- Concretization of parts of the story
- Narrative structure and events
- Story line
- First step to the scenario
  - 1/5 of scenario final size

| Planning |
| Proto |
| Scenario |
| Settings / Character design |
| Storyboard |
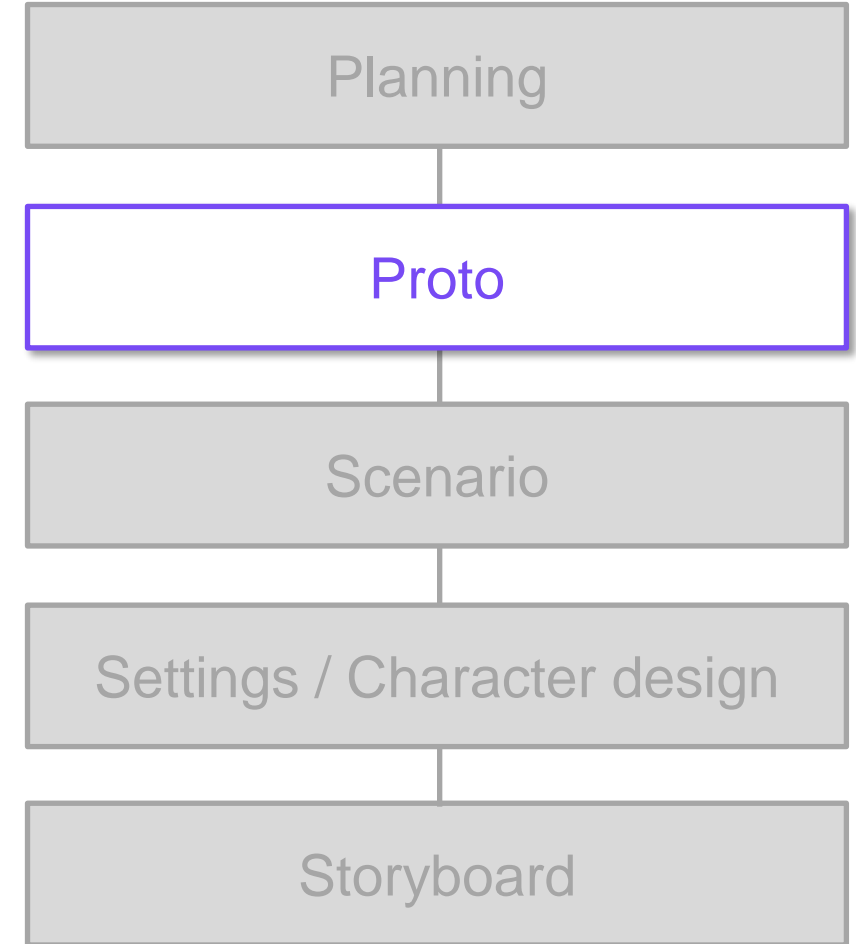
Scenario

- ## Based on the Proto
  - Reorganize the structure
  - Add dialogs
  - Add action lines
- ## Base of the storyboard
- ## Defines the needs for character settings

| Planning |
| Proto |
| **Scenario** |
| Settings / Character design |
| Storyboard |

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Butt Detective on air in NHK Educational TV

おしりたんてい　第３３話　３稿

ブラウン「もぉー！」
おしりたんてい、そんなブラウンを制するように、
おしりたんてい「フム、ブラウン。では、私たちも向かいましょうか」
ブラウン「（キョトンと）え？　…港ですか？」
おしりたんてい、プルンと頬を揺らして、
おしりたんてい「いえ、銀行強盗たちの元へ
……」
と、後ろ手を組みながら、歩いていく。
ブラウン、戸惑いつつ、後を追いかけて。

（アイキャッチ）
ブラウン「みんなー！　この後、お話の中に＠色のおしりが＠個隠されているよ。さがしてみてね！」
おしりたんてい「フーム……」

□ＫＮＫぎんこう・裏手（夕）
沈みゆく夕陽が、銀行や町並みをオレンジ色に染めていて―。
銀行の裏にある『ハトタクシー』の前に、
１台のタクシーが止まっている。
さらに、『ハトタクシー』の車庫の辺りに潜むように、２つのシルエットが立っていて（ホースとワトン）。
すると、銀行の裏口が開き、中からカバンを持ったシルエットが２つ出てきて――
潜んでいた２つのシルエットと合流。
そのままタクシーに乗り込む（※読み物６巻３８Ｐ参照）。

□タクシー・内
助手席に座ったのはワトンで。
ワトン、シートベルトをつけながら、運転手（※顔は見せず）に、
ワトン「駅に行ってくれ」
後部座席には、ホース、マスクを着けたおりたうさと、サングラスをかけたくまさわちゃたろうがいて（うさと＆くまさ

-ア-

Scenario: Production Example

おしりたんてい　第３３話　３稿

Directions

Time and place

Character name and dialog

□タクシー・内
助手席に座ったのはワトンで。
ワトン、シートベルトをつけながら、運転手（※顔は見せず）に、
ワトン「駅に行ってくれ」
後部座席には、ホース、マスク、サングラスをかけたくまさわちゃたろうがいて（うさと＆くまさおりたうさと、サングラスをかけたくま

６巻３８P参照）。

銀行の裏にある『ハトタクシー』の前に、１台のタクシーが止まっている。
さらに、『ハトタクシー』の車庫の辺りに潜むように、２つのシルエットが立っていて（ホースとワトン）。
すると、銀行の裏口が開き、中からカバンを持ったシルエットが２つ出てきて──潜んでいた２つのシルエットと合流。
そのままタクシーに乗り込む（※読み物

□ＫＮＫぎんこう・裏手（夕）
沈みゆく夕陽が、銀行や町並みをオレンジ色に染めていて──。

おしりたんてい「フーム……」
してみてね！」
＠色のおしりが＠個隠されているよ。さが
ブラウン「みんなー！ この後、お話の中に
（アイキャッチ）

と、後ろ手を組みながら、歩いていく。ブラウン、戸惑いつつ、後を追いかけて。
……」
おしりたんてい「いえ、銀行強盗たちの元へ
ブラウン「キョトンと）え？ …港ですか？」
たちも向かいましょうか」
おしりたんてい「フム、ブラウン、では、私
おしりたんてい、ブルンと頬を揺らして、
るように、
おしりたんてい、そんなブラウンを制す
おしりたんてい「もぉー！」
ブラウン「もぉー！」

Settings / Character design

- Base of the look consistency
- Adaptation from original work to anime

Planning
Proto
Scenario
Settings / Character design
Storyboard

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最終更新日　2018/01/17　決定稿　00_001_01_ラッキーキャット・おしりたんてい事務所_外観

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たんてい事務所 間どり

最終更新日　2017/12/27　決定稿　01_001_01_おしりたんてい事務所_間取り　　※設定の無断転売・製作用途外の使用禁止

Settings / Character Design: Production Example

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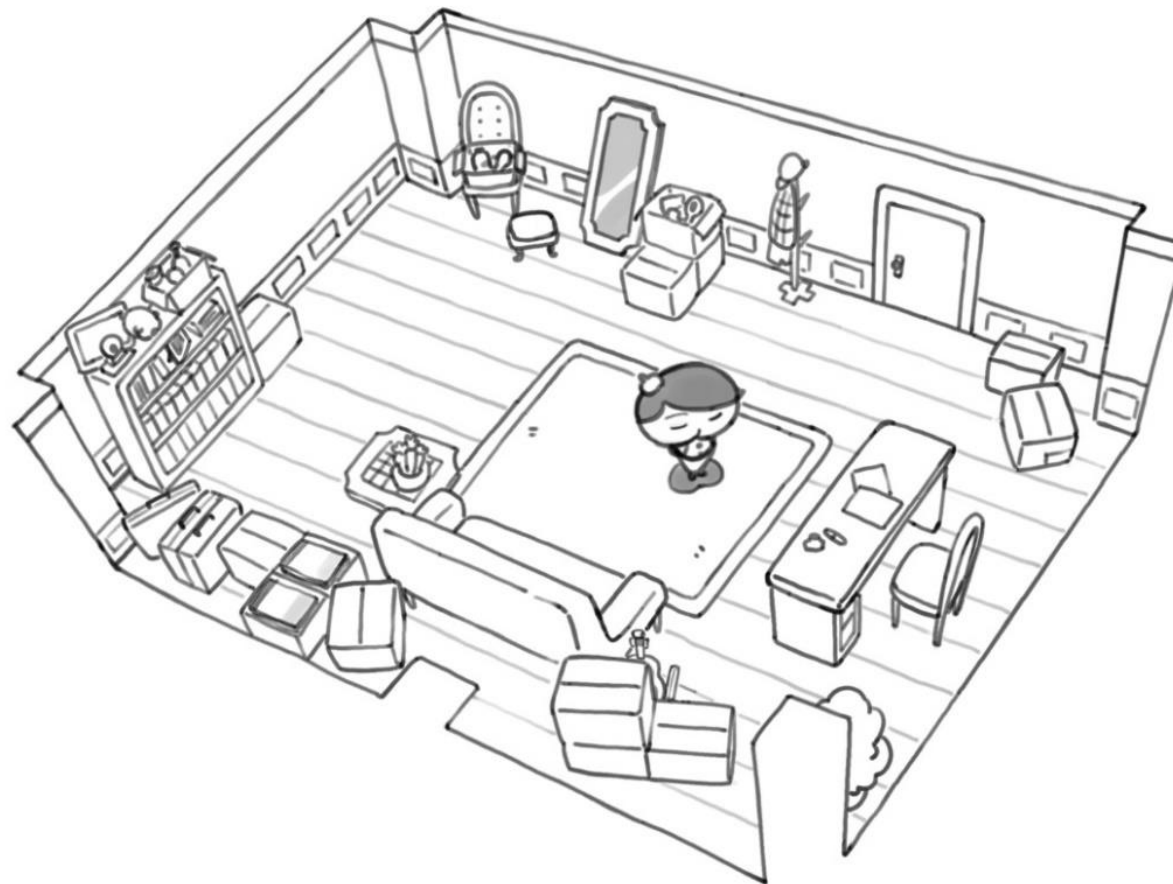
Storyboard

- Visual version of the scenario
- Base of the whole production
- May trigger new settings creation
- Enable cost evaluation
- Very important
  – Decides 80% of the final picture

Planning

Proto

Scenario

Settings / Character design

Storyboard

Storyboard: Production Example
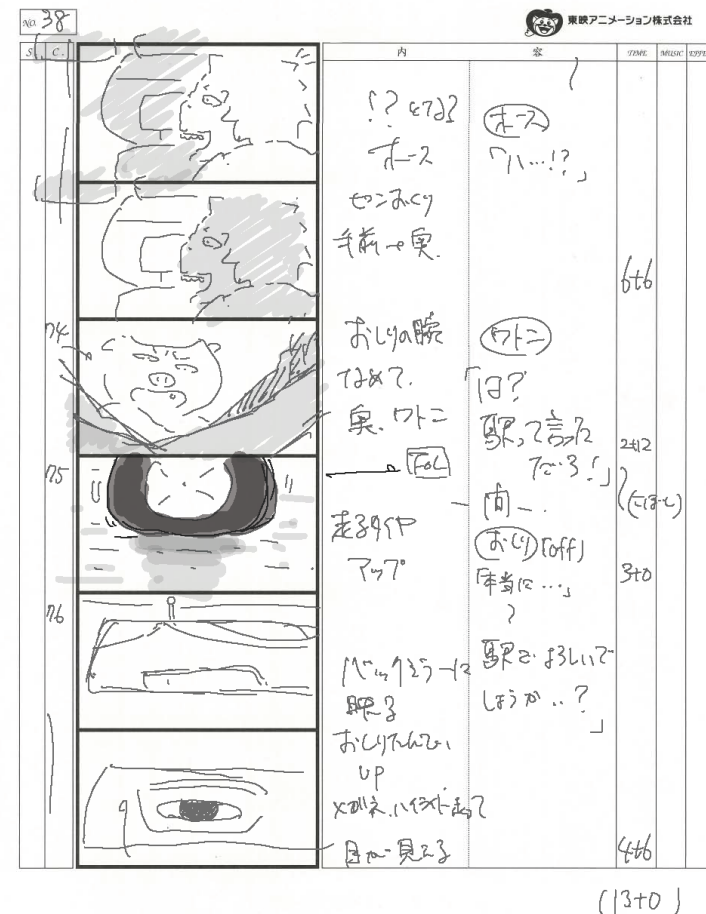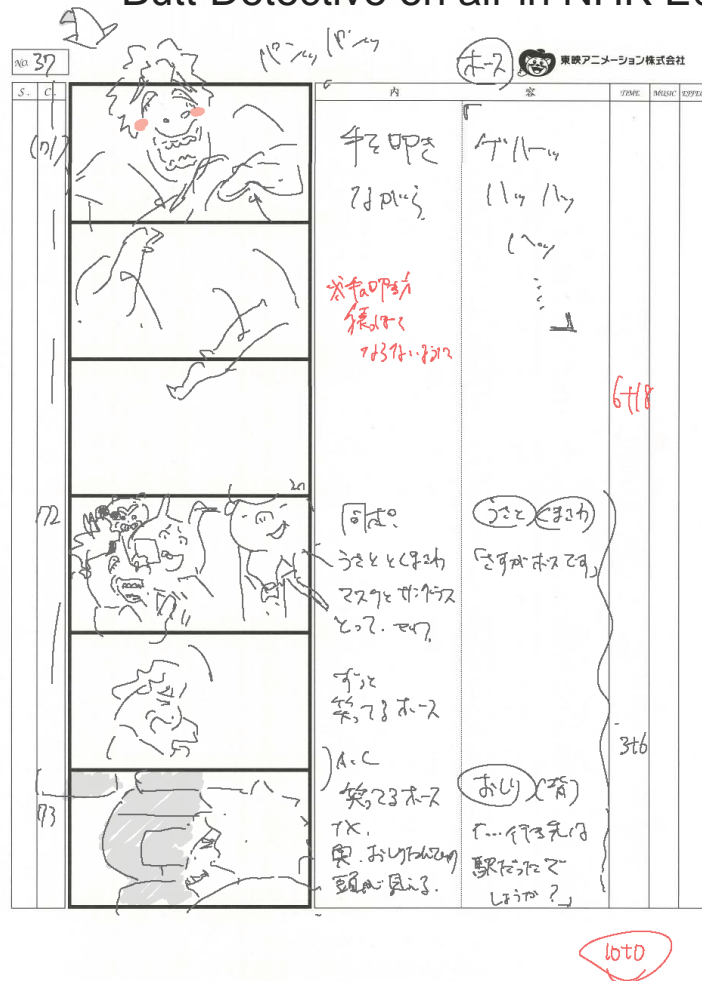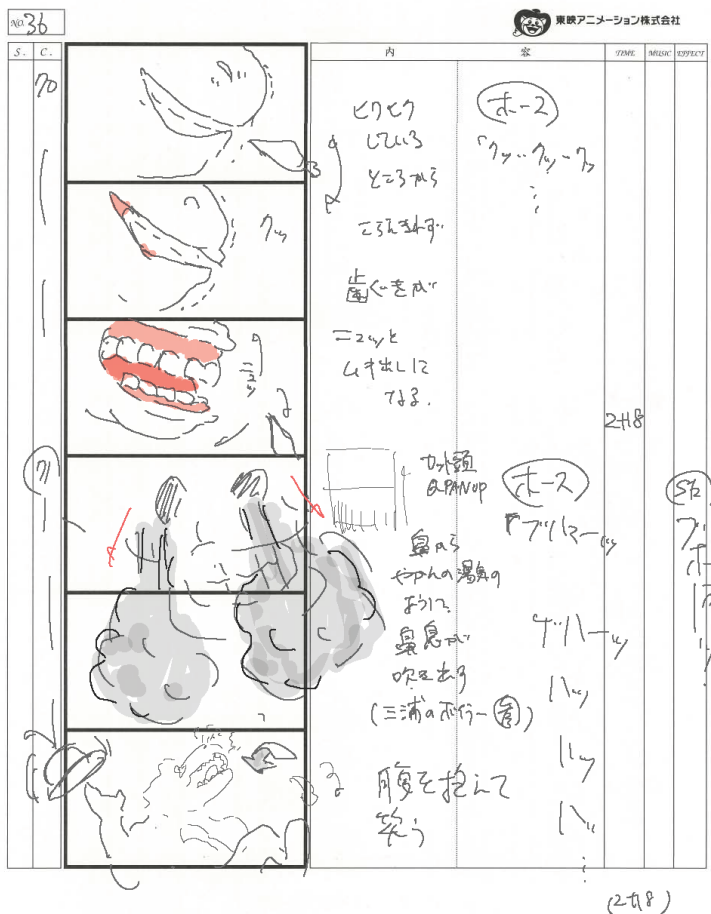
Storyboard: Production Example

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Layout and story

Music

Shot number

Shot length

Directions

Character name and dialog
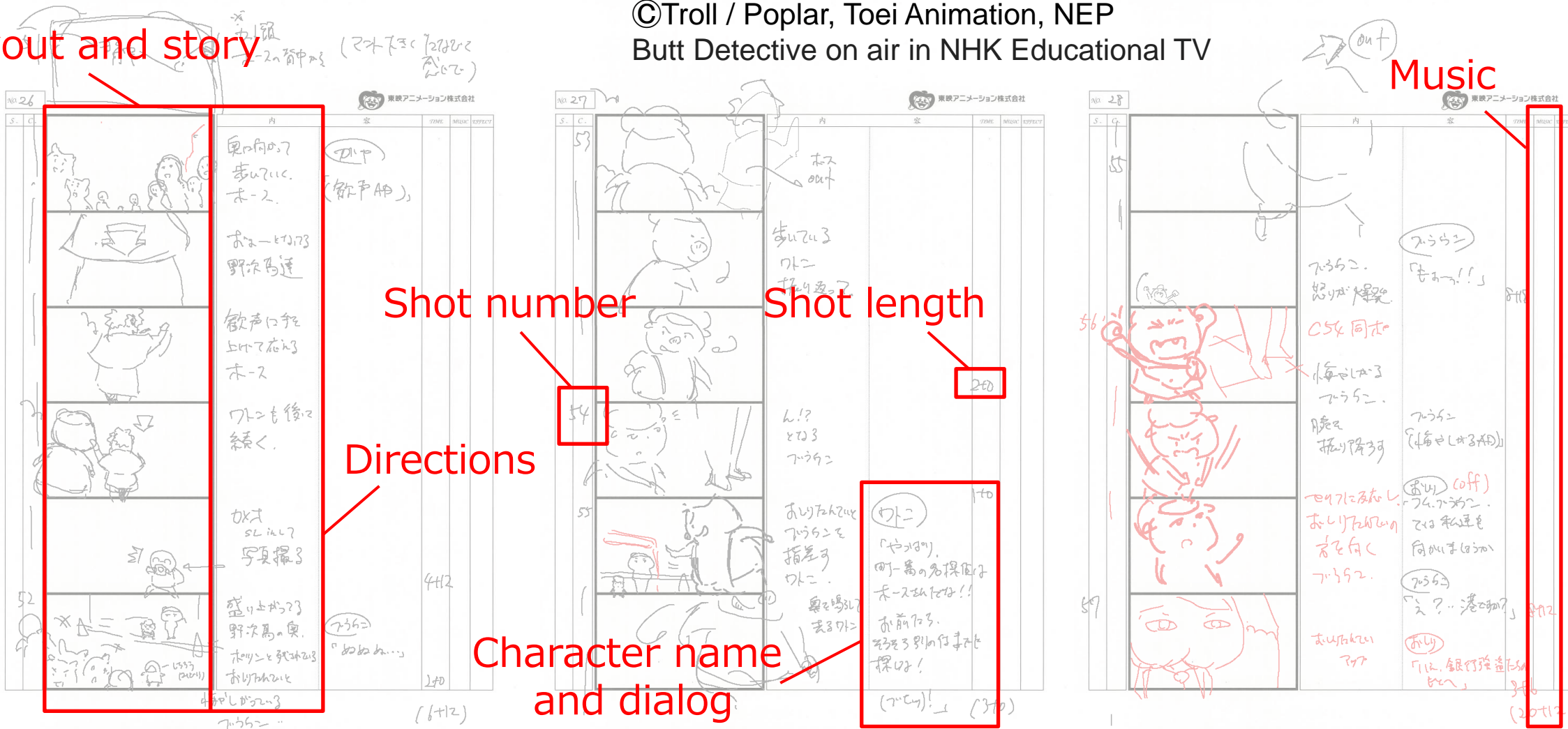
Storyboard: Production Example

おしりたんてい　第３３話　３稿

わは、４つのジュラルミンケースを抱えている）。全員シートベルトを着用する、さらに、後部座席の後ろに、３つのぬいぐるみ（真ん中は下を向いたブラウンで、人形用のチャイルドシート的なものに座っていて）が置かれている（※読み物６巻３９Ｐ参照）。

ホース、キザに目を閉じたまま、
ホース「うまくいったぜ！」
と、帽子を取りながら、
ホース「この町の警察も、ちょろかったな」
ニヤリと不敵な笑みを浮かべるホース。
隣で、ニコニコ顔のうさとと、くまさわ。
ワトン、後ろを振り向き、
ワトン「今回もボスの計画は完璧ですぜ」
ホース「あたぼうよ！　銀行がもぬけの殻だと気づくころには、俺たちは遠くの町さ！
ゲッハッハッハッハッ！」
歯をむき出し、下品に笑うホース。
うさととくまさわ、マスクとサングラスを取りながら、
うさと＆くまさわ「さすがボスです」
――不意に、口を開く運転手（後ろ姿）。
運転手「行き先は、駅だったでしょうか？」
ホース「（口を開いたまま）ハ…？」
ワトン「（イラッと）」　駅って言っただろ！」
運転手「（低いトーンで）本当に、駅でよろしいでしょうか……」
運転手、ゆっくり顔をあげると――バッ
クミラーに映る眼鏡が、キランと光る。
それは、運転手に変装したおしりたんていで。
ホースたち、思わず驚愕の叫びをあげて、
ホースたち「お、おまえは、おしりたんてい！」
おしりたんてい、冷静に運転し続ける。
すると、チャイルドシートに座りながら、
ブラウン「ガオー」と上半身を起こすブラウン。
ブラウン「お前たちは、探偵じゃなくて、本

-8-

Storyboard: Production Example

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Storyboard: Production Example

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Storyboard: Production Example

Example where order of dialogs differs between scenario and storyboard

Scenario P7

Scenario P6

In the storyboard, this dialog has been omitted

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Overview of Production Steps

- Main process
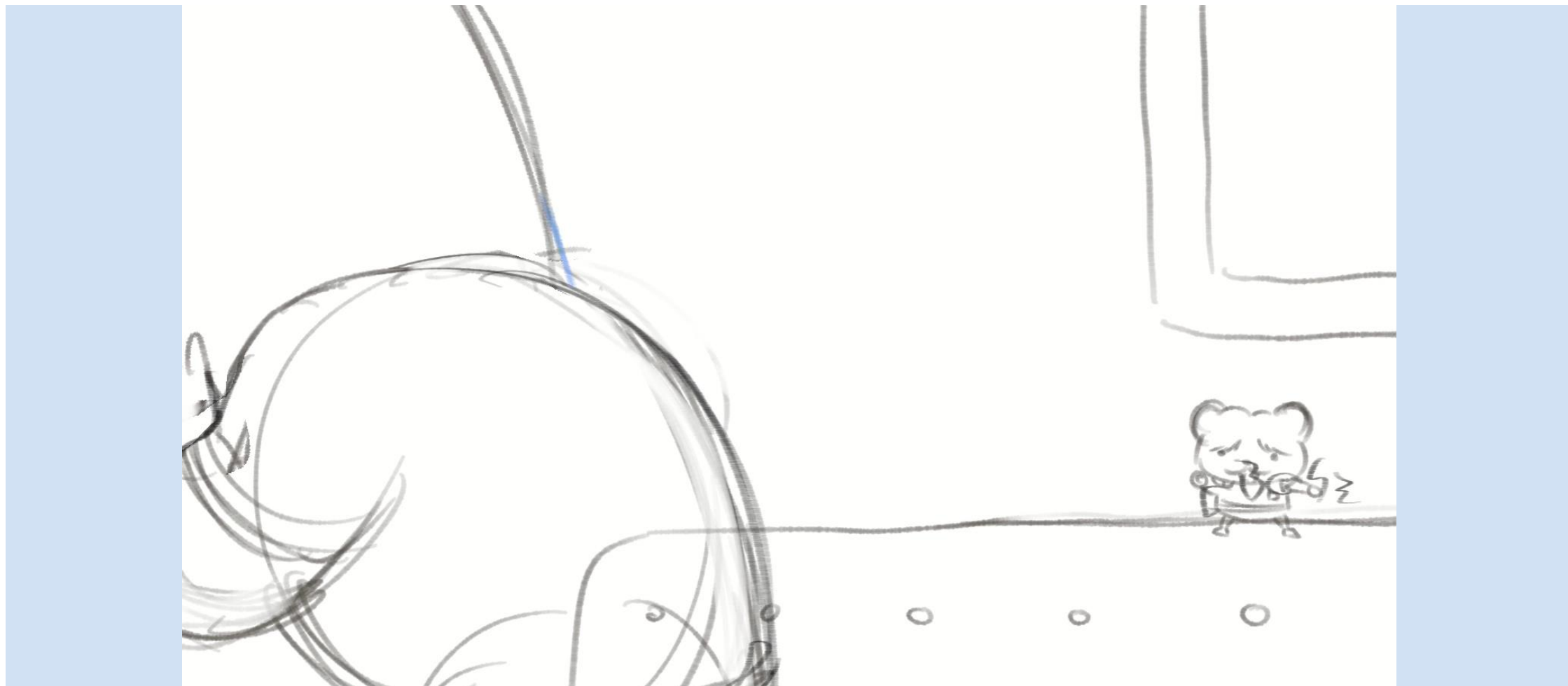 - People
  - Budget
- From 3 months to more than 1 year

```
         ┌──────────────┐
         │    Layout     │─────────────┐
         └───────┬───────┘             │
                 │                     │
         ┌───────┴───────┐             │
  ┌──────│ Key animation │             │
  │      └───────┬───────┘             │
┌─┴────────────┐ │          ┌──────────┴───┐
│ Color Design │ │          │ Backgrounds  │
└─┬────────────┘ │          └──────┬───────┘
  │      ┌───────┴───────┐         │
  └─────▶│  In-betweens  │         │
         └───────┬───────┘         │
                 │                 │
         ┌───────┴───────┐         │
         │   Clean-up    │         │
         └───────┬───────┘         │
                 │                 │
         ┌───────┴───────┐         │
         │  Compositing  │◀────────┘
         └───────────────┘
```
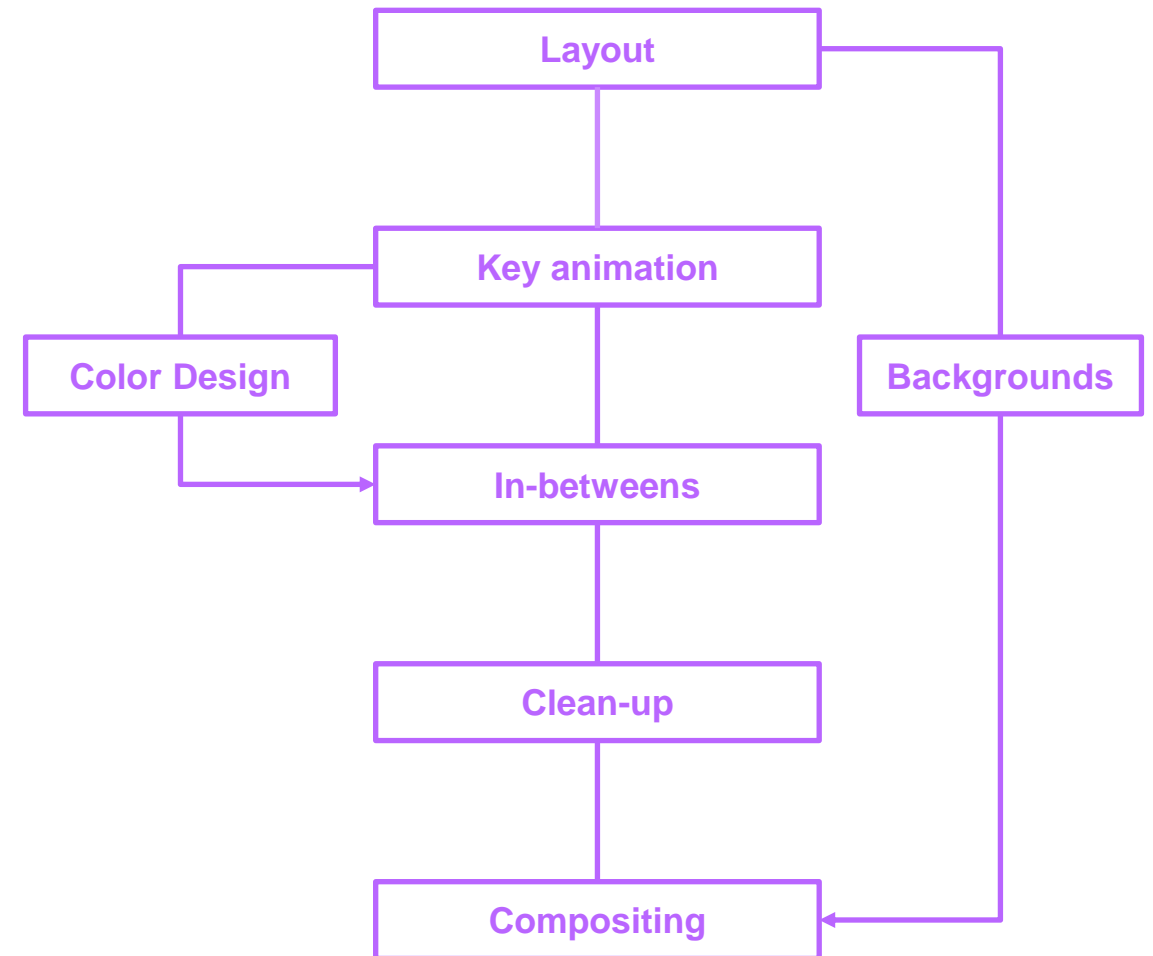
Layout

- Structure of the shot
  - Amount of detail/content
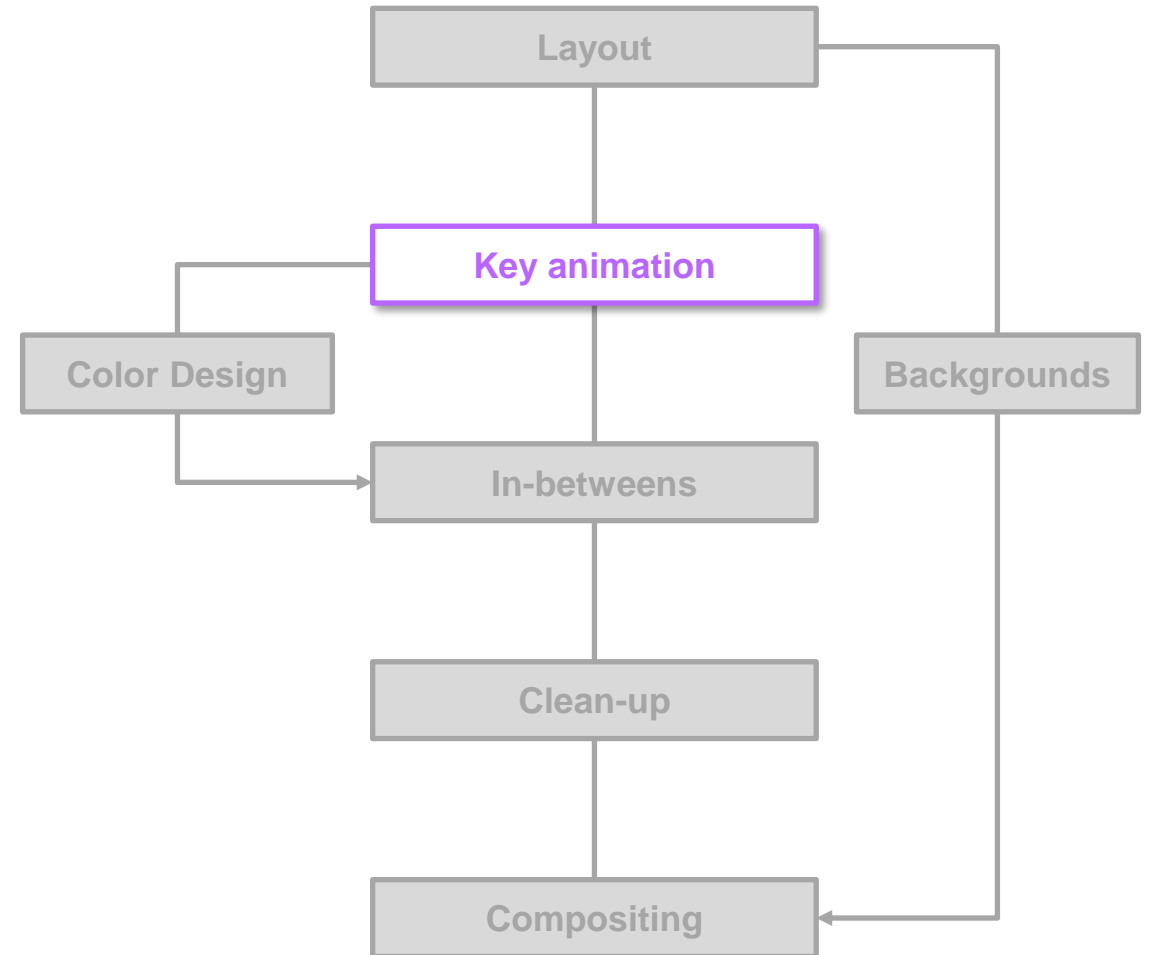 - Requires lots of check
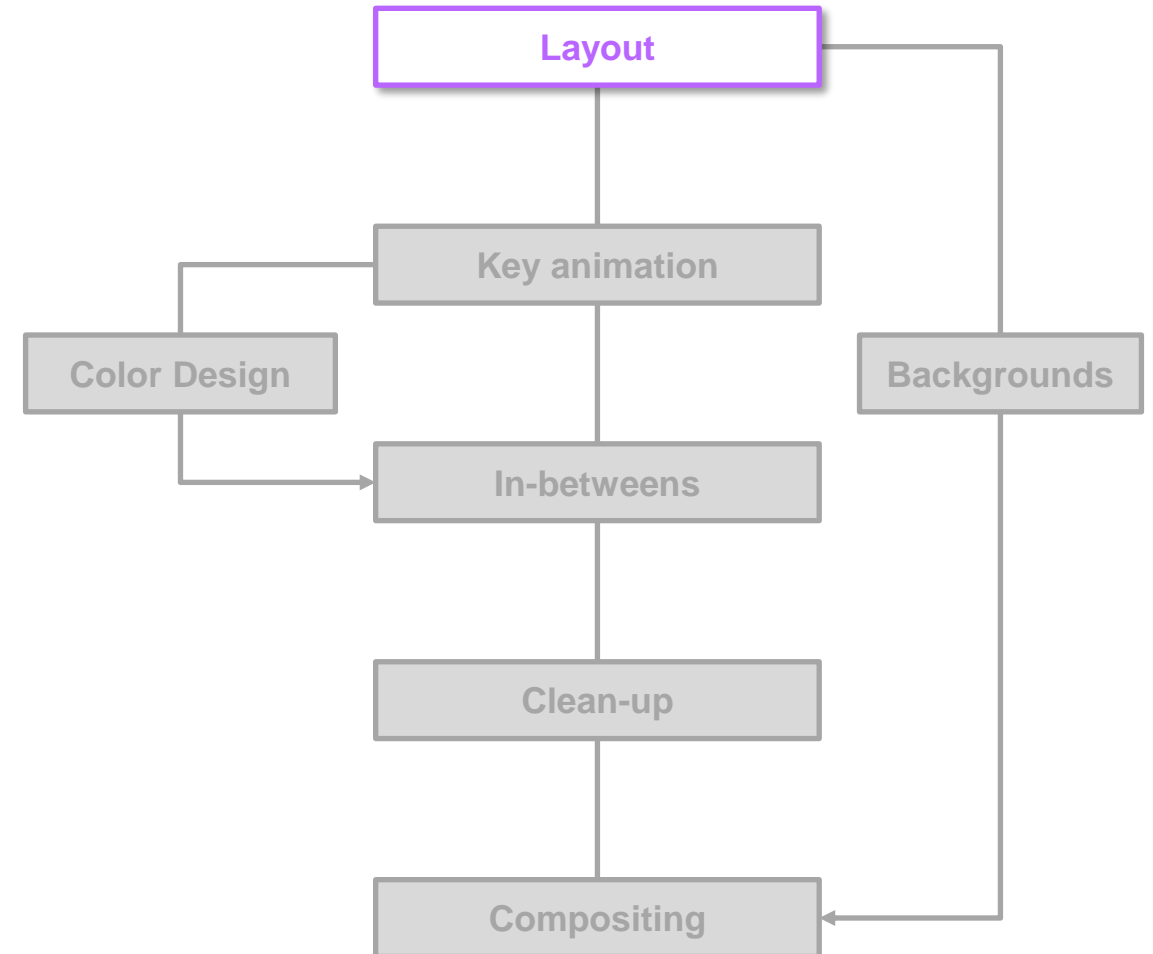
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Key Animation

- Most popular step
- Base of character animation
- Sets the in-betweens frame count

Key Animation:Time Sheet

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Key Animation: Time Sheet

Shot information: show name, episode number, shot number, shot length

Key frame column (action timing)

Sound column (Character speech and SE timing)

Camera column (Camera work type and timing)

Key frame number (action keyframes)

In-betweens indications

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Key Animation: Production Example

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Color Design

- Decides cel colors
- Give direction to clean-up
- Differences between color director and designer

Layout

Key animation

Color Design

Backgrounds

In-betweens

Clean-up

Compositing

Color Design: Production Example

Color Design: Production Example

In-betweens

- In between key frames
- Big impact on quality
- Lots of outsourcing abroad

Layout

Key animation

Color Design

Backgrounds

In-betweens

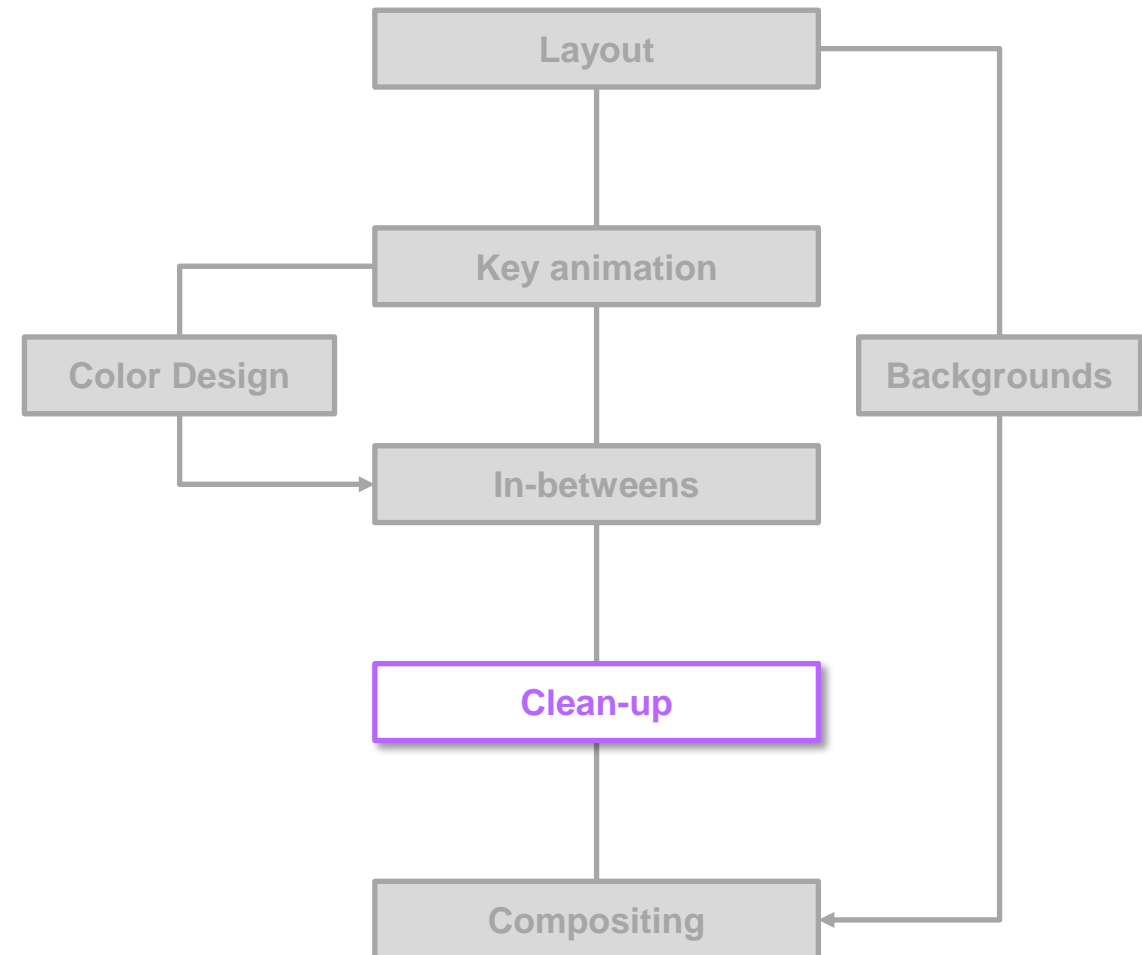Clean-up

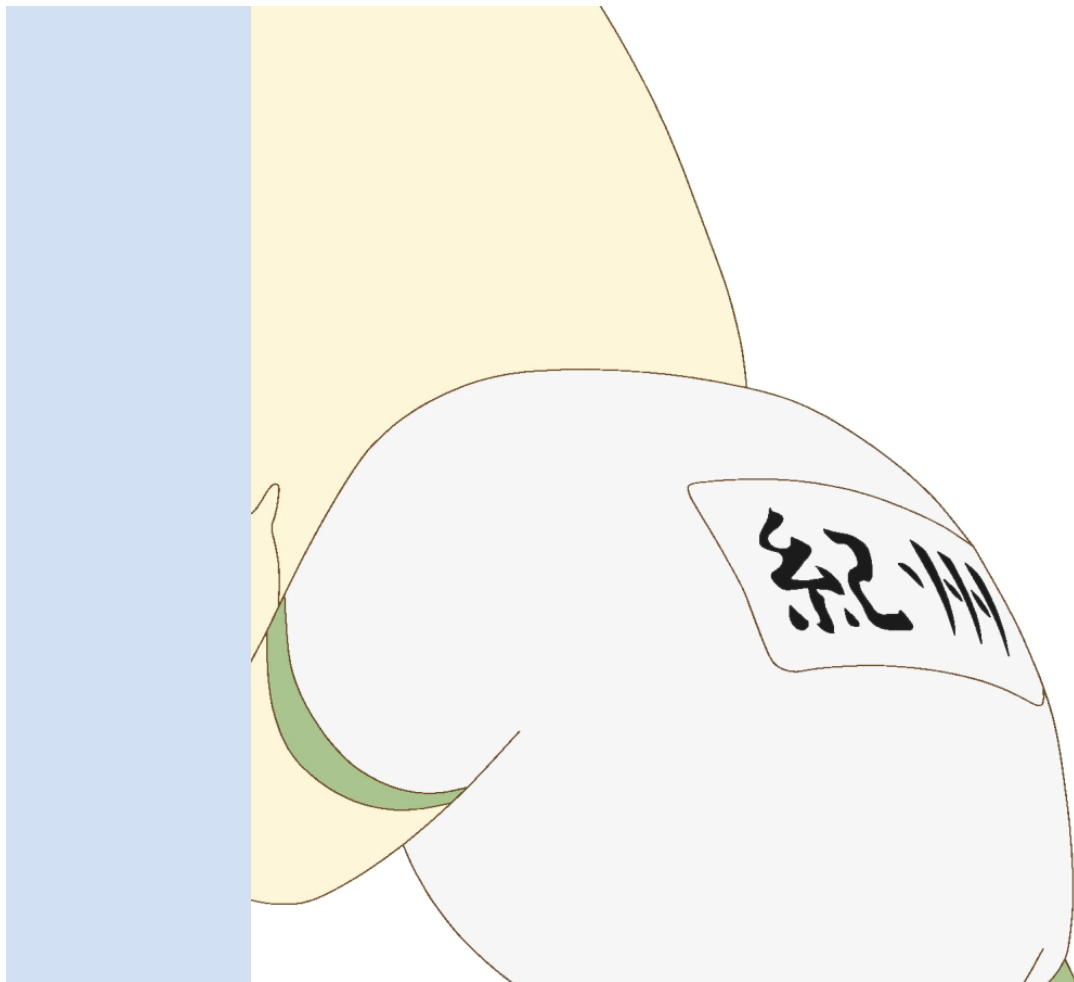Compositing
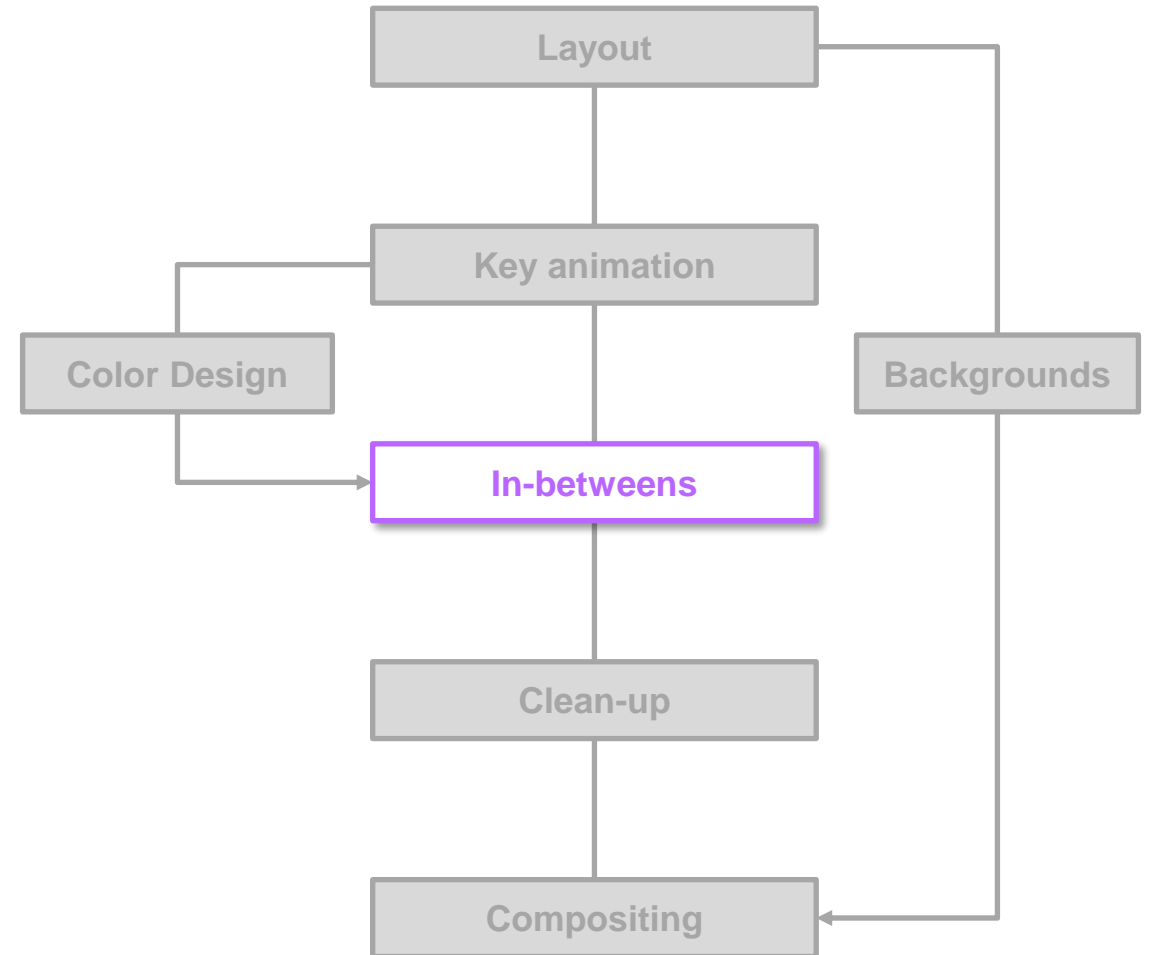
In-betweens: Production Example

Butt Detective on air in NHK Educational TV

Cleanup

- Digital coloring
- Remove imperfections
  - Lines
  - Dots
- Lots of outsourcing abroad
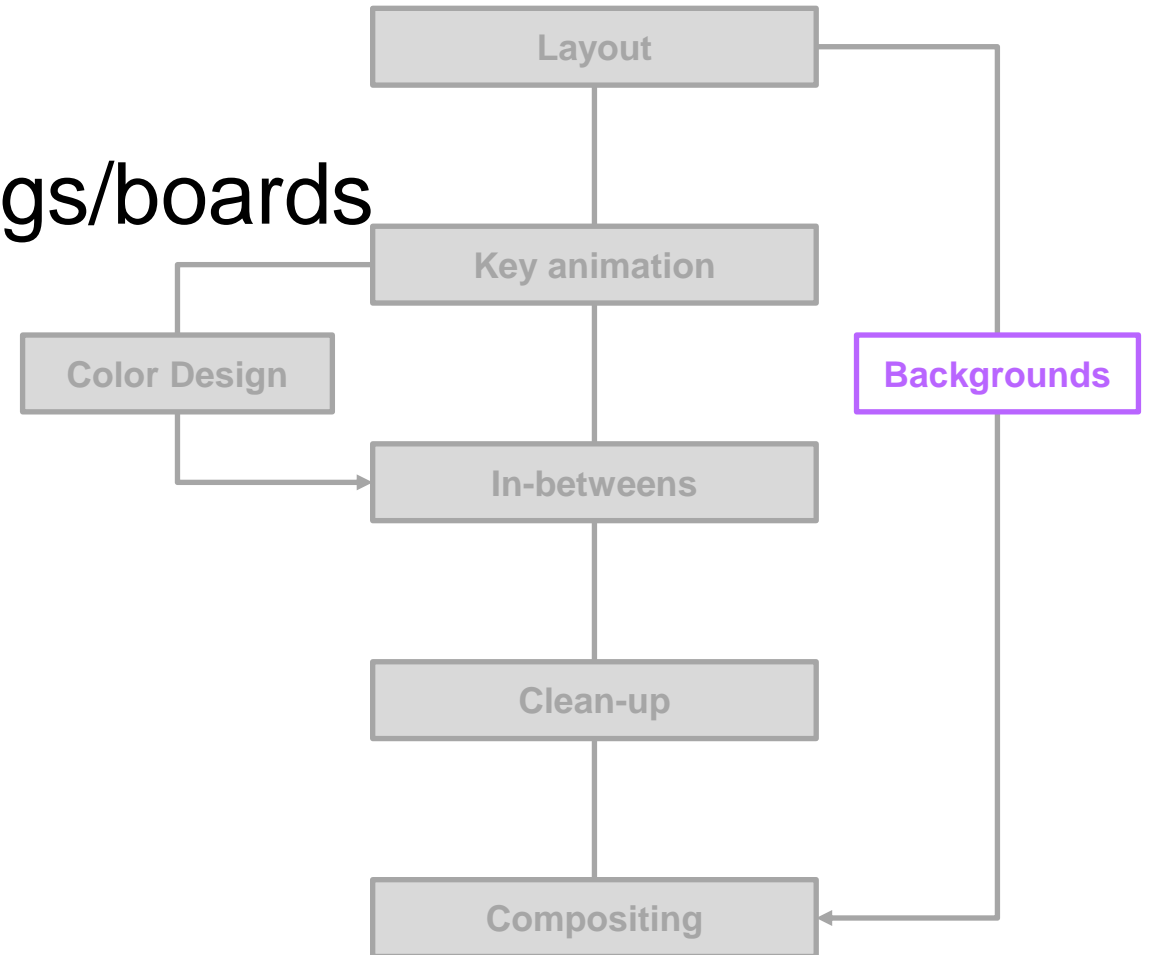
Cleanup: Production Example

Butt Detective on air in NHK Educational TV

Backgrounds

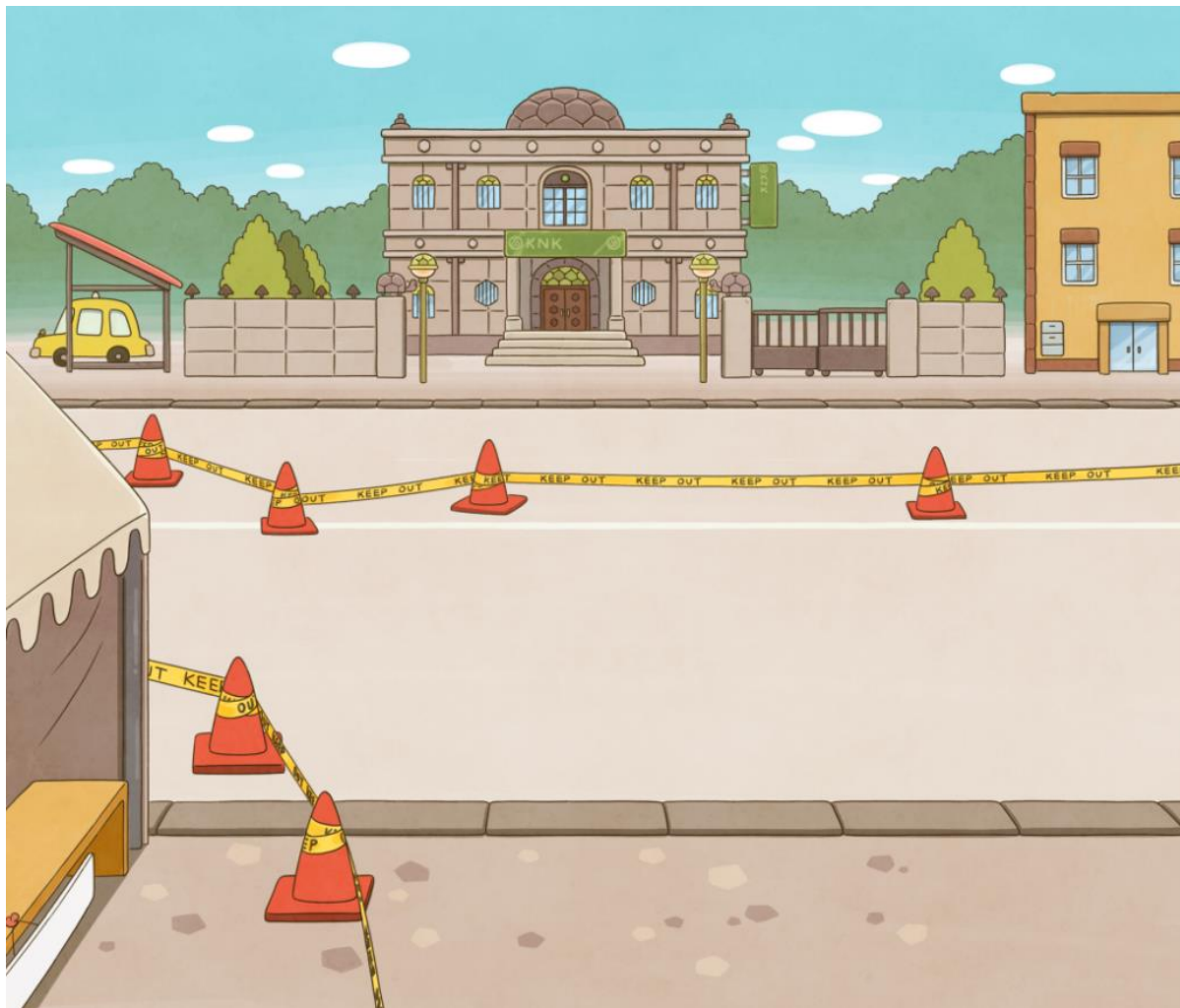- Defines the world look
- Based on layout and art settings/boards

Backgrounds: Production Example

OSR2018TV_ep07_s001c140 (03+00)

Butt Detective on air in NHK Educational TV

Backgrounds: Production Example

Butt Detective on air in NHK Educational TV

Backgrounds: Production Example

Butt Detective on air in NHK Educational TV

Backgrounds: Production Example

Butt Detective on air in NHK Educational TV

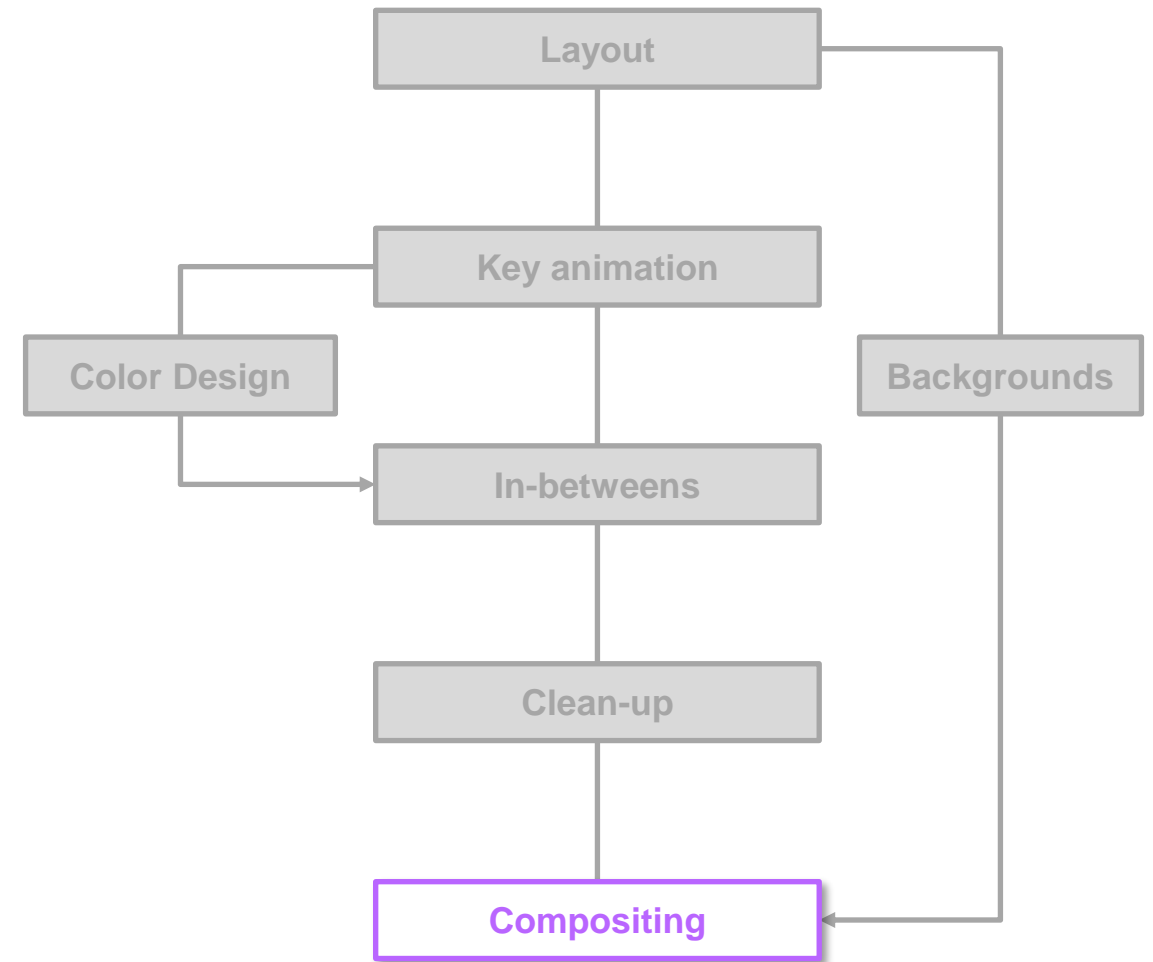# Backgrounds: Production Example

Butt Detective on air in NHK Educational TV

Compositing

- ## Final image
  - Combines cel and background
  - FX
  - Final look

- ## Generate retakes

Compositing: Production Example

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絵コンテ

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Overview of Post-Production Steps

- Final step
- Few staff, high cost
- From some days to month

```
                    ┌─────────────┐
          ┌─────────│   Editing   │────────┬──────────┐
          │         └──────┬──────┘        │          │
   ┌──────┴────────┐       │        ┌──────┴────┐ ┌────┴─────┐
   │ Post recording│       │        │   Music   │ │ Sound FX │
   └──────┬────────┘       │        └──────┬────┘ └────┬─────┘
          │         ┌──────┴──────┐        │          │
          └────────▶│   Dubbing   │◀───────┴──────────┘
                    └──────┬──────┘
                           │
                    ┌──────┴───────┐
                    │ Linear editing│
                    └──────────────┘
```
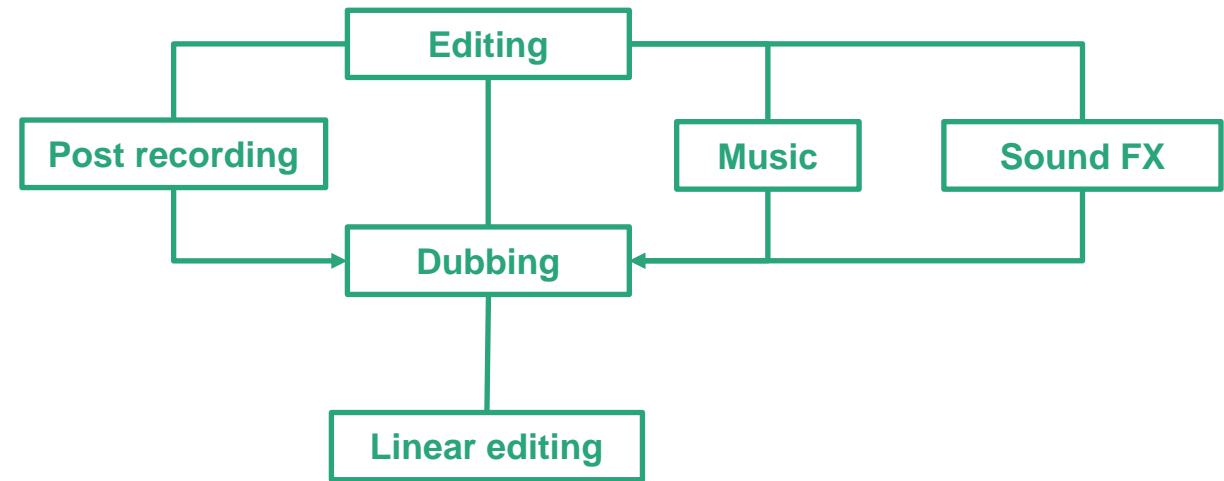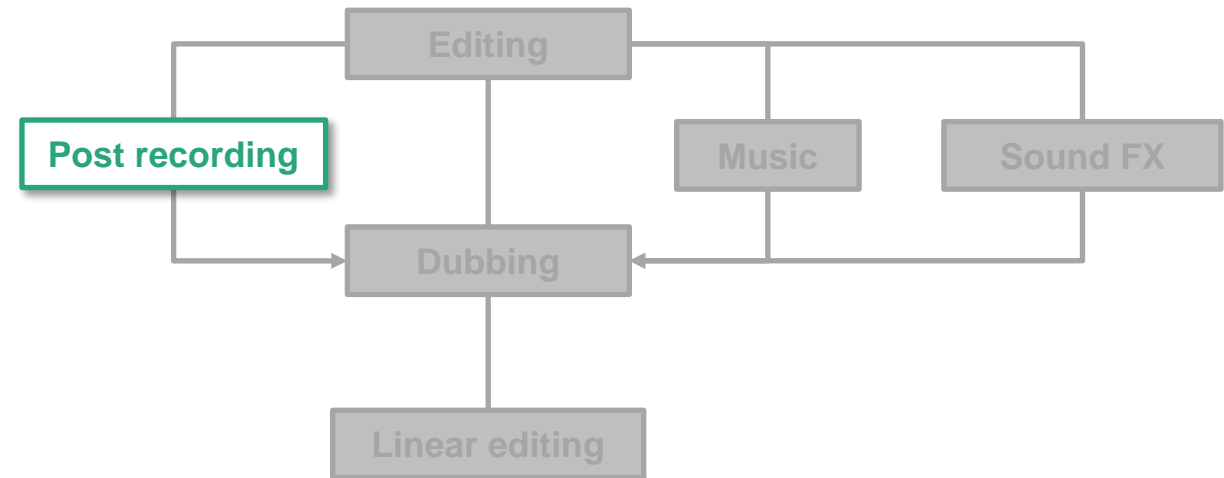
Editing

- Shot length and rhythm
- Gather all shots in one
- Some filter processing
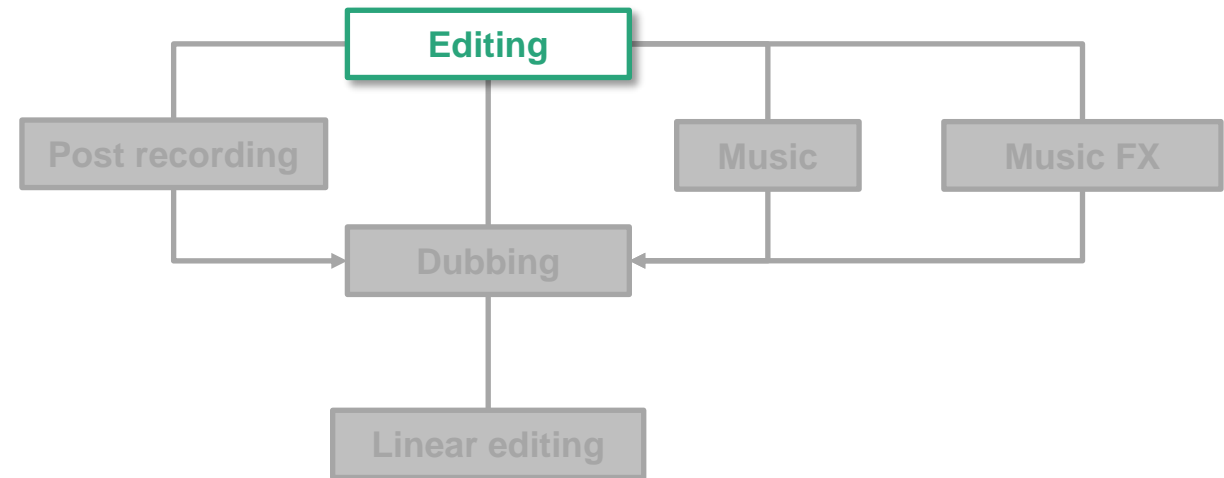
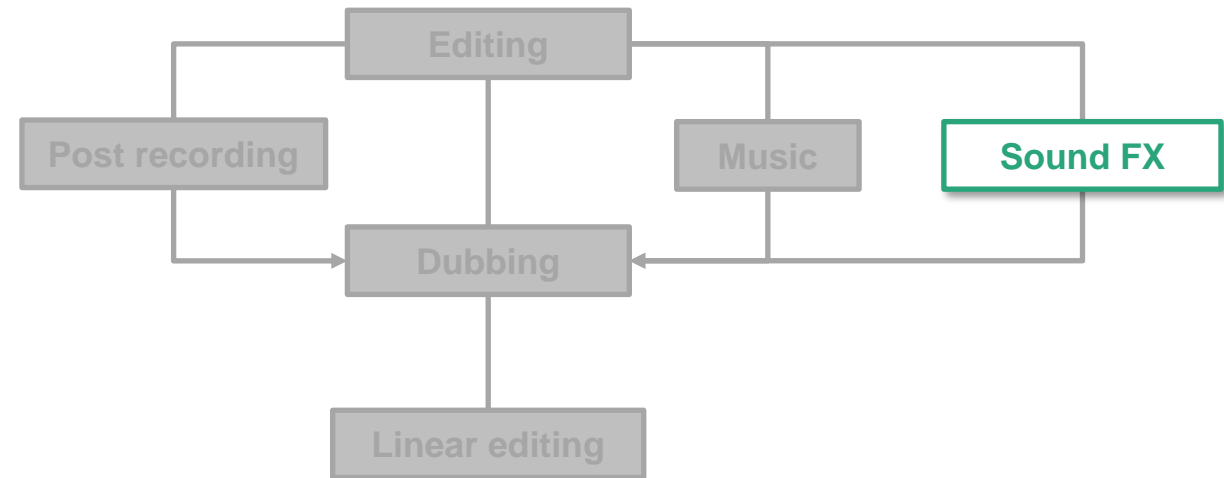# Post-Recording

- Bring life to characters
- Rush against time

```
                    ┌──────────────┐
                    │   Editing    │
              ┌─────┴──────────────┴─────┐
┌──────────────┐                    ┌──────────┐   ┌──────────┐
│Post recording│                    │  Music   │   │ Sound FX │
└──────────────┘                    └──────────┘   └──────────┘
              │                          │               │
              └──────┐  ┌────────────────┴───────────────┘
                  ┌──┴──┴─────┐
                  │  Dubbing  │
                  └─────┬─────┘
                        │
                 ┌──────┴───────┐
                 │ Linear editing│
                 └──────────────┘
```

Music

- Create the world mood
- Create emotions
- Differences between movies and TV series

Editing

Post recording

Music

Sound FX

Dubbing
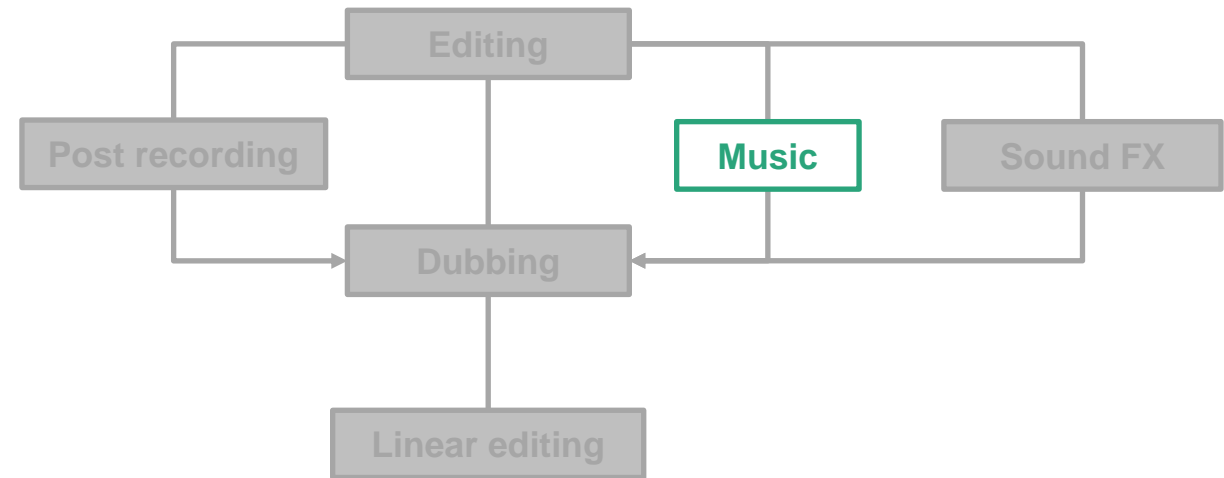
Linear editing

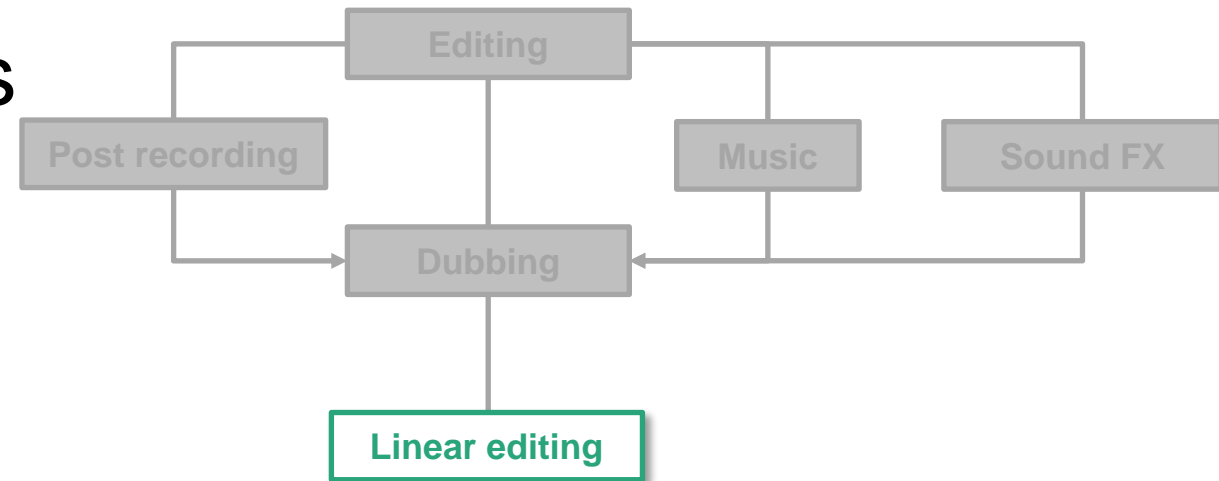# Sound FX

- Create/record/gather sounds

Dubbing

- Adjust and decide sound balance for each shot
  - What sound should be noticed
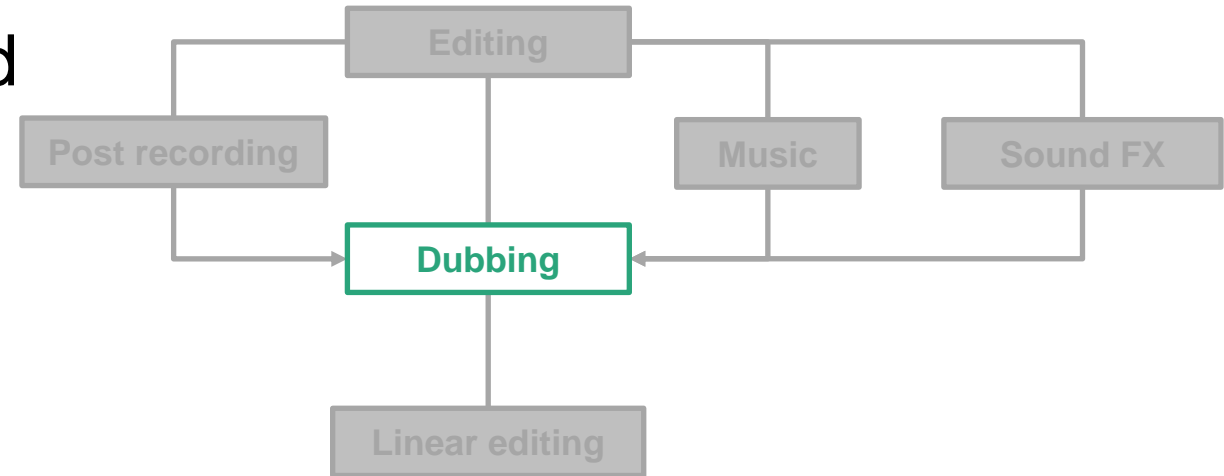
Post-Production: Linear Editing

- Create media according to the release format
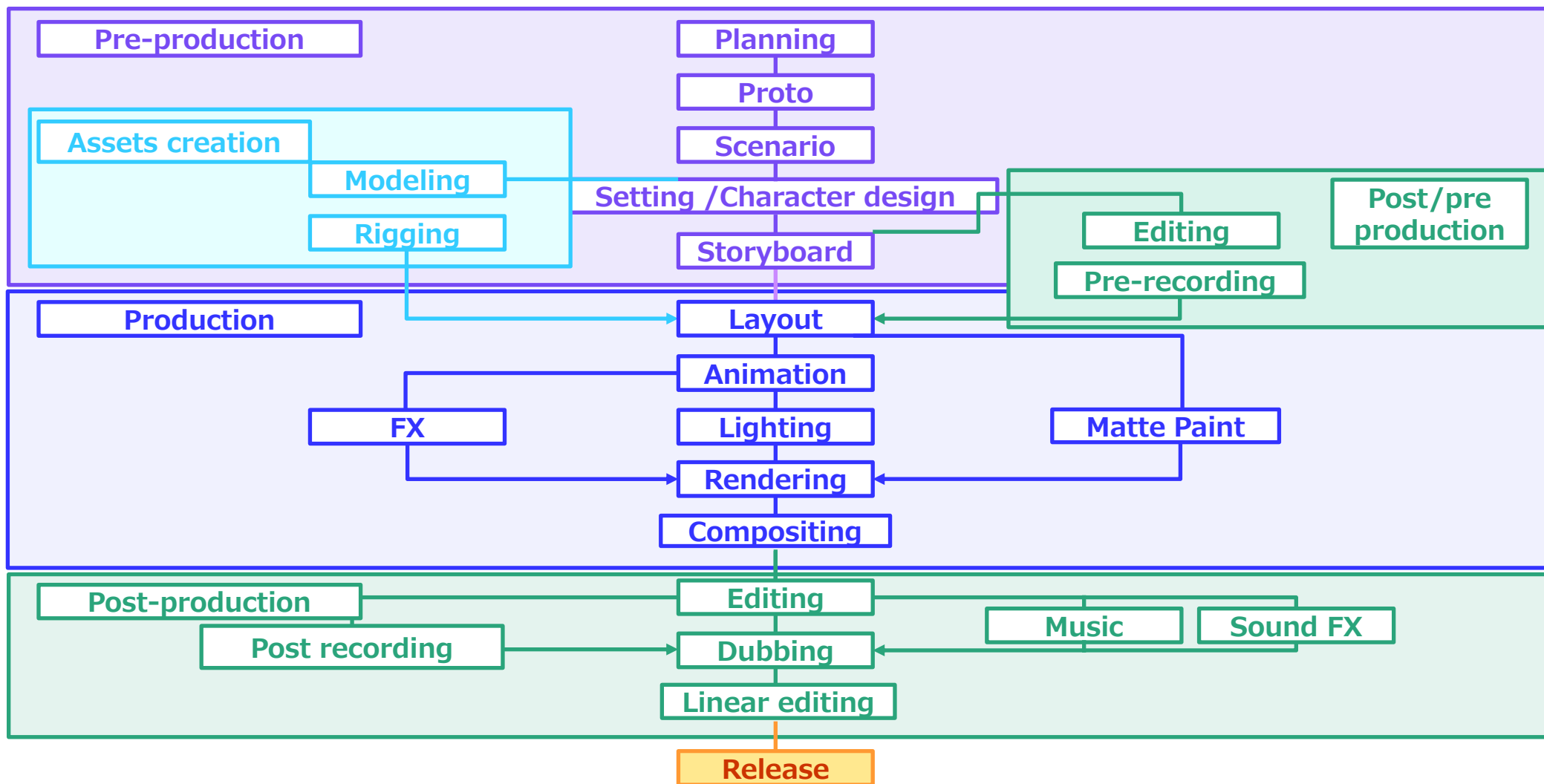- Final check and adjustments

The 3D Anime Production Workflow

About the Workflow

- ## Pre-production
  - Determine shots and costs at scenario step
    - Number of assets and situations
  - Build final look and estimate workflow and costs from there
- ## Production
  - Pre-recording
    - Animation created according to sound
  - Division of work with specialists
- ## Post-production
  - Just like 2D

Overview of the 3D Anime Production Workflow

- ## Specificities
  - Importance of preproduction and design of the pipeline
  - Adjust animation to pre recorded voices (Pre recording)
- ## Pro
  - Few quality consistency differences between shots
  - Some animation are easier to produce in 3D than 2D drawings
    - Material and textures
    - Complex camera works
- ## Cons
  - Difficult to handle irregular cases
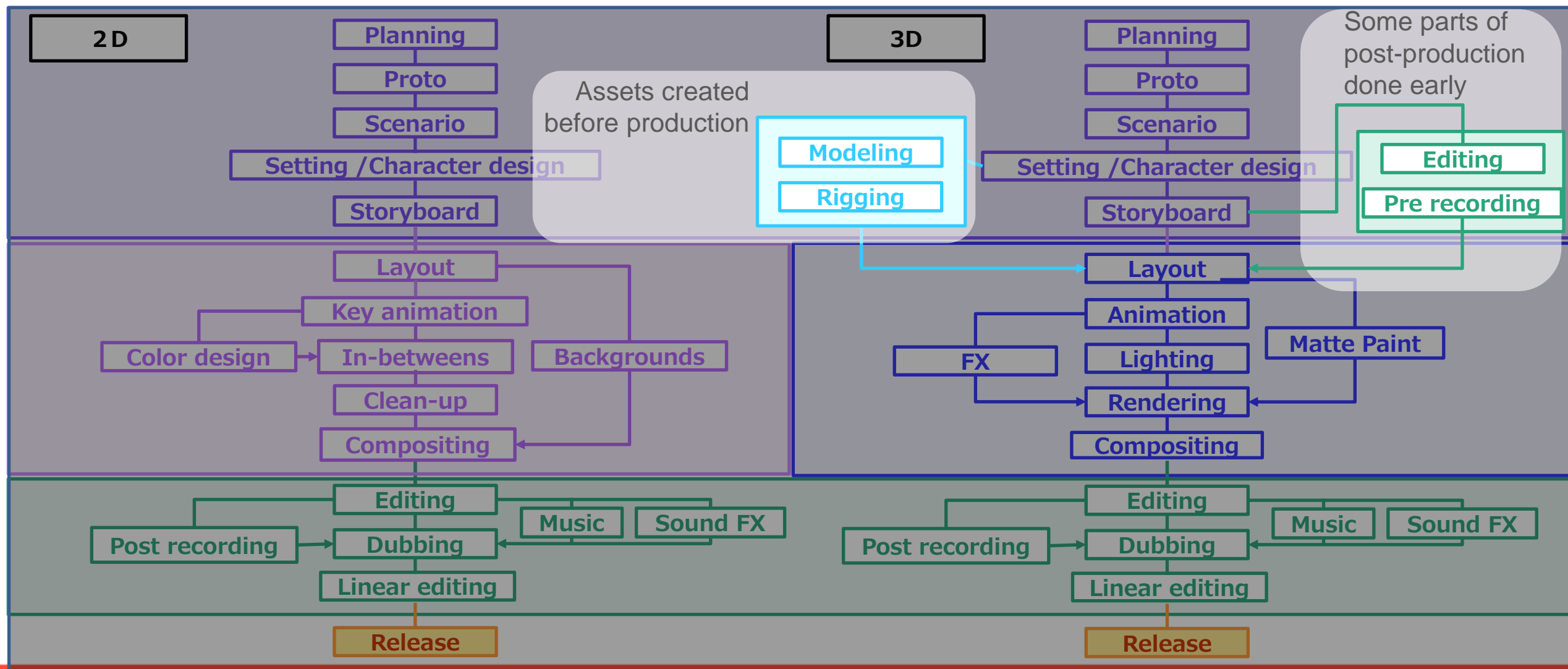 - High initial cost

Overview of The 3D Anime Production Workflow

Pre-production

- Planning
- Proto
- Scenario
- Setting /Character design
- Storyboard

Assets creation
- Modeling
- Rigging

Post/pre production
- Editing
- Pre-recording

Production
- Layout
- Animation
- FX
- Lighting
- Matte Paint
- Rendering
- Compositing

Post-production
- Editing
- Music
- Sound FX
- Post recording
- Dubbing
- Linear editing

Release

Overview of The 2D Anime Production Workflow

Pre-production

- Planning
- Proto
- Scenario
- Setting /Character design
- Storyboard

Production

- Layout
- Key animation
- Color design → In-betweens — Backgrounds
- Clean-up
- Compositing

Post-production

- Editing
- Post recording → Dubbing ← Music — Sound FX
- Linear editing

Release

Comparing 2D/3D Anime Production Workflow

2D

- Planning
- Proto
- Scenario
- Setting /Character design
- Storyboard
- Layout
- Key animation
- Color design
- In-betweens
- Backgrounds
- Clean-up
- Compositing
- Editing
- Music
- Sound FX
- Post recording
- Dubbing
- Linear editing
- Release

3D

- Modeling
- Rigging
- Planning
- Proto
- Scenario
- Setting /Character design
- Editing
- Pre recording
- Storyboard
- Layout
- Animation
- FX
- Lighting
- Matte Paint
- Rendering
- Compositing
- Editing
- Music
- Sound FX
- Post recording
- Dubbing
- Linear editing
- Release

Comparing 2D/3D Anime Production Workflow

Modeling: Production Example
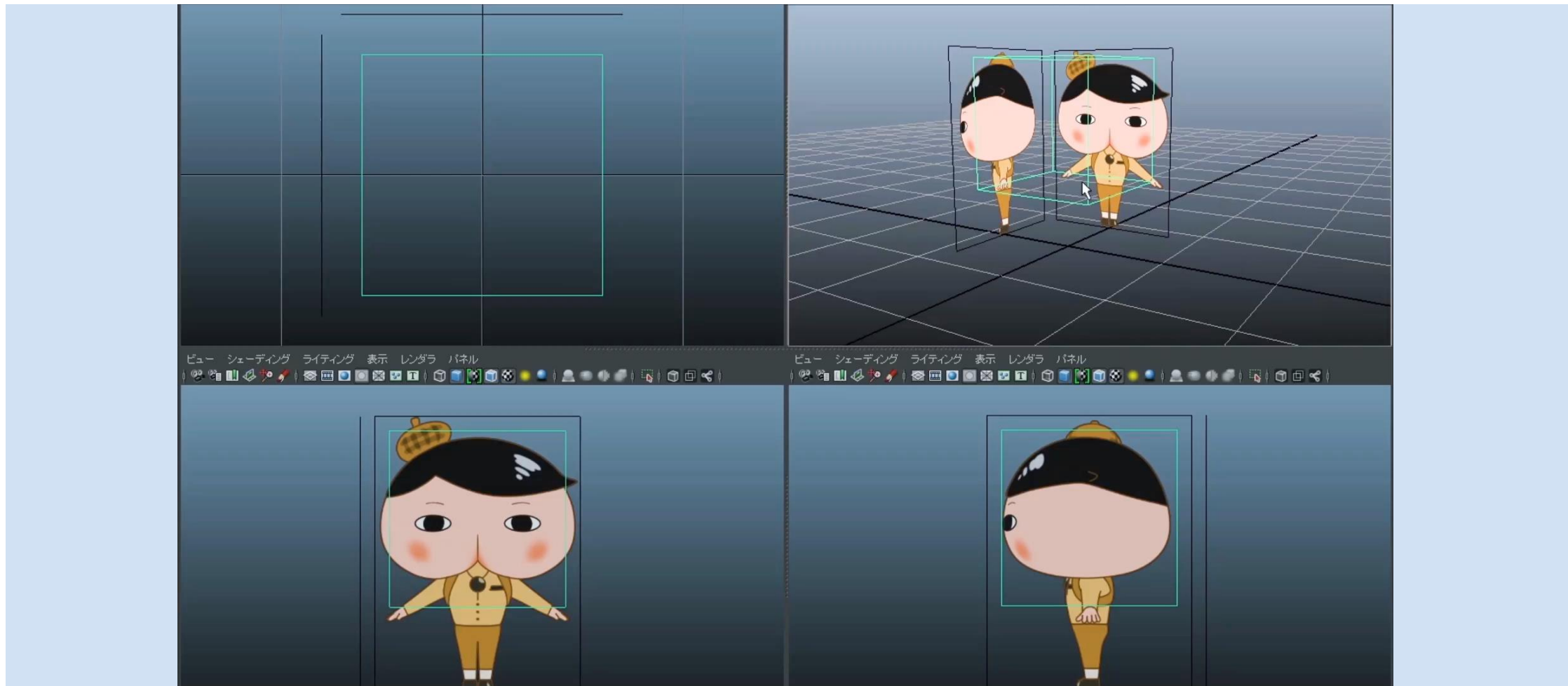
Butt Detective on air in NHK Educational TV

©Troll / Poplar, Toei Animation, NEP

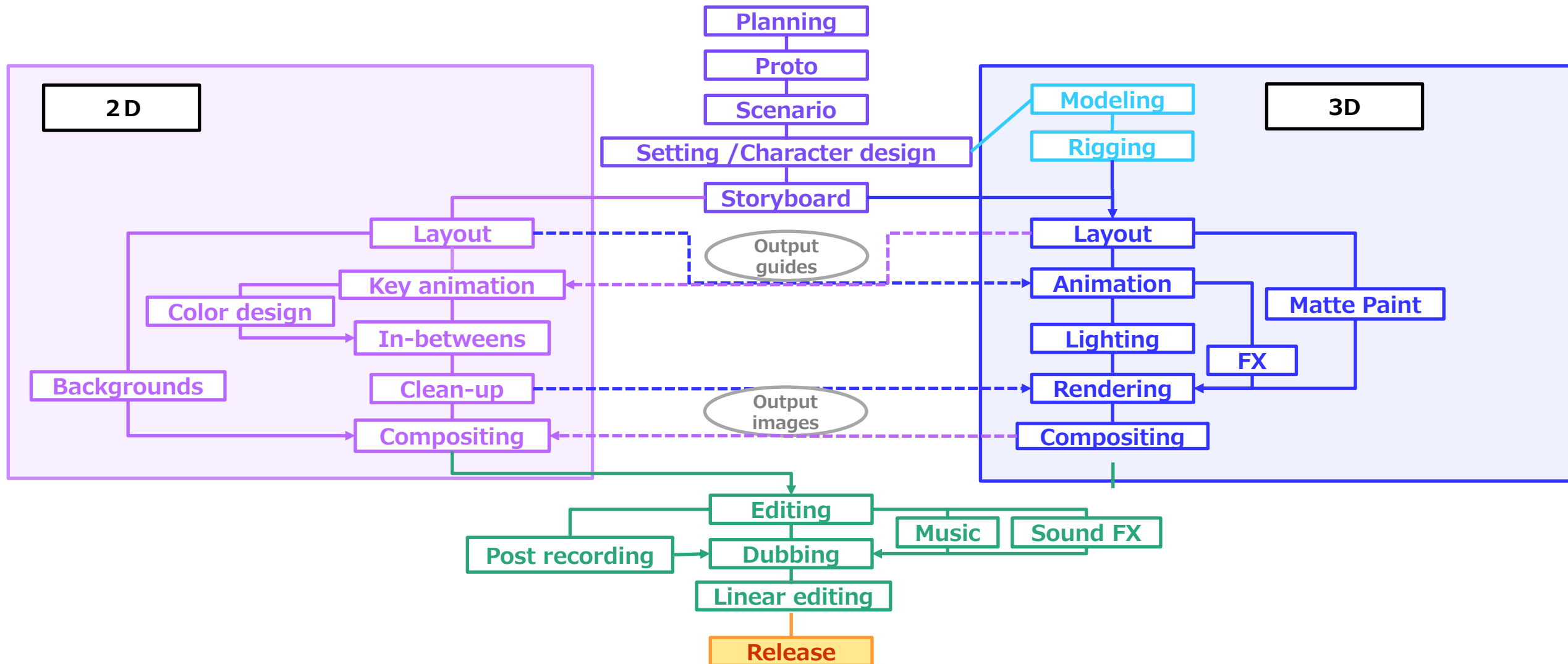Butt Detective on air in NHK Educational TV
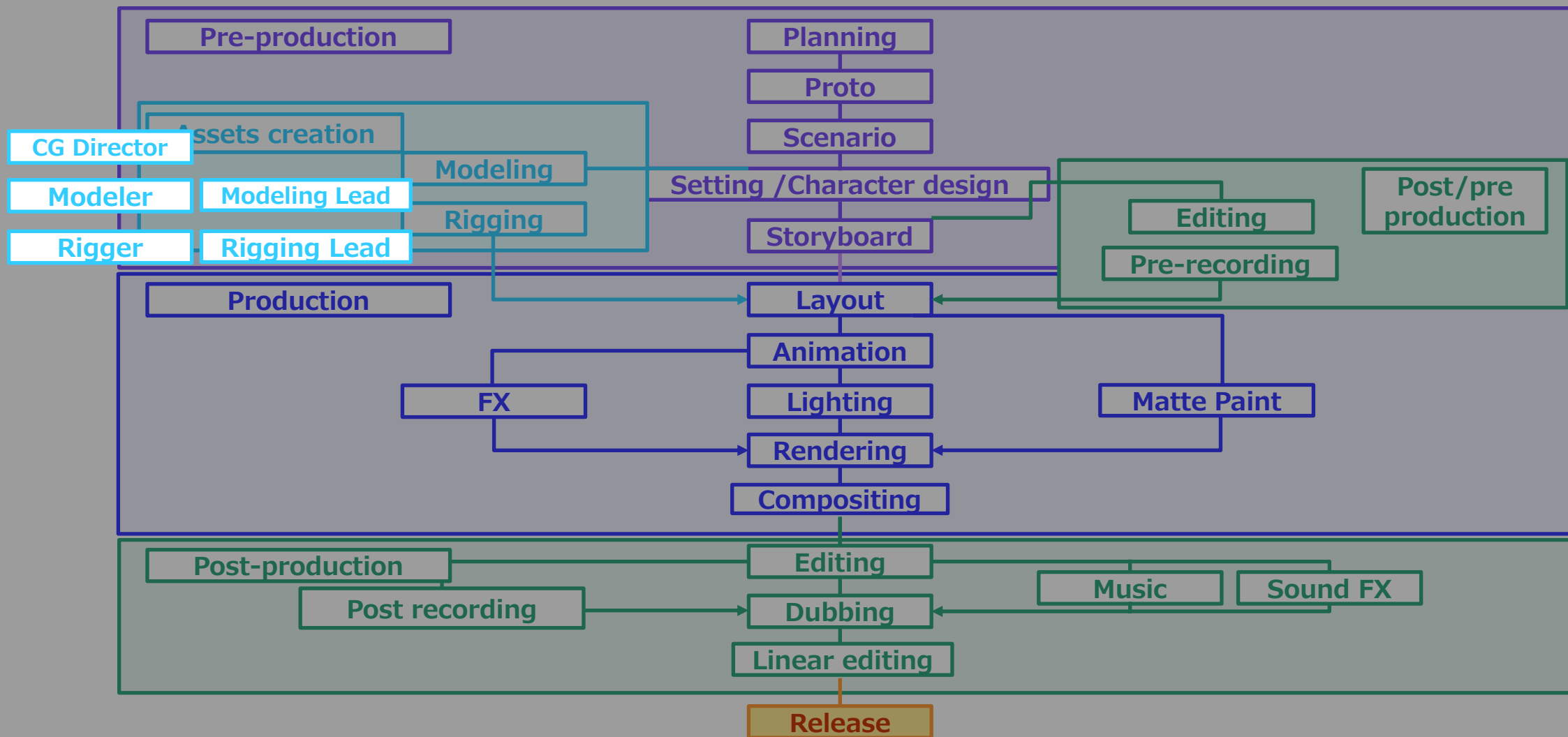
The 3D Anime Production Workflow Staff

- ## CG director
  - Connect the director and 3D staff / check each section

- ## Modeler
  - Modeling of character, props, vehicules, robots, backgrounds

- ## Modeling lead
  - Check and direct modelers

- ## Rigger
  - System to animate the models

- ## Rigging lead
  - Check and direct riggers

The 3D Anime Production Workflow Staff
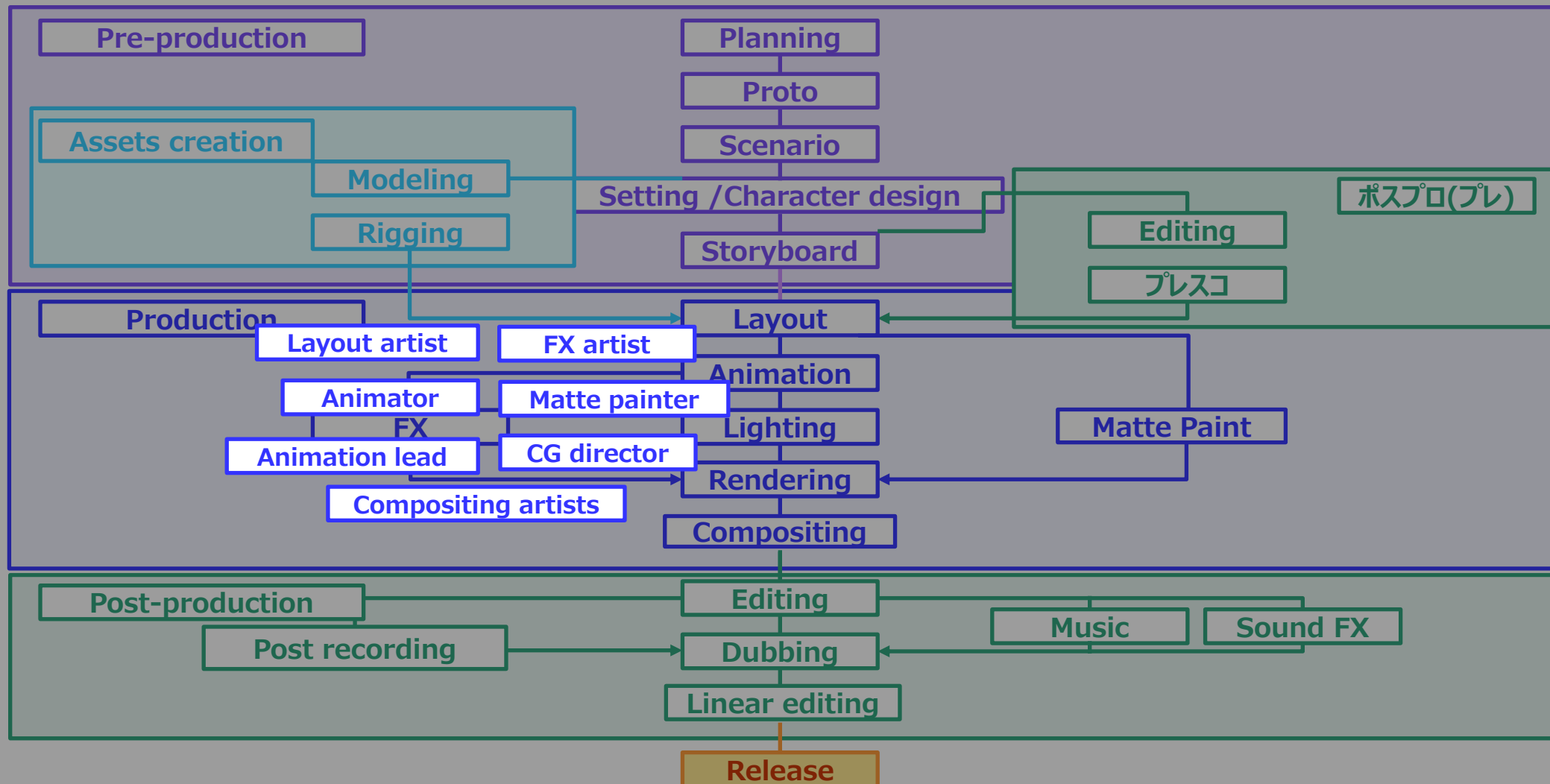
The 3D Anime Production Workflow Staff

- Layout artist
  - Structure of the shot according to storyboard

- Animator
  - Character animation
  - Temporary FX

- Animation lead
  - Animator direction and check

- FX artist
  - FX matching the animation

- Compositing artist
  - Gather all footage to create the final look

- Matte painter
  - Create what 3D modelers cannot/ usually backgrounds

Layout: Production Example

Butt Detective on air in NHK Educational TV

Animation: Production Example

Butt Detective on air in NHK Educational TV
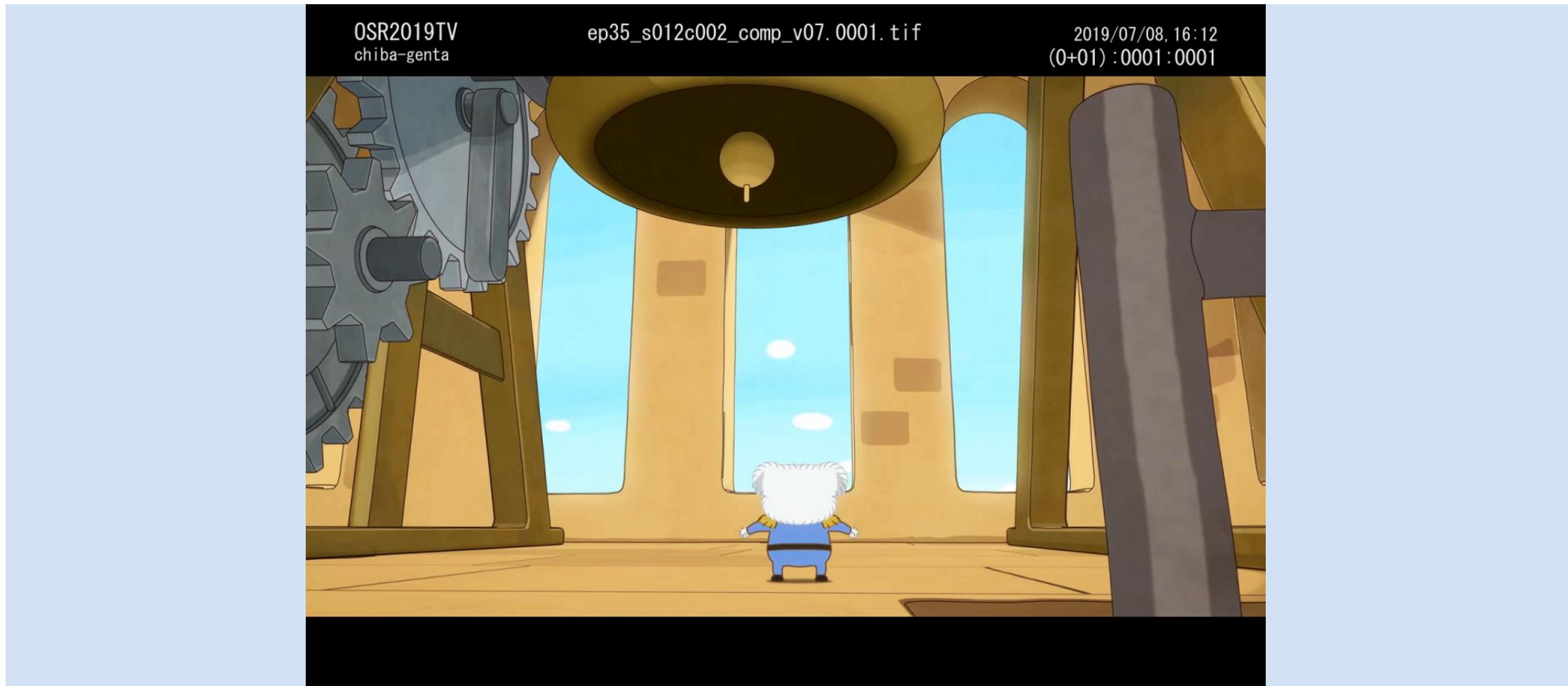
Compositing: Production Example

Butt Detective on air in NHK Educational TV

Storyboard to Compositing: Production Example

Butt Detective on air in NHK Educational TV

The 2D + 3D Anime Production Workflow

About the Workflow

- ## Preproduction
  - From scenario stage, analyze the content and compute the workload
  - Decides what is in 3D
  - Test of final look is crucial to do at early stage

- ## Production
  - Decide if starts from 2D (drawing) or 3D
  - Meeting with director
    - Define the storytelling
    - Decide person in charge

- ## Post production
  - Just Like 2D

Overview of the 2D+3D Anime Production Workflow

- Specificities
  - Many shapes of workflows
  - Good affinity with digital 2D drawing
  - Use after/pre recording depending of for 2D/3D characters respectively
- Pro
  - High range of visual expression, material and texture, complex camera works
  - Can use 2D and 3D where they best fit
- Cons
  - Requires experienced production management staff
  - Data conversion and bridges
  - Need more meetings

Comparing 2D/3D Anime Production Workflow

Comparing 2D/3D Anime Production Workflow
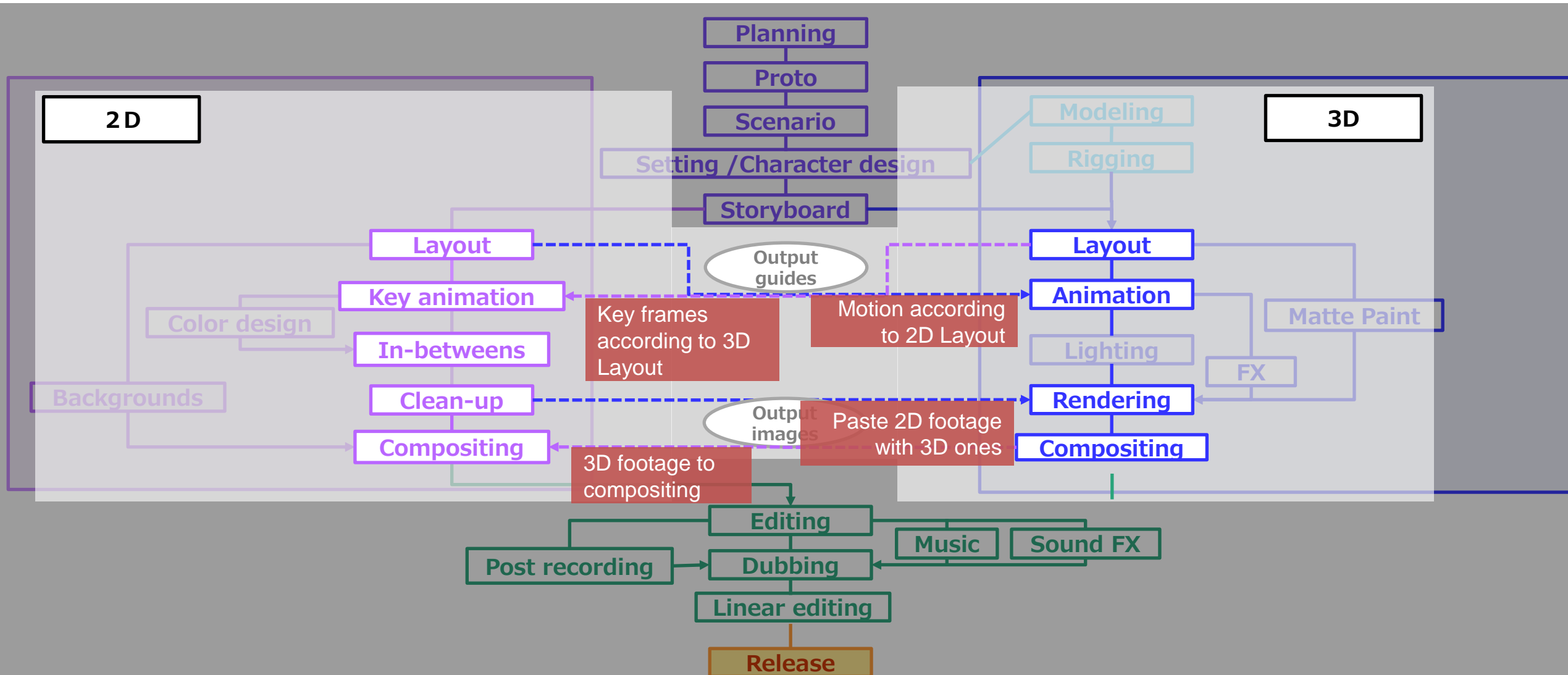
2D

3D

Planning

Proto

Scenario

Modeling

Rigging

Setting /Character design

Storyboard

Layout

Layout

Output guides

Key animation

Animation

Color design

Key frames according to 3D Layout

Motion according to 2D Layout

In-betweens

Lighting

Matte Paint

FX

Backgrounds

Clean-up

Rendering

Output images

Paste 2D footage with 3D ones

Compositing

Compositing

3D footage to compositing

Editing

Music

Sound FX

Post recording

Dubbing

Linear editing

Release

Storyboard: Production Example

Butt Detective on air in NHK Educational TV

Storyboard: Production Example

3D foreground character

決め絵的
必殺技を放つ
絵の中のおしり探偵

Drawing, key animation
Background character and smoke
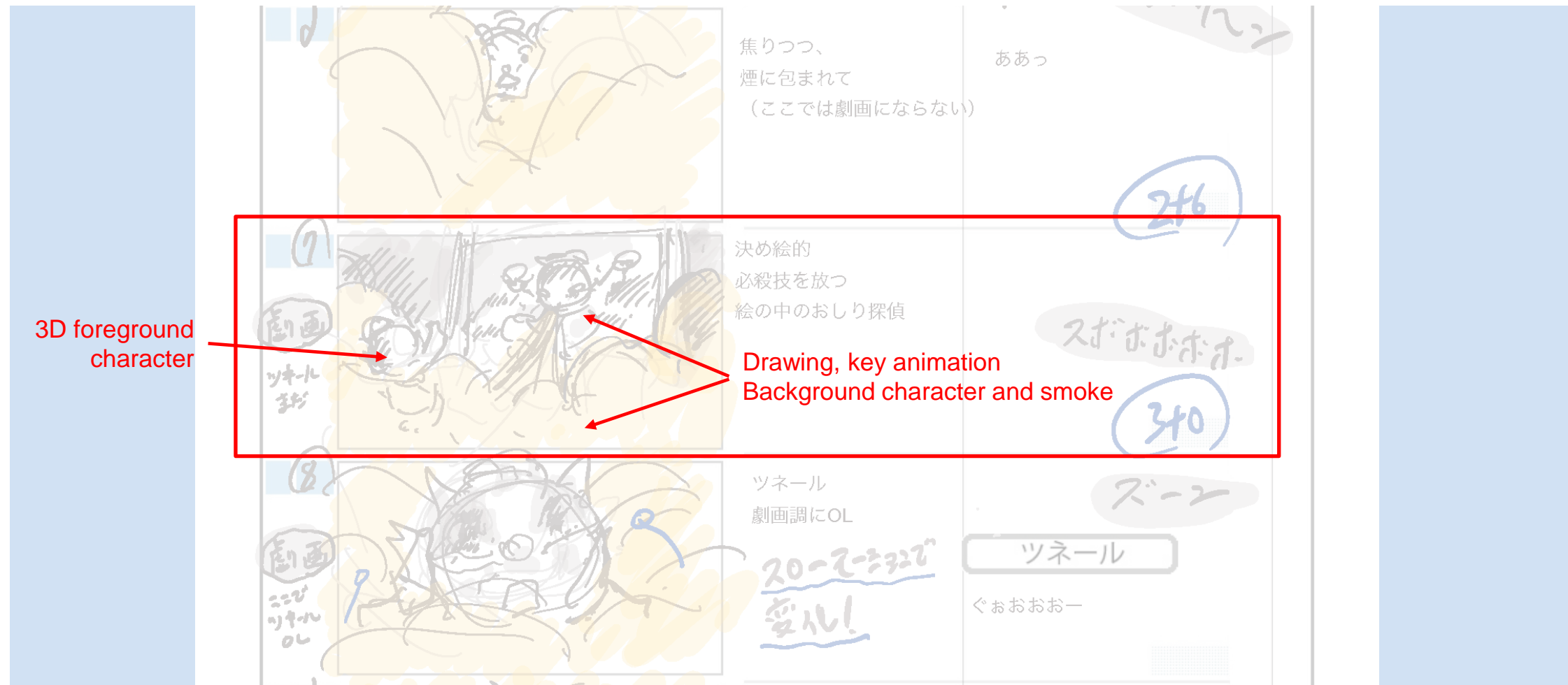
Butt Detective on air in NHK Educational TV

Layout: Production Example

Butt Detective on air in NHK Educational TV

Guides Output: Production Example

Butt Detective on air in NHK Educational TV

Guides Output: Production Example
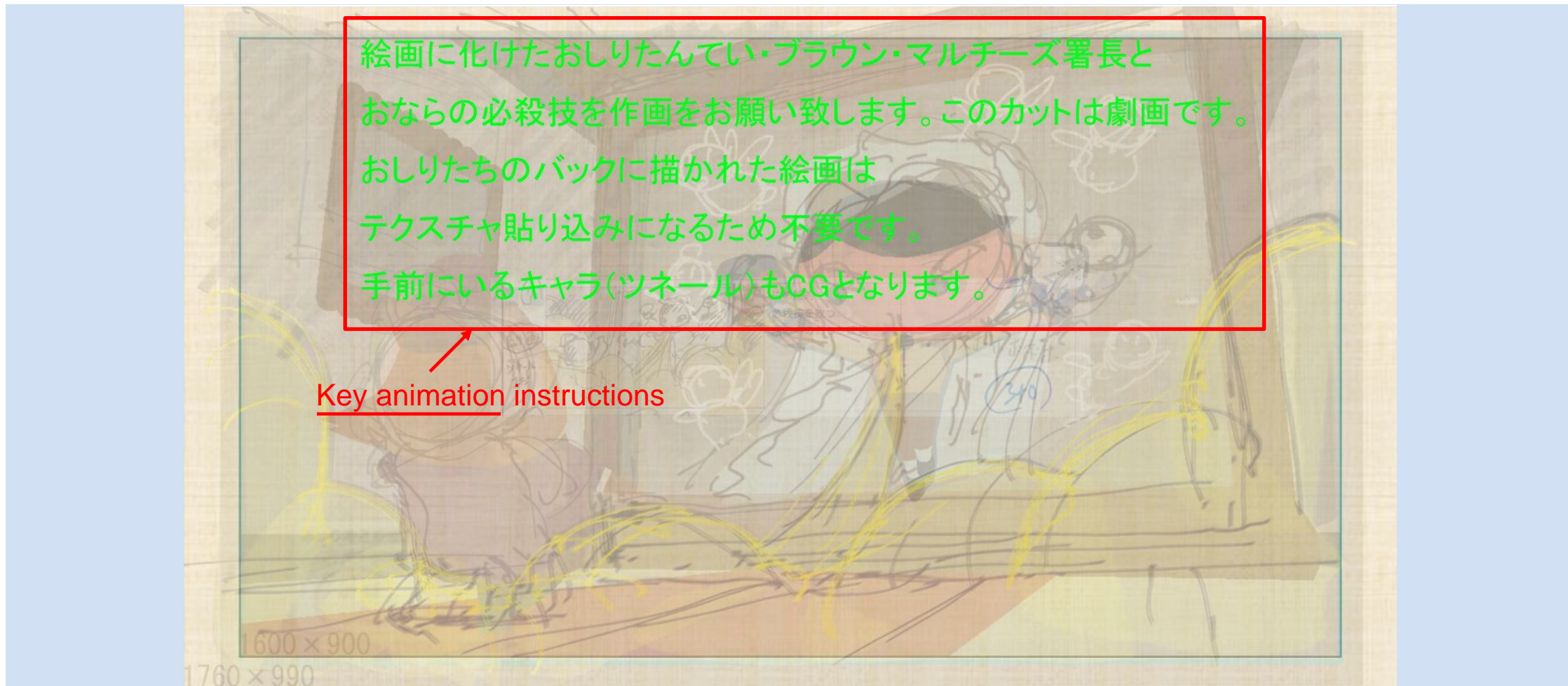
絵画に化けたおしりたんてい・ブラウン・マルチーズ署長と

おならの必殺技を作画をお願い致します。このカットは劇画です。

おしりたちのバックに描かれた絵画は

テクスチャ貼り込みになるため不要です。

手前にいるキャラ（ツネール）もCGとなります。

Key animation instructions

©Troll / Poplar, Toei Animation, NEP

Butt Detective on air in NHK Educational TV

Key animation: Production Example

Butt Detective on air in NHK Educational TV

Compositing: Production Example

Butt Detective on air in NHK Educational TV

Conclusion

- ## Difference with abroad
  - Budget is smaller
    - Mix 2D/3D to get best cost performance
  - Post recording rather than pre recording
  - Still use a lot of paper
- ## Japanese animation future
  - Digital production to coordinate 2D/3D better
  - Adoption of AI
    - Increase automation
    - Focus on creation

Robots in Japanese Animation

Marc Salvati

OLM Digital, Inc.
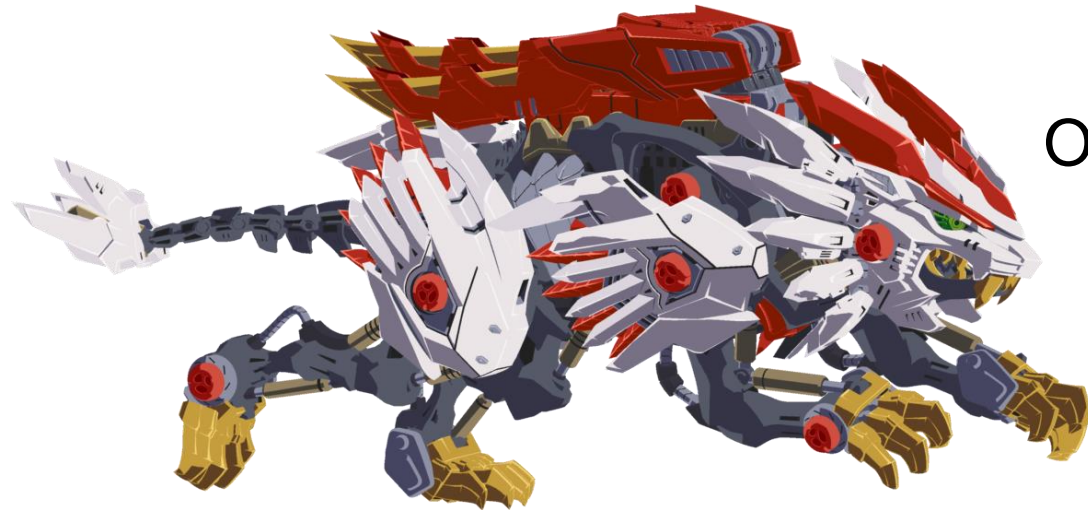
©TOMY/ZW 製作委員会・テレビ東京
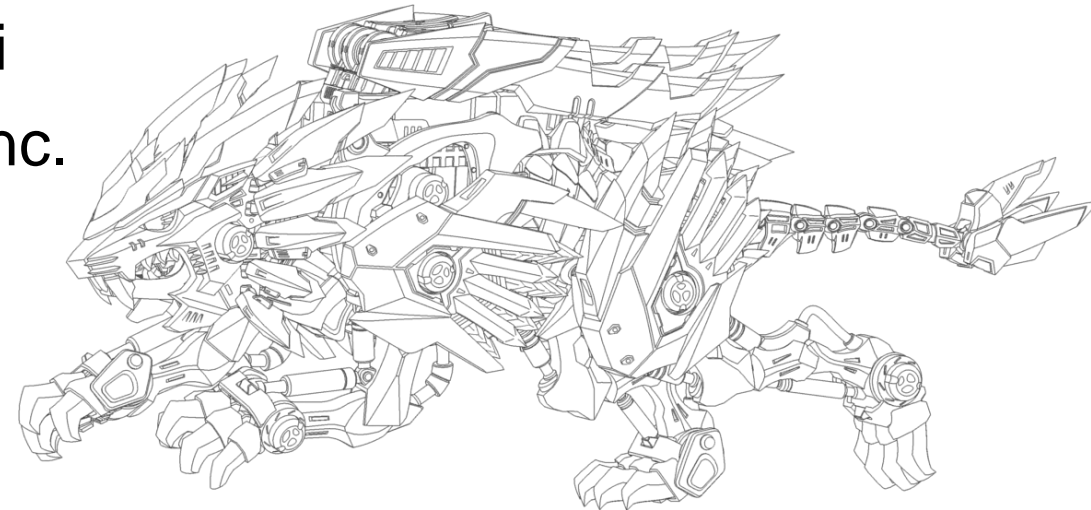
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OLM,Inc. OLM Digital,Inc.

IMAGICA GROUP
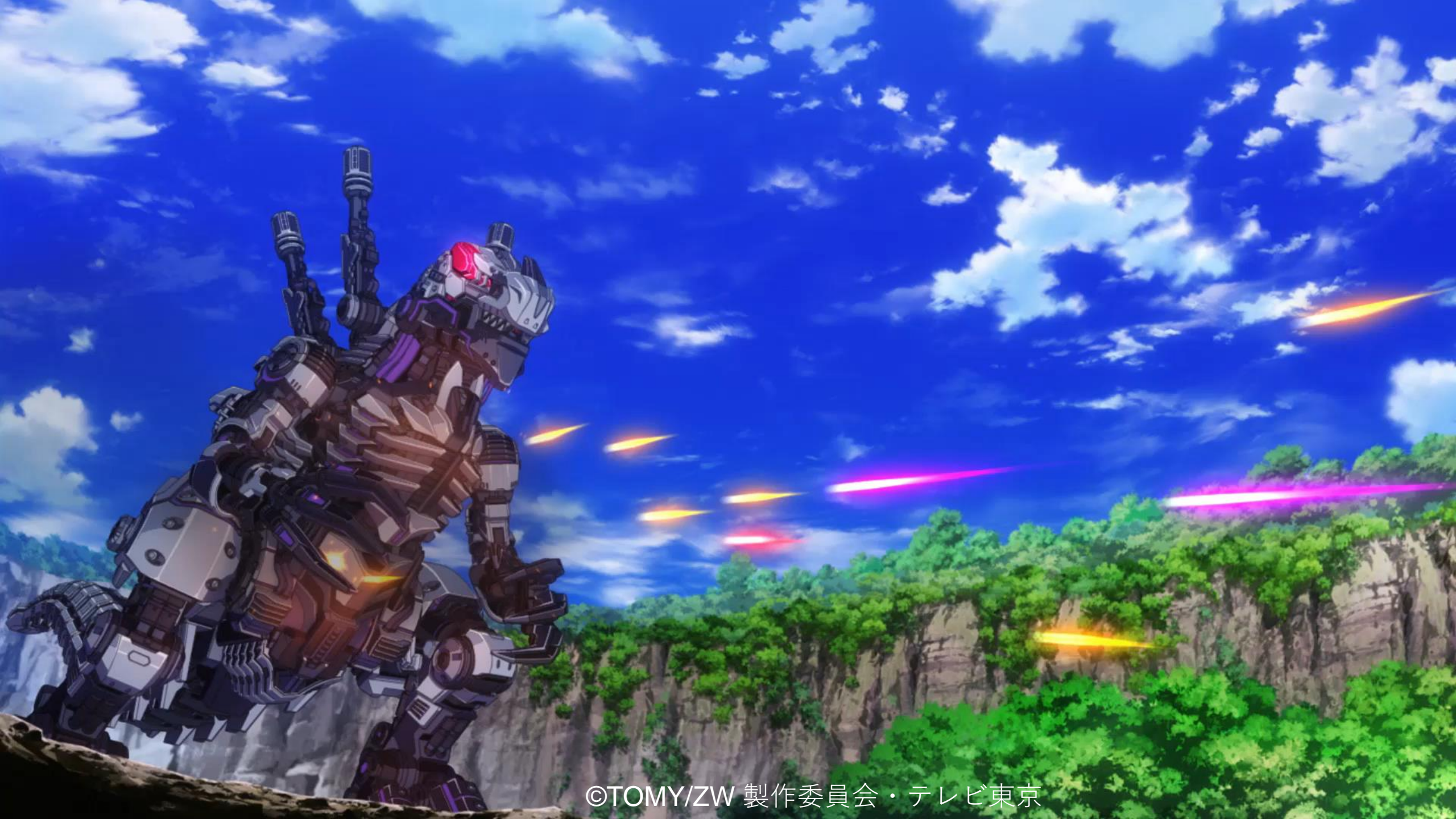
Summary

- About Zoids

- Zoids Wild (2018)
  - Design and modeling
  - Shading and lighting
  - Animation
  - FX and Compositing

- Serie evolution
  - Zoids Wild Zero (2019)
  - Zoids Wild Senki (2021)

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About Zoids

- Sets on planet Zi
  - Zoids
    - Mechanical living creature
    - Used as weapon
  - Human + Zoids = increase fighting power
- TV serie and toys in the early 2000s
  - Zoids Chaotic Century (1999)
  - Zoids New Century (2001)
  - Zoids Fuzors (2003)

Anime VS Toy

©2001 SHO-PRO・MBS・JRK

Zoids 2000s Series

©1999 SHO-PRO・MBS・JRK   ©2001 SHO-PRO・MBS・JRK   © ShoPro・TV Tokyo

About Zoids Wild

- New TV serie
  - [Zoids Wild](#) (2018)
  - [Zoids Wild Zero 1](#), [2](#) (2019)
  - [Zoids Wild Senki](#) (2021)

- Settings changed to Earth

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Zoids Wild (2018)

Concept

- Targeting young kids
  - 6-10 years old
  - Extravagant
    - Gorgeous effects
    - Lots of tametsume in animation
    - Layout and perspective exaggeration
- Link between the zoids and human
  - Being one with the Zoids
  - Mount the Zoids
    - Zoids are smaller than original TV series
    - No cockpits
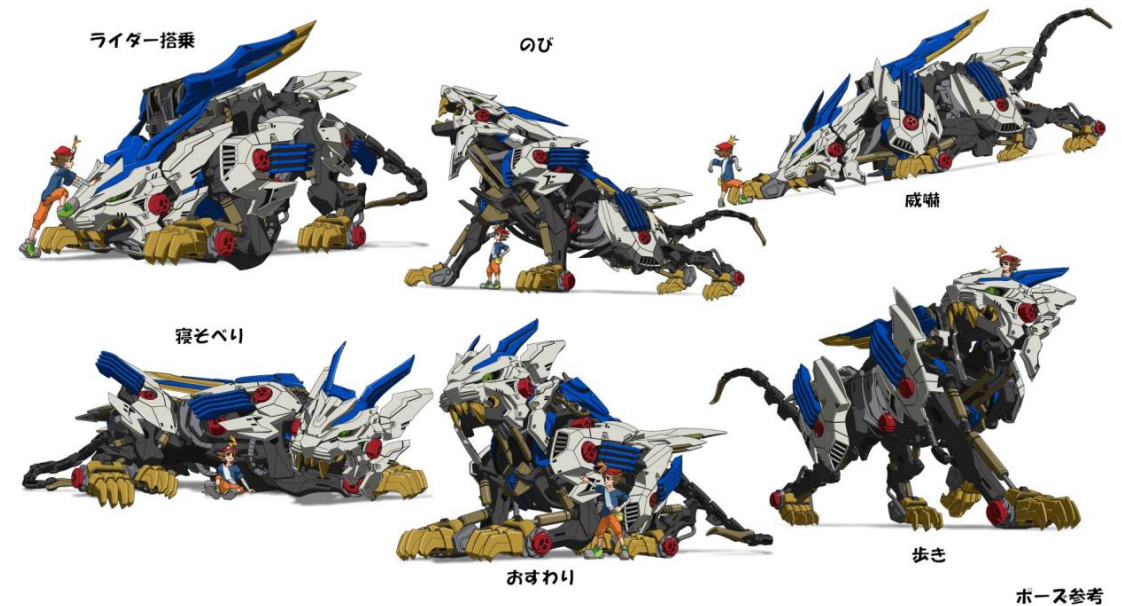
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Concept

- Zoids features
  - Wild/Death blast to increase power
    - Heroes' connection with the Zoids
    - Bad guys forcingly inserting Zoids key
  - Living machines
    - Big eyes VS Old TV series (no eyes)
    - More emotions, more like animals

- Client request
  - Zoids 3DCG
  - Human hand drawn

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Modeling

Size

- Zoids (1999)
  - Zoids are big
  - Human use cockpits

- Zoids Wild (2018)
  - Down scale to human size
  - Human can ride the Zoids

©1999 SHO-PRO・MBS・JRK   ©2001 SHO-PRO・MBS・JRK

ライダー搭乗   のび

寝そべり

おすわり   歩き
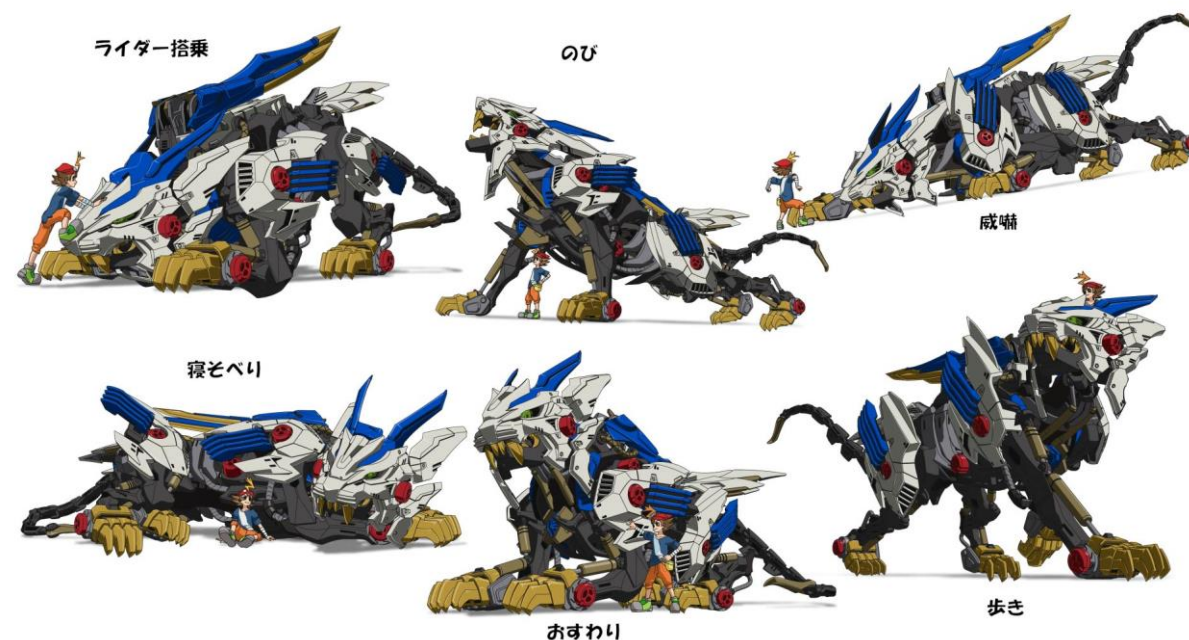
ホース参考

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From Toys to CG

- Start from the CAD data of the toys

- Edit for the cartoon
  - Enable animation
  - Enable cool motion but stay good looking

- Changes the visual of toys
  - Requires approval from the toy company

Approval Process: Mix of Digital / Analog

Visual Changes: Details

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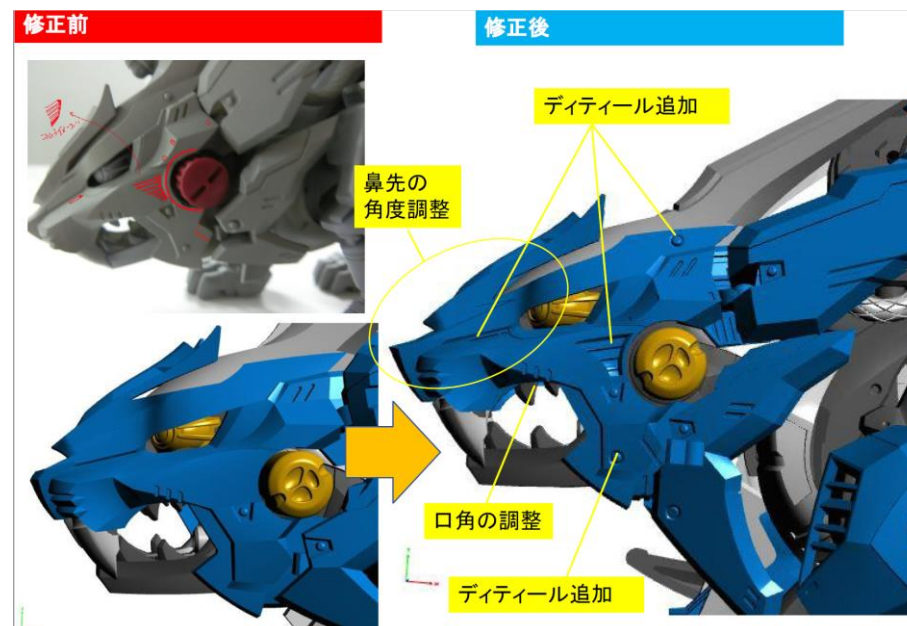
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Final

Final Toy
©TOMY／ZW製作委員会・MBS
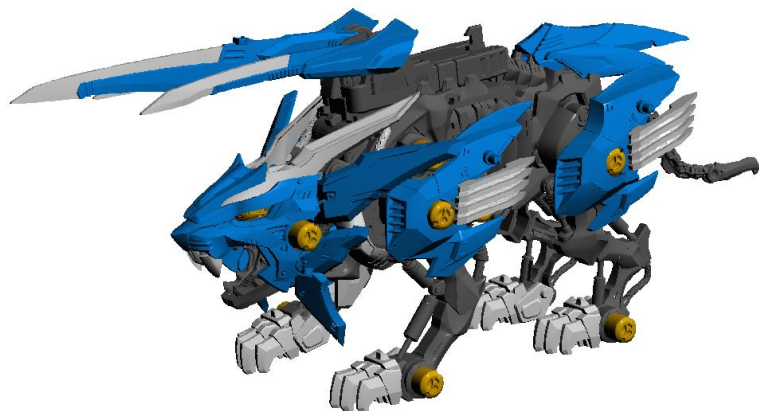
Final Toy CAD
©TOMY／ZW製作委員会・MBS

Toy box
©TOMY／ZW製作委員会・MBS

ワイルドライガー   2017/11/22

※色は仮色になります。最終はアニメ色彩設計に準じます。
　アニメ設定により形状の微調整をする可能性がございます。   OLM Digital.inc

Final Cartoon Design
©TOMY／ZW製作委員会・MBS

Color Changes

- More colors than the toy
  - Because we can
  - Too expensive for mass production

Real Toy
©TOMY／ZW製作委員会・MBS

Final Cartoon Design
©TOMY／ZW製作委員会・MBS

Color Changes

- More colors than the toy
  - Because we can
  - Too expensive for mass production

Real Toy
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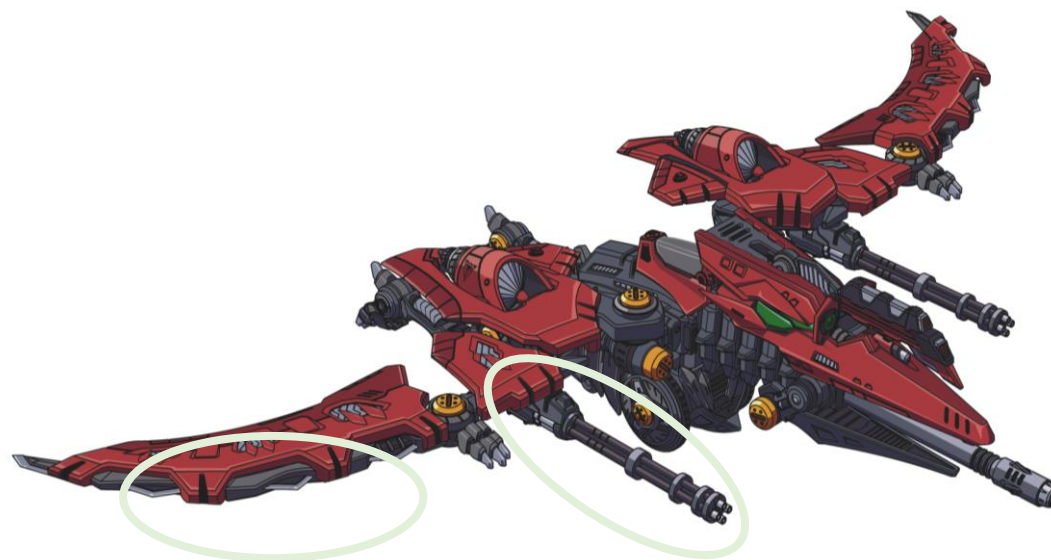
Final Cartoon Design
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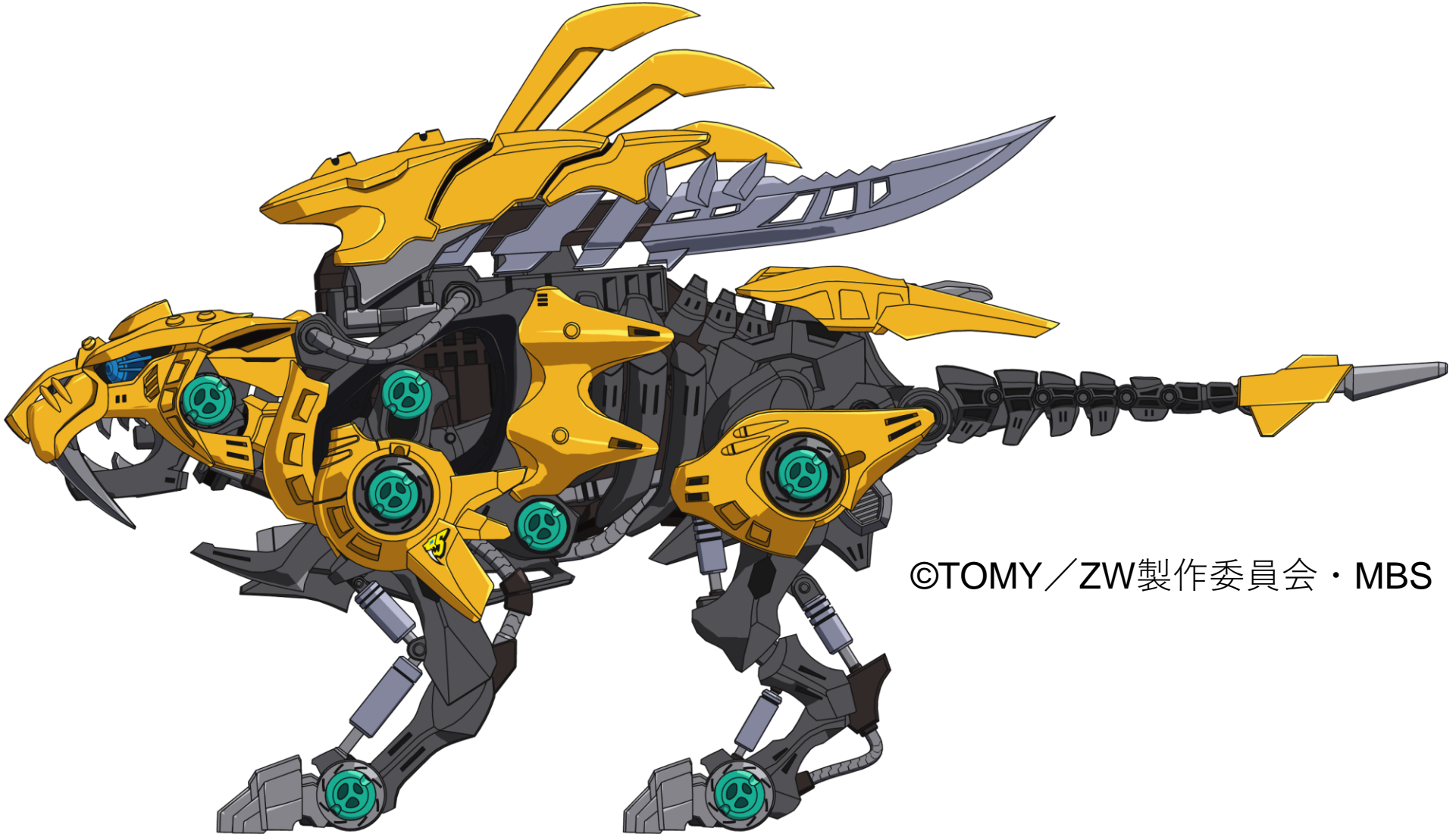
Modeling for animation

Modeling for animation

- Original design had shaft/piston that extends/contract
  - Change to avoid complex rig

Original VS corrected design
©TOMY／ZW製作委員会・MBS
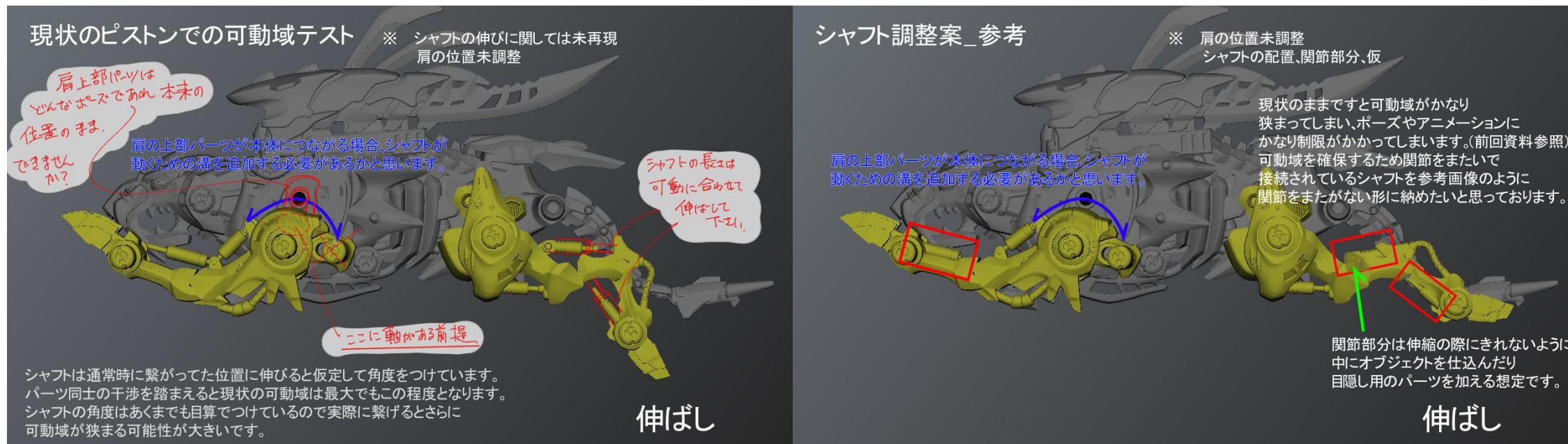
Modeling for animation

- Original design had complex shoulder
  - Piston part would create intersections
  - Would need to add a rail so that the piston may slide
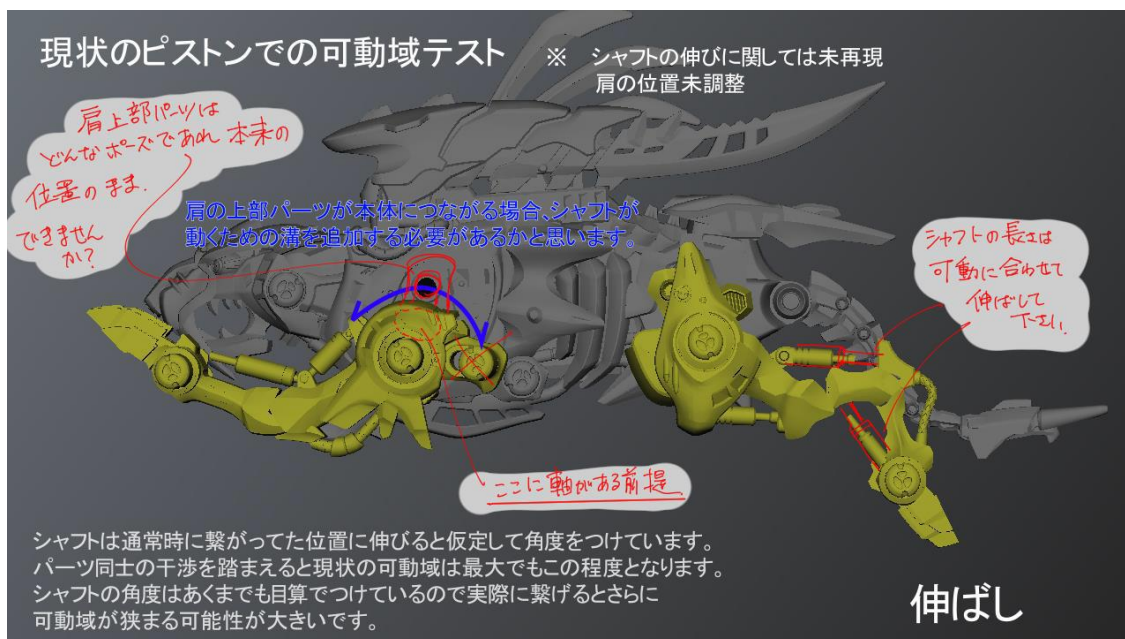
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Keep the piston on the main body
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Modeling for animation

- Real lion shoulder is high
  - Follow toy design
  - Add shoulder offset capability in the rig

担当：OLM kkimura　999 話　0001　アニメーション　000132/000132

肩位置上げ

細かい箇所は後程調整予

Shoulder like animal

肩位置デフォルト

Shoulder from toy design

歩きテスト

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Modeling for animation

- Belly was too big to animate
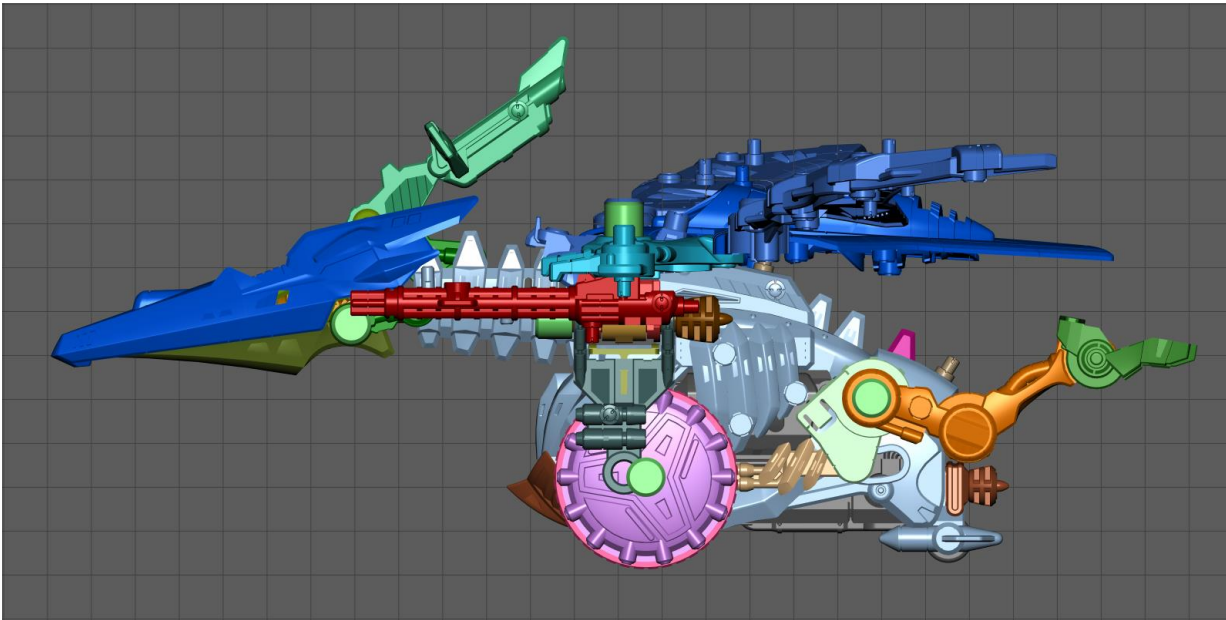
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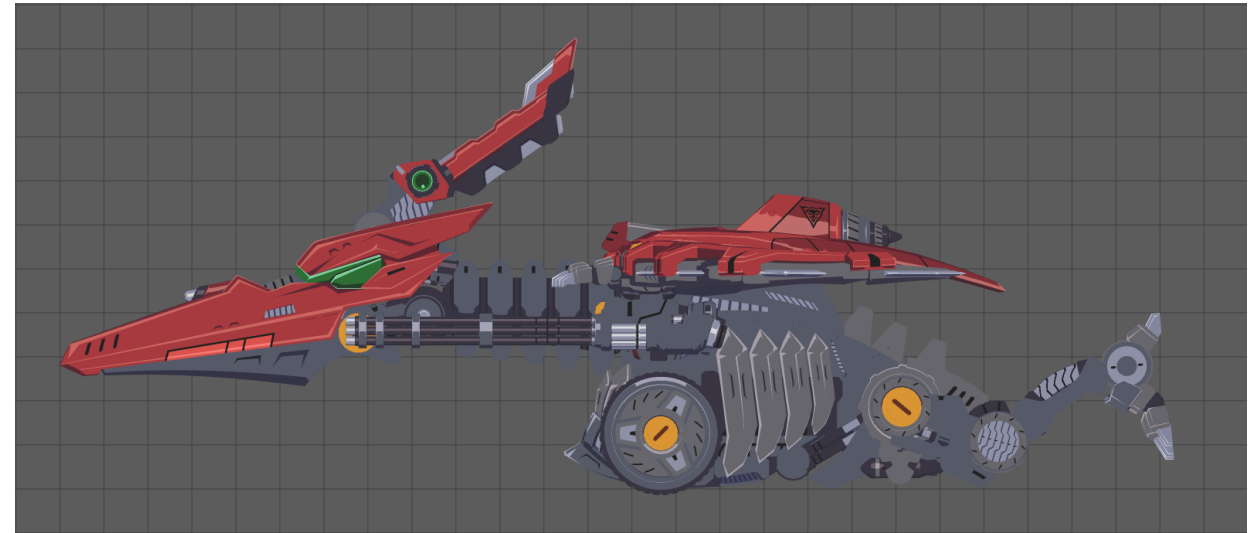
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Modeling for animation

- Added articulation in the wing to make it easier to animate
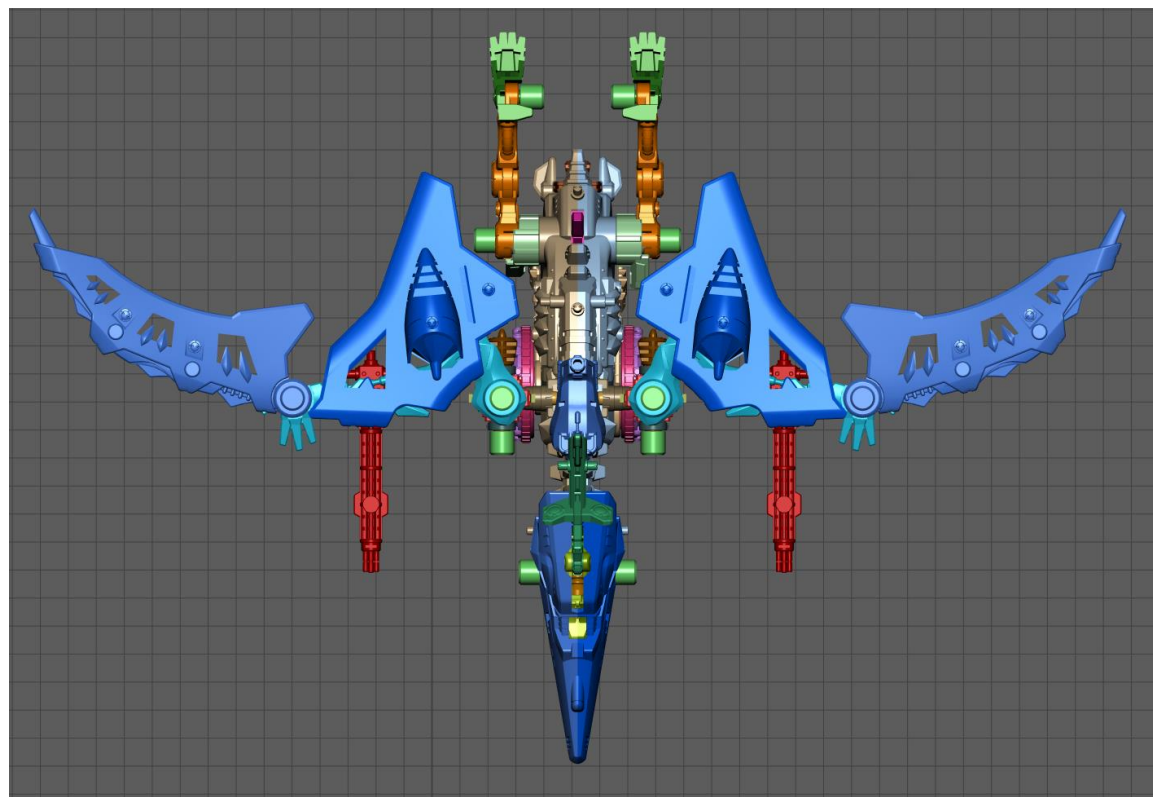
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Animation

Walk and run test

- First time for lot of staff to animate 4 legs animals
- Needs
  - Cycle
  - Feel the ground
  - Feel the weight
  - Wild feeling rather than robot
    - Not too smooth
    - Not too hard
    - Not too random

Walk and run test

The body looks like it s hanging in the air

Walk and run test result

- Half were not cycles
- Needs reference

Reference: between Robot and Animal

- Robot
  - Main thema: Easy to read
  - Like original TV serie
  - Stiff body with stiff spine
  - Sound of steps only once per cycle
  - Longer aerial time => strong force required => big and powerful robot
- Wild
  - Main thema: Exaggerated motion
  - Motion bending from the head to the tail
  - Smaller and wild robots => rough motion

Reference : between Robot and Animal

Robot style animation
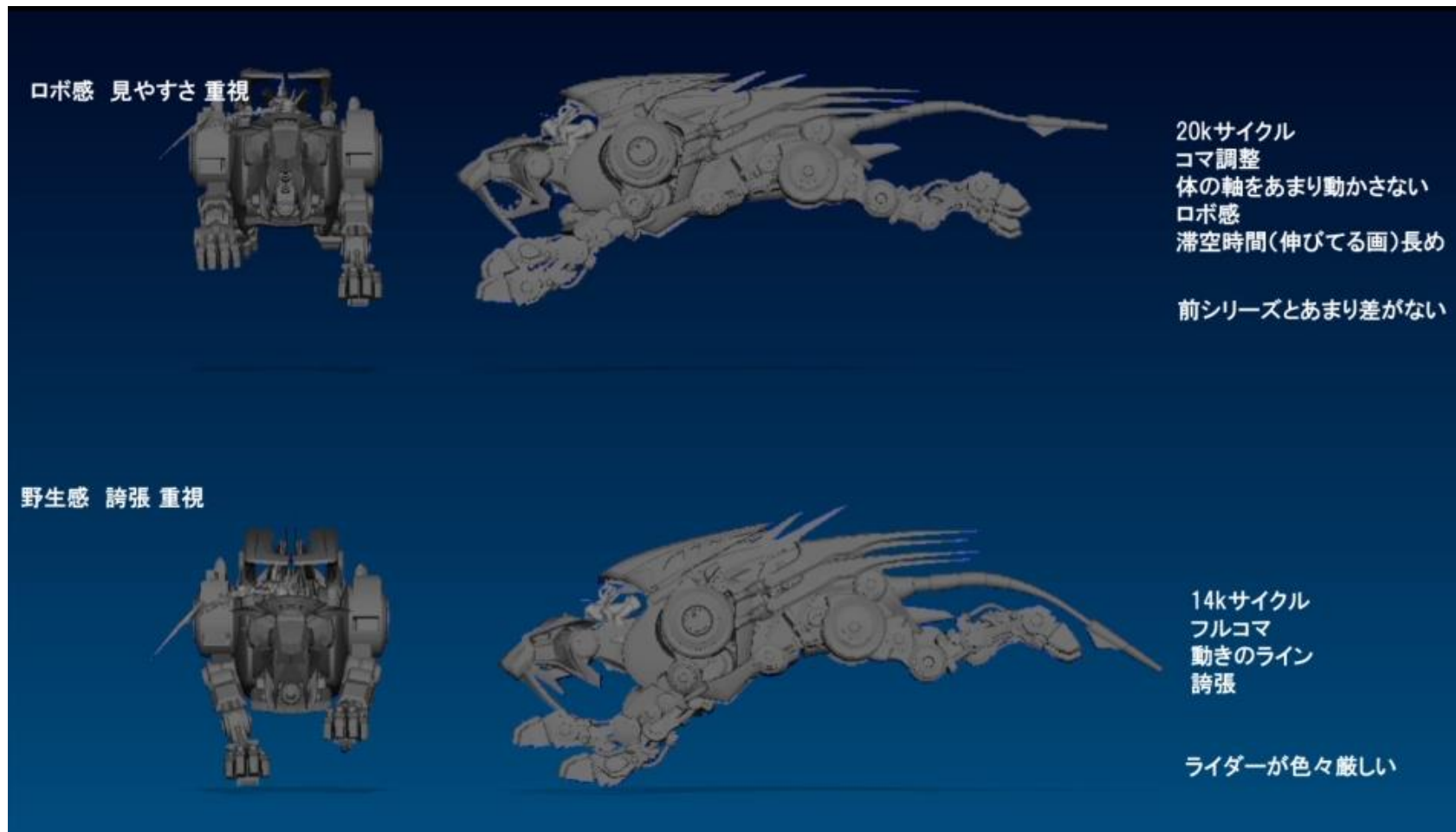
Wild style animation

Reference : between Robot and Animal

- Robots motion are too slow

- Wild has more exaggeration

- In-between wild and robot
  - Wild motion is too dynamic for rider
  - On 2s

Final Reference Run Animation

Animation library

- As reference/start for animators
- Help keeping the schedule
- Before the project starts
  - No time during the production
  - Don't have storyboard, don't know what kind of action will come
- Forecast what will be used
  - Walk/Run/Idle for most Zoids
    - Run = Walk *speed
    - Same structure for some Zoids, re-use of some animation
  - Attack/Jump/Roar/Idle
    - Didn't use that much in the end

Walk

歩き　　walkB AN　　歩きモーションA　　zFTigerA　歩きA

zGanontusA　歩きA　　zGGatorA　歩きA　　zGRaptorA　歩きA　　zGSaurusA　歩きA

歩きA　　ハンターウルフ tempAN 歩き　　AN//44fループ　　歩きA　　zKabterA　歩きB・遅め

001

Run

runB AN

zFTigerA 走りA

AN//28fループ 走りA

001

ハンターウルフ tempAN 走り（AUX前後あり）

zGRaptorA 走りA

zGGatorA 走りA

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Roar, Jumb, Idle, Attack

Roar
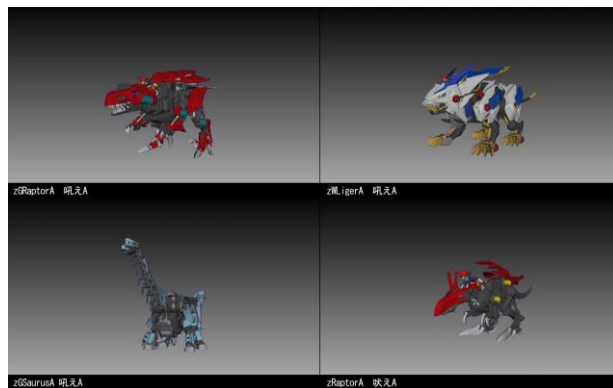
Jump
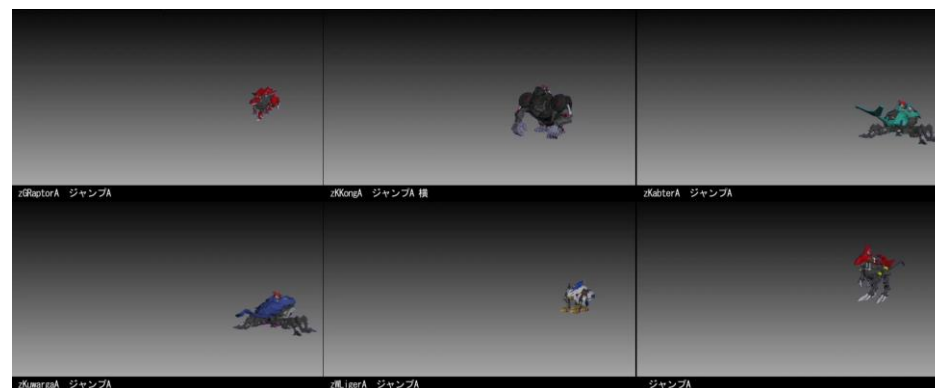
Idle
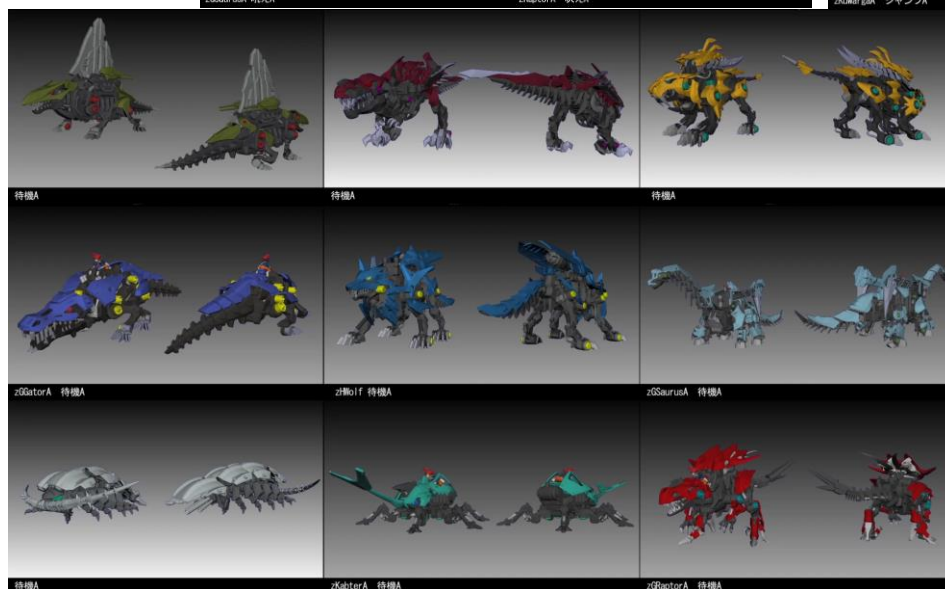
Attack

Animation and Limited Animation

Base Motion: Pose to pose

- Create the key frame
- One pose per key frame
  - Key every controller
- Minimize the number of controller that have animation
  - Apart of key frame, don't put any animation!
- Need to use rig controller smartly
  - Motion decomposition using hierarchy of controllers

Base Motion: Pose to pose

1F 構えスタートポーズ
©TOMY

20F 攻撃ポーズ
©TOMY

10F 振りかぶりポーズ
©TOMY

32F 攻撃終わりポーズ
©TOMY

Tame (Accumulation) / Tsume (Fast action)

- Add key before/after the key poses
  - Before/after key poses
  - Key all controllers
  - Don't change the poses
- Adjust timing
  - Slow for tame/accumulation
  - Quick for tsume/fast action
- Can use AE time remap to create a sample before
  - Especially useful for retakes
  - Easier to adjust

Base Motion: Pose to pose
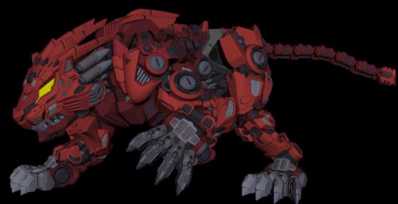
1F　構えスタートポーズ
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10F　振りかぶりポーズ
©TOMY

32F　攻撃終わりポーズ
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Tame (Accumulation) / Tsume (Fast action)

Tame   Tsume   Tame   Tsume   Tame   Tsume
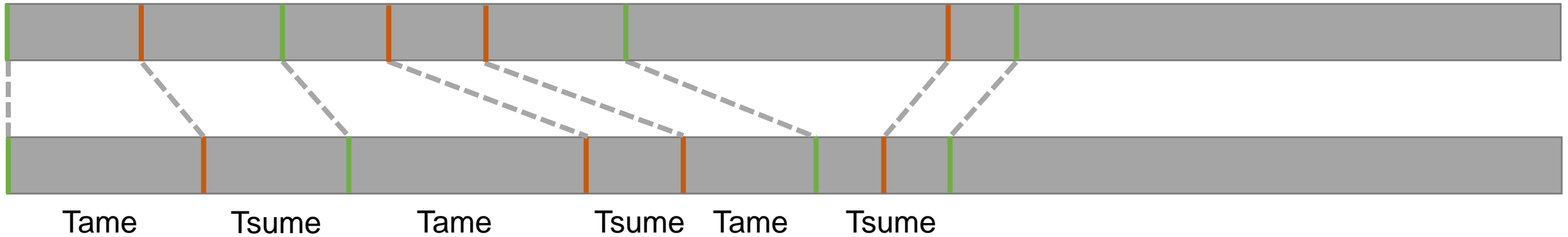
Side by Side Example

Left: just the key poses, Right: after Tametsume

Limited Animation (Koma Ochi)

- Less than 1 drawing per frame
  - One 1s : one drawing per frame (backgrounds)
  - One 2s : one drawing every 2 frames
  - One 3s : one drawing every 3 frames
  - Use After effects Time remap set on 2s by default
- Irregular
  - Add frame to read motion that are too fast
    - Up to full frames, on 1s
    - Can get too smooth
  - Emphasis on tame
    - Up to on 3s
    - Animation is not moving that much so drawing don't jump too much

Details and Timing

- Add detail motion
  - Follow through (from the 12 principles of animation)
  - Action/Reaction
- Timing adjustment
  - Time remapping in After Effects
- Secondary motion
  - After timing adjustment to not loose details
  - Hairs and cloths dynamic motion
    - Just for CG character
    - In Zoids, usually far away, so not critical
  - Facial expressions
  - Manage intersections

The don'ts Notes

- Don't key controllers subsets at various time
  - Makes the animation complicated to adjust and manage
- Avoid straight ahead work
  - Opposite to pose to pose
  - Impossible to manage personally
- Avoid animation layers
  - Difficult to control/manage
  - Every animator use them differently
  - Most people use too much layers
- Avoid scale with graph editor
  - Keyframe may end up at non integer positions
  - Difficult to adjust timing after wards
- Limited animation pitfall
  - The speed feeling on 2s and on 1s is very different
  - For very fast action on 1s is ok
  - Lips motion is always limited
    - Be careful to no skip a pose with timing adjustment

CG and Hand-Drawn Hybrid

CG and Robots

- Difficult to draw robots
  - Lots of articulated parts and details
  - Lots of action
- CG is efficient for robots
  - TV series have tight schedules
- Mixing CG and drawing is difficult
  - Contact between characters and robots
  - Drawing to set at the right depth
    - Need parts rendering
  - CG character mix well with CG robots
    - Less expressive

Try to Draw only Eyes and Mouth

- CG robots and CG humans
- Human eyes and mouth hand drawn
  - Send camera information and face locator position to After Effects
  - Remap eye/mouth animation in 2D
- Not satisfying, abandoned

目・鼻・口をＡＥ上で貼り付け

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目・鼻・口をＡＥ上で貼り付け

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Parts Rendering

- Render Robots and masks
  - Lines
  - Color
  - Masks
  - Character
- Use masks to isolate parts
  - Robots face
  - Body
- Use CG character render as guide
- Composite
  - Mask the foreground to composite over drawing
  - Requires back and forth between compositing and 3D
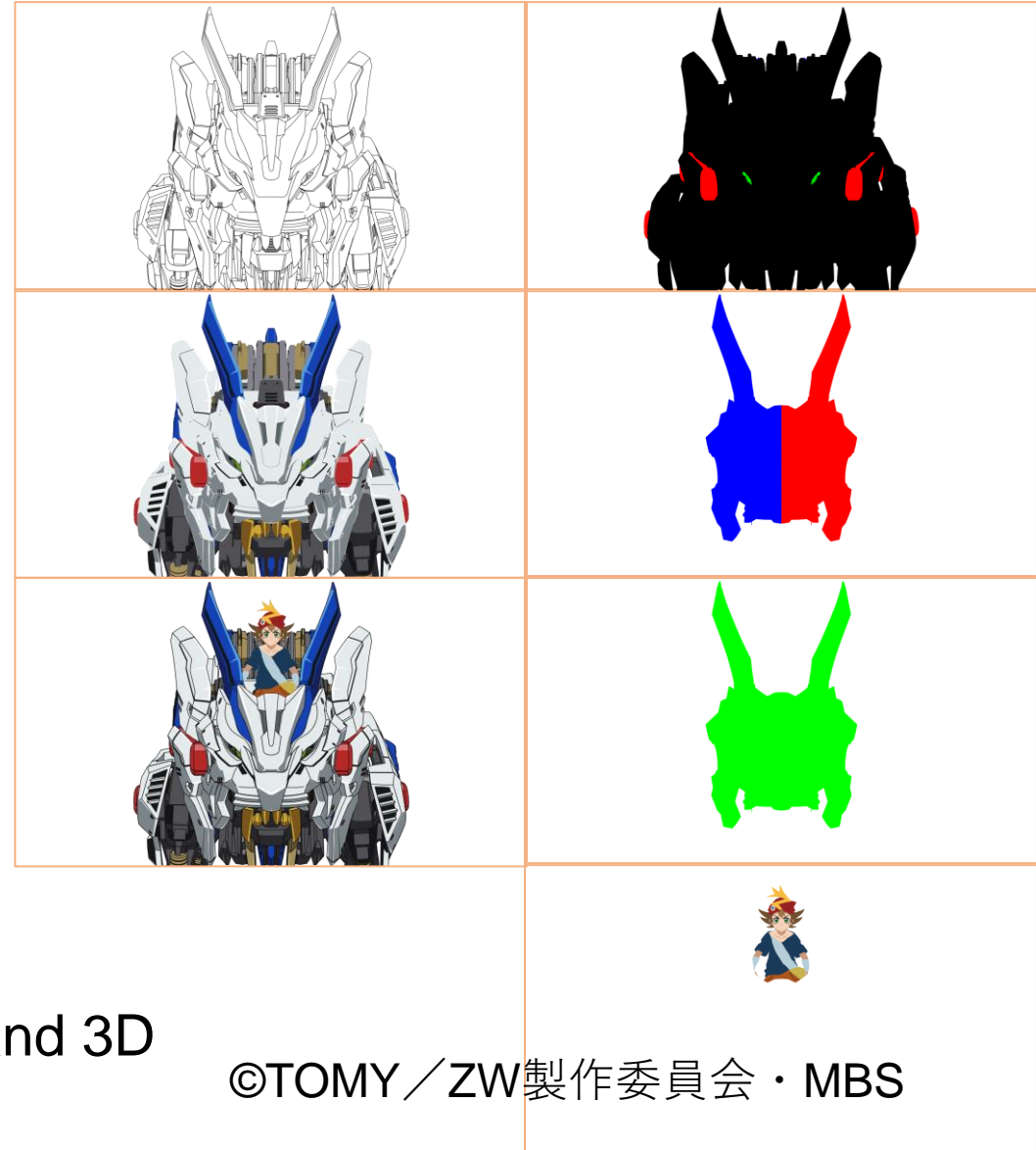
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Parts Rendering

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Parts Rendering

- Render multiple angles library
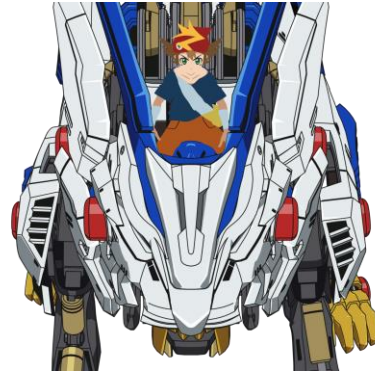
Compromise to Achieve CG Hand Drawn Hybrid

- Close up using parts rendering
  - Zoids 3D CG
  - Human hand-drawn
- Intermediate/long distance with CG
  - Zoids and character in CG
  - Character CG may be replaced/drawn over/retouched by drawing section
- Action scenes
  - Zoids and character in CG
  - Some hand drawn retouch by CG staff

Zoids Wild: Action Scenes Retouch

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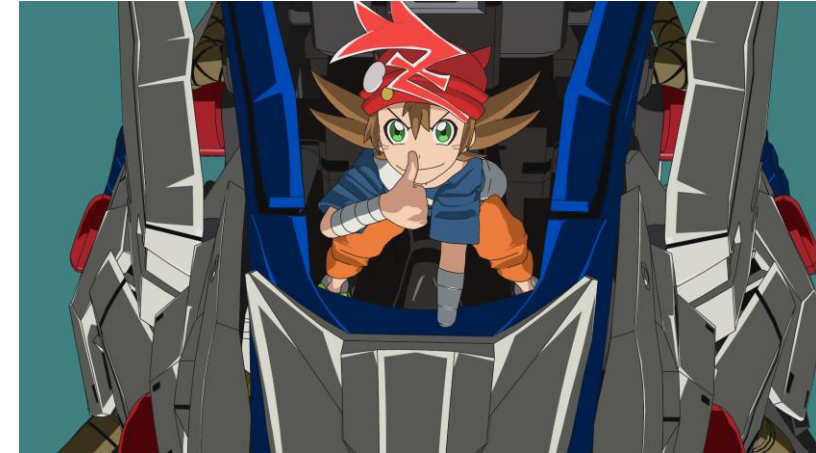
Before
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After
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Zoids Wild: Action Scenes Retouch

Before

After

Look

Look

- Avoid the 3D CG look
  - CG with smooth gradation like in games

- Output masks and AOVS
  - Lot of work in comp

- No transparency
  - Too complicated for TV serie

Look: Normal Shot

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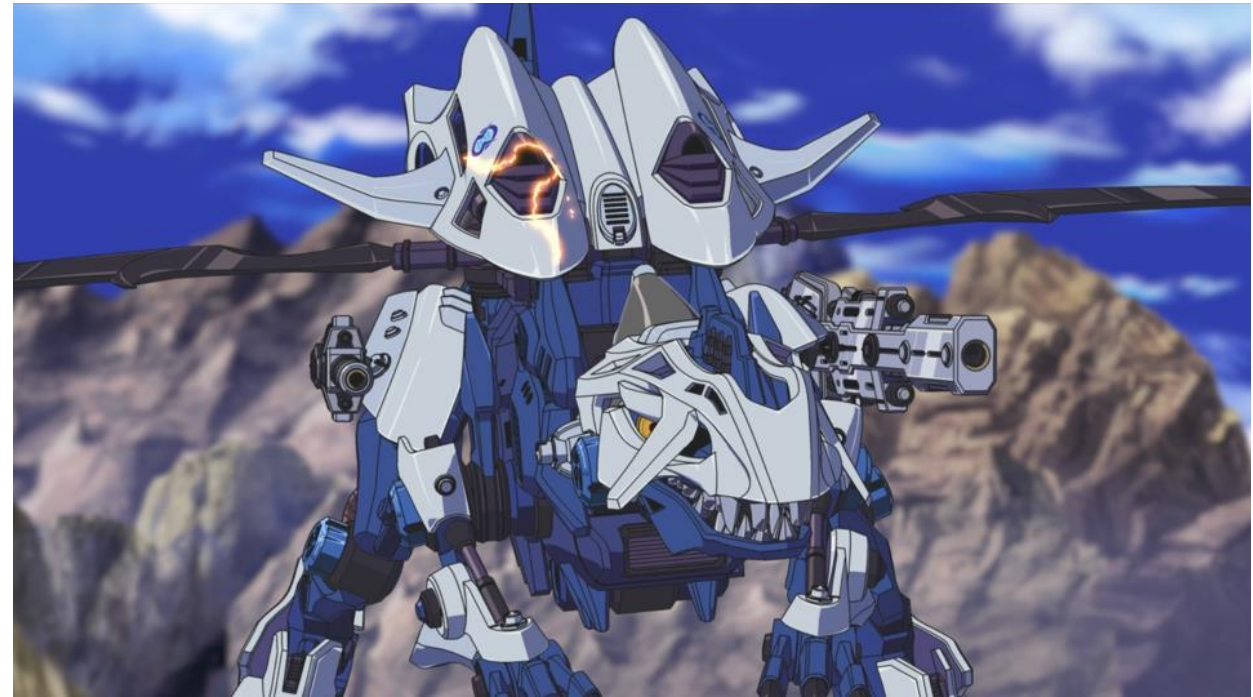
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Look: Gorgeous Shot

Look: Toon Shader

- Contours
  - Object outline
  - Feature lines
- Cel shading
  - Ramp indexed by brightness
- In Arnold
  - In house shader
  - GPU preview
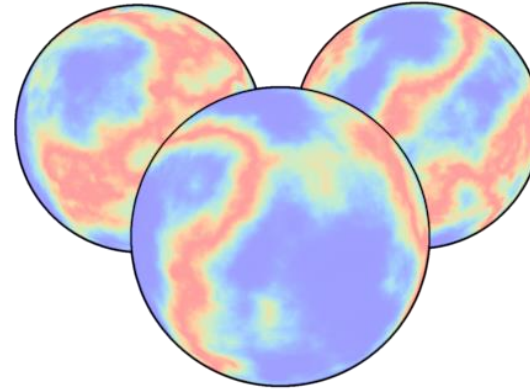
Contours
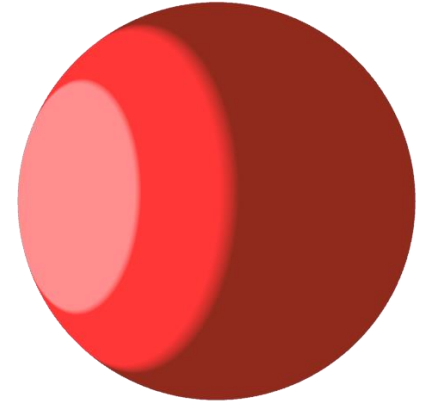
Cel shading

Cel Shading

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Basic Cel Shading

- 3 basic color
  - Normal, shadow, highlight
  - Map using brightness

- Control over transitions

- Up To five colors
  - Secondary shadow, secondary highlight
  - In Zoids 4 colors using secondary shadow
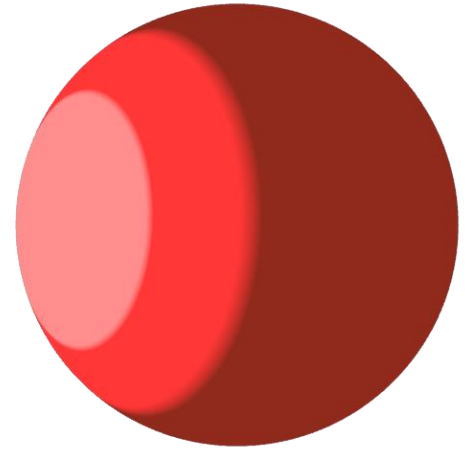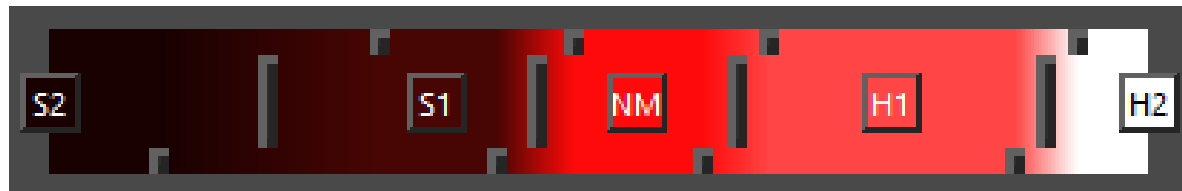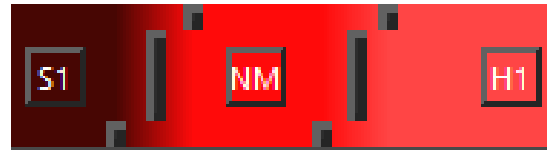
Basic Cel Shading

- Use 4 colors, 4 textures
- Some highlight/shadows in the color texture
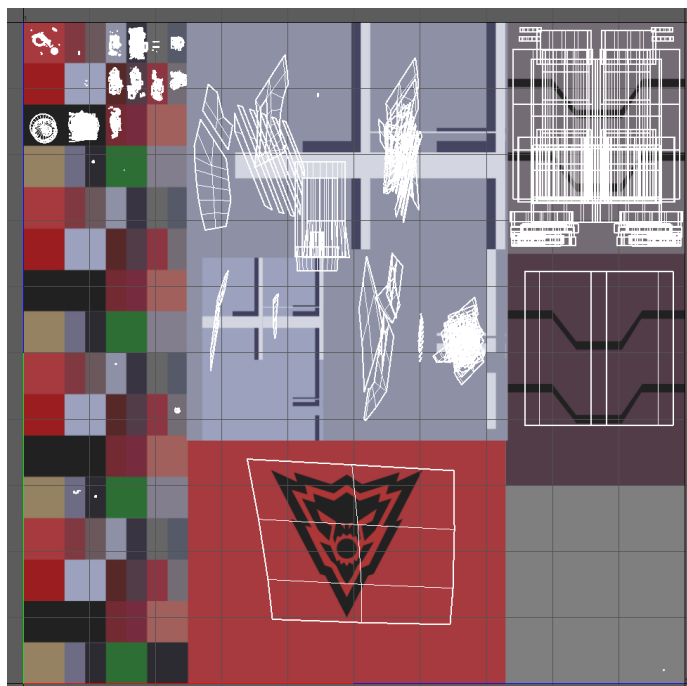
©TOMY
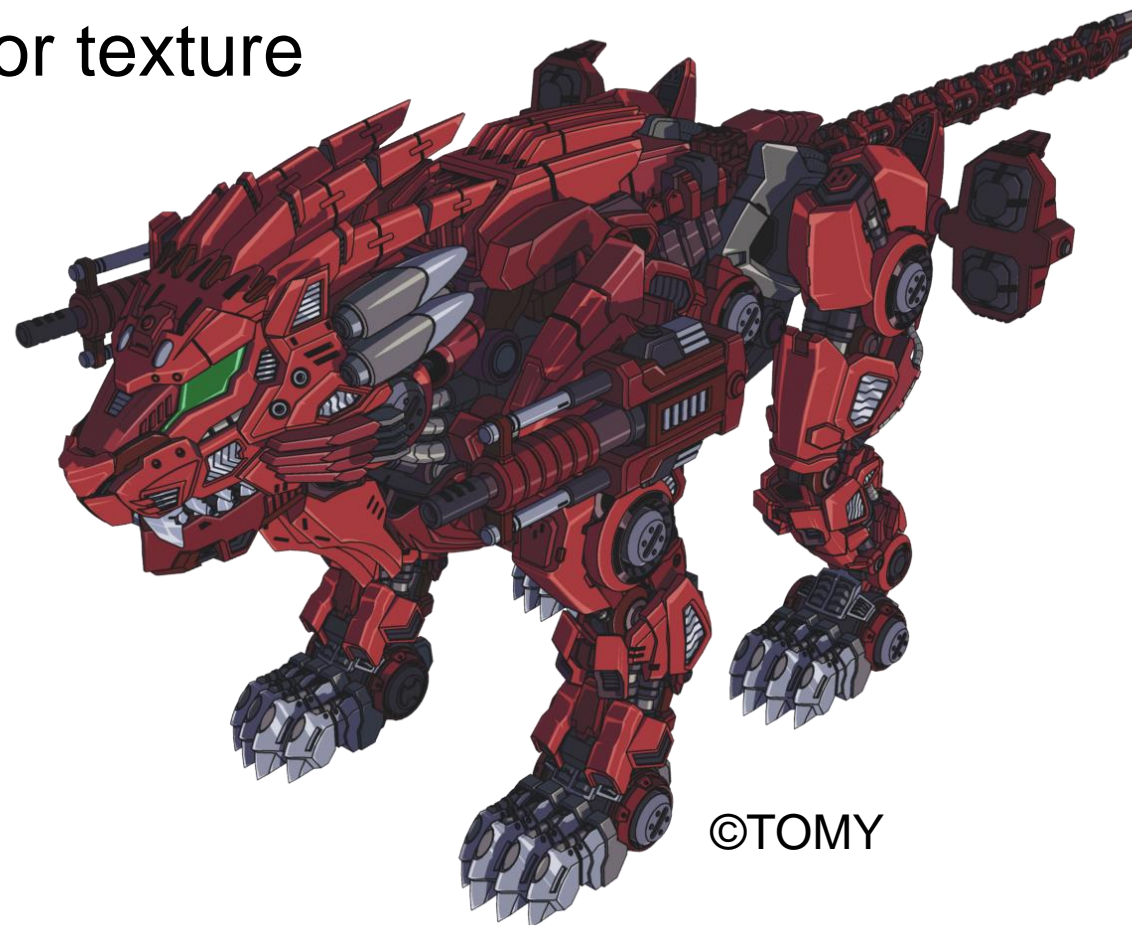
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Basic Cel Shading

- Use 4 colours pattern
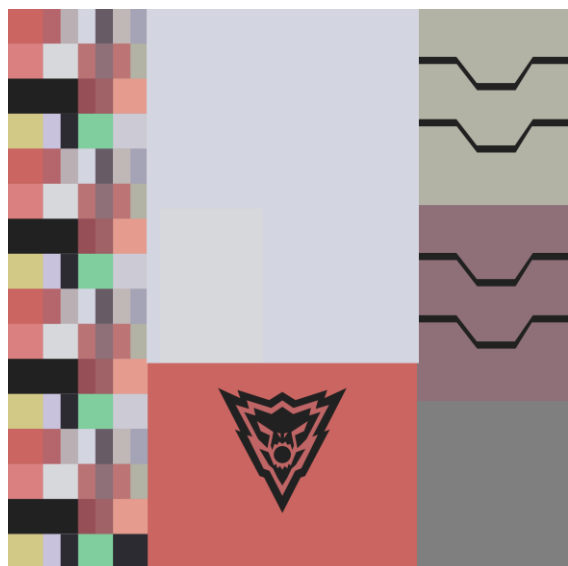
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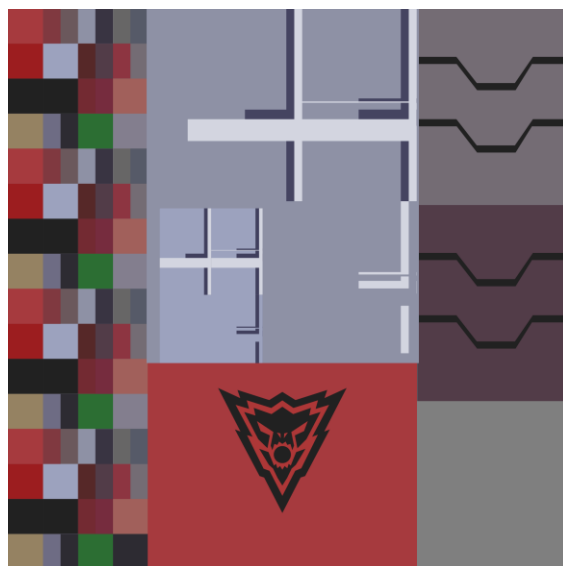
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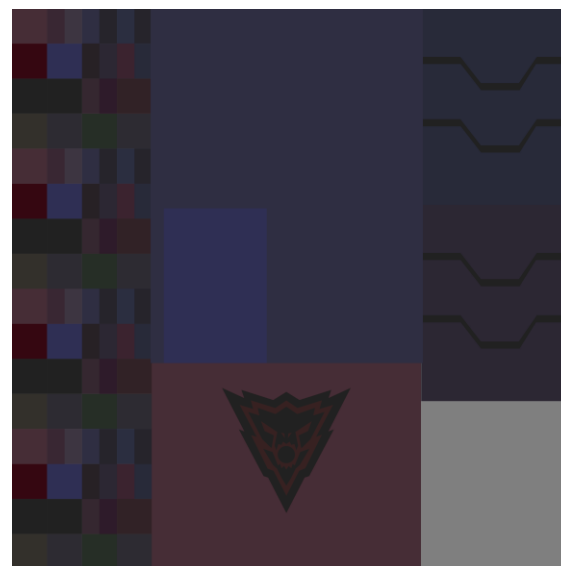
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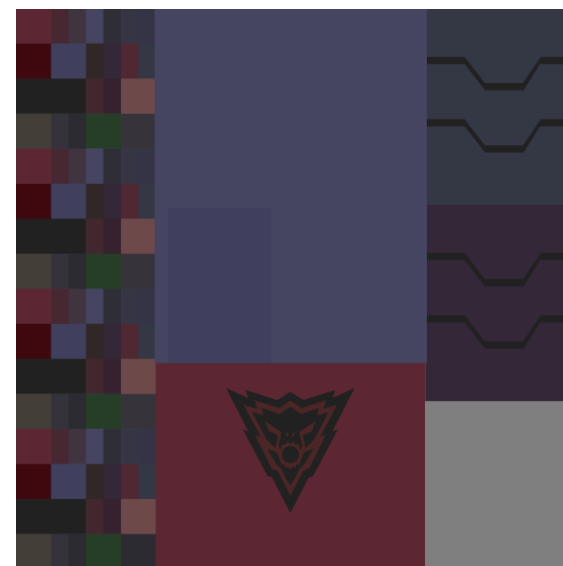
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Basic Cel Shading

- Use any input texture/shader to map colors
  - Replaces brightness

- Rim light
  - Offset to the ramp
  - Mimic light from the back
  - Rim color
  - Rim smoothing
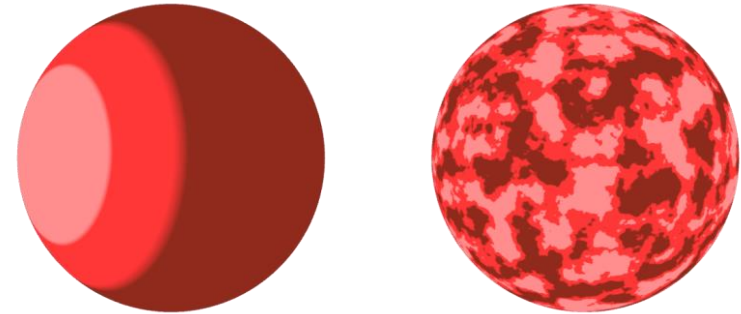
Ouput using brightness VS output using texture
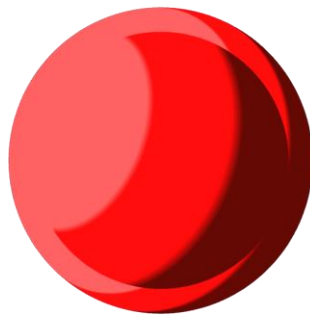
| No rim | With rim | Wide rim | Narrow rim | Smooth rim | Rim color |
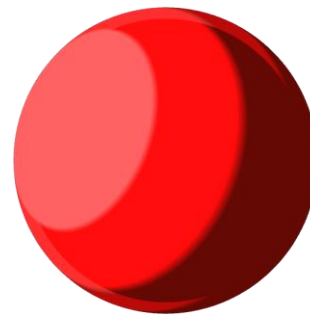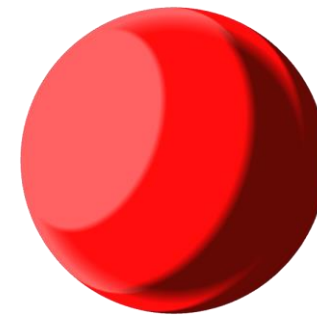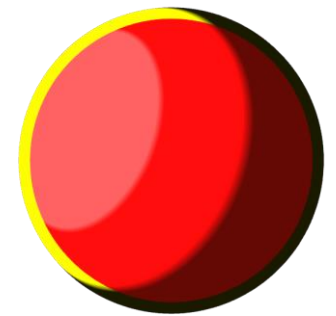
Cel Shading with Offset Texture

- Input offset texture to brightness
  - Design highlights and shadows
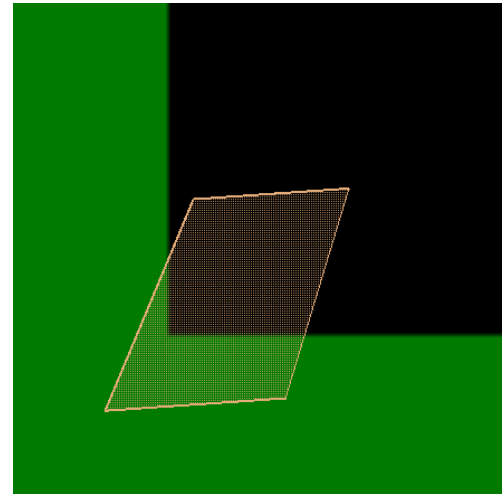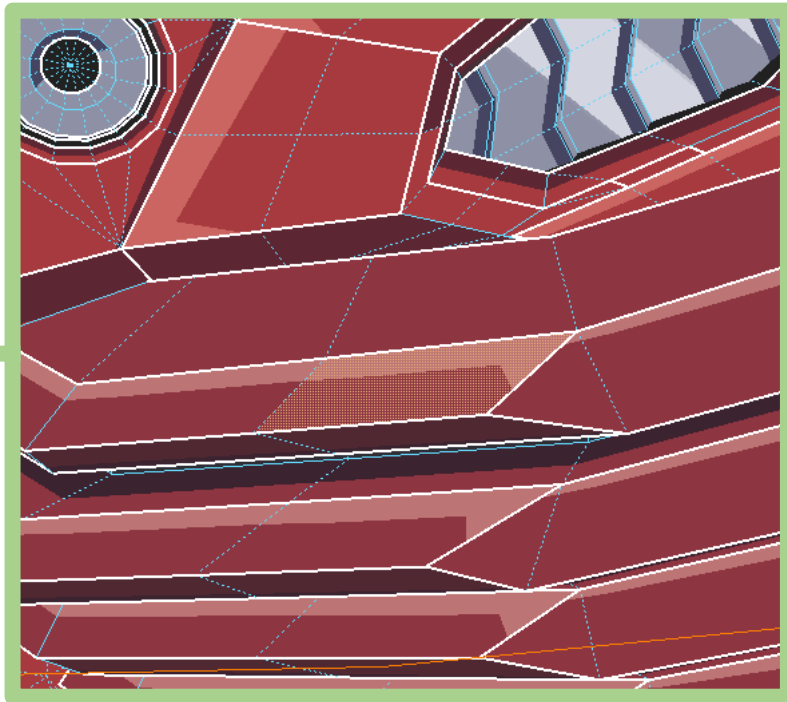 - Green (+), Blue (-)
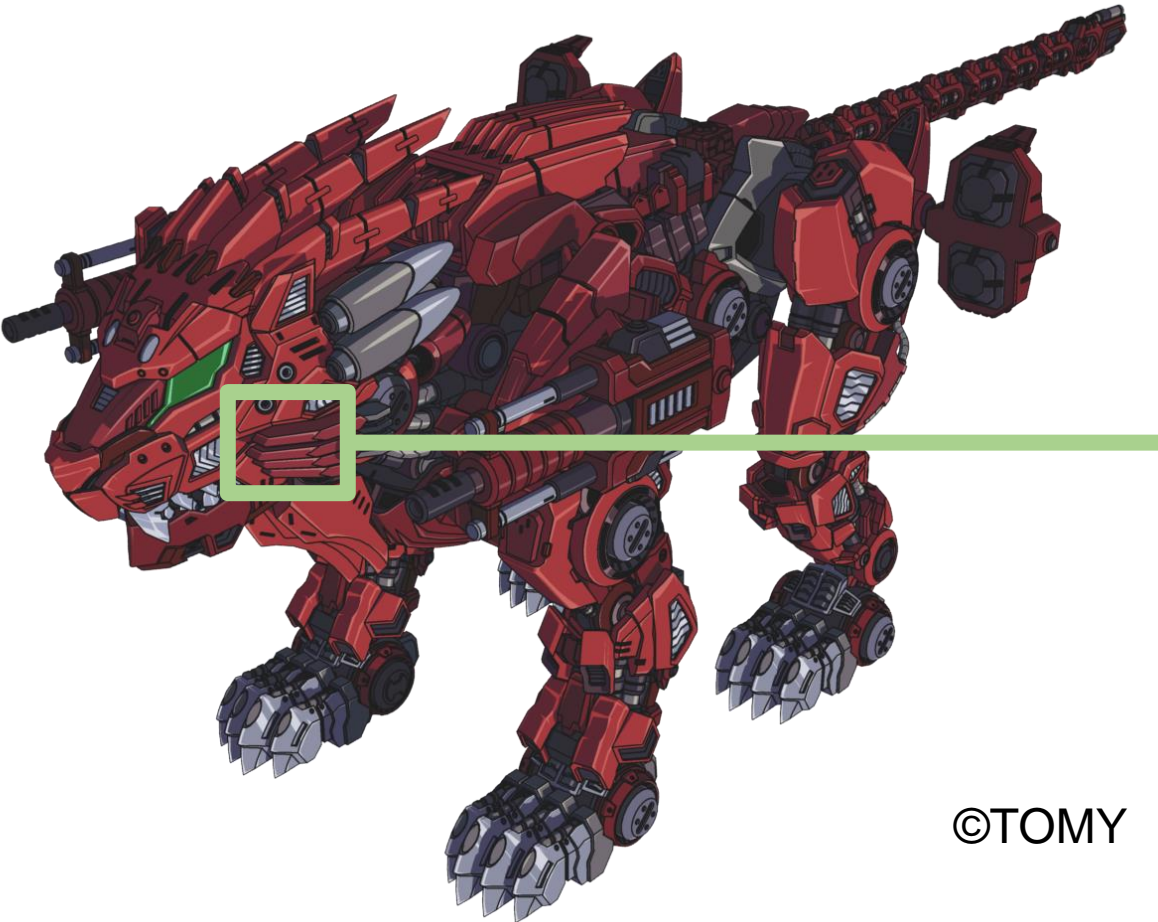- GPU preview
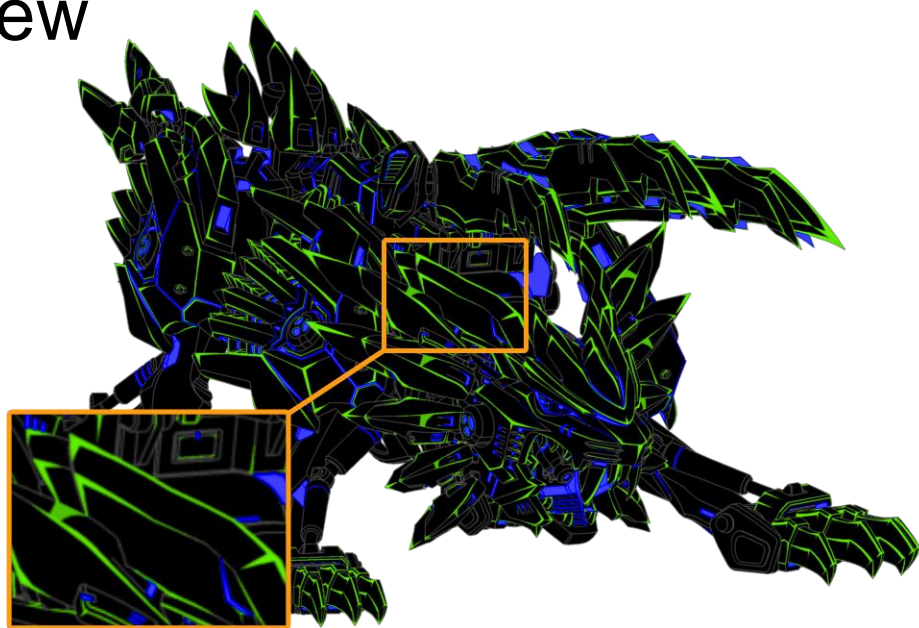
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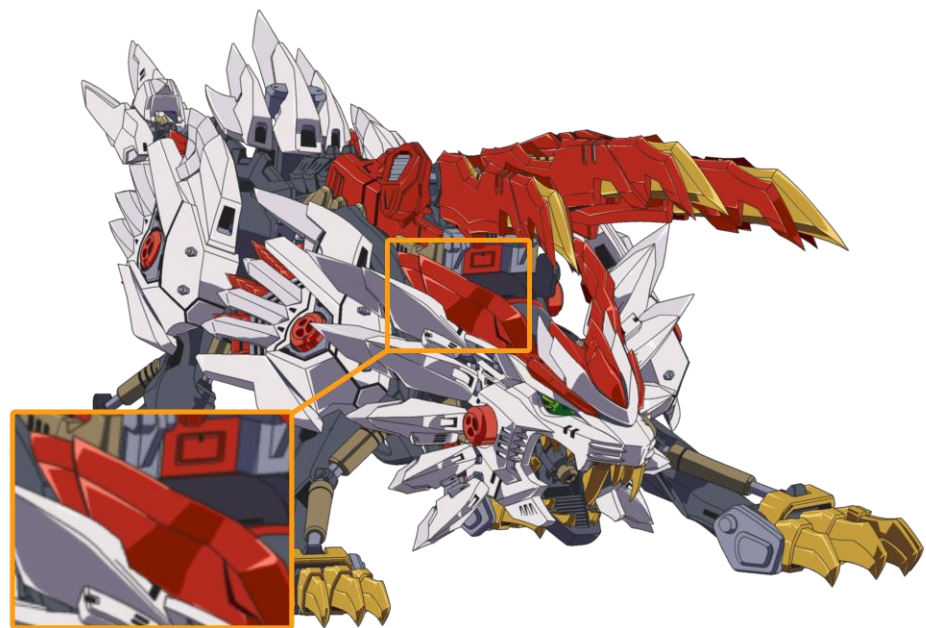
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Cel Shading with Offset Texture: Highlights
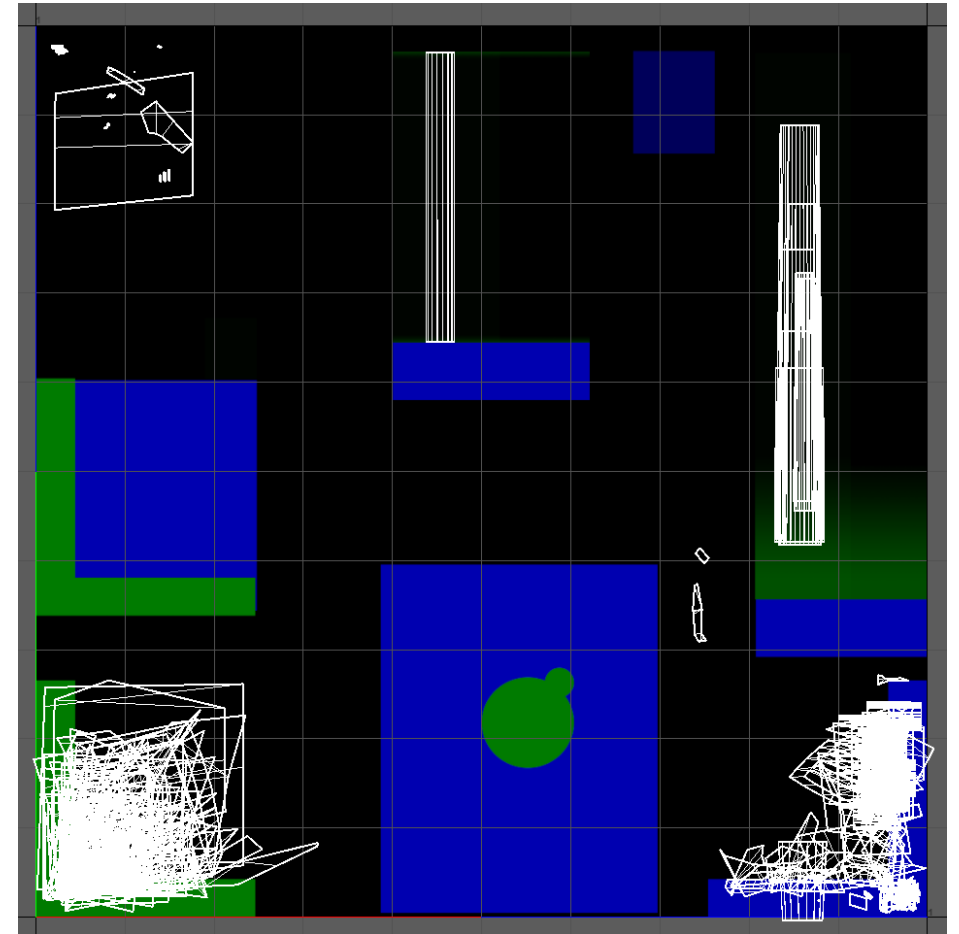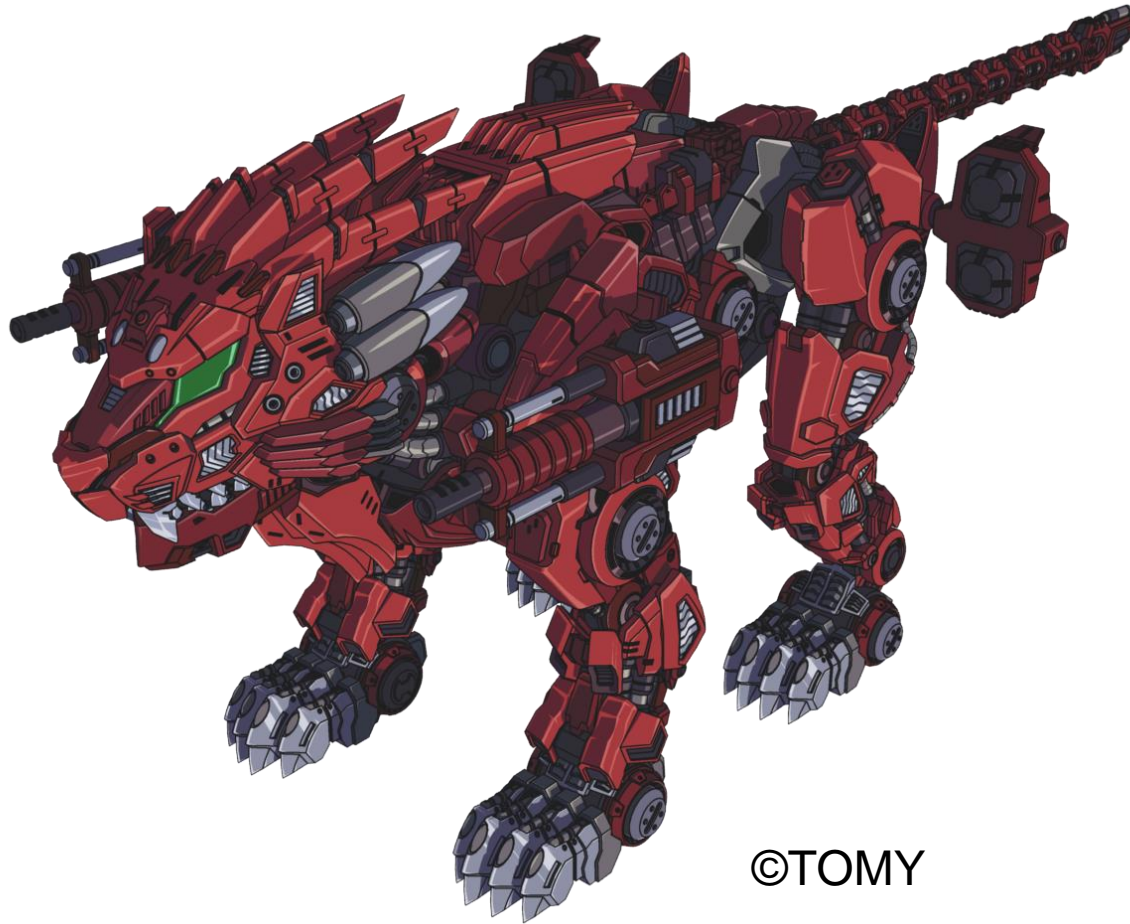
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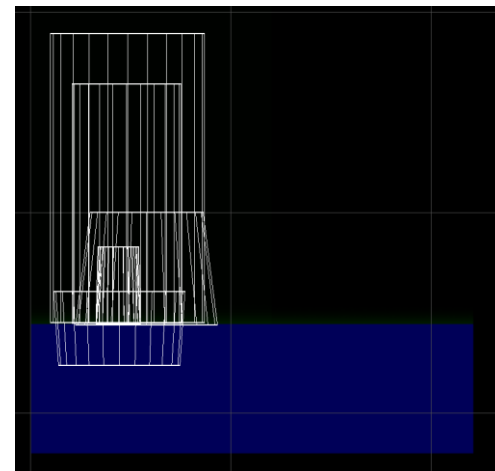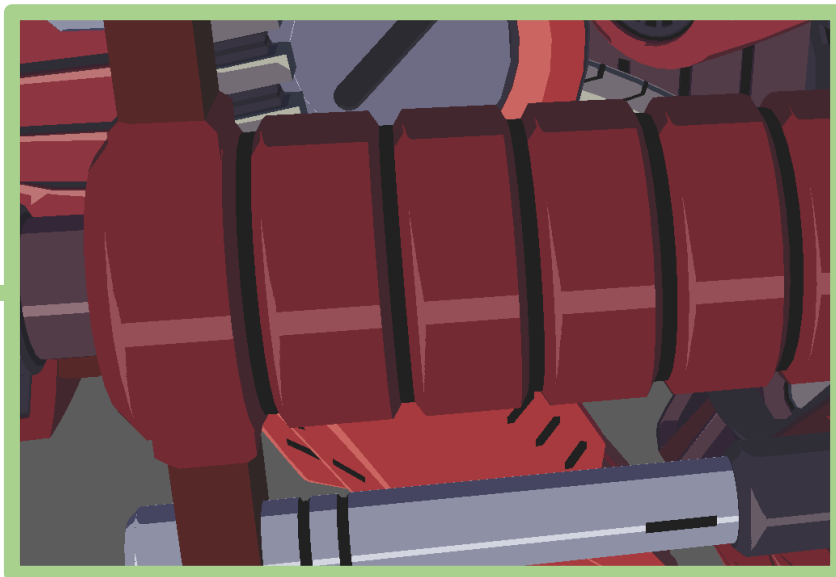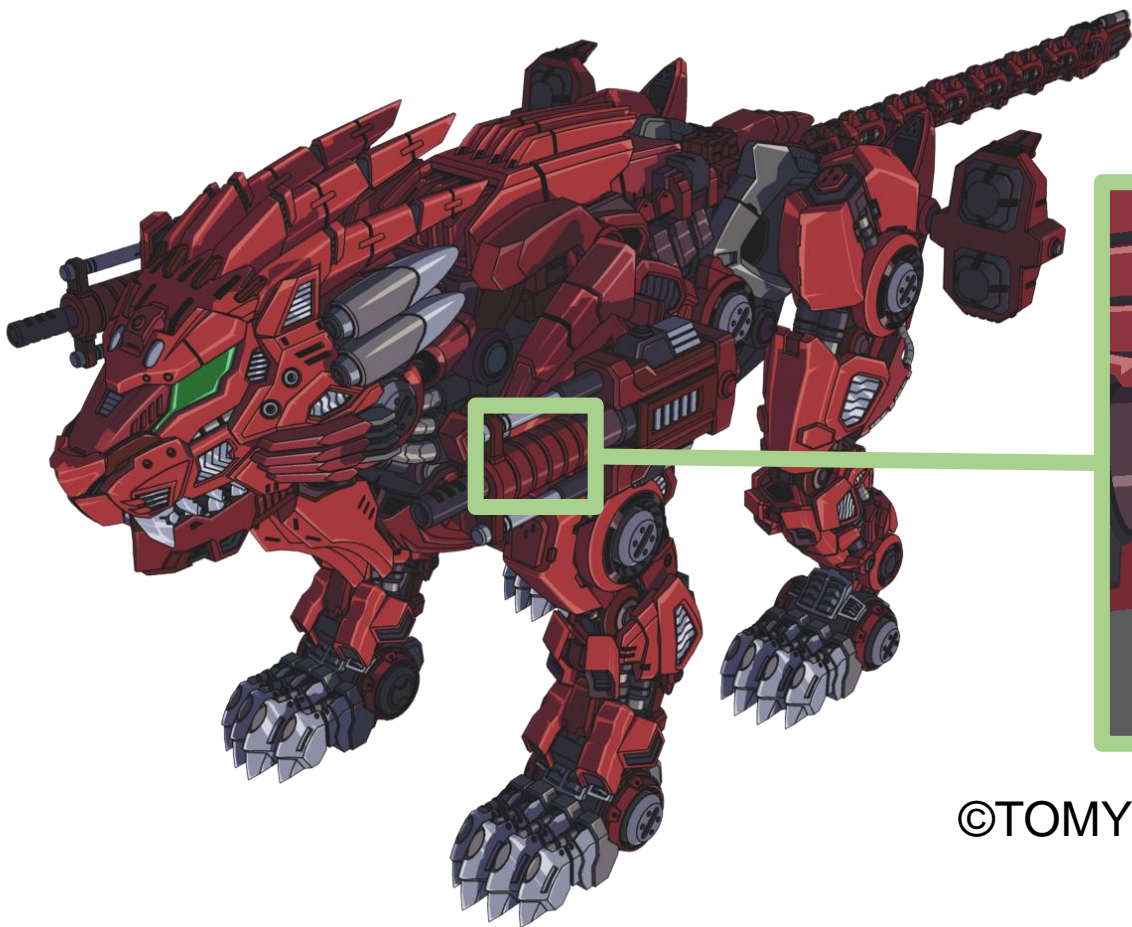# Cel Shading with Offset Texture: Highlights

- Design highlights shape using UV placements

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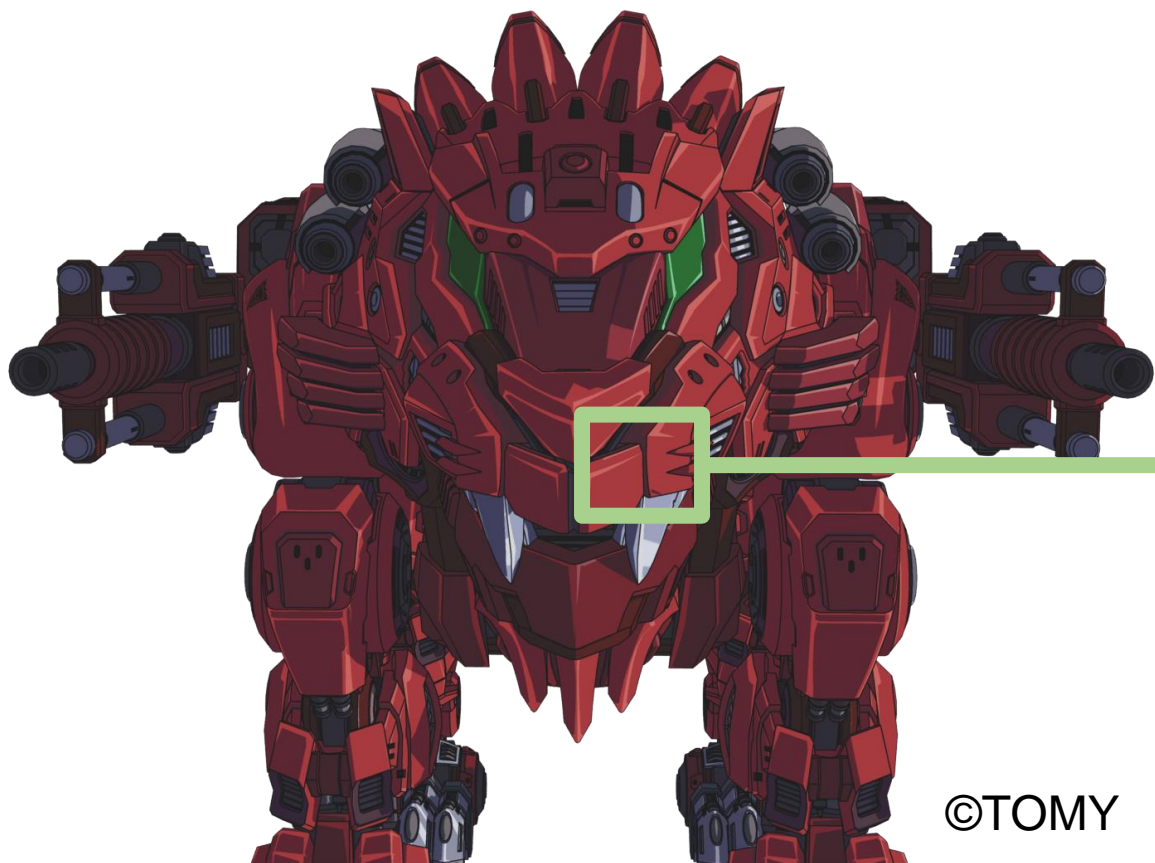# Cel Shading with Offset Texture: Highlights

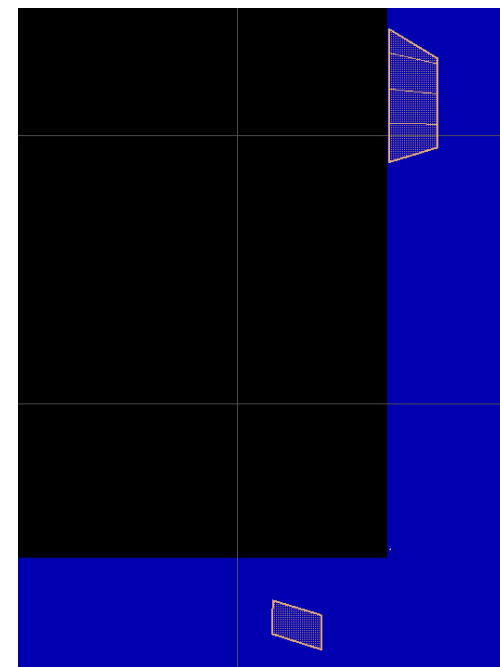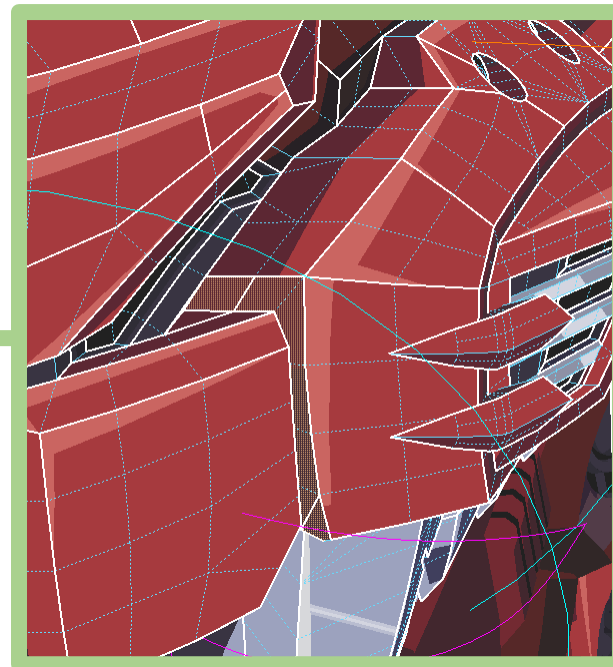- Design highlights shape using gradations in offset texture

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Cel Shading with Offset Texture: Shadows
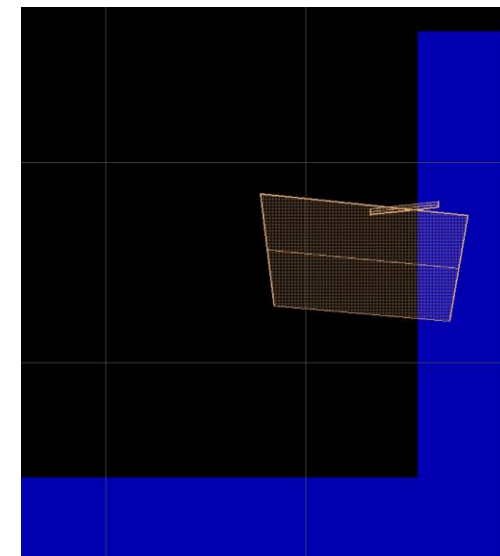
- Design shadow lines using UV placements

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Cel Shading with Offset Texture: Shadows

- Design shadow lines using UV placements
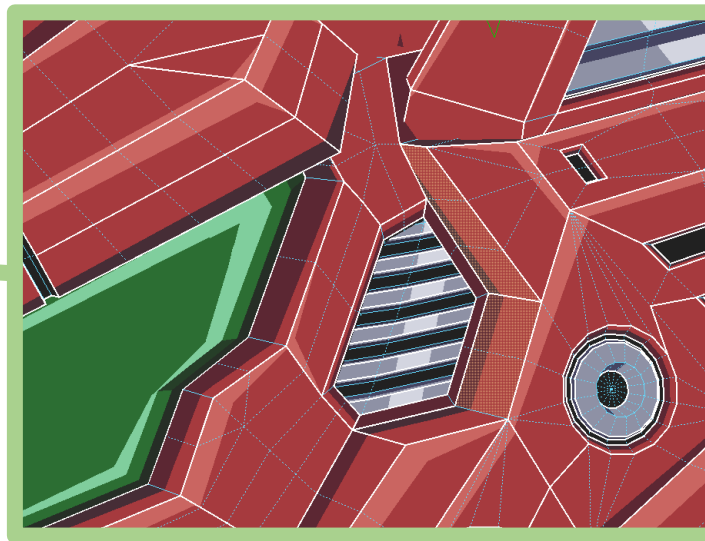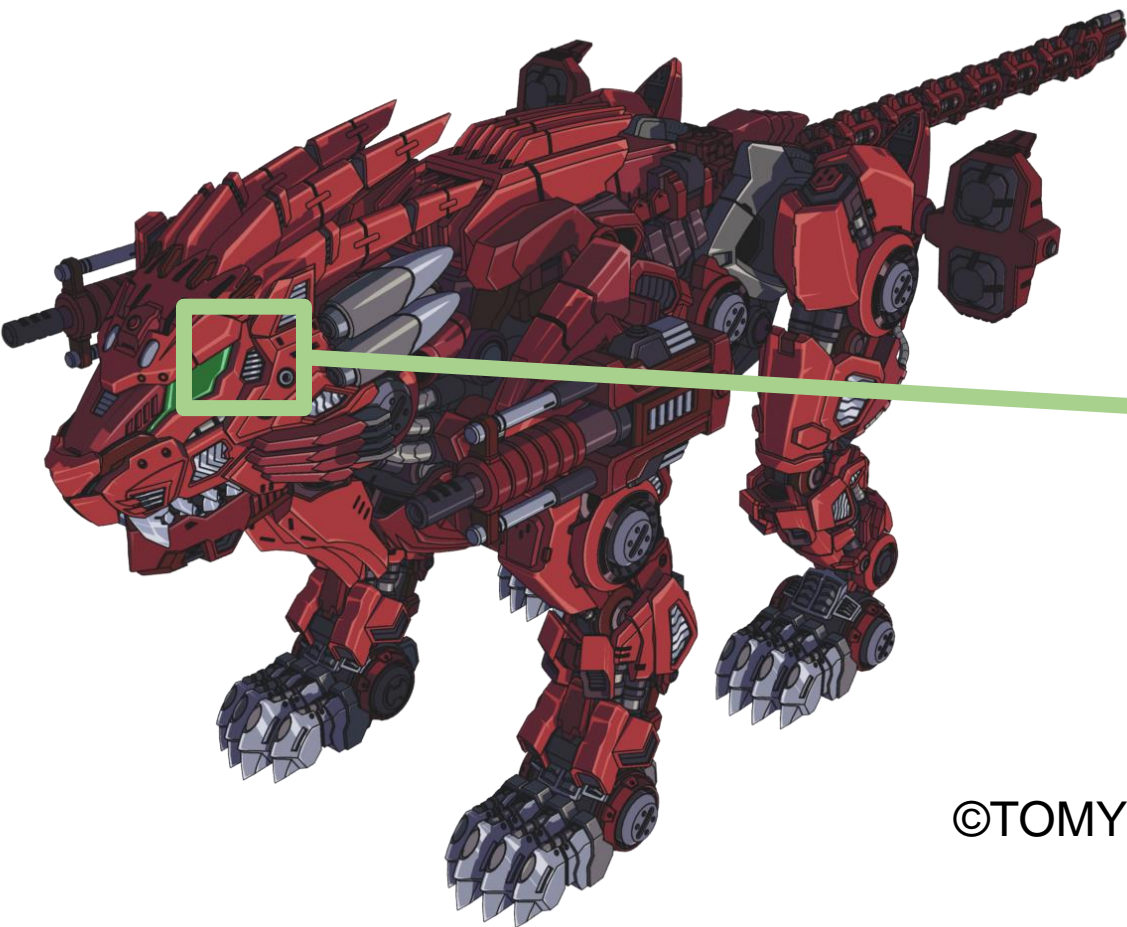
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Shading Pattern

- Color coded per channel
  - Red: input + offset (1), offset only (0)
  - Green: use highlight (1), no highlight (0)
  - Blue: use rim light (1), no rim light (0)
- Mostly used
  - White: Input + offset, with highlight, with rim light
  - Yellow: Input + offset, with highlight, no rim light
  - Red: Input + offset, no highlight, no rim light

Shading Pattern
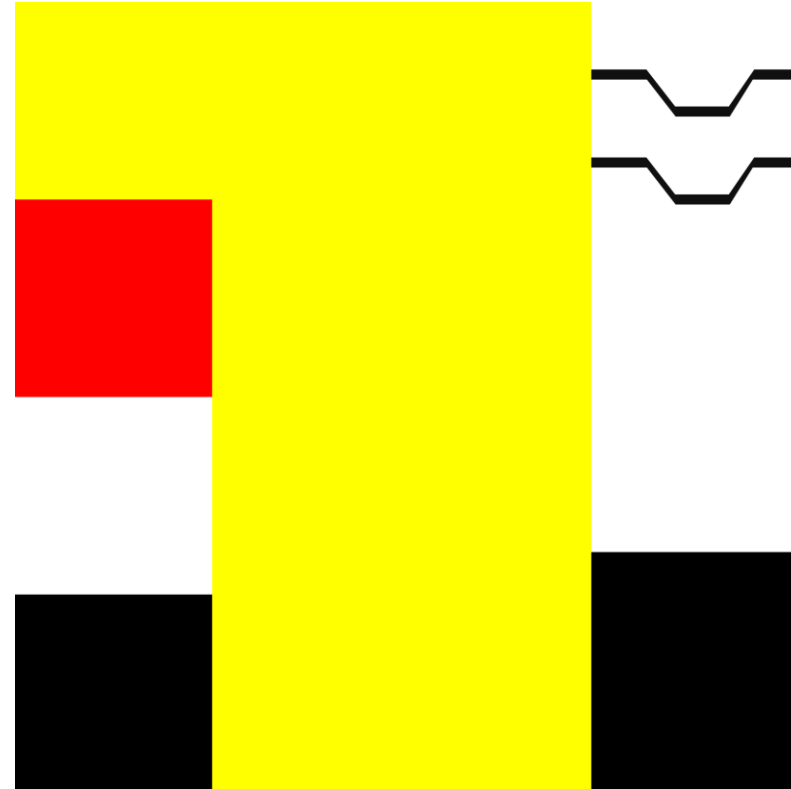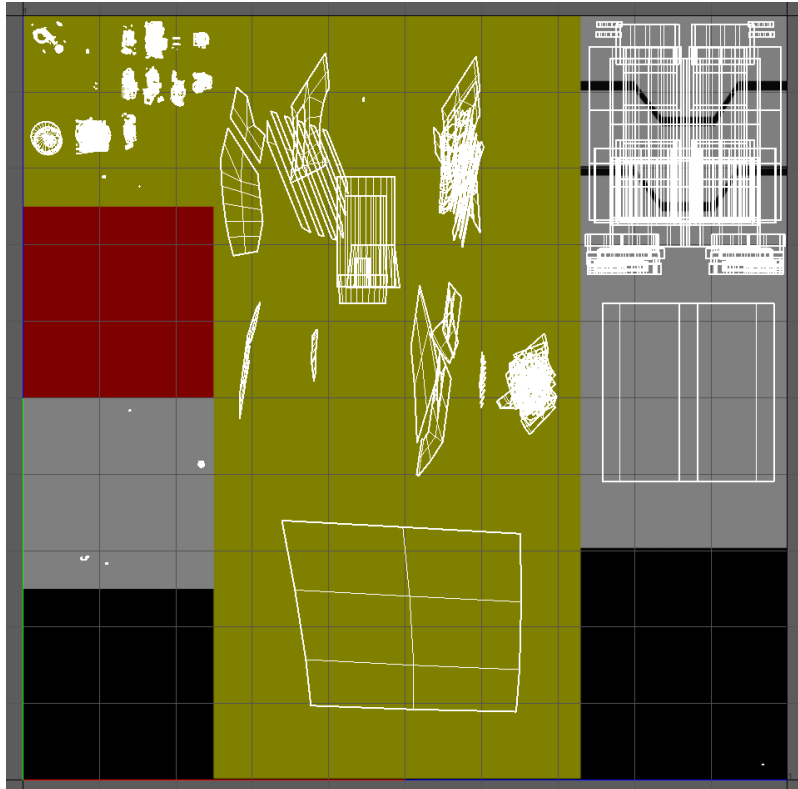
Shading Pattern: Rim Lights

• Sets rim light regions using UV placements
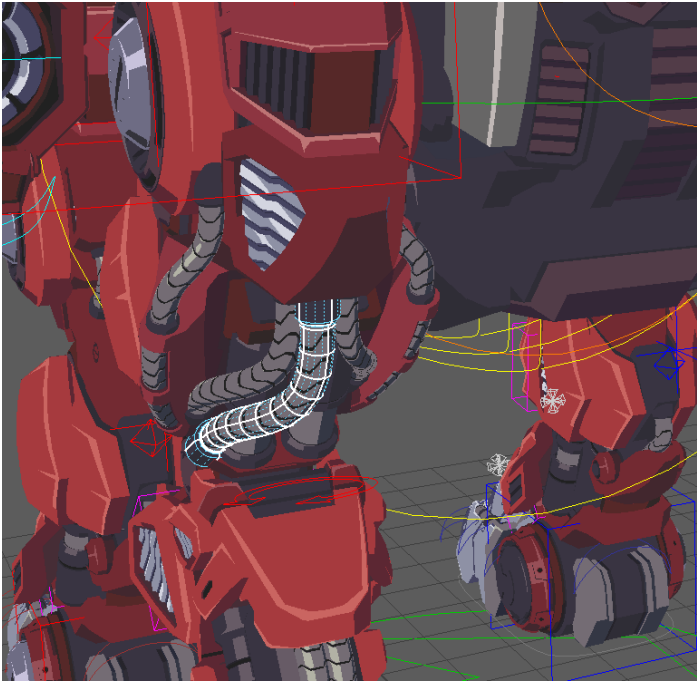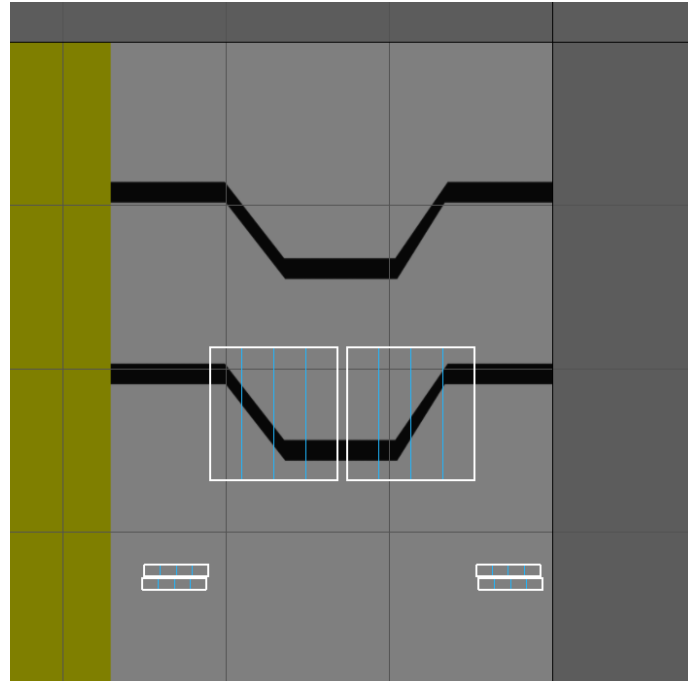
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Lock Normals to Avoid Flickering

No lock VS With lock
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Contours Rendering

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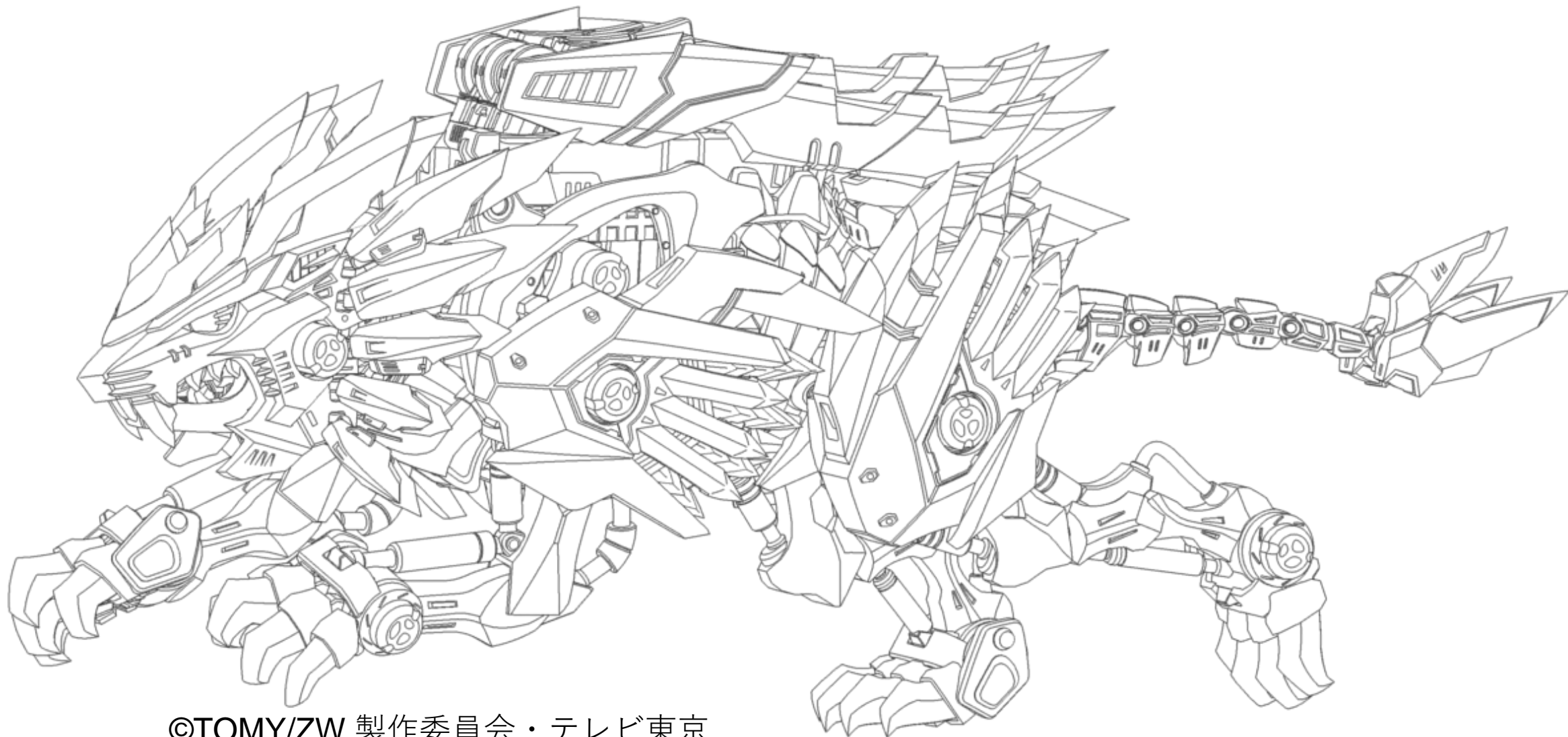
Contours Rendering

- Compare samples value to draw contour
  - Object ID, UV
  - Depth, normal, color
- Control of contour output
  - Color
  - Width
  - Transparency
  - Contour group

Contour with BG

Different object IDs

Contour with BG

Contour from intersection
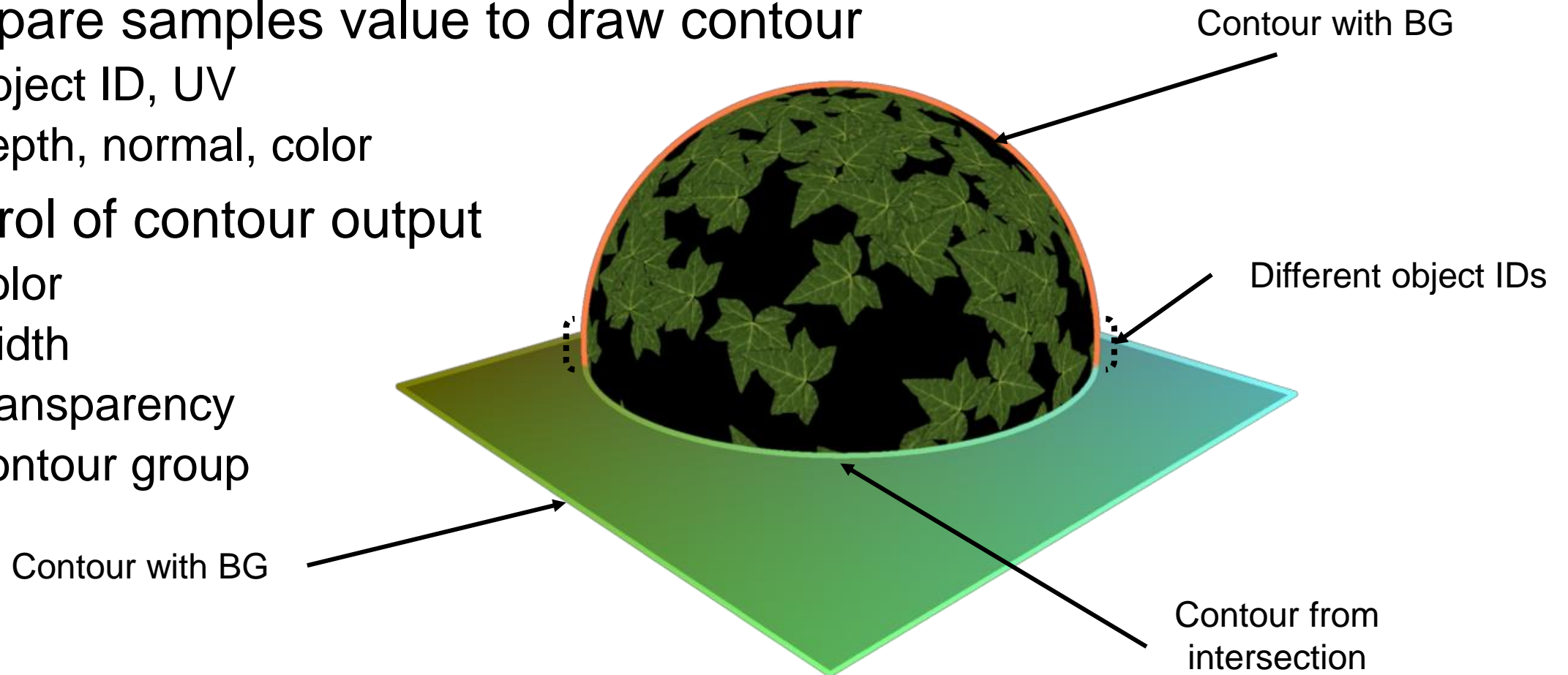
Contours Rendering

- Compare samples value to draw contour
  - Object/face ID, UV
  - Depth, normal, color
- Control of contour output
  - Color
  - Width
  - Transparency
  - Contour group

Contours from Normals

Control from wireframe

Contour from color

Contour from Depth
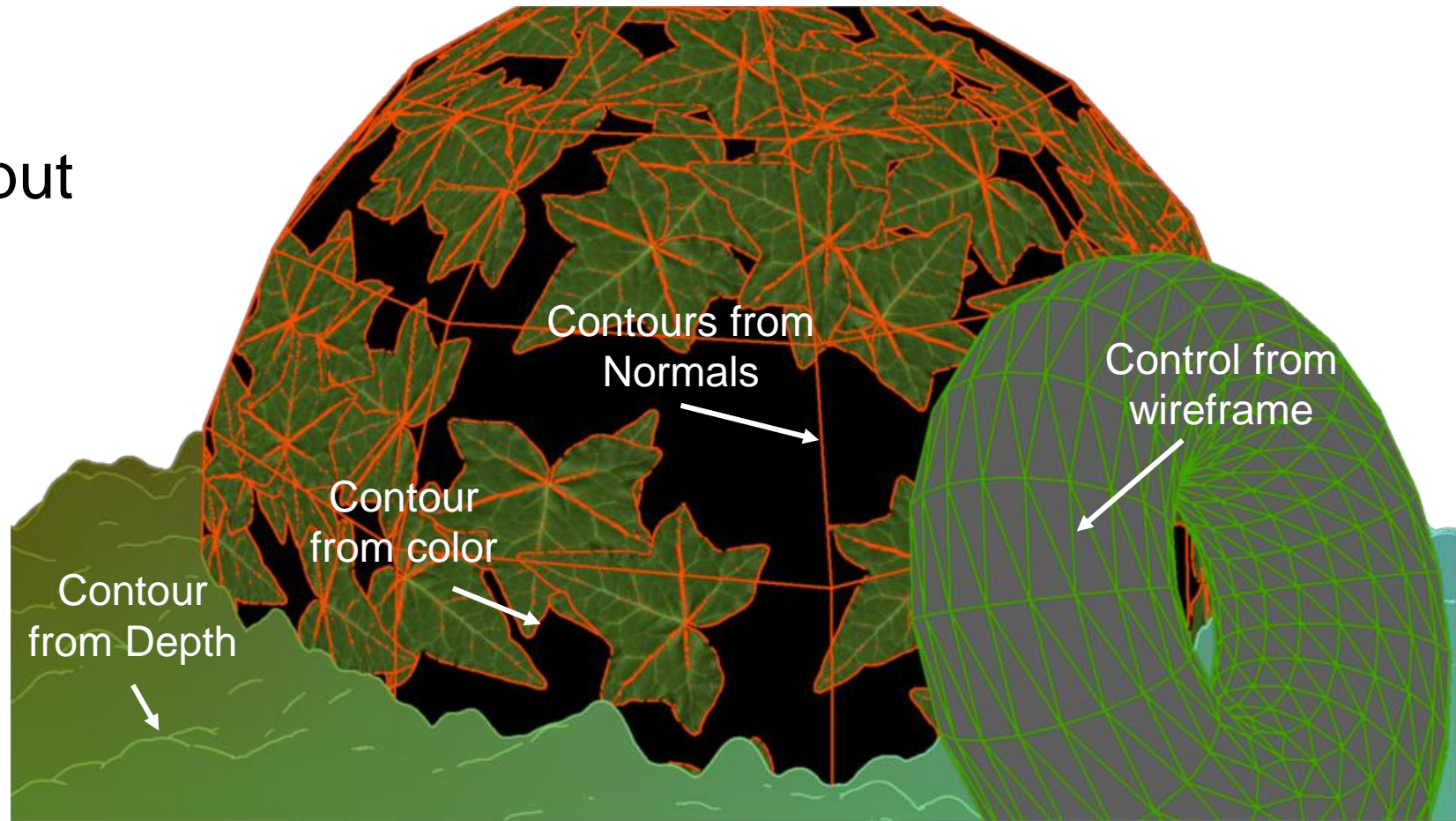
Contours in Zoids

- Object ID / face normal produces too much contours
- Textures / UV placements to generate contours only where needed

All contours
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Specific contours
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Contours in Zoids

- UV placed in color grid
- Color differences > 2 squares => contour
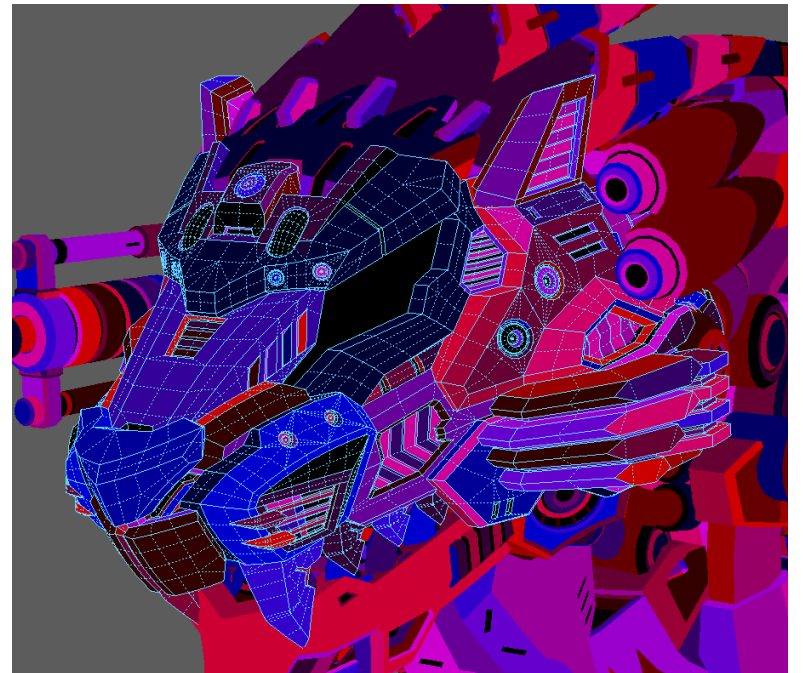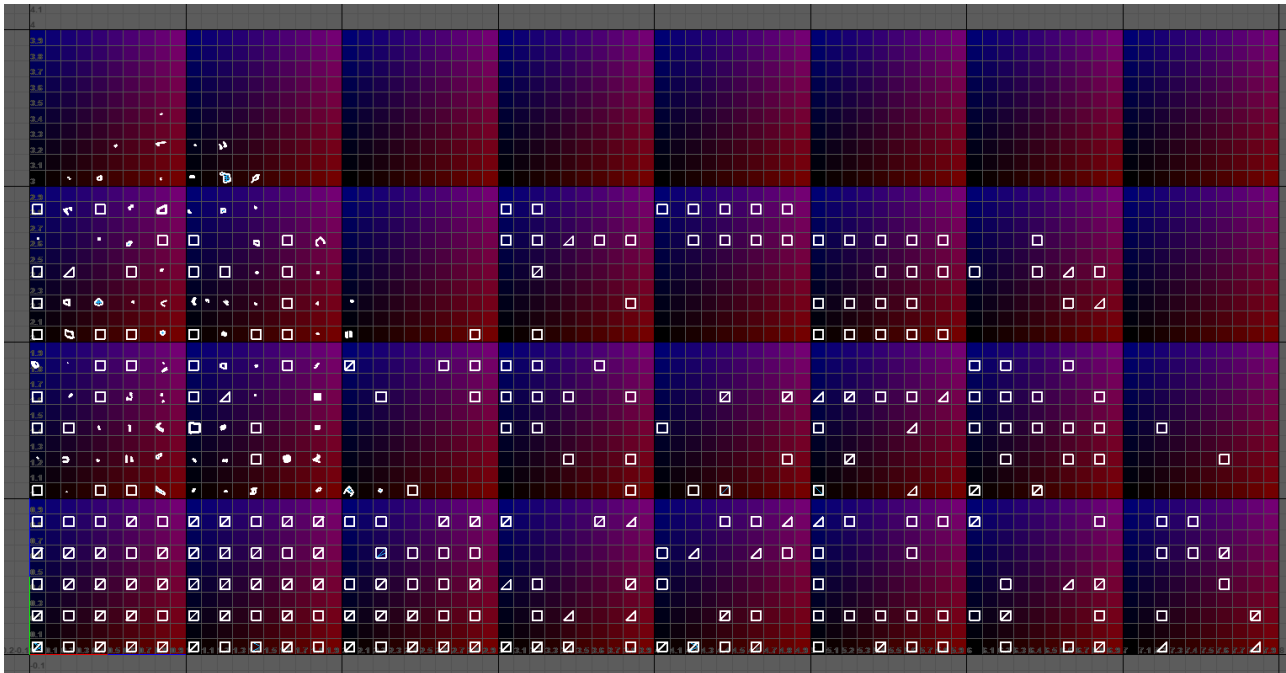
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Contours in Zoids
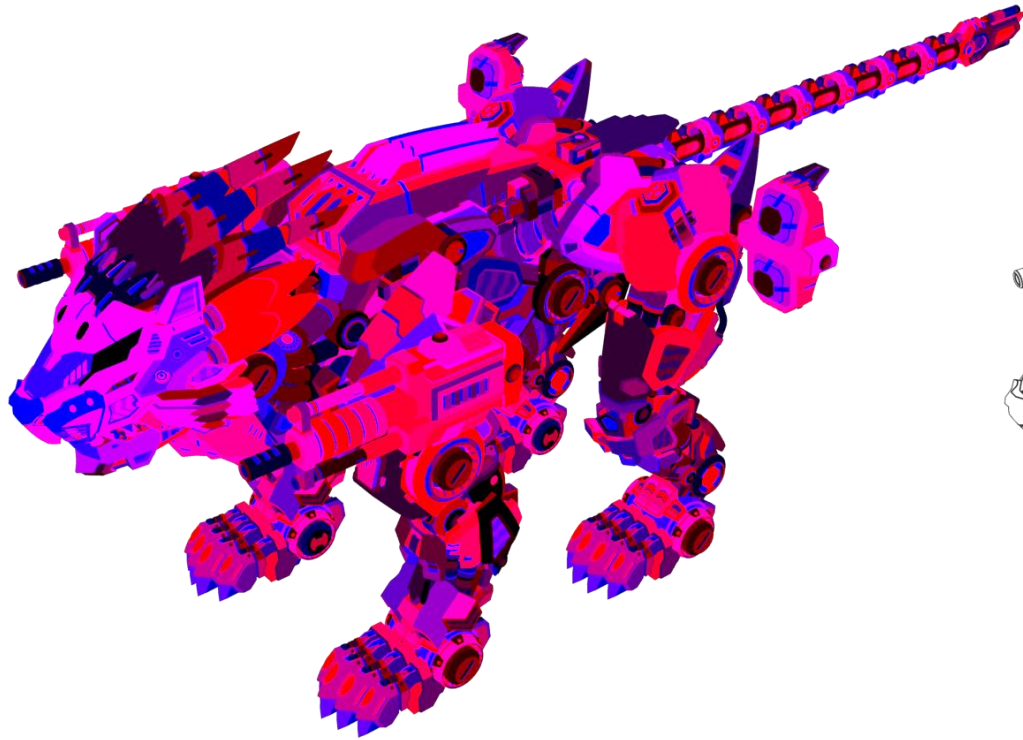
©TOMY
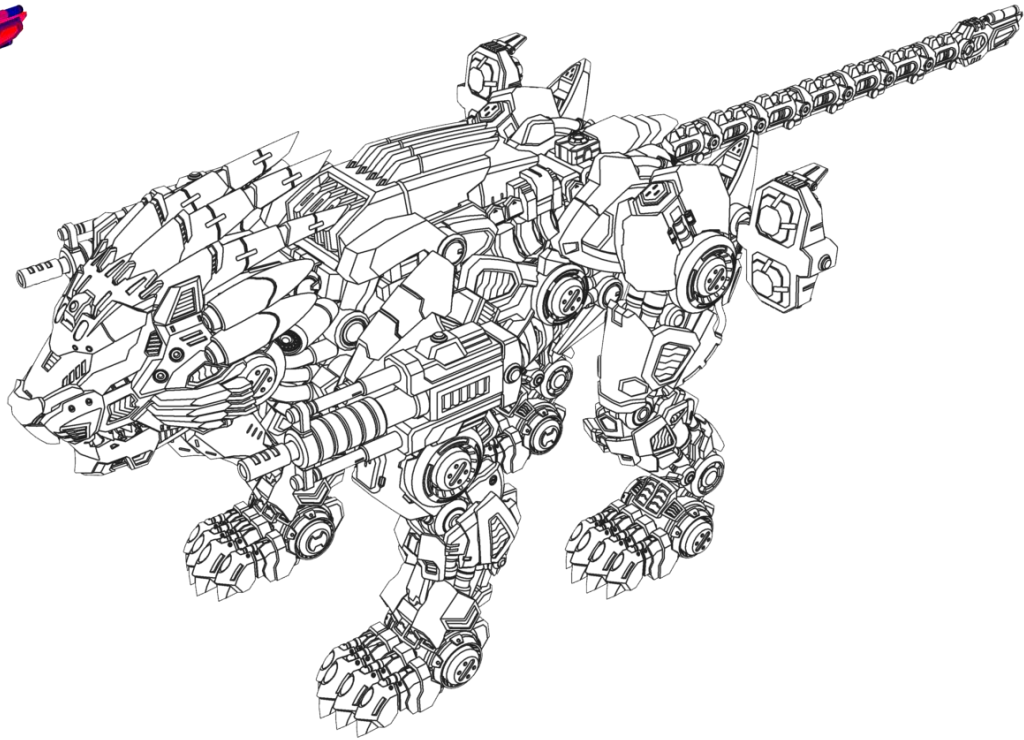
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FX

FX

- Mix of 3d and 2D effects
  - Just the one that makes the shot looks cool
- FX library
  - 2D/3D
  - Elements (fire, water, wind, sparks)
  - Explosion, smokes and debris
  - Fractal, aura..

2D FX Library
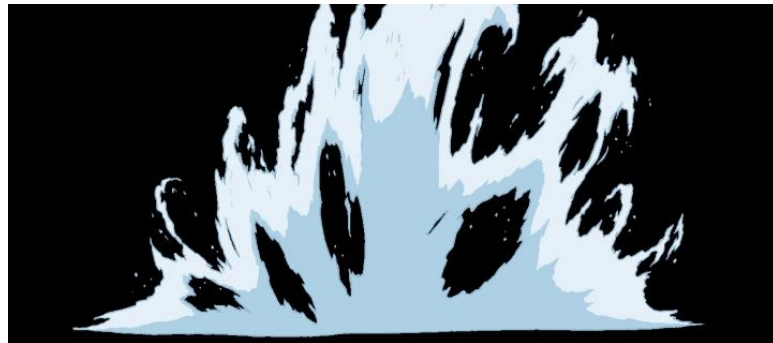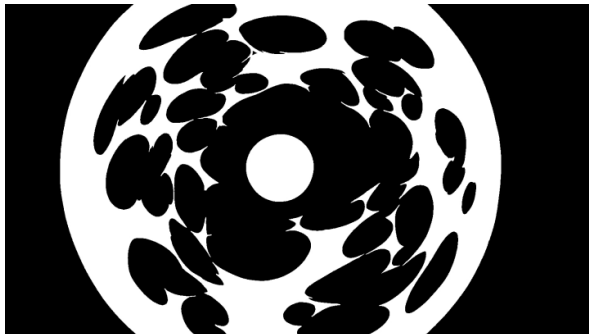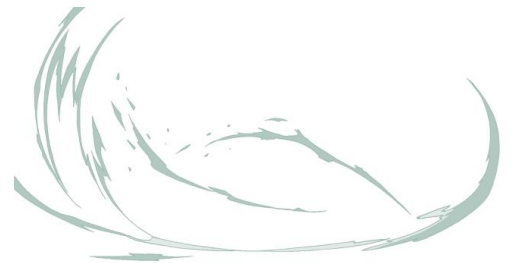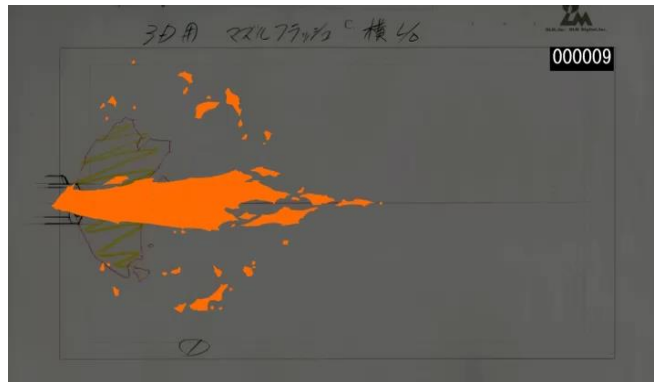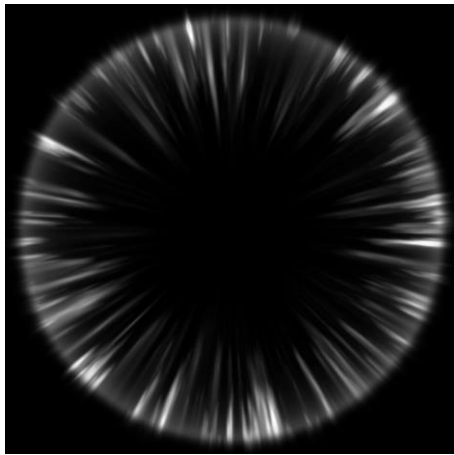
3D FX Library
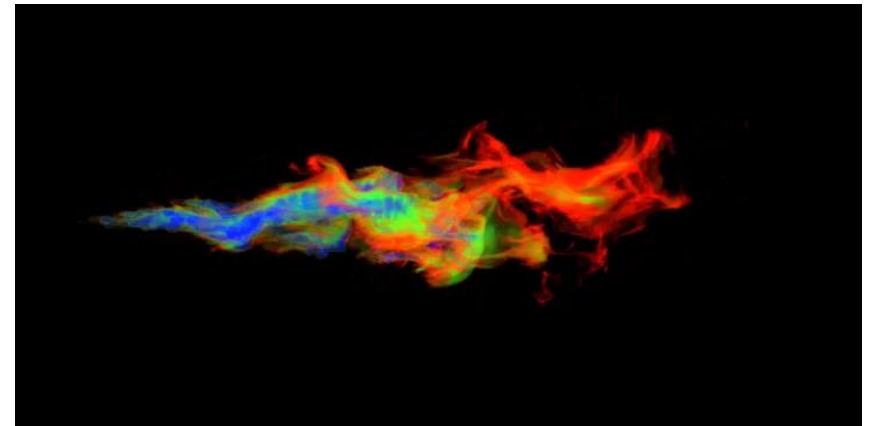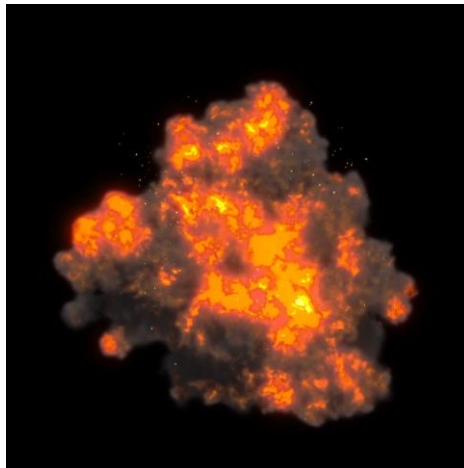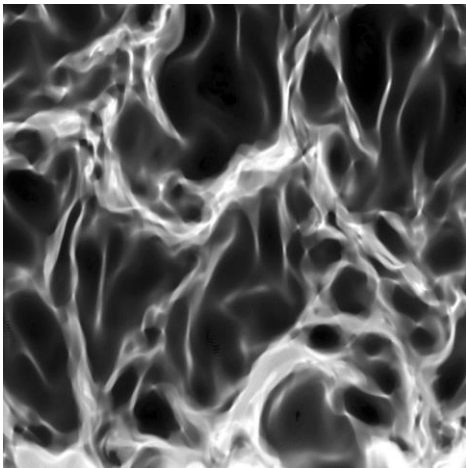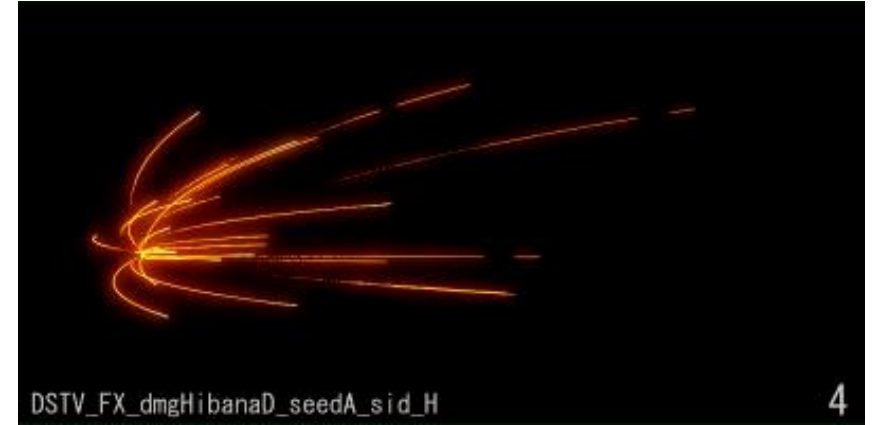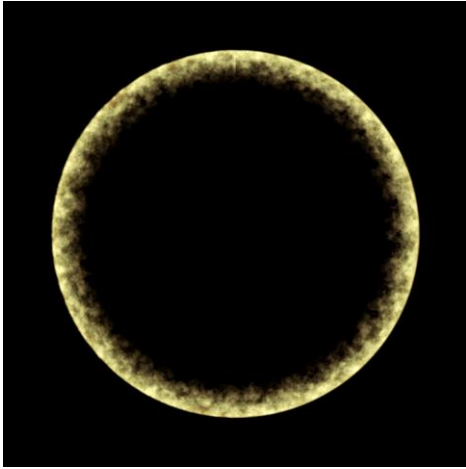
FX in Animation

- In traditional animation key frame artists always include FX

- Include FX for CG too
    - Temporary (Atari) but necessary
    - Layout section needs FX (where ok to cut)

Rough, Layout and Animation, Final
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Shader FX: Dust

- Procedural shader
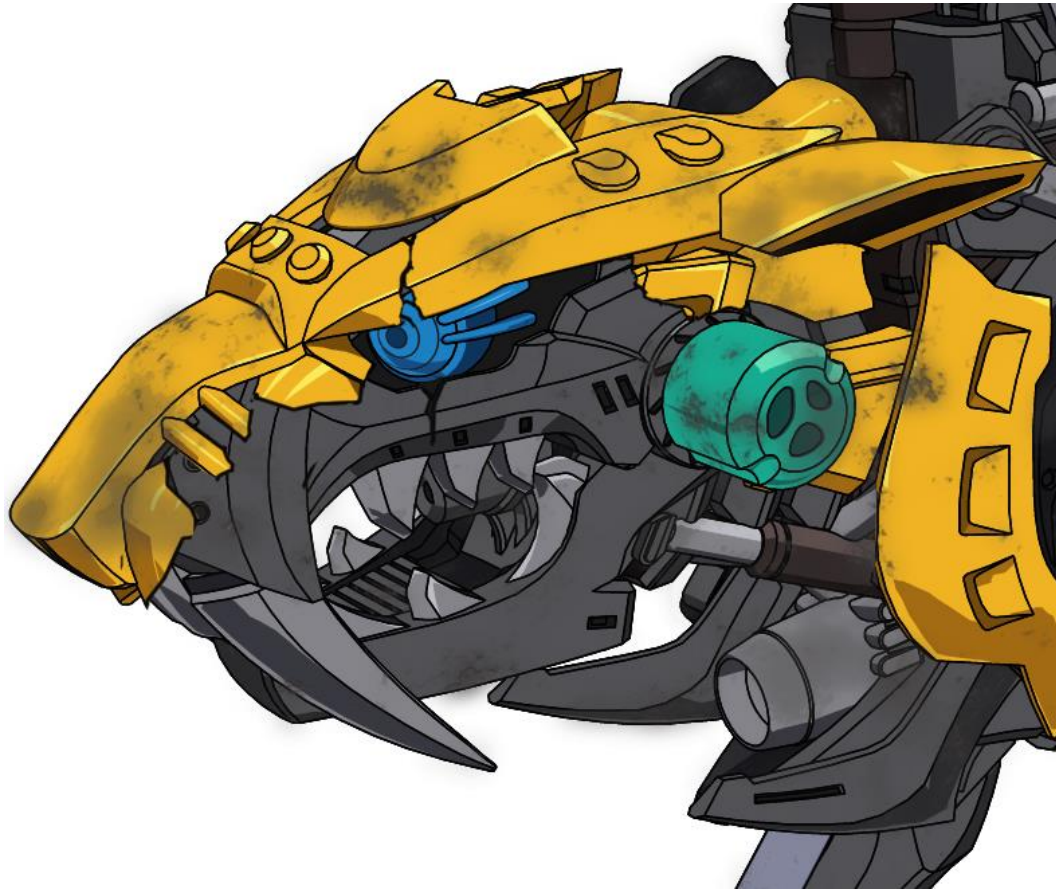
Shader FX: Cracks

- Texture projection
- Reference texture object
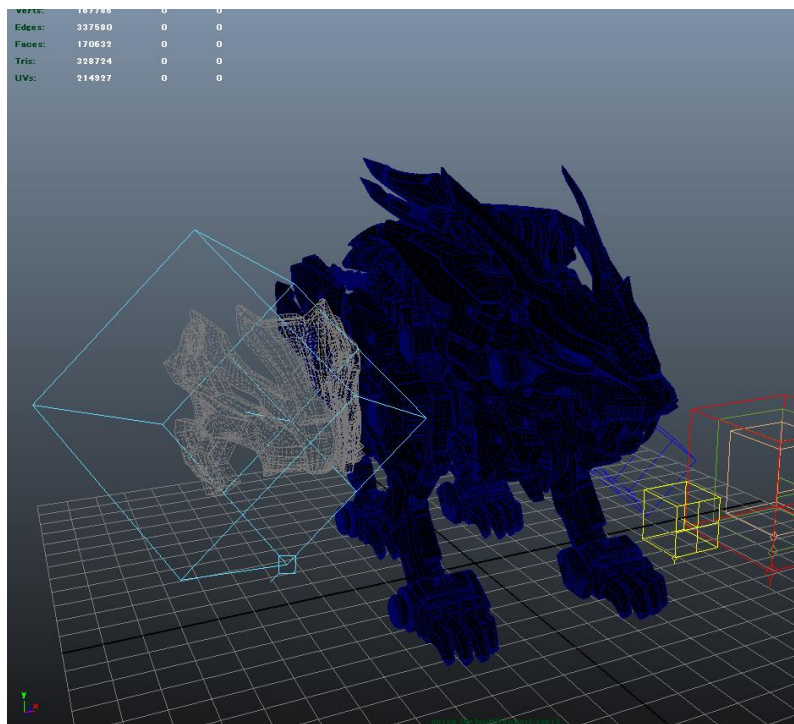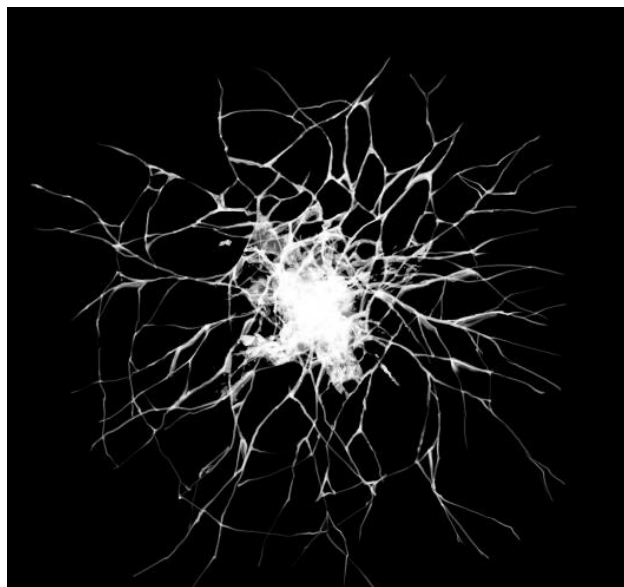
Lighting

- 1 directional light only
- Add light as post-production effect
  - Light from FX

FX Light using Point Light + Lambert
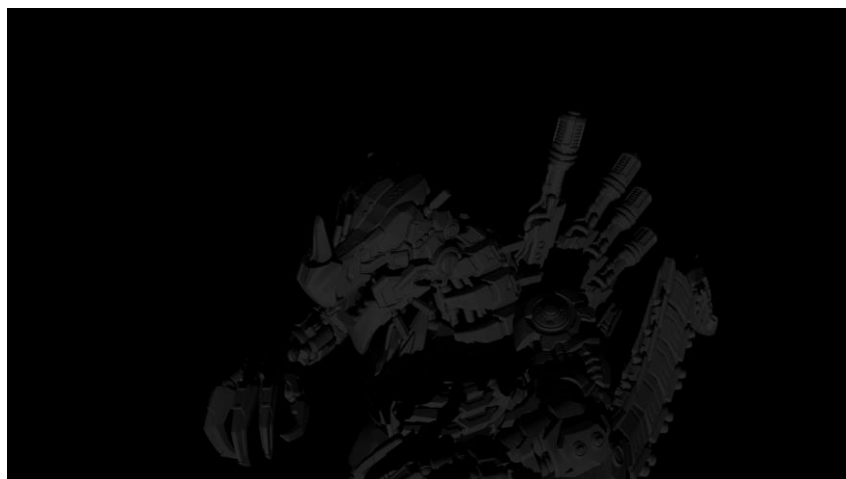
1 point light + lambert

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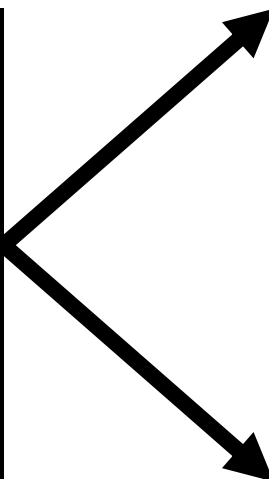
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Shadows from Ambient Occlusion

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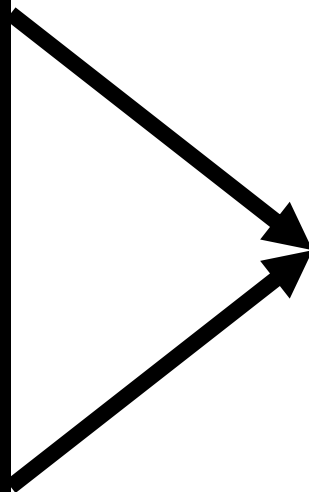
©TOMY
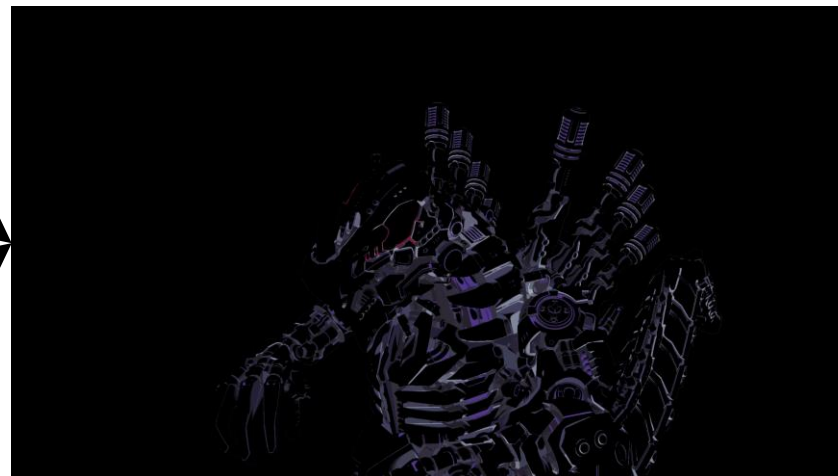
Final Compositing

Evolution from First to Third Season

From Zoids Wild to Zoids Wild Zero/Senki

- Director change
  - Gup with zoids, had a specific image
- Target change
  - First series: elementary school kids
  - Second/third season: junior high school kids and fans
    - More reality
    - Look/animation/FX
- For fans who grew up with older TV series
  - Homage
    - Opening
    - Eye catch before commercial are back
  - Design closer to old toys
- Settings
  - War and fight between multiple zoids
  - Back to use cockpits, no drawing of mounting characters
    - Cost down
- Zoids Wild Senki
  - Cannot produce the toys in foreign factories because of COVID
  - Smaller scale and internet diffusion
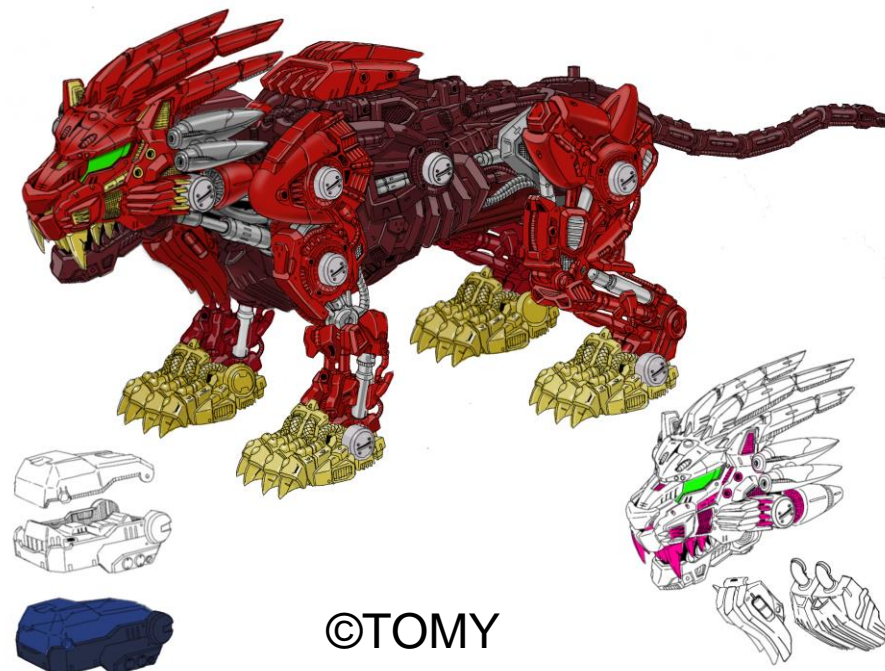
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Modeling: Back to original toys design

Original TV series
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Zoids Wild
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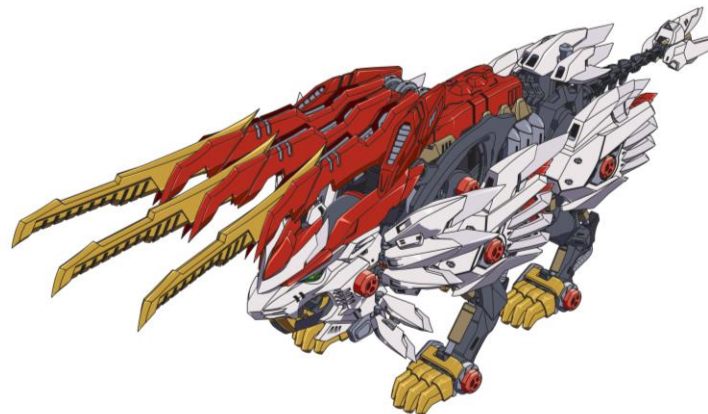
Zoids Wild Zero
©TOMY/ZW 製作委員会・テレビ東京
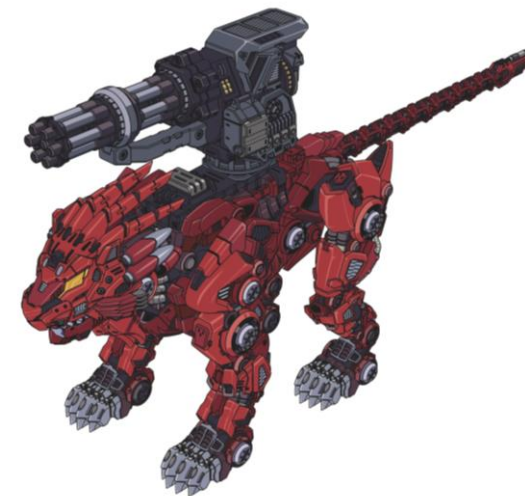
Zoids Wild Senki
©TOMY

Animation

- Zoids Wild: lots of tametsume
- Zoids Wild Zero/Senki: less
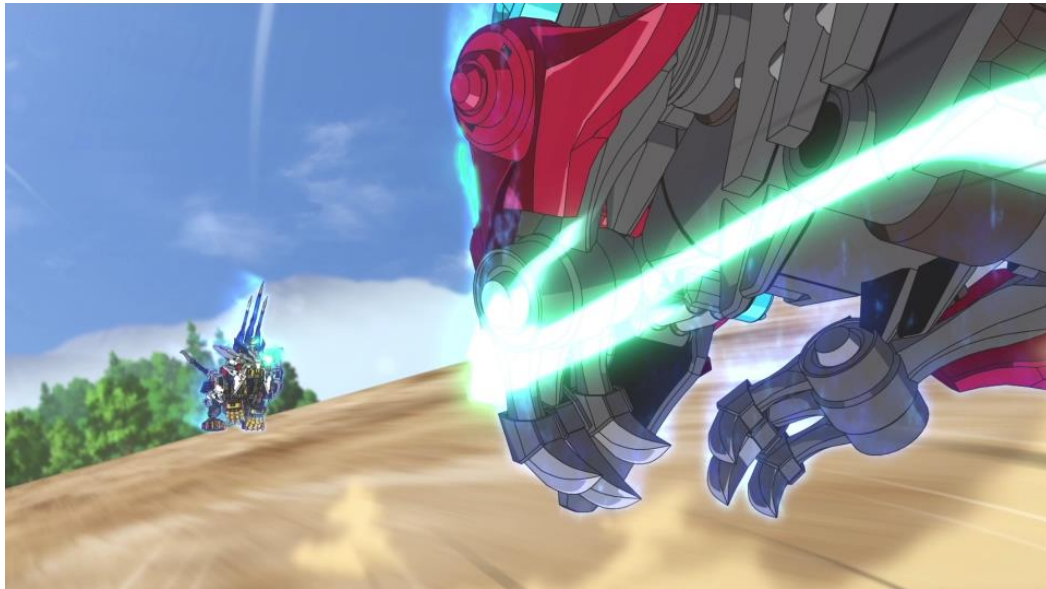
Zoids Wild
©TOMY／ZW製作委員会・MBS

Zoids Wild Senki
©TOMY

FX

- Zoids Wild
  - For small kids
  - Extravagant
    - Image space (no bg, like ultraman)
    - Gorgeous effects
    - Ghost, cartoon motion blur
- Zoids Wild Zero/Senki
  - For older kids
  - More realism
    - Transformation inside reality
    - No ghosts
    - Less fancy FX, no sparks
      - Nothing that wouldn't be real

Zoids Wild
©TOMY／ZW製作委員会・MBS

Zoids Wild Senki
©TOMY

Layout/Perspective

- Zoids Wild
  - Use a lot of wide-angle lens
  - Close objects are bigger
  - Far object are smaller
- Zoids Wild Zero/Senki
  - Telephoto lens
    - Normal cut 50-100
    - Close up:200-300 to get details in bg
  - Flatter, neutral, real

Layout/Perspective

- Telephoto lens (400mm)
  - Clear silhouette
  - Shows robot massiveness
  - Needs details and features to be readable
  - Weapons are not emphasized
- Good for
  - Crowd battle scenes
  - Shot with detailed BG
- Used mainly in Zoids Wild Zero/Senki

Default pose
©TOMY

Layout/Perspective

- Wide angle lens (20mm)
  - Easy to emphasize weapons
  - Strong motion dynamic
  - Silhouette less readable for 4 legs
  - Face bigger than weapons
- Good for
  - Fight scenes (1 on 1)
  - Shot with simple BG
- Used mainly in Zoids Wild
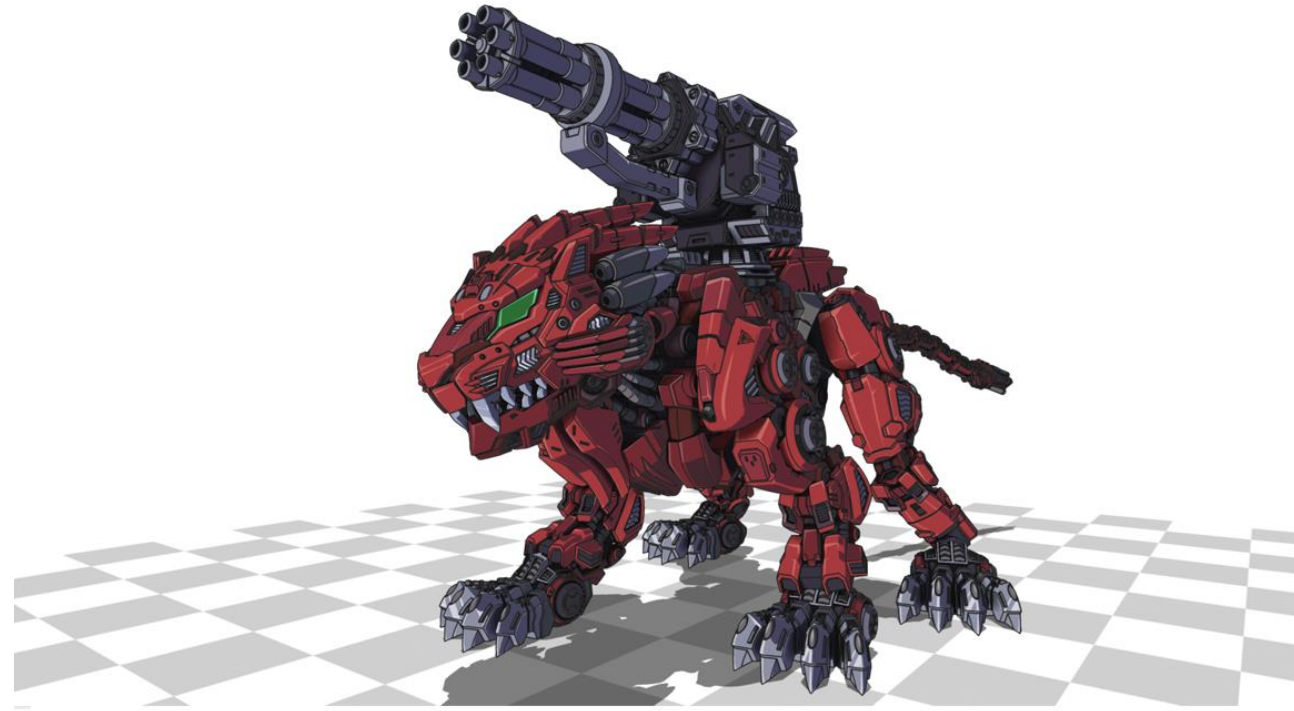
Default pose
©TOMY

Layout/Perspective

- For climax shots

- Wide angle lens (35mm)

- Pose and parts scale adjustments
  - Show lower body silhouette
  - Show robot massiveness
  - Emphasize weapons

- Used in the whole series
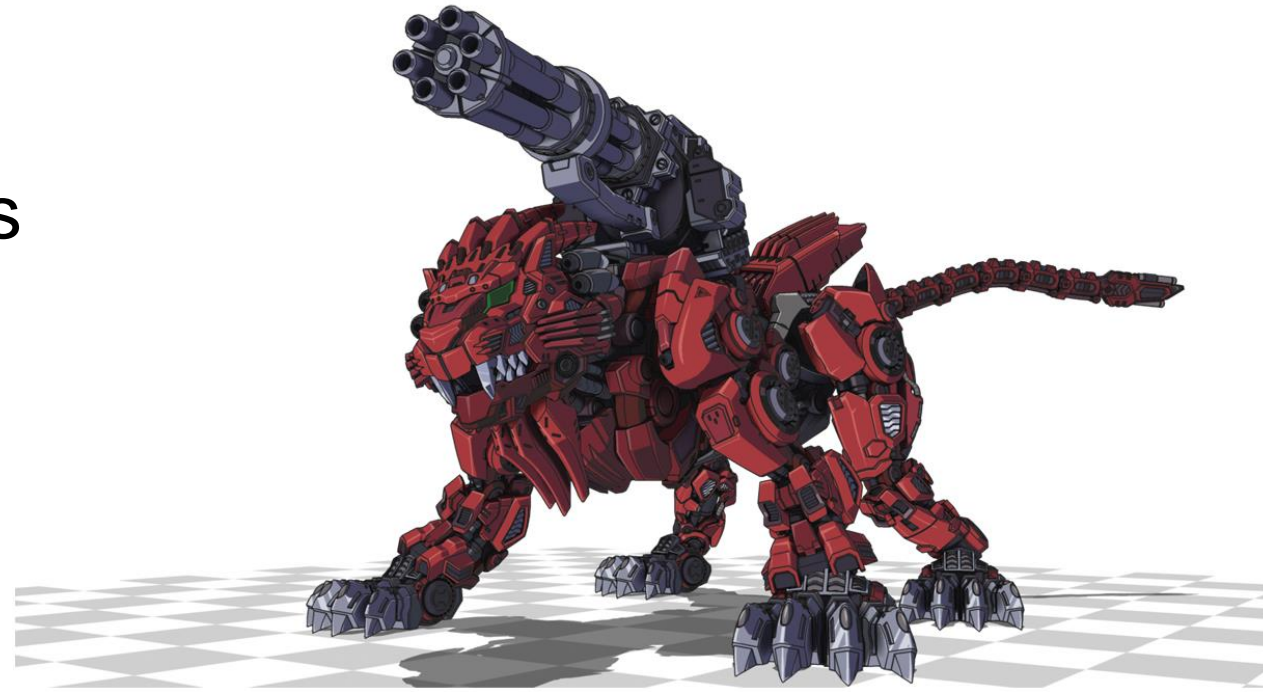
Adjusted pose
©TOMY

Look test

©TOMY/ZW 製作委員会・テレビ東京

Look test breakdown

Look Test Result: too Extravagant

Final Look: Extravagant only in Climax

©TOMY

©TOMY

Non climax shot VS climax shot

Zoids Wild Zero
Gorgeous Eye Catch Homage

Zoids Wild Zero: Opening Homage

©1999 SHO-PRO・MBS・JRK

©TOMY/ZW 製作委員会・テレビ東京

©1999 SHO-PRO・MBS・JRK

©TOMY/ZW 製作委員会・テレビ東京

Zoids Wild Zero
Final Episode Homage

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Conclusion

- Efficient robot animation
  - Animation library
  - Fast toon shader
  - Systematic composition
  - Stable look
- Lot of work in compositing
  - Defines the final look
- Director change during a project implies lot of modification
  - Impact on efficiency
  - New vision

Japanese Animation in 2021 - To CG or not CG?

The Challenges Adapting Hand-drawn Designs To 3D CG

Controlled Simplification Is Hard

Course Notes
Andreas Bauer, Polygon Pictures Inc.

Summary

- **CG Anime**
- **Contours**
- **Hair**
- **Eyes**
- **Rim Lights**
- **Shadows**
- **Conclusion**

Pacific Rim: The Black
© Courtesy of Legendary
A Netflix Original anime series

CG Anime

...is still controversial.

Most die-hard anime fans do not accept CG anime - because '*it just does not look right*'.

And they are probably correct.

Pacific Rim: The Black
© Courtesy of Legendary
A Netflix Original anime series

Hand-drawn Design Challenges

Contours are not merely outlines, they express an artistic emphasis.

Hair is highly stylized, to avoid having to draw individual hairs.

Eyes are typically the main focus, and as emotional as possible.

Rim Lights are merely bright outlines, for contrast against the background.

Shadow Lines are always simplified, expressing only the overall shape.

Cast Shadows are preferred sketchy, with little detail.

Contours

Contrary to animation in the U.S. which dropped contour lines when it moved from hand-drawn 2D to 3D CG, CG anime in Japan still tries to keep contour lines.

While plain contours are easy - artistic contours are *really* hard.

This is a whole talk in itself.
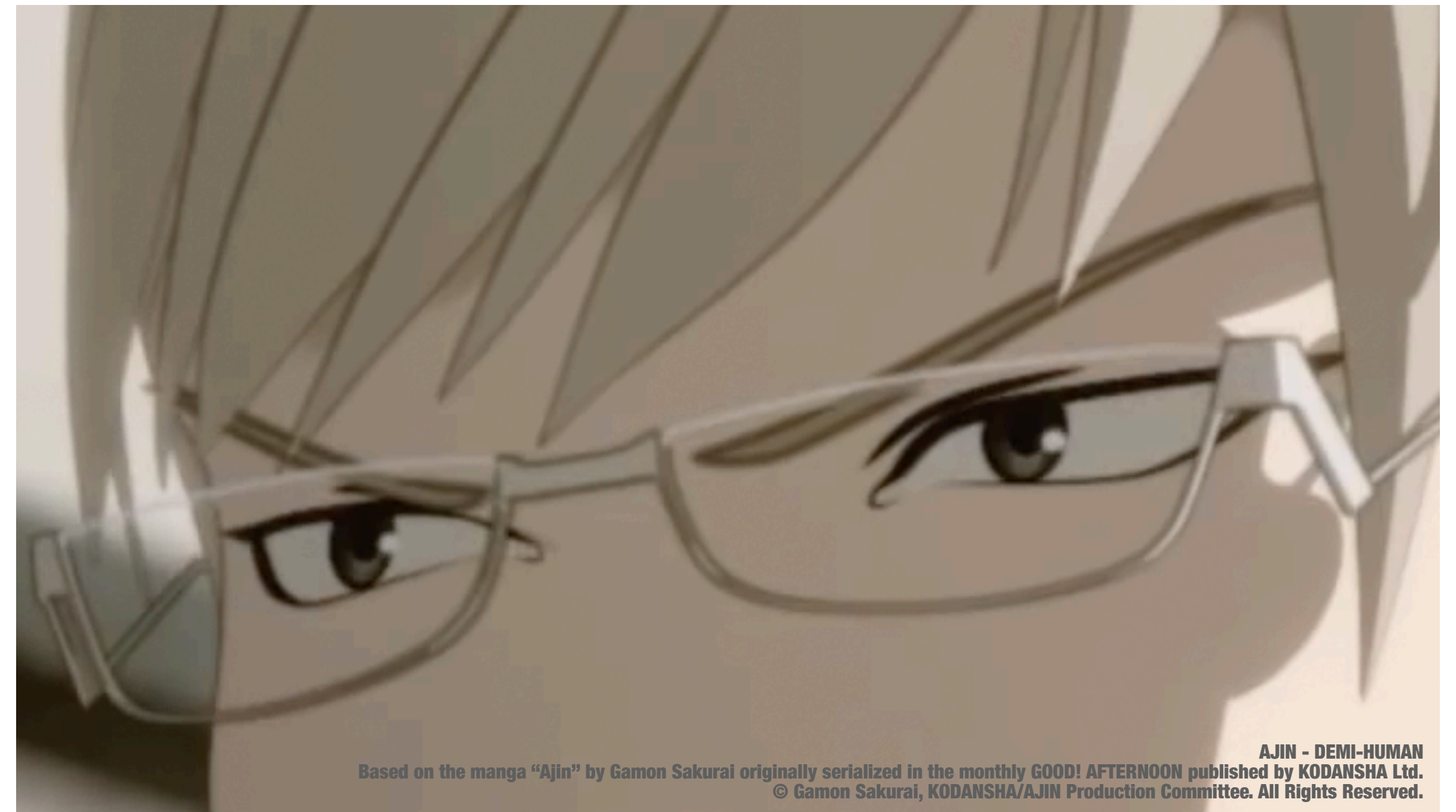
Contours drawn behind glass

Contours

http://tinyurl.com/SIGGRAPH2017

If you are interested to learn more about CG contours, please follow the above link to my 2017 SIGGRAPH*) talk in the ACM Digital Library.

*) ACM SIGGRAPH
Special Interest Group on Computer Graphics and Interactive Techniques of the Association for Computing Machinery, the world's first and largest computing society

Hair

- **Hair Tubes**
- **Curly Hair**
- **'Spherical Normals'**
- **'Hair Tube Normals'**
- **Procedural Hair Highlight**
- **Selective Hair Transparency**

Hair
Hair Tubes

To avoid having to draw lots of individual hairs, whole strands of hairs are drawn as a single '**Hair Tube**'.

Problem:
Curly, scraggly or unkept hair.

'**Hair Tubes**'

Hair
Curly Hair

When hair geometry gets very detailed, for example with scraggly or curly hair, shadow lines become a mess.

One solution can be '**Spherical Normals**'.

Model

Default shadow lines on curly hair look likely messy

Hair
'Spherical Normals'

'**Spherical Normals**' are sphere-like normals, newly created from the object's center, or a locator.

More artistic shadow line on curly hair

Hair
'Spherical Normals'
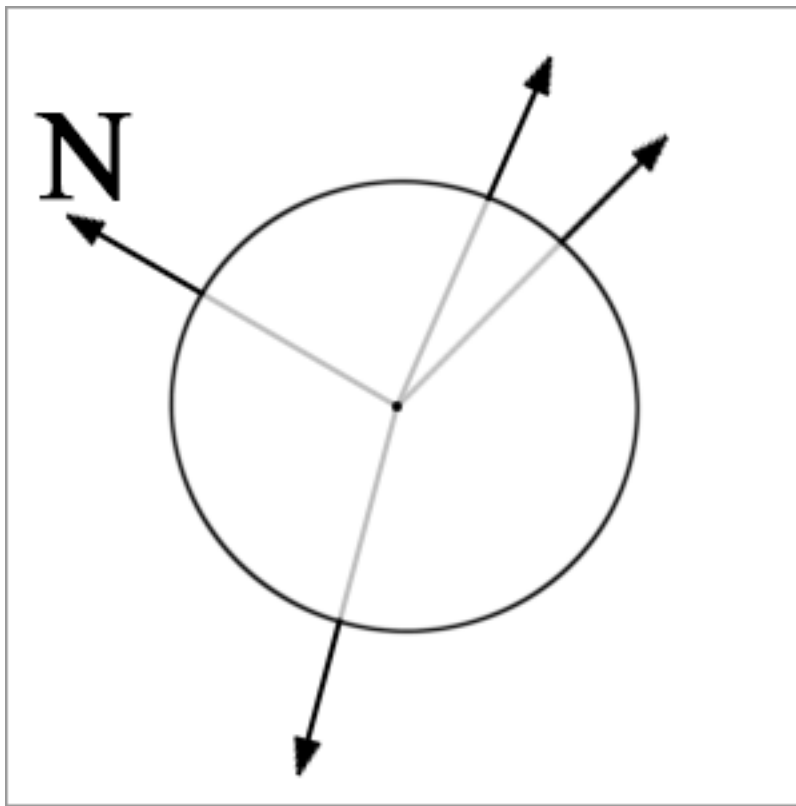
1

Normals (N) on a sphere are unique.
No two normals point in the same direction.
And all normals of the sphere seemingly converge at the center of the sphere.
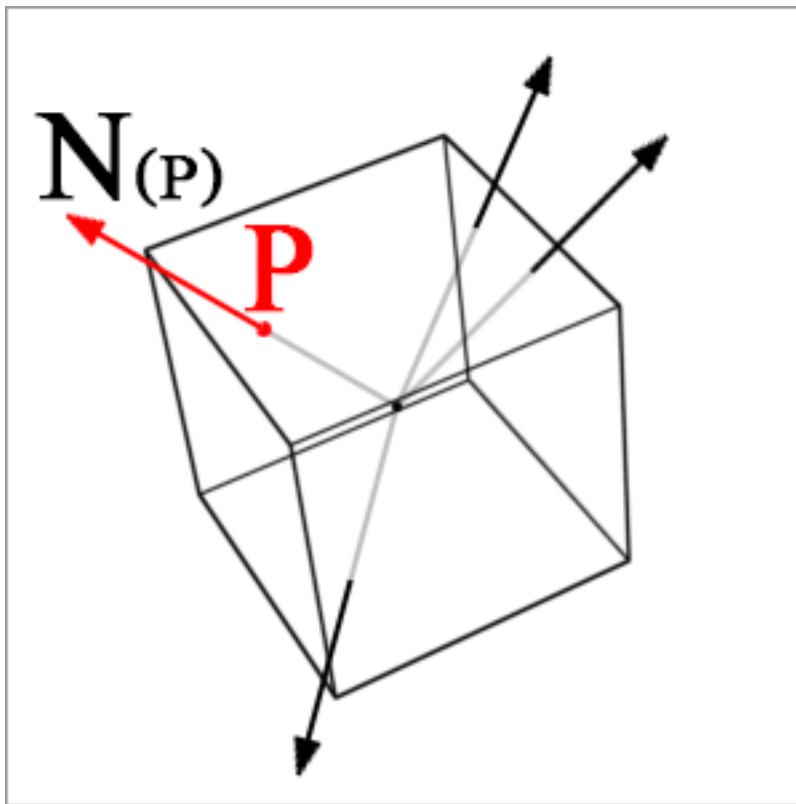
2

We can apply this concept in reverse by calculating a new vector from the object center to the current shading point (P) and using this vector as the new surface normal ($N_{(P)}$) - creating '**Spherical Normals**' on the object.

Ronja, the Robber's Daughter
© NHK • NEP • Dwango, licensed by Saltkråkan AB, The Astrid Lindgren Company
Title Calligraphy by: Toshio Suzuki

Improved shadow line with '**Spherical Normals**'

Hair
'Spherical Normals'

3

Blending the original surface normal with '**Spherical Normals**' creates shading that is more and more sphere-like - even on cubes.
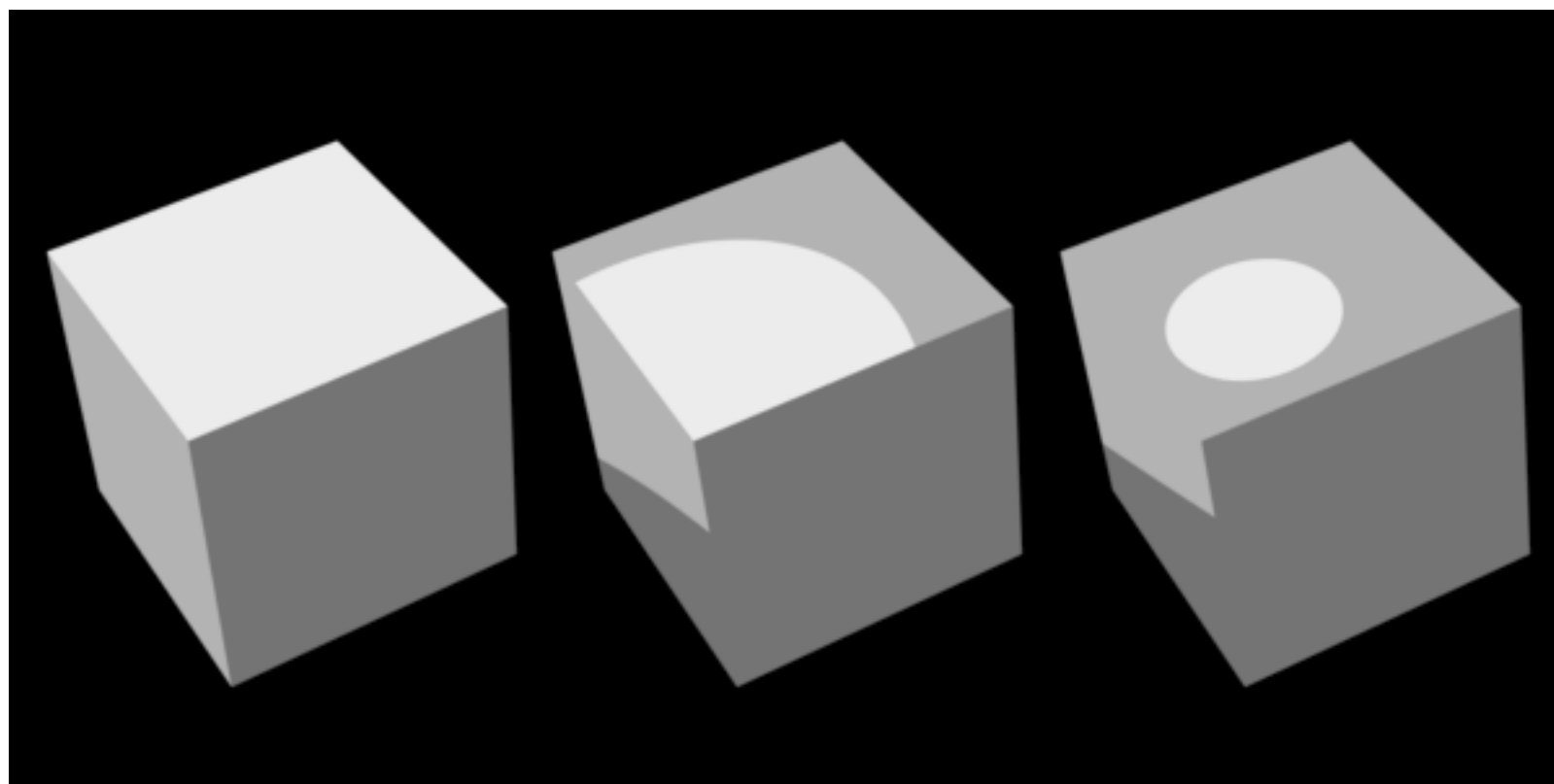
'**Spherical Normals**' at 0%, 50% and 100% (left to right).

4

The origin point of '**Spherical Normals**' can not only be the object center, but also a dedicated locator - this allows to customize the shading.
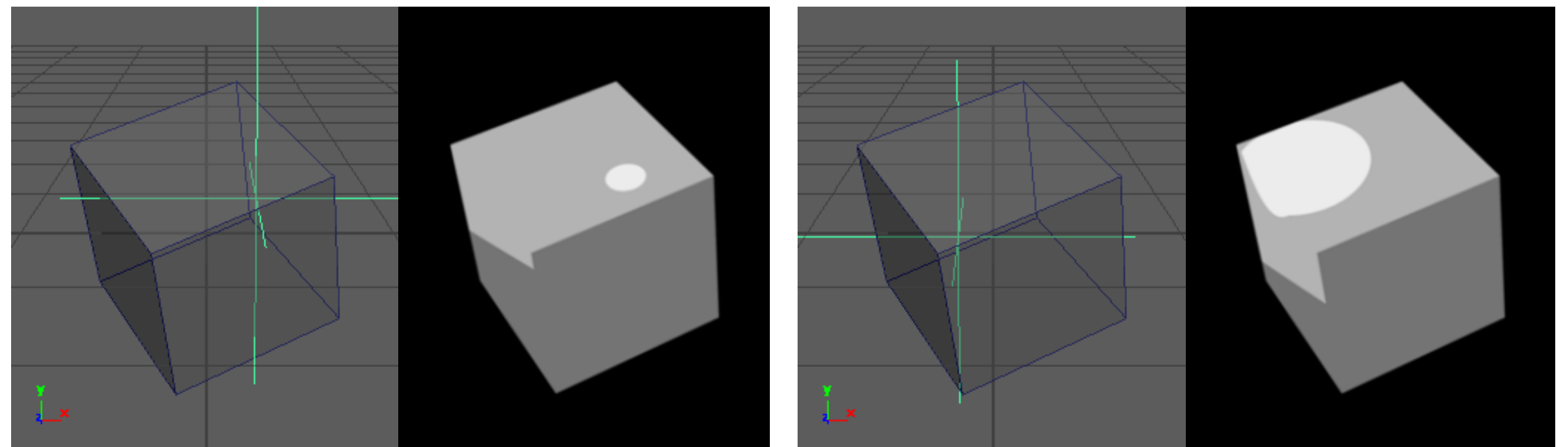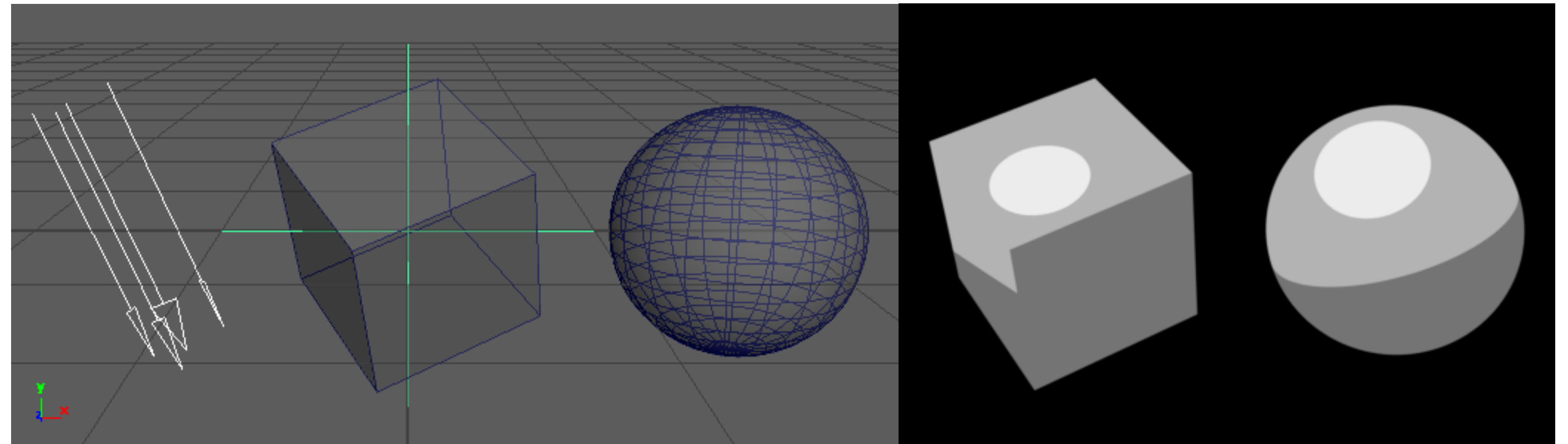
Customizing '**Spherical Normals**' by moving the center locator

Hair
'Hair Tube Normals'

On bushy hair - for example a tail or long curls - 'Spherical Normals' are not a good enough solution.
The result is too plain.

'**Hair Tube Normals**' keep the shadow line simple while re-introducing some sense of shape of the '**Hair Tube**'.

Surface Normals

'**Spherical Normals**'

Hair
'Hair Tube Normals'

'**Hair Tube Normals**' are created by calculating the average direction of each 'Hair Tube' and using it as the *one* normal for the whole 'Hair Tube'.

Blending both '**Spherical Normals**' and '**Hair Tube Normals**' provides the control for these cases to create the desired shadow lines.

'Hair Tube Normals'   'Spherical Normals'

Hair
Procedural Hair Highlight

Computer-generated hair highlights - unlike static textures - can dynamically adapt and change with camera viewing angle or light direction.

Currently, our shader library includes 5 different types of hair highlights, customizable in a wide variety of ways to create a large selection of styles.

Hair
Procedural Hair Highlight

Depending on which side of the head the camera is looking at, different shapes can be created for front, back, left and right sides - with in-between angles interpolated automatically.

The highlight is still fully reactive to light direction changes.

(model)
Pacific Rim: The Black
© Courtesy of Legendary
A Netflix Original anime series
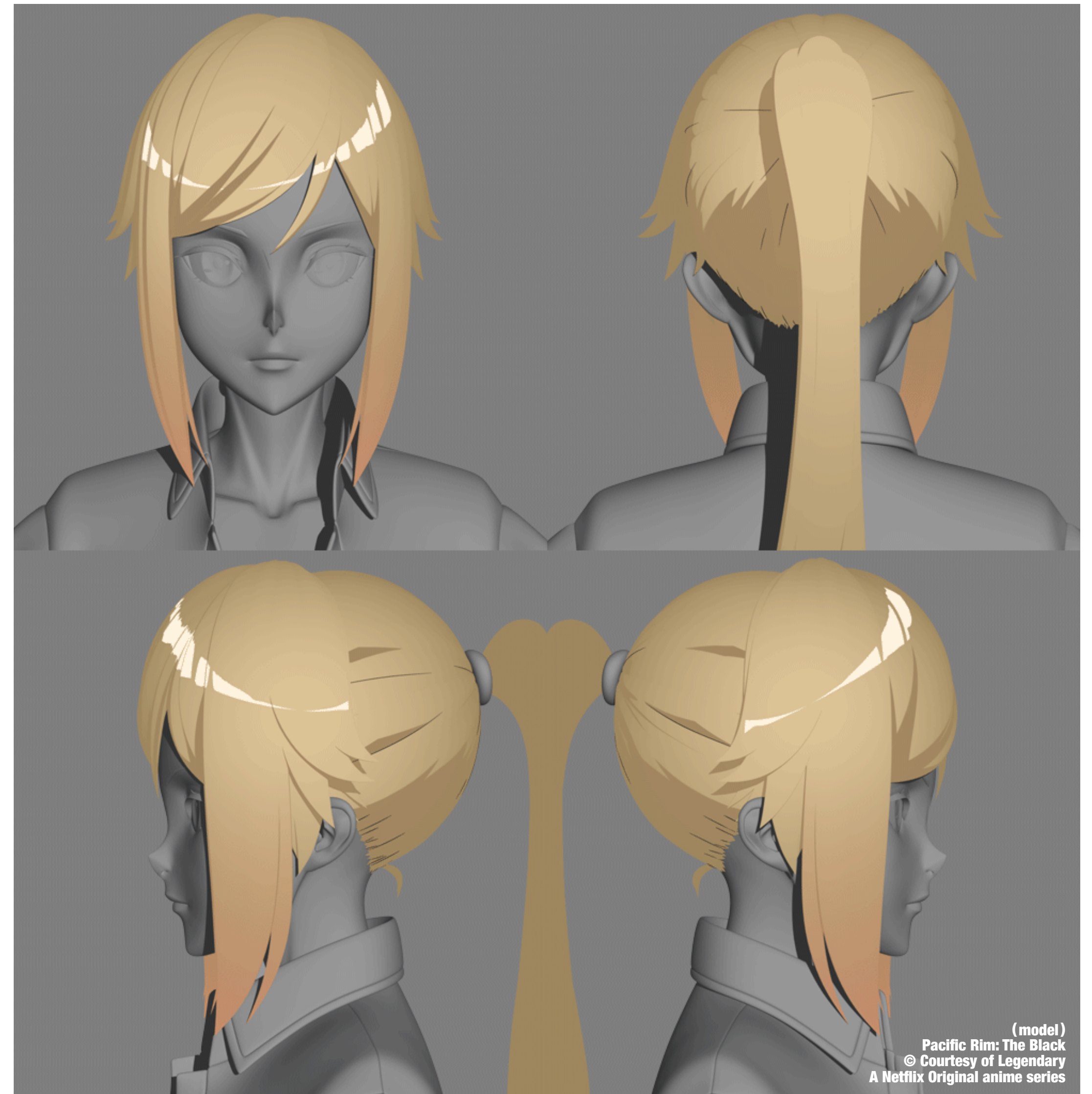
Procedural Hair Highlight shaped differently on each side

Hair
Procedural Hair Highlight - 'Pacific Rim: The Black'

1

The Procedural Hair Highlight style used for '**Pacific Rim: The Black**' had 3 elements rendered into individual RGB channels of one single hair highlight mask.

These were either colored via 3 additional shader layers, output as 3 separate color buffers, or output as one RGB mask buffer and then colored in post-production.

Both methods allow easy modifications of these elements in post-production.

The hair highlight mask **R** channel holds the main specular hair highlight, channel **G** a spherical camera facing ratio (fresnel), and channel **B** a vertical gradient.

(model)
Pacific Rim: The Black
© Courtesy of Legendary
A Netflix Original anime series
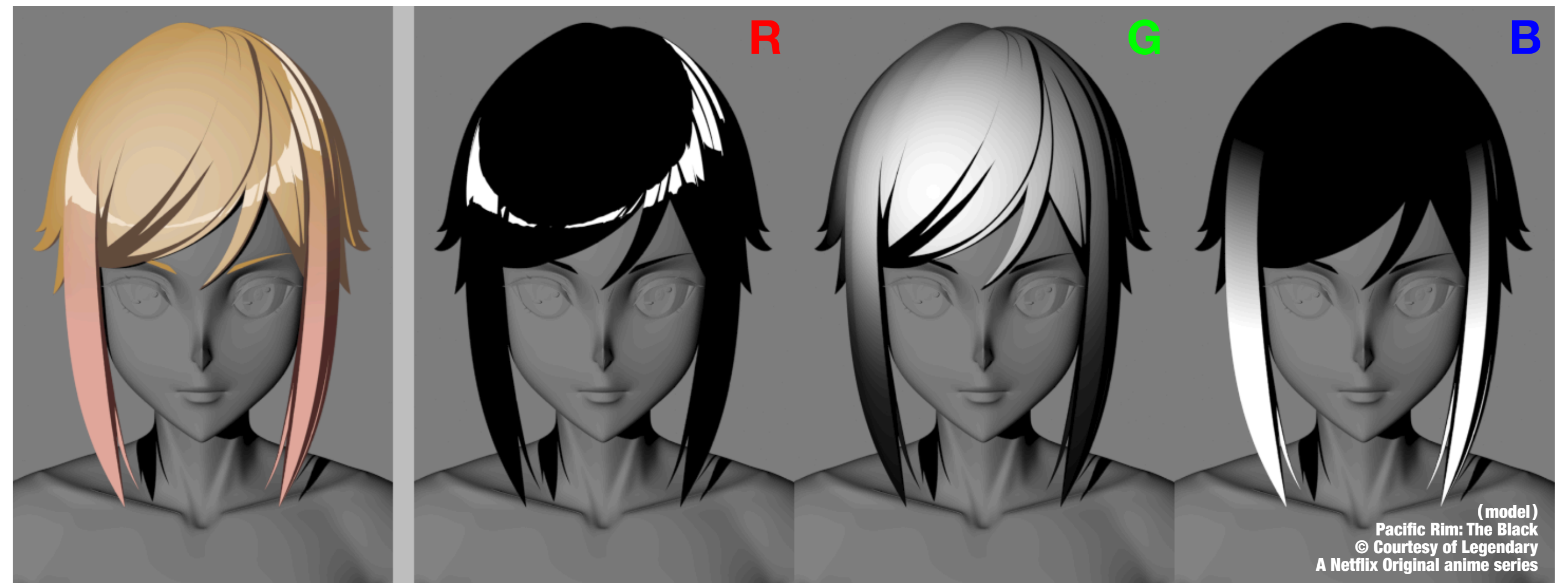
Hair highlight elements rendered into individual **RGB** mask channels

Hair
Procedural Hair Highlight - 'Pacific Rim: The Black'

2

The shader calculates all elements from **Object Space** positions, using **X** and **Z** values directly from the model, plus a **Y**-plane '**Vertical Position**' offset.

This defines the spherical center for all procedural texture calculations.

If the model will strongly deform, Object Space positions can also be baked onto the model as per-vertex data.

Spherical Facing Ratio parameters are straightforward and simple.
The **Vertical Gradient** parameters are based on and require '**Normalized UVs**'.

(model)
Pacific Rim: The Black
© Courtesy of Legendary
A Netflix Original anime series
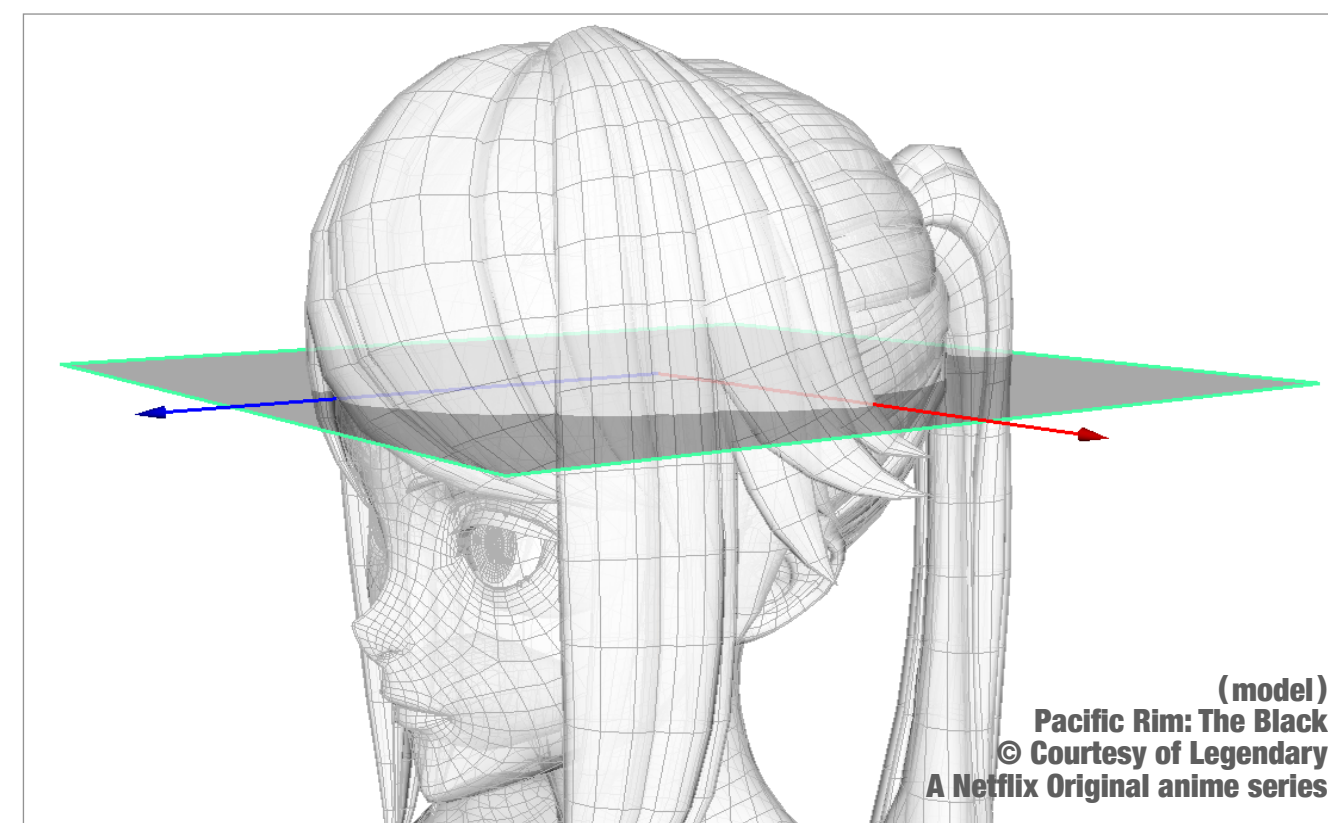
Y-plane '**Vertical Position**' offset
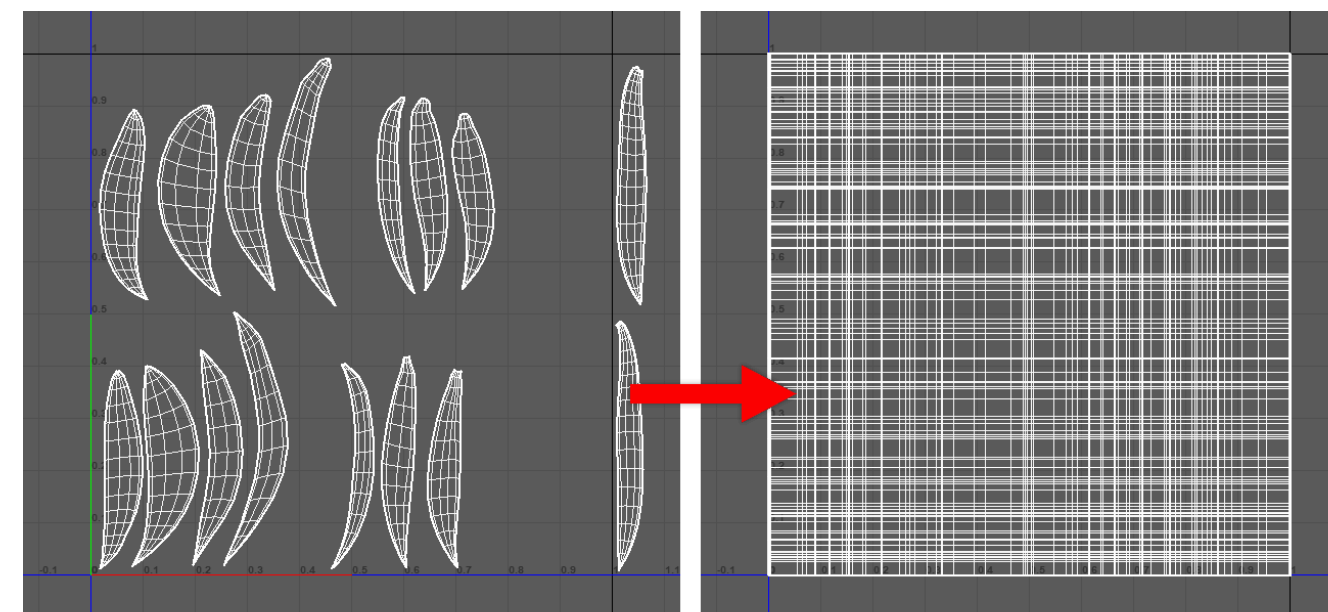
'**Normalized UVs**'
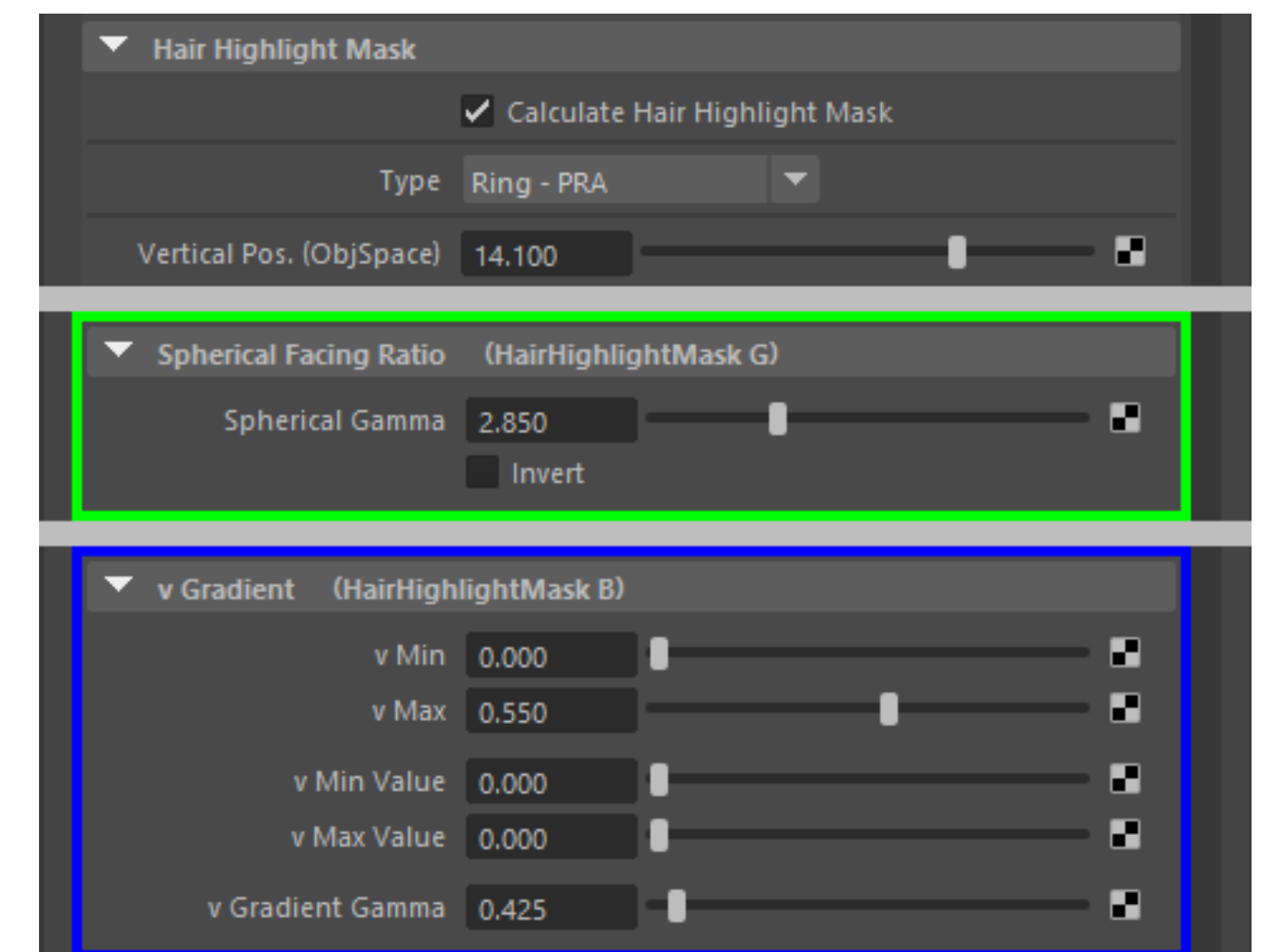
'**Vertical Position**',
Spherical Facing Ratio and
Vertical Gradient parameters

Hair
Procedural Hair Highlight - 'Pacific Rim: The Black'

3

The **Main Specular** parameters are used in Camera Space (as seen from the camera) to shape the front, back, left and right sides.

The highlight width can be set individually for the left edge, center and right edge.

Left and right edges can also be bent up or down, and the center shifted left or right.

To break up the highlight shape, gaps and spikes can be introduced, based on and calculated from the '**Normalized UVs**' and the **Spherical Facing Ratio**.

Finally, noise randomizations can be added, biased towards the center or edges.
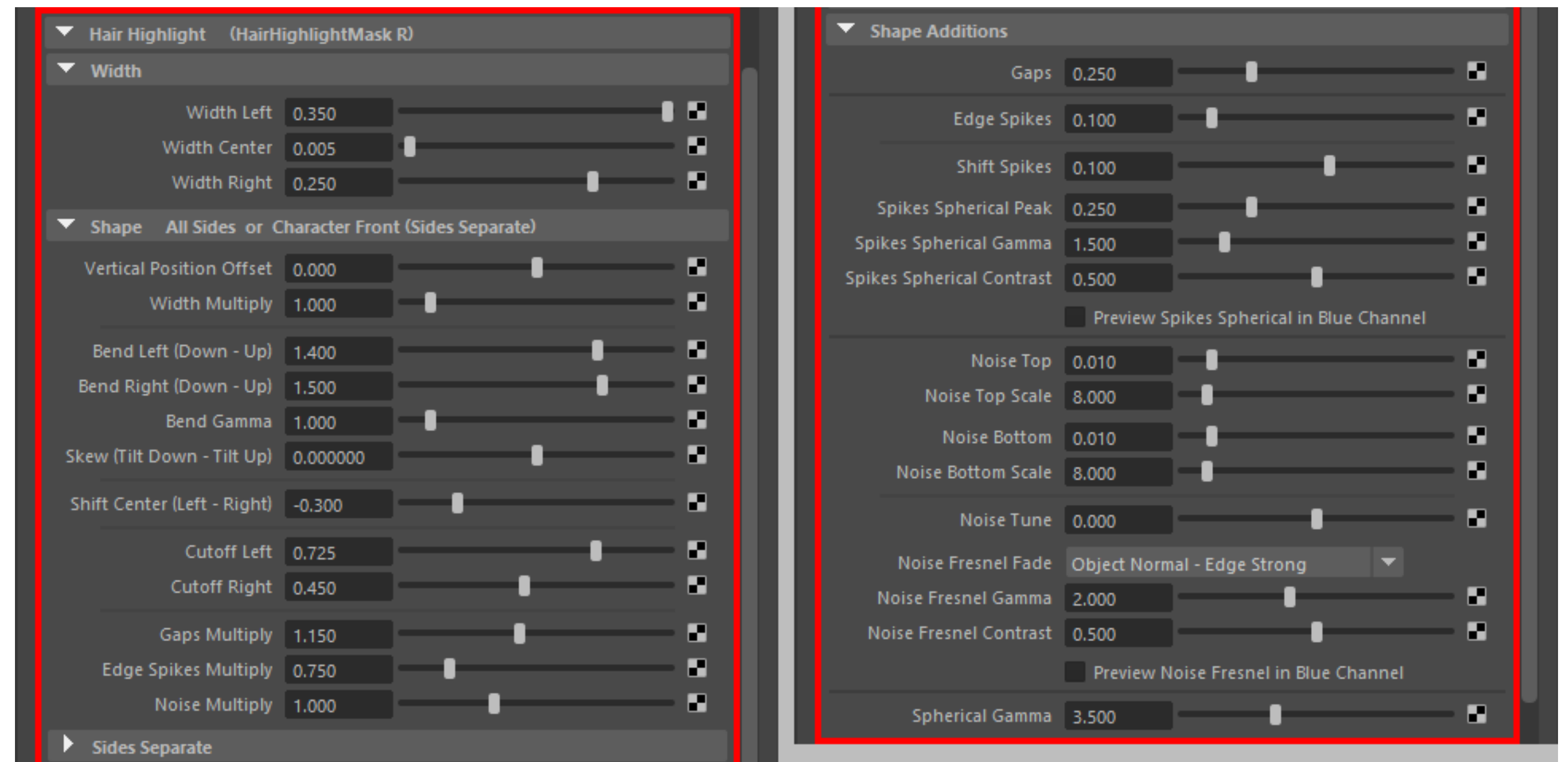
Main Specular parameters

Hair
Procedural Hair Highlight

Procedural designs can be highly fluent and dynamic.

For example small changes in head rotation can morph the highlight into slightly different design patterns.

Highlight pattern changing slightly with camera viewing angle

Hair
Selective Hair Transparency

A rather recent style element.

Hair Tubes are drawn semi-transparent in front of certain specific objects - typically only eyes, eyelashes and eyebrows.

This transparency is truly selective as it does not apply to any other objects like skin, clothing or other Hair Tubes.

Semi-transparent hair in front of eyes, eyelashes and eyebrows

Hair
Selective Hair Transparency - 'Trace Through To ID'

1

All hair tube alpha channels can remain at default value 1 - because this is a separate, simulated transparency.

When the camera ray hits a certain shader, for example a hair tube material, a new probe ray is sent continuing along the ray direction, searching for any object with a material that is assigned a specific '**ID**'.

If found, that found object's surface color is calculated and blended with the surface color of the first material that sent out the probe ray.

Every toon shader material can be assigned its own '**My ID**'.
And every toon shader material can also '**Trace Through To ID**', to search for a shader with a specific '**My ID**' number.

'**My ID**' does not have to be unique, many materials can share the same '**My ID**' - for example eye, eyelash and eyebrow materials.
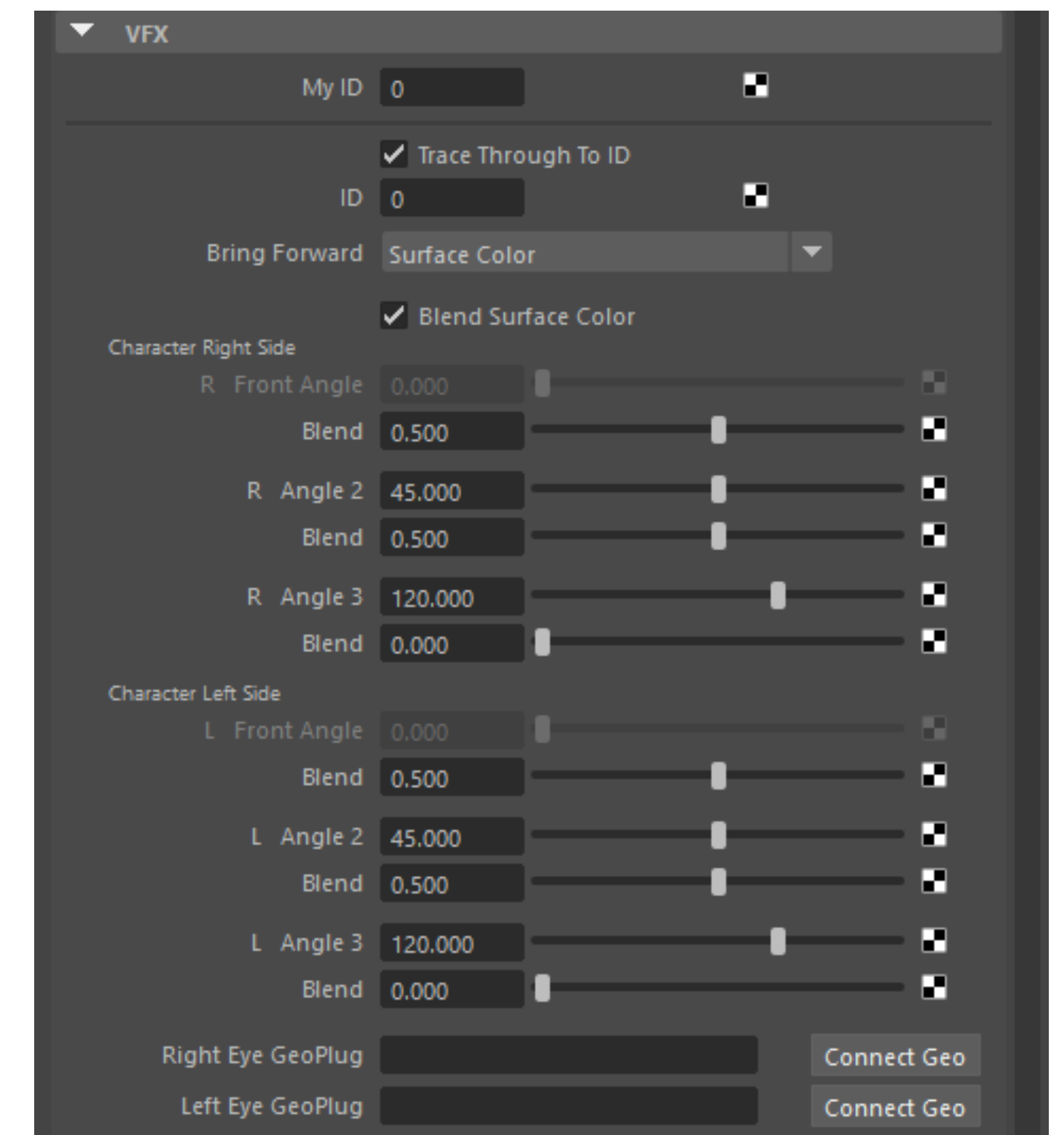
'**My ID**' and '**Trace Through To ID**' parameters

Hair
Selective Hair Transparency - 'Trace Through To ID'

2

Blending the front material's surface color with the found object's surface color can be done in two ways.

Either with a static, fixed blend value.

Or with an automatically adjusted, gradual value based on camera viewing angle.
In this case front views are typically most transparent, and side views are getting gradually more opaque.

Our implementation offers both blend options.

Automatically adjusting transparency based on camera viewing angle

Eyes

- **Eye Geometry**
- **Eye Highlights**
- **Eye Shadow**

Eyes
Eye Geometry

Early eye designs used rather simple geometry - just a single sphere.
Its size and shape was roughly anatomically correct.

Recent designs became much more complex, are in layers and no longer anatomically correct.
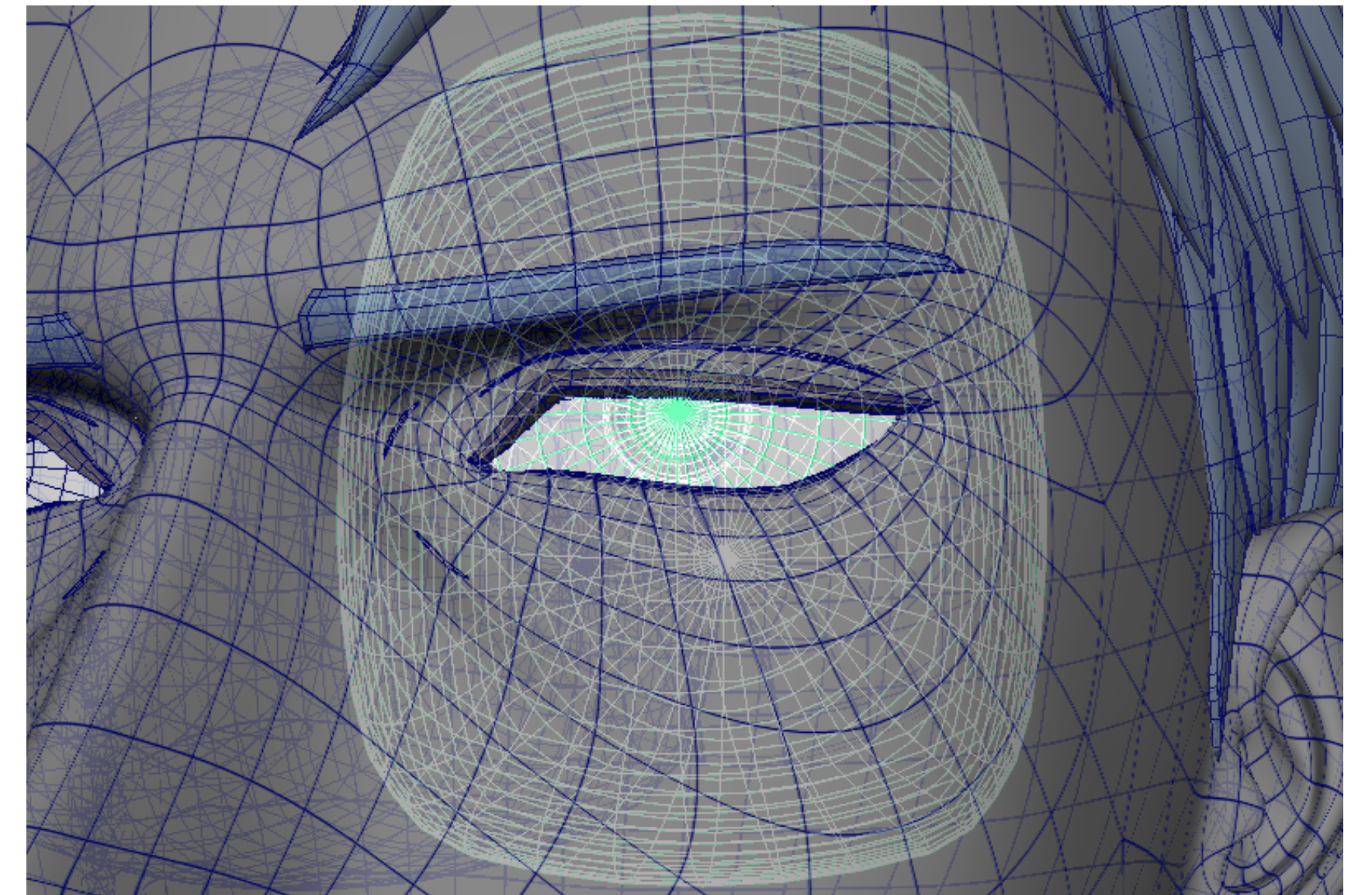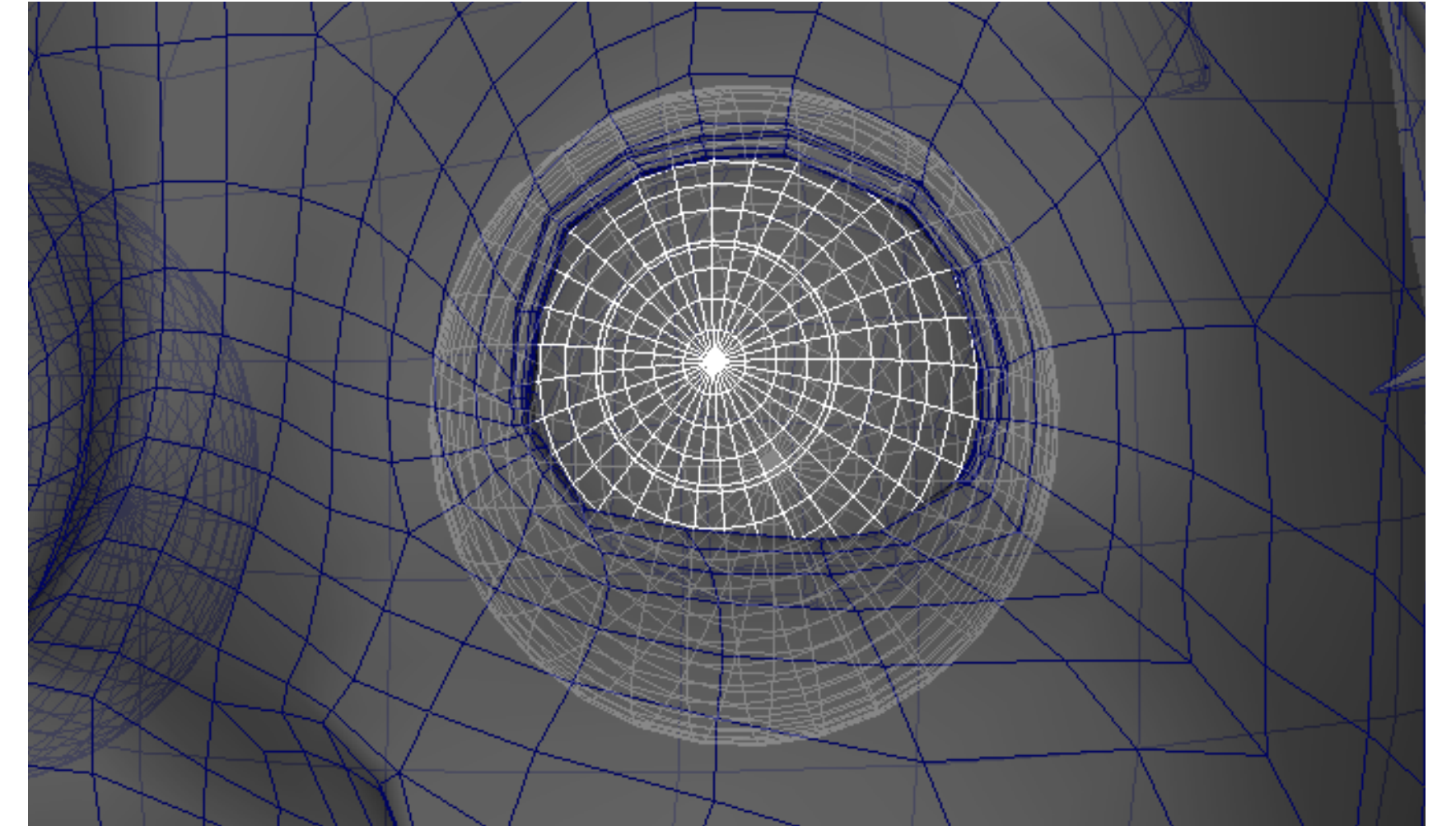
Early (top) and recent (bottom) eye designs

Eyes
Eye Highlights

Very early eye designs used no separate eye highlight - it was merely part of the color texture.

Recent designs use separate, fully rigged eye highlight geometries - and often more than one.

Early eye highlight design,
also using regular scene lights to cast shadows on the eye

Eyes
Eye Shadow

Early eye designs used just regular scene lights to cast shadows on the eyes.

Later designs switched to a planar texture projection.

But both lacked artistic control.

Recent designs use **Procedural Eye Shadows** with full control.

HUMAN LOST
© 2019 HUMAN LOST Project

Regular scene shadows on eye

Pacific Rim: The Black
© Courtesy of Legendary
A Netflix Original anime series

Procedural Eye Shadow

Eyes
Procedural Eye Shadow

1

Procedural Eye Shadows are ray-traced, completely independent of all scene lights and allow to shape and adjust the shadow for each eye individually.

To the geometric center of the eye (E) add an '**Offset XYZ**' value in Object Space to create a new **virtual eye center** (V) roughly lined up horizontally (*vector vi*) with the **iris center** (I).

Probe rays are sent out from this virtual eye center, searching only for objects that are allowed to cast shadows on the eye surface - typically only **eyelash geometries**.
Any intersection with these objects (P_1 - P_3) is output as shadow on the eye surface.

(model)
Pacific Rim: The Black
© Courtesy of Legendary
A Netflix Original anime series
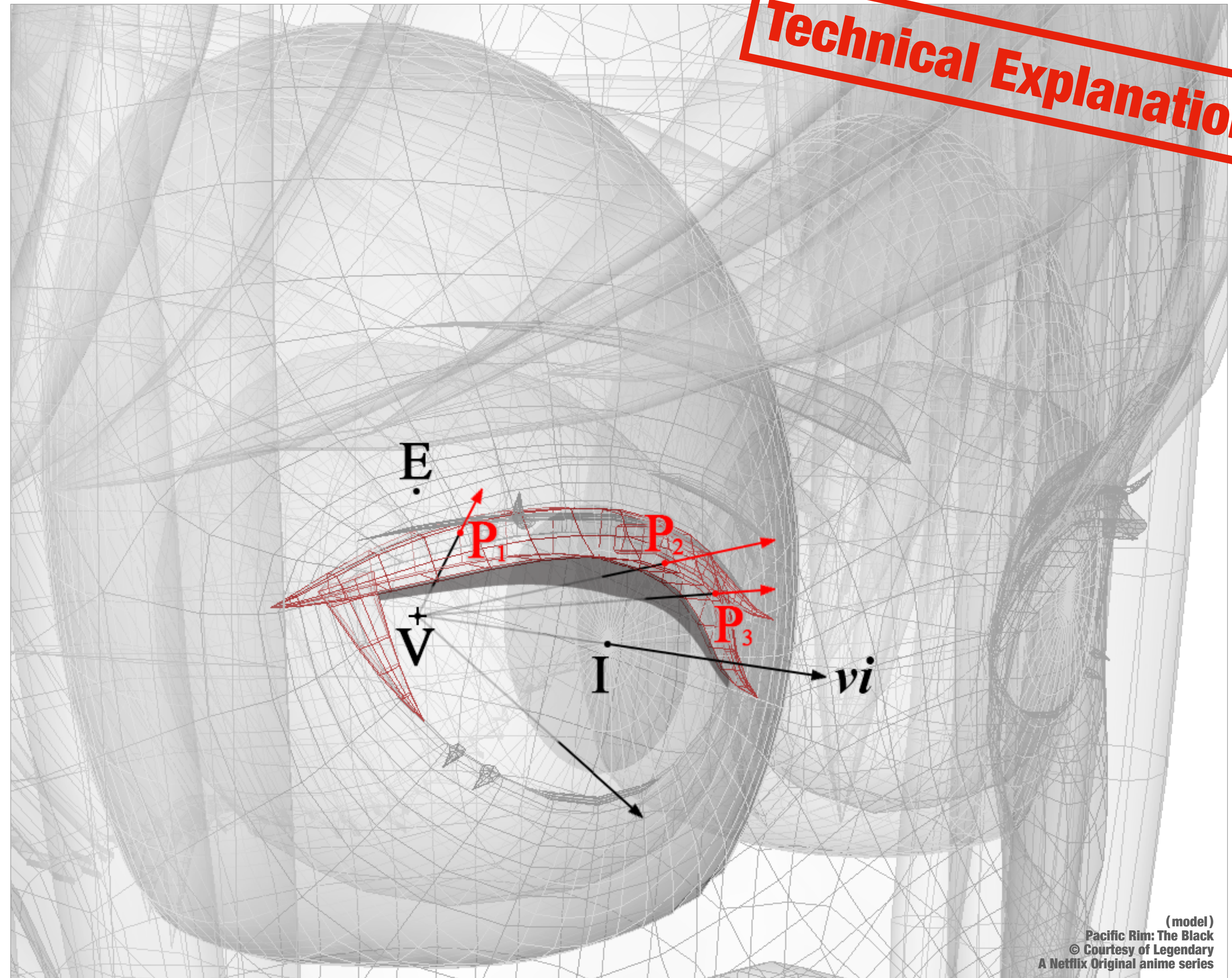
Procedural Eye Shadow casting probe rays from the **virtual eye center**

Eyes
Procedural Eye Shadow

2

To calculate **Procedural Eye Shadows** the shader needs to be told the eye ball geometry, the list of objects allowed to cast shadows on the eye surface, and the '**Offset XYZ**' value.

3

Changing the '**Offset XYZ**' value shifts the **virtual eye center** in Object Space. This also moves the eye shadow, effectively shaping it.

The image shows some shaping variations.

In shot production the vertical position of the eye shadow line is the most important control. Therefore an animatable '**Offset**' slider is also provided; it ultimately adds to '**Offset XYZ**'.

(model)
Pacific Rim: The Black
© Courtesy of Legendary
A Netflix Original anime series
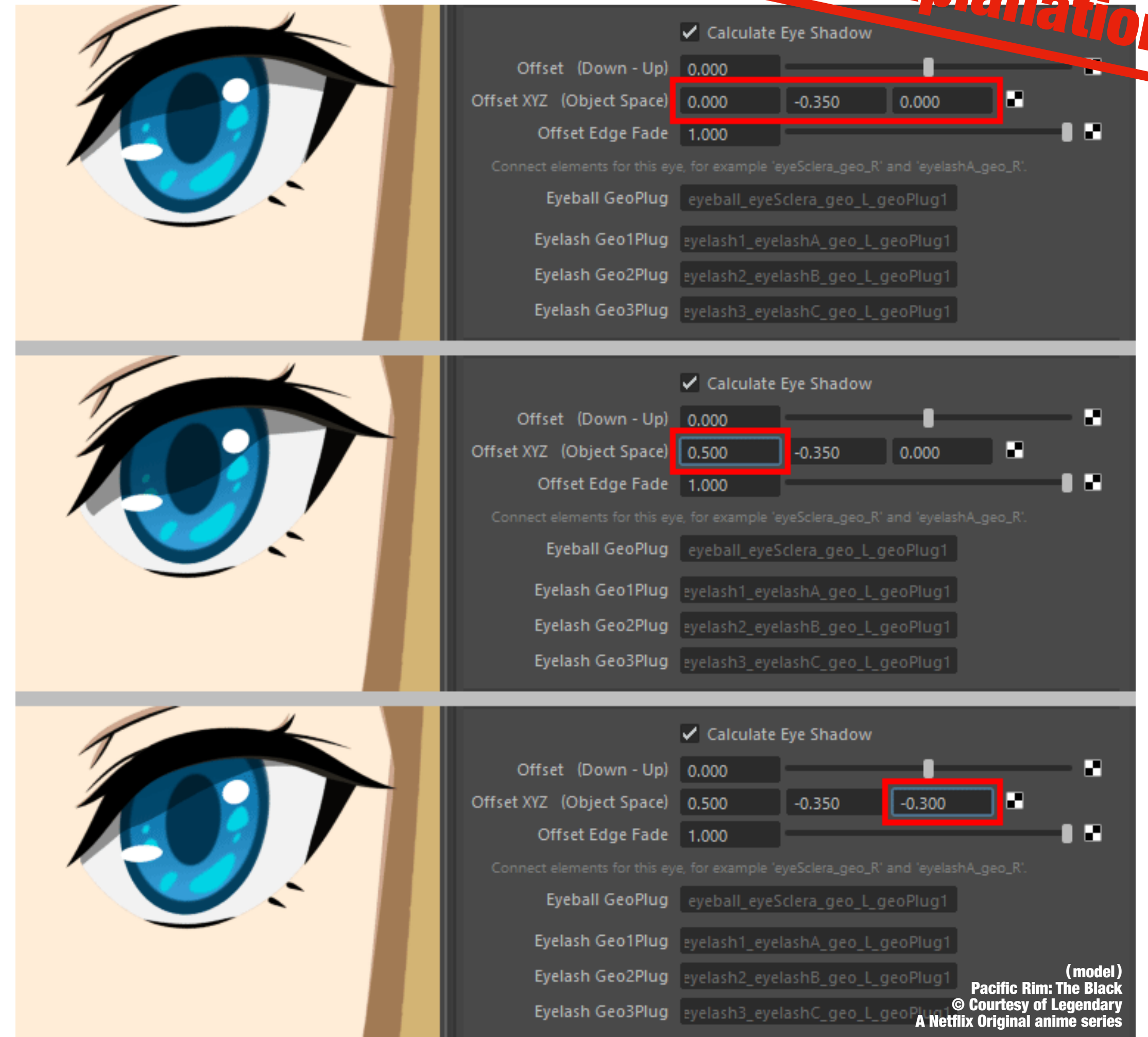
Shaping the eye shadow with '**Offset XYZ**'

Rim Lights

Initially rim lights were not used.

But this often resulted in poor contrast against backgrounds with a similar brightness.

The initial solution was to place additional lights in the scene for rim lights.

最後の希望は、手放さない

Knights of Sidonia
© TSUTOMU NIHEI • KODANSHA／KOS PRODUCTION COMMITTEE

Without rim lights background contrast can be poor

Rim Lights

Placing additional lights in the scene to create rim lights works well on simple, smooth shapes.

First Problem:
Highly detailed geometries, like cloth folds, reveal too much detail with scene rim lights and tend to look busy.

Scene rim lights on smooth geometry

Scene rim lights on highly detailed geometry

Rim Lights

Second Problem:
Depending on camera attributes, rim lights based on real scene lights will suffer distortions.

Especially towards the edge of the view.
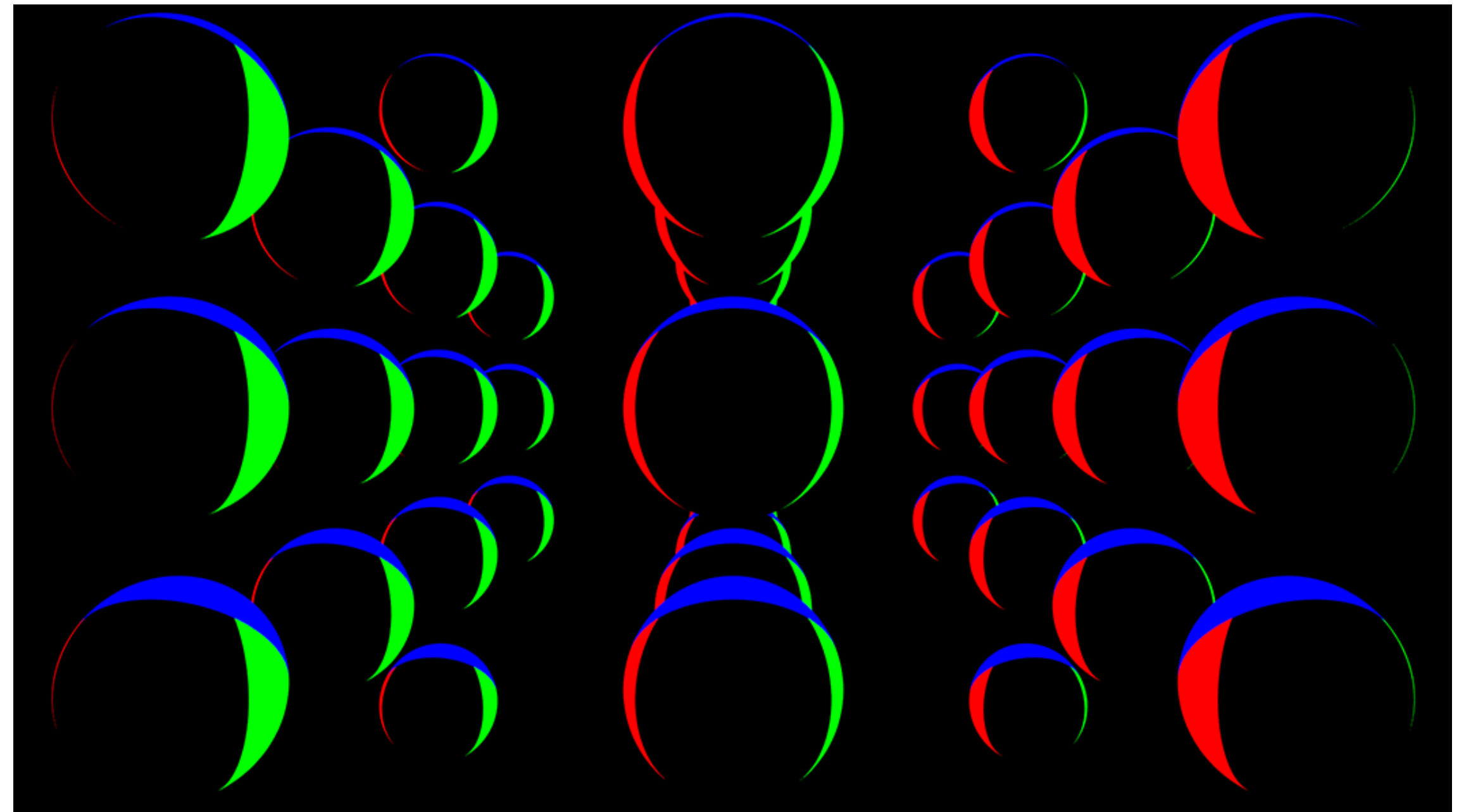
Scene rim lights experiencing camera distortions

Rim Lights
'Tint Lights'

Procedural Rim Lights solve both problems. They no longer require additional scene lights and by using orthogonal Camera Space they avoid all distortions.

Additional scene lights can still be used as '**Tint Lights**' to create artistic lighting effects.
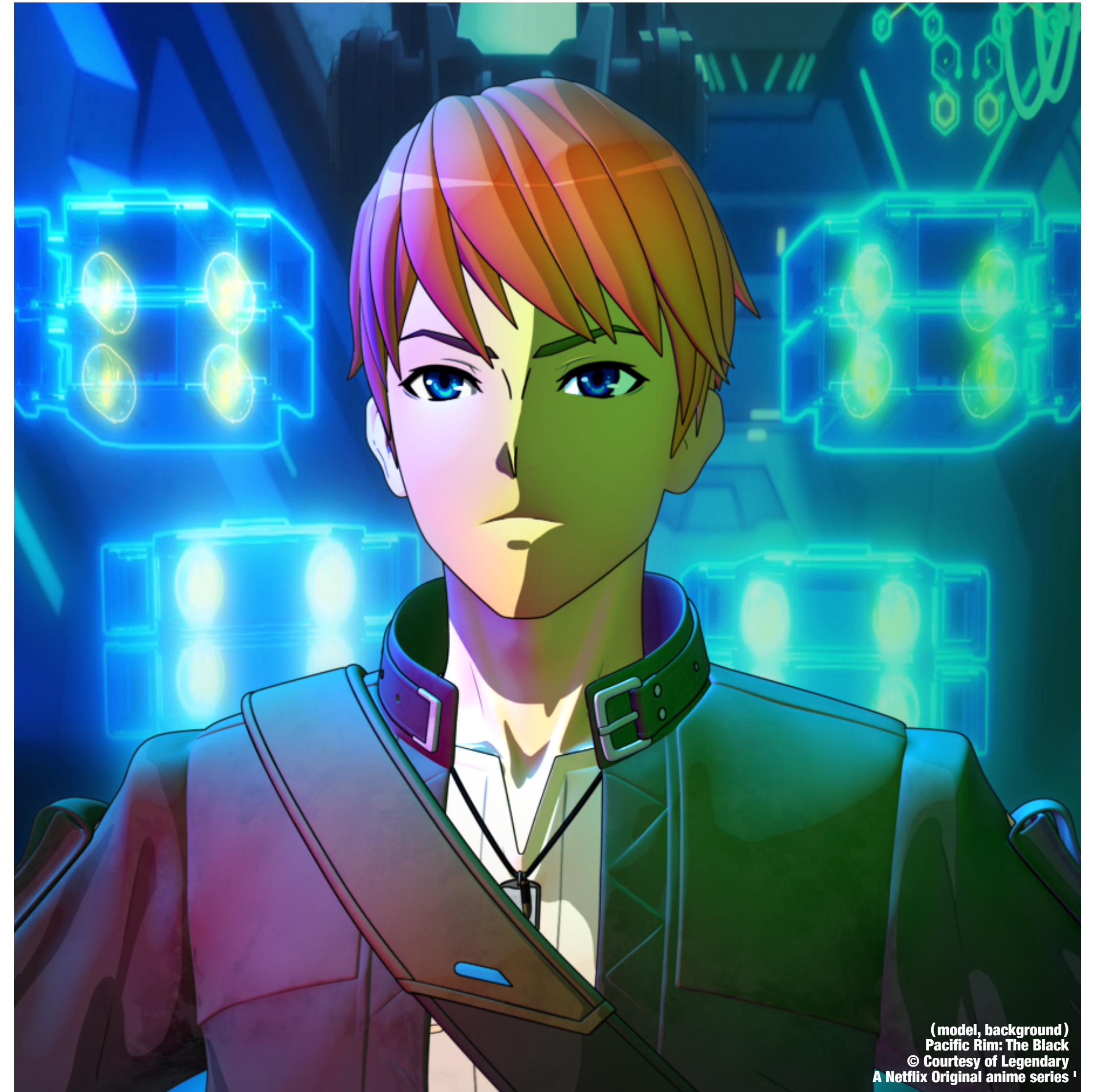
'2.5D' artistic impression using '**Tint Lights**'

Rim Lights
Procedural Rim Lights

1

Similar to standard **normal relighting tools**, a virtual light direction vector is specified in Camera Space via **X** and **Y** angles (in degree). The **Z** axis is the camera direction.

This is treated in the shader like a regular directional light, but output only into a buffer.

2

To simulate rim light shadows, a simple occlusion test is done, sending a **probe ray** from the surface point in the opposite virtual light direction to test for object intersections.

Typically only close-by objects should cast shadows, so a '**Max Distance**' is applied.
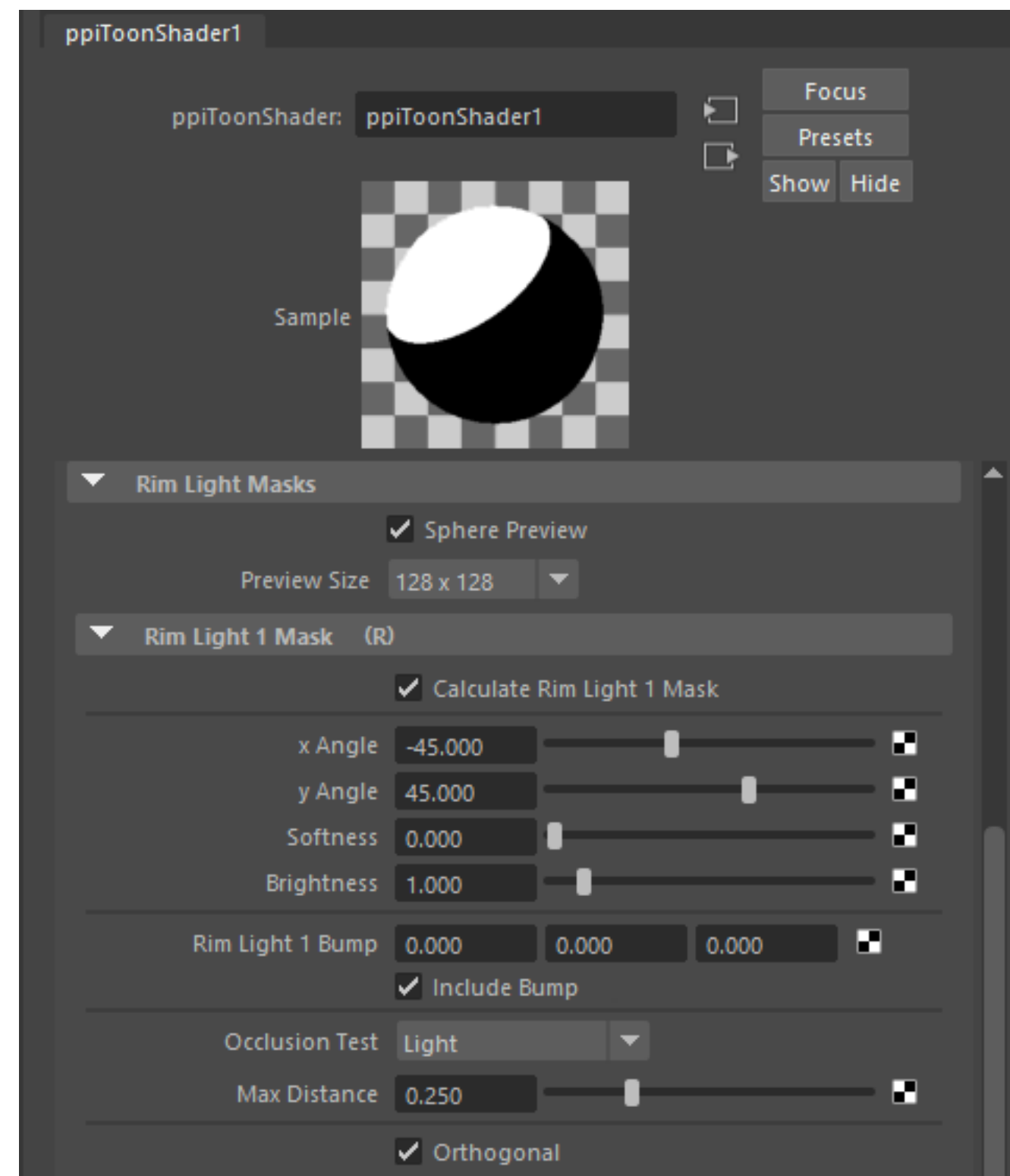
Procedural Rim Light parameters

Converting **X** and **Y** angles to a virtual light direction vector (mental ray `code` `example`)

Rim Lights
Procedural Rim Lights

3

To achieve an orthogonal rim light result, the angle between the camera view direction (**Z** axis in Camera Space) and the vector from the camera position to the current shading point can be used as a 'correction factor' for the virtual light direction vector.

Rotating the virtual light direction vector by this correction factor makes the rim light result orthogonal, similar to a parallel projection from the camera view plane.

4

The rim light gets its final shape by clipping it with a thick outline contour.
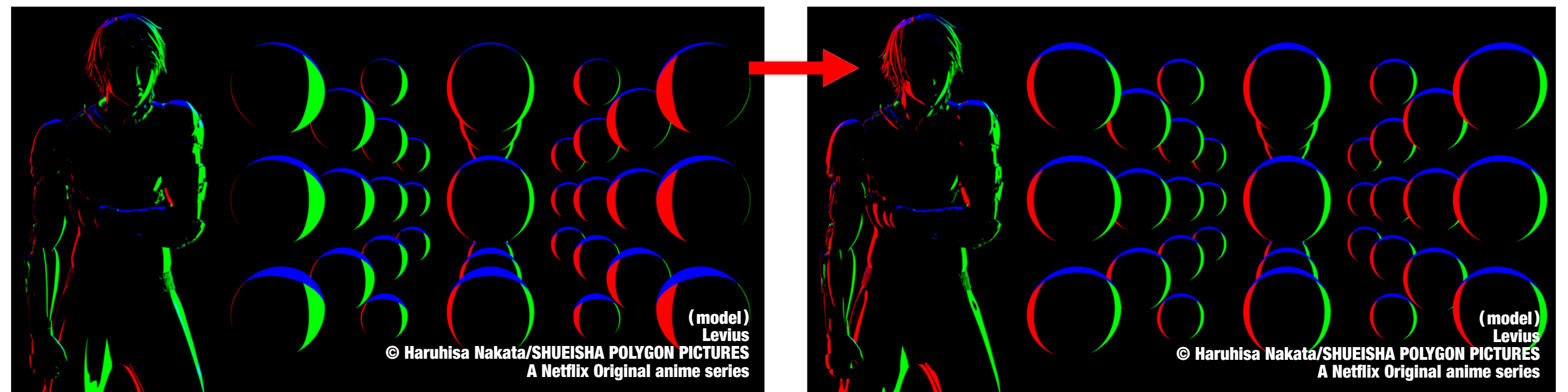
From scene rim lights to **procedural orthogonal rim lights**
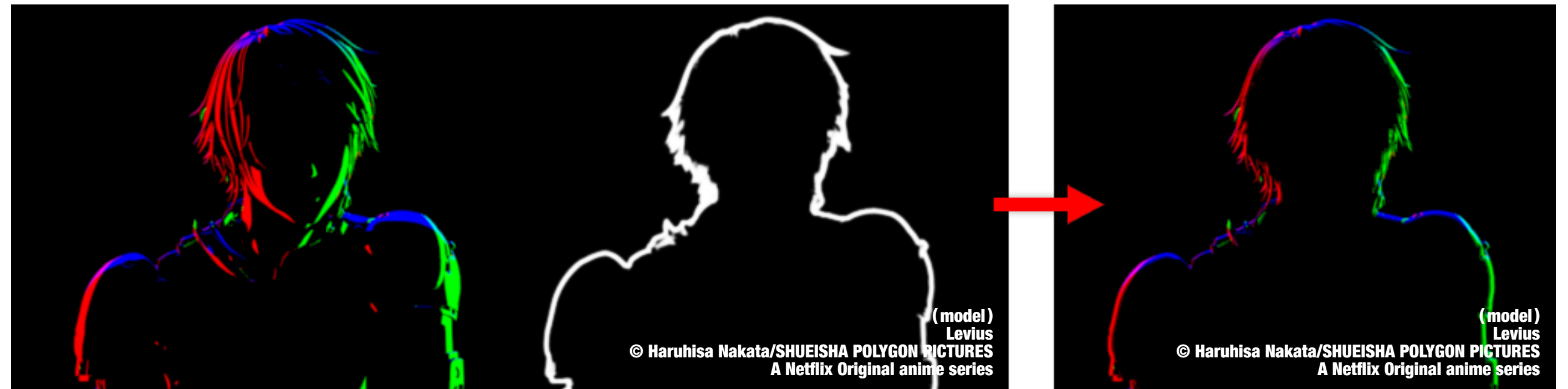
Clipping orthogonal rim lights with **outline contour**

Shadows
Shadow Types

- **Self-Shadow (■)**

- **Secondary Shadow (■)**

- **Cast Shadow from Self (■)**

- **Cast Shadow from Others (■)**

- **(Ambient Occlusion)**
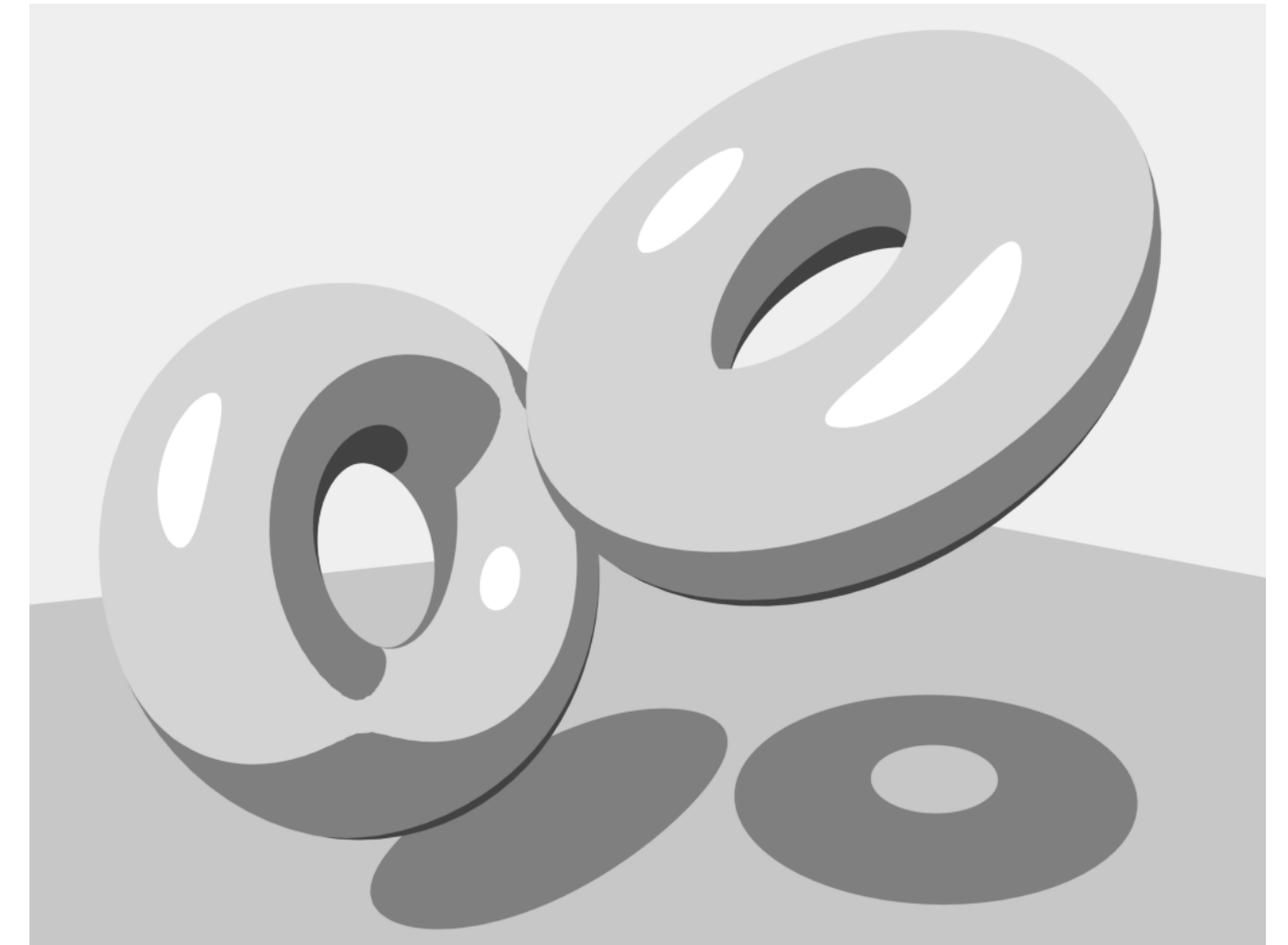
Scene with various shadow types
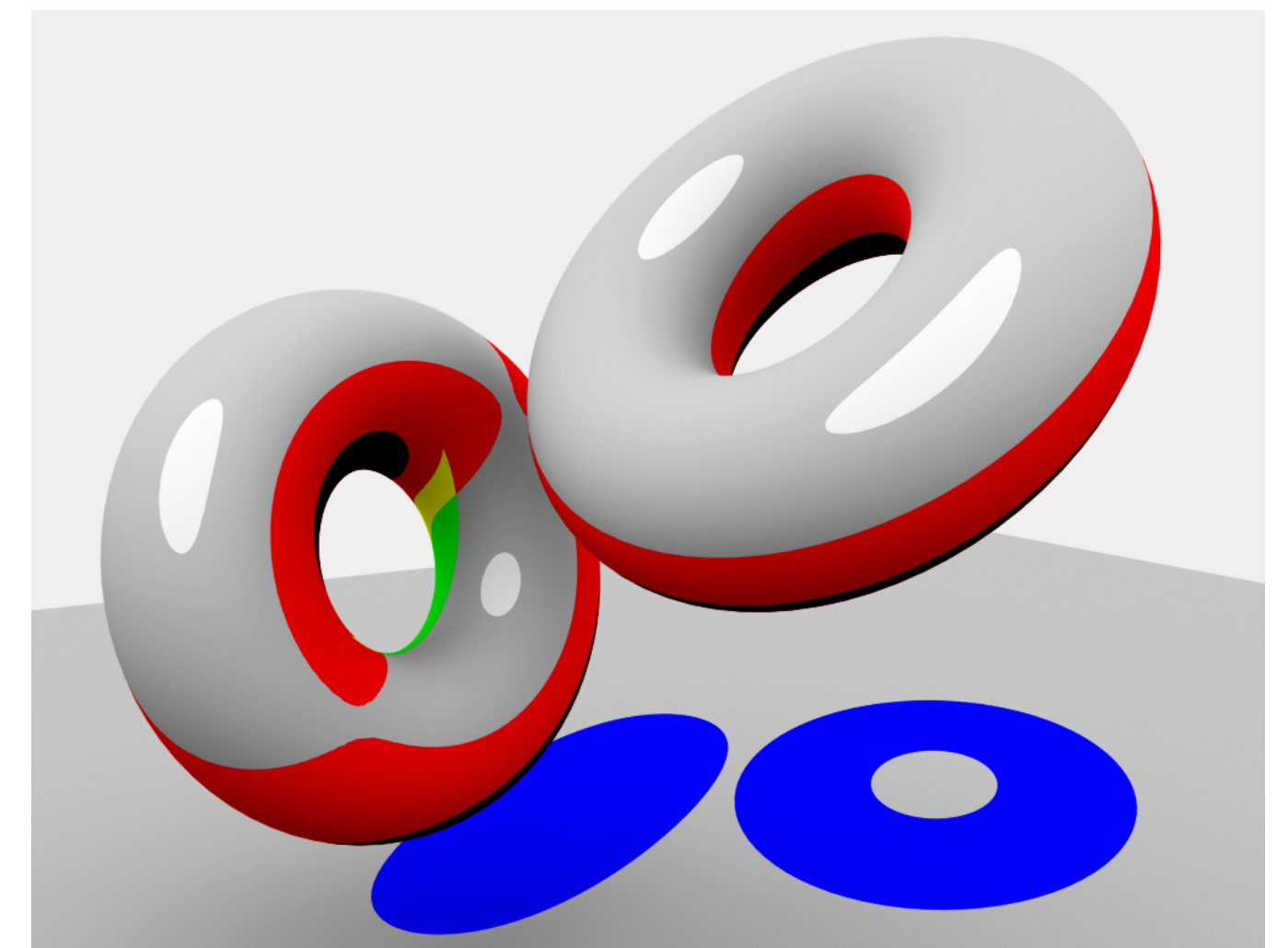
Shadow types indicated by color

Shadows
Cast Shadow from Self / Others

Body geometry typically receives only **Cast Shadow from Self** - but not from other objects.

Hair geometry on the other hand typically receives only **Cast Shadow from Others** - but not from itself.

(model)
DRIFTING DRAGONS
© Taku Kuwabara, KODANSHA/DRIFTING DRAGONS production committee

With '**Cast Shadow from Self**'

(model)
DRIFTING DRAGONS
© Taku Kuwabara, KODANSHA/DRIFTING DRAGONS production committee
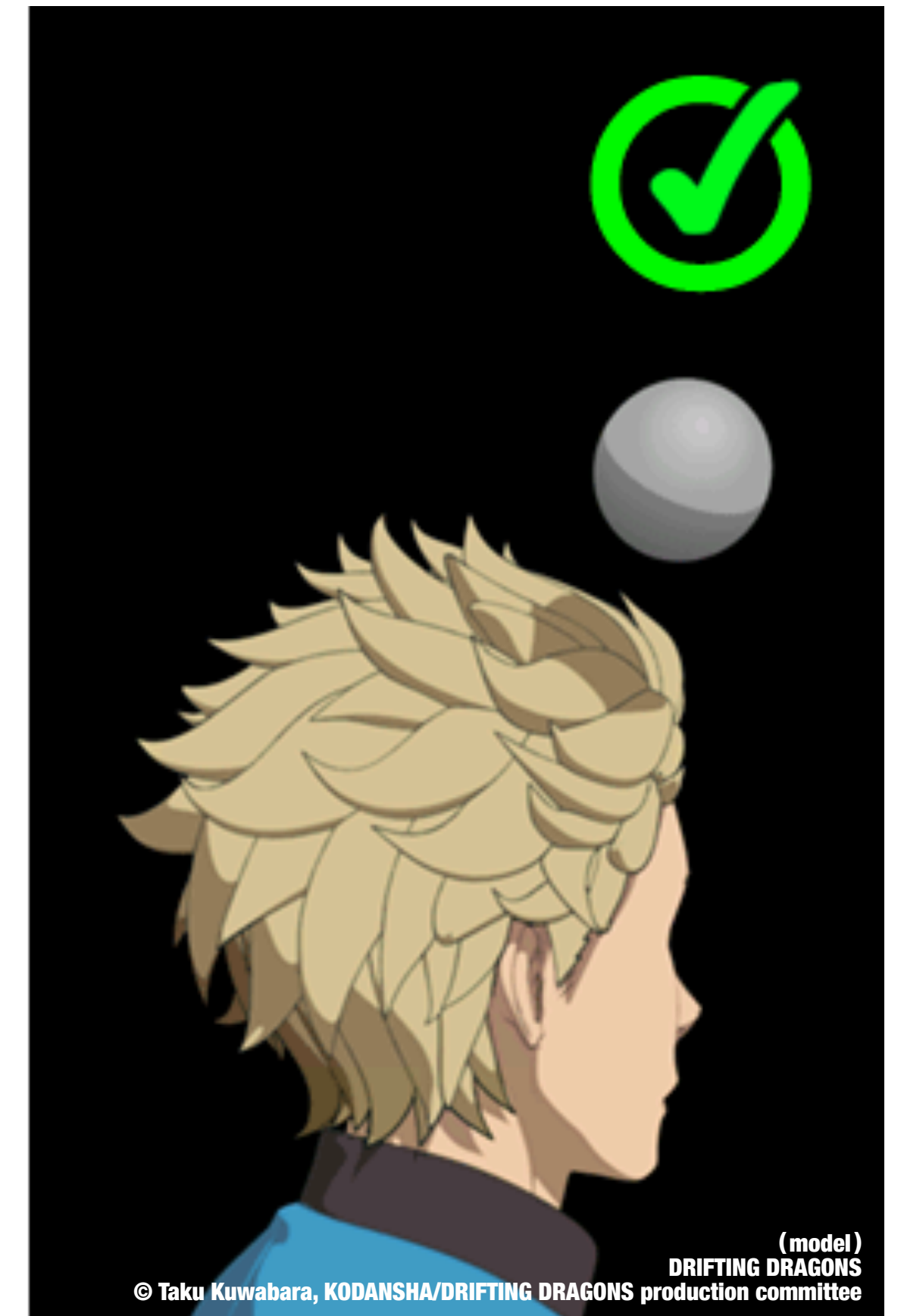
Without '**Cast Shadow from Self**'

Shadows
Fixing 'CG-like' Shadows

Fixing Self-Shadows

- **'Smooth Normals'**
- **'Normal Transfer'**
- **'Light Bending'**
- **Separate Bump for Light / Shadow**

Fixing Cast Shadows

- **'Distance Fade'**
- **'Sharpen Soft Shadows'**
- **Combined Shadows**
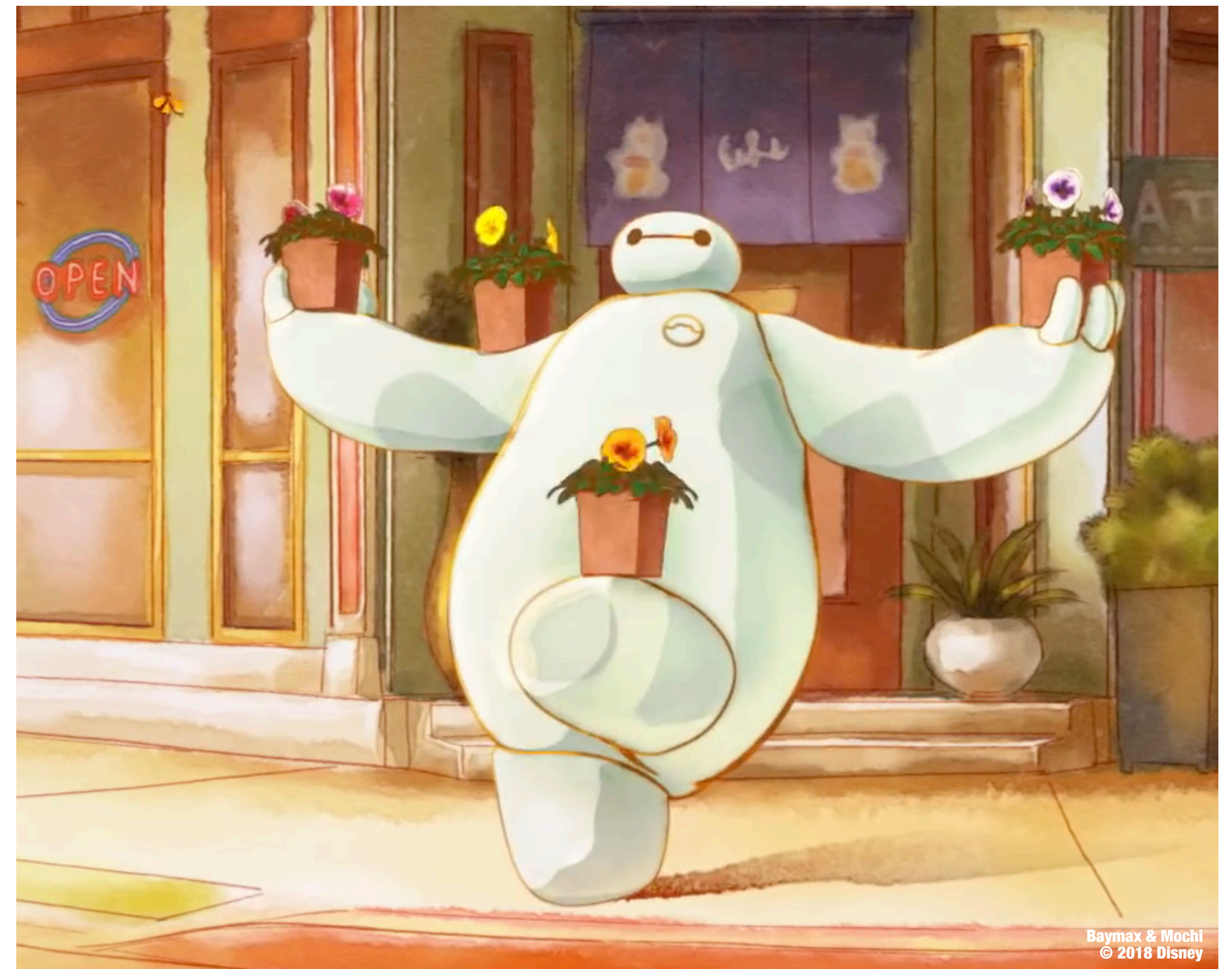
Shadows

Highly detailed geometry is often wanted - especially when it creates an interesting looking silhouette.

Problem:
The more detail an object has, the more 'CG-like' its shadows will become.
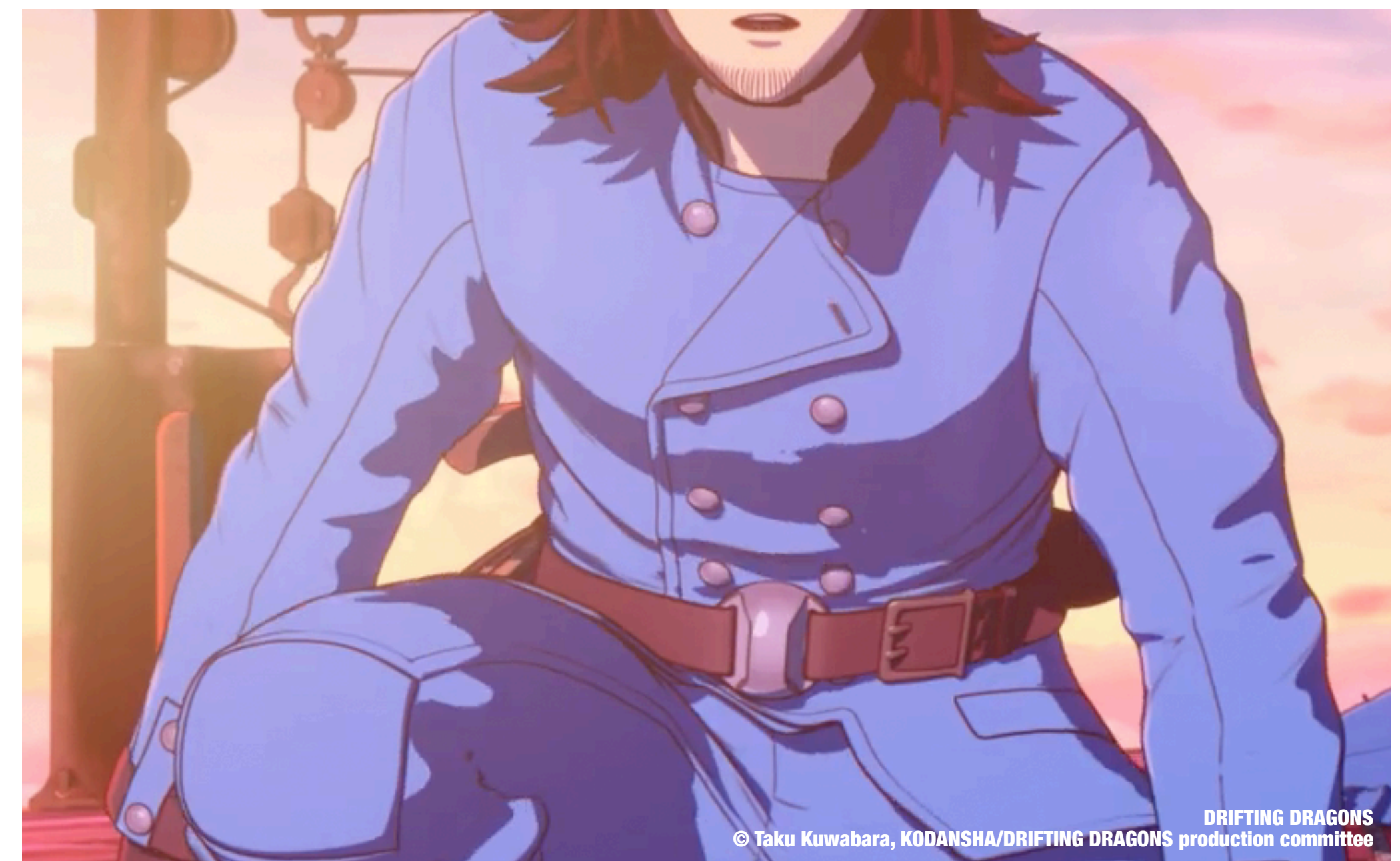
Highly detailed geometry has 'CG-like' shadows

Shadows

'Smooth Normals'

'**Smooth Normals**' reduce shading detail - without reducing geometric detail.

Geometry vertices are relaxed and the resulting smoother normals are baked back onto the geometry as an additional set of normals.
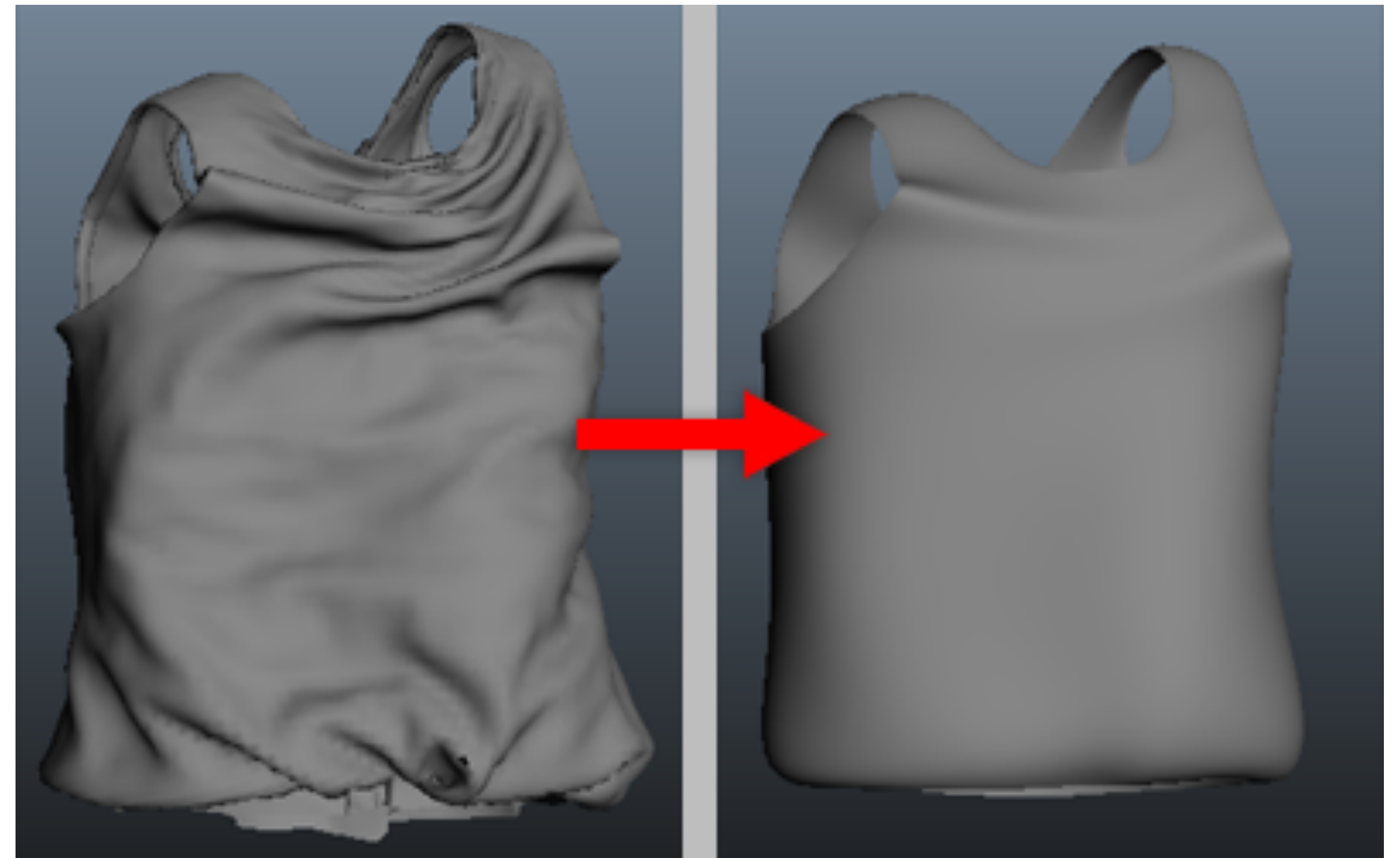
Highly detailed geometry after relaxing its vertices

Shadows
'Smooth Normals'

1

'**Smooth Normals**' are typically re-created per frame as part of a pre-frame render script.

This script uses Maya's built-in function '`polyAverageVertex`' which moves vertices of a polygonal object to round its shape - which also smoothes its normals.

This function is run a number of iterations - the more iterations, the smoother the normals become.

2

Once the object's shape is rounded to the required degree, its smooth normals are copied.

The object is returned to its original shape and these normals are baked onto the object as an additional set of per-vertex normals.

'**Technical Explanation**'

Normal Smoothness   0

Normal Smoothness   5

Normal Smoothness   45
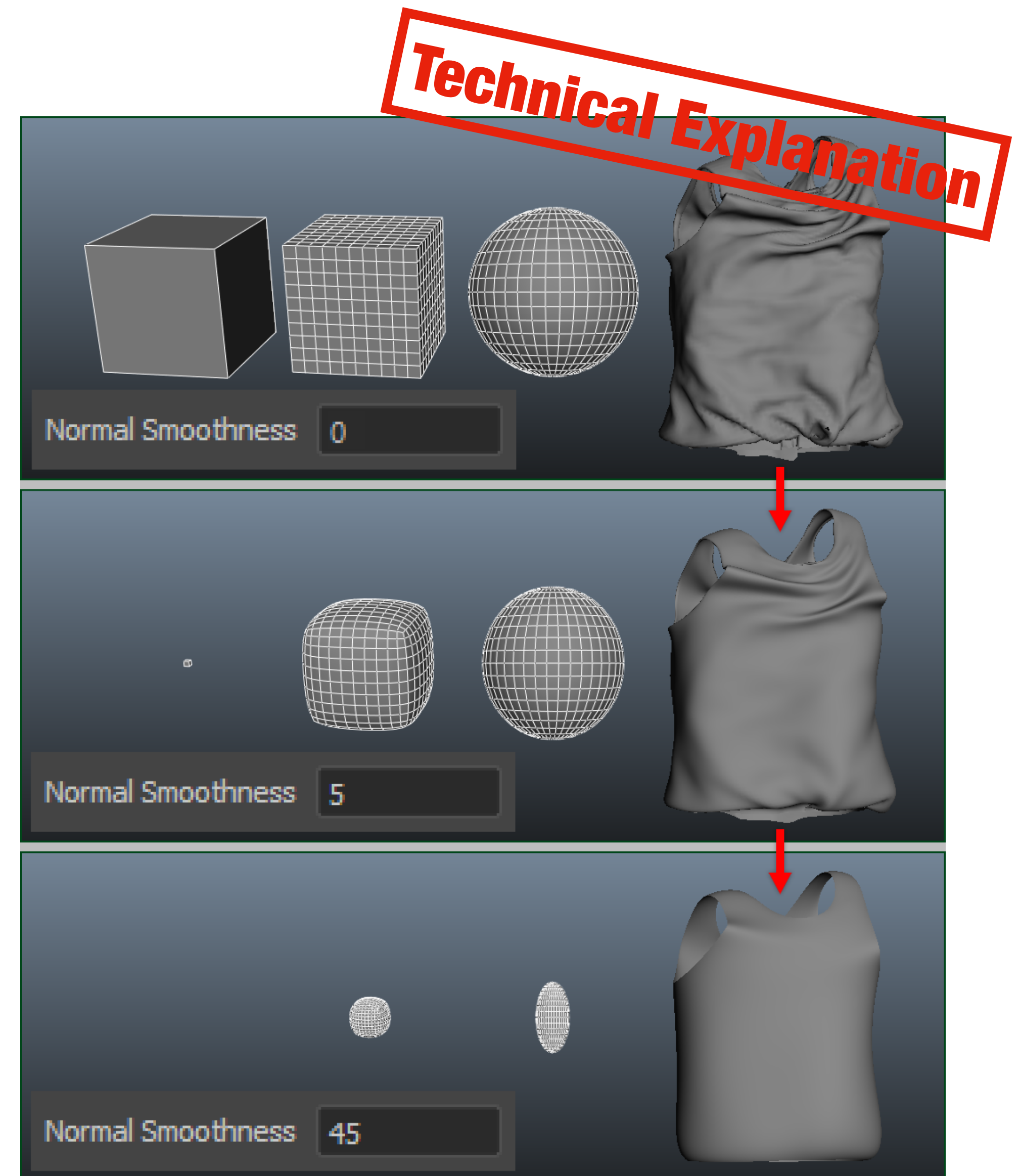
'`polyAverageVertex`' using 0, 5 and 45 iterations

Shadows
'Smooth Normals'

Being able to gradually blend between the original surface normal and '**Smooth Normals**' allows to really tweak a shadow line to the desired artistic result.
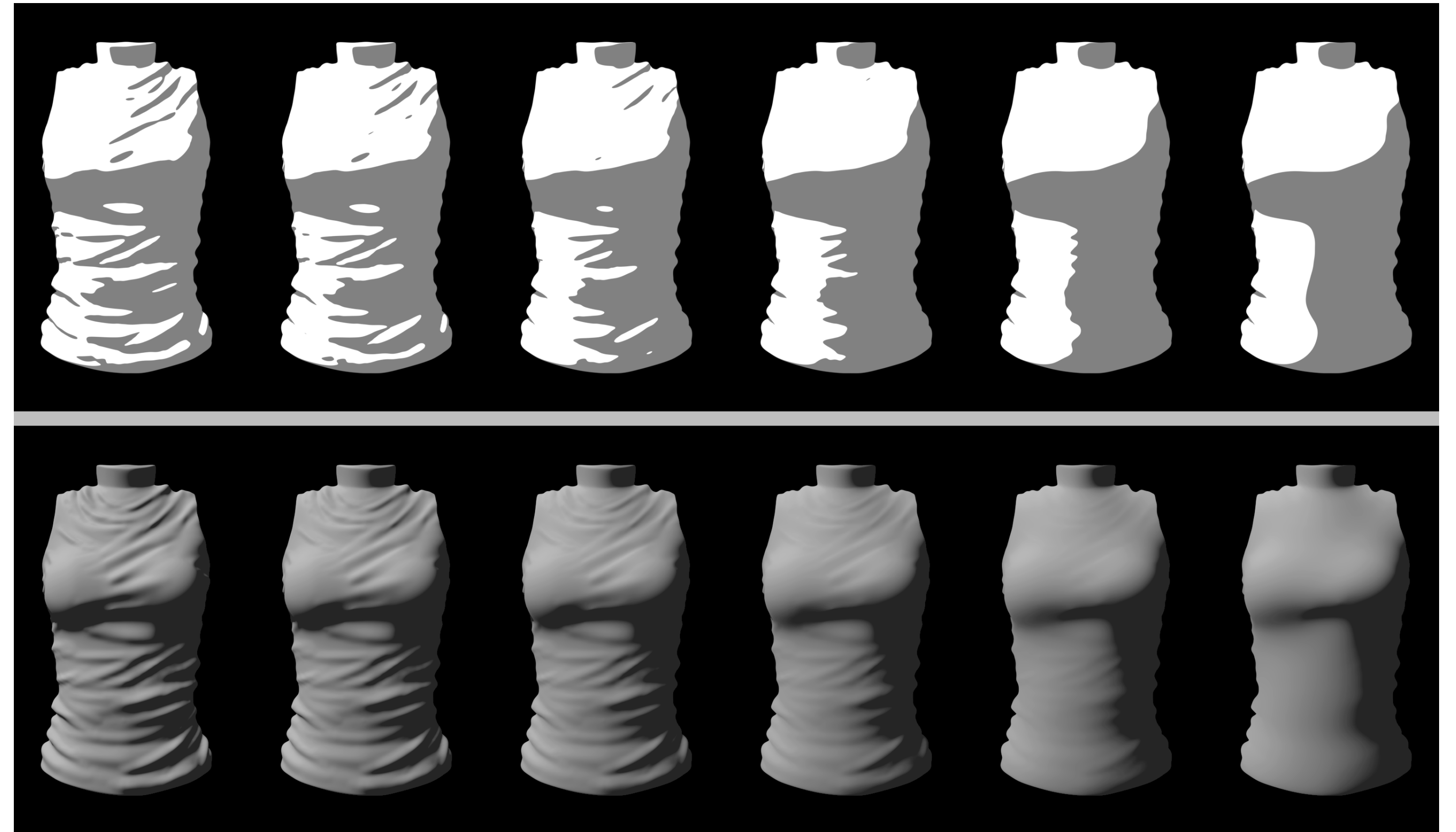
Gradually blending from original surface normal to '**Smooth Normals**'

Shadows
'Smooth Normals'

When blending between all three - the original surface normal, '**Smooth Normals**' and '**Spherical Normals**' - an even wider variety of shadow lines can be achieved.

Shadow line variations by blending various normals

Shadows
'Normal Transfers'

Unlike '**Smooth Normals**', '**Normal Transfer**' can smooth only selective geometry parts, for example just the face.

As part of a pre-frame render script, normals from a second, hidden geometry are copied onto the render geometry.
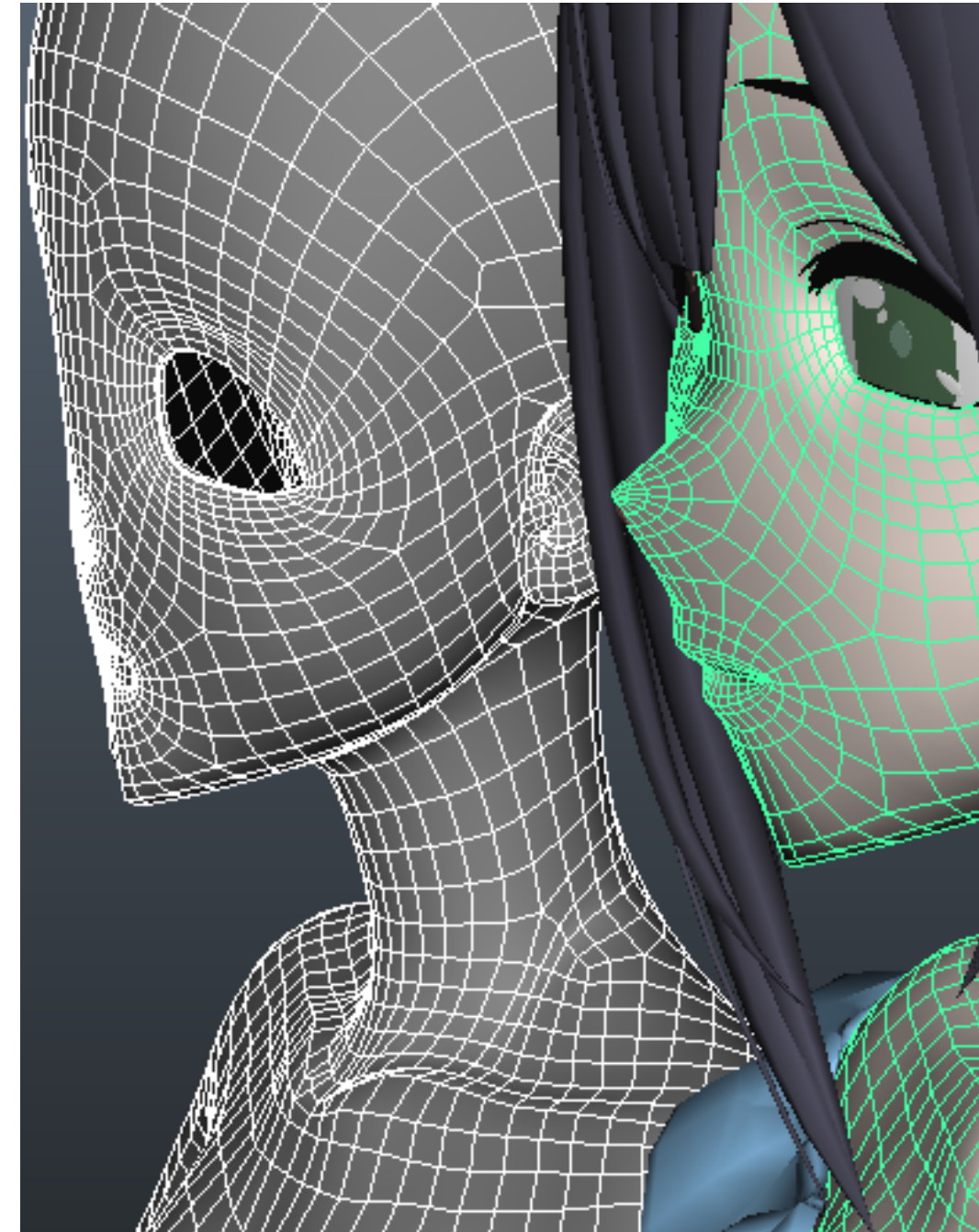
Smooth 'source' geometry and 'target' render geometry
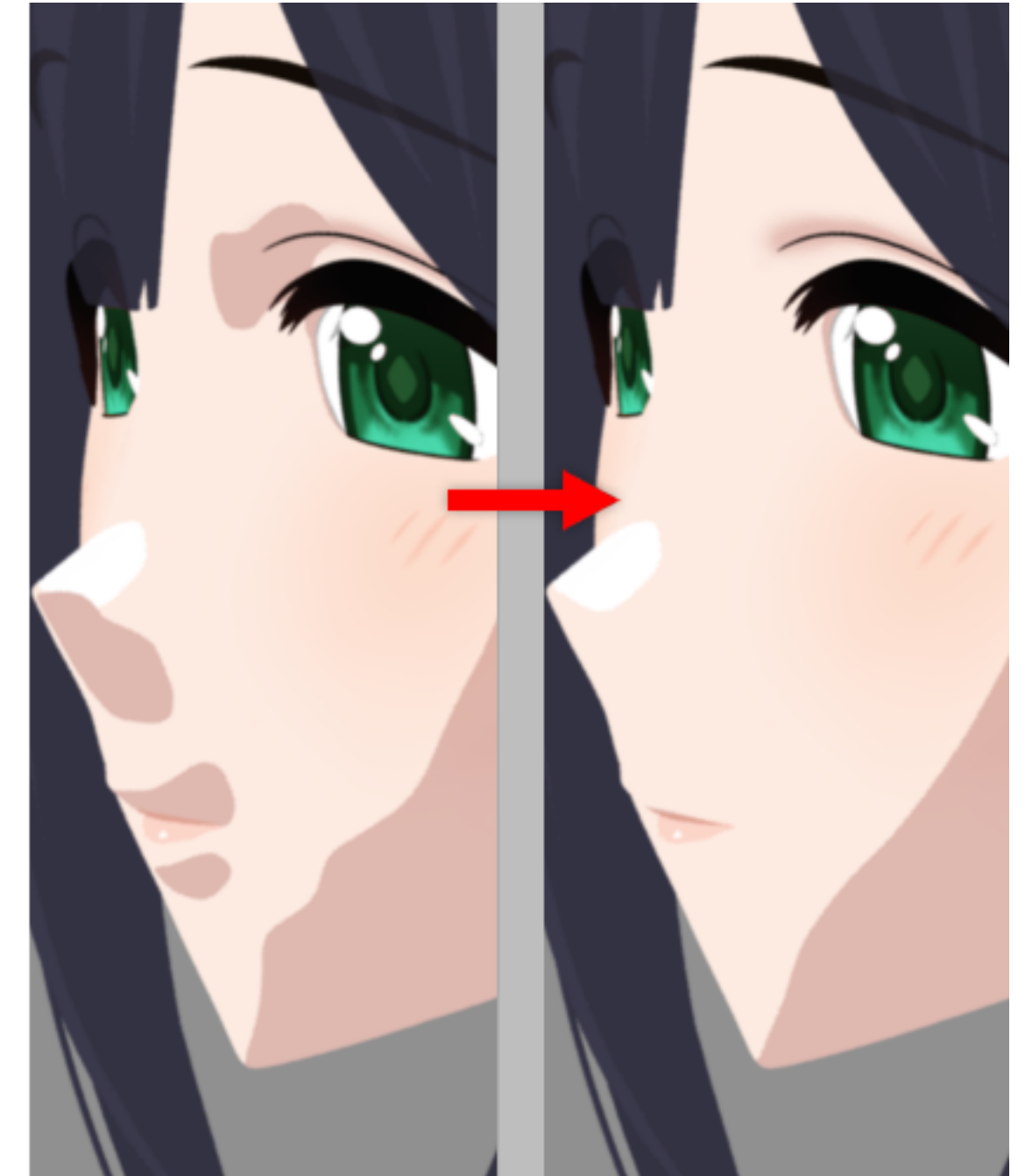
'**Normal Transfer**' result

Shadows
'Light Bending'

For artistic purposes '**Light Bending**' can move the shadow line (Light-Shadow Border) more towards the light or further away from it.

Shadows
'Light Bending'

1

The example image shows a light direction vector (**L**), a spherical object and a surface normal (**N**).

Rotating the surface normal (**N**) towards the *inverse* light direction **bends the normal towards the light** - increasing the lit area on a front-lit object, making it visually brighter.

Rotating (**N**) towards the light direction **bends the normal towards the shadow** - increasing the shadow area on a front-lit object, making the object visually darker.

Light and inverse light direction vectors define the maximum possible bending (100%).
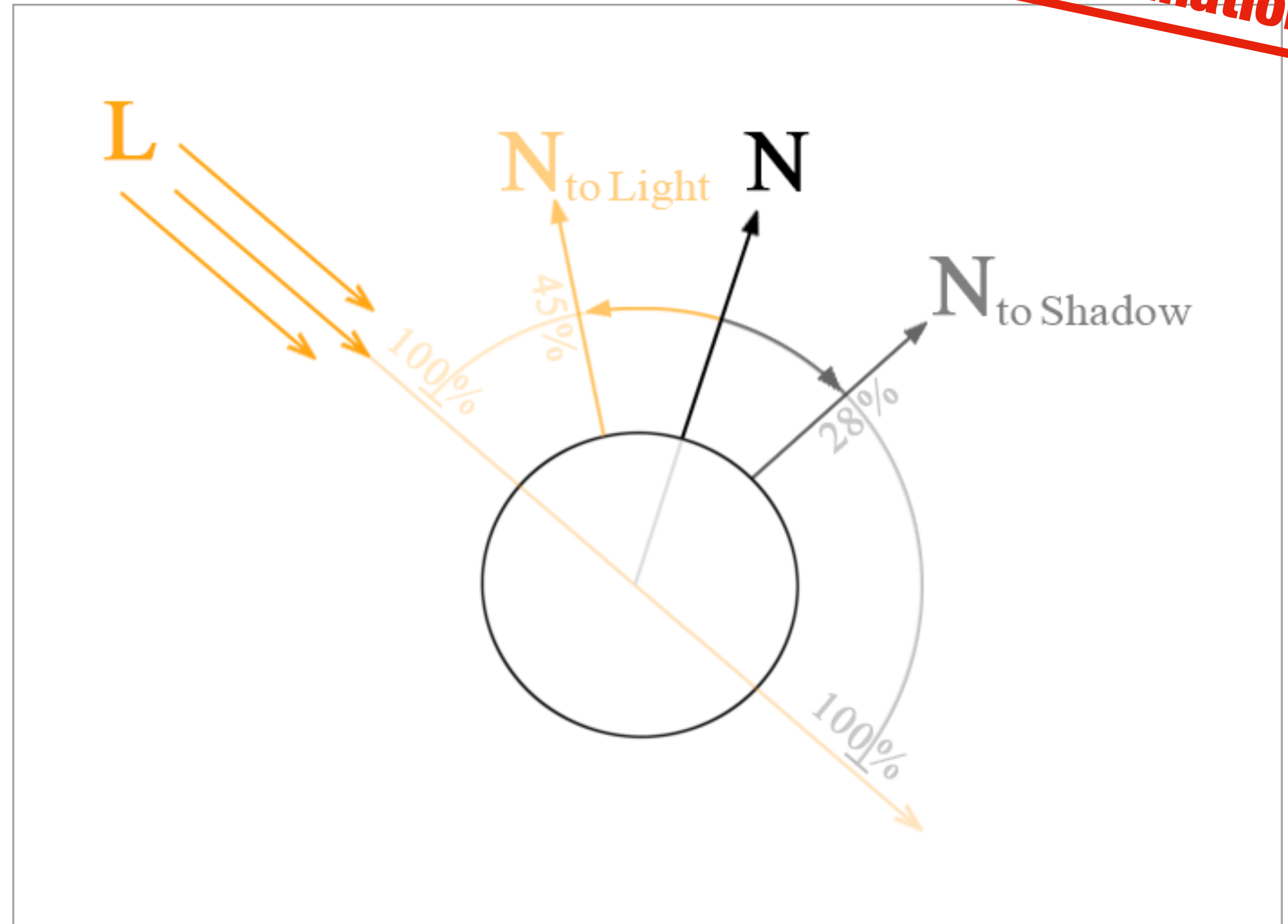
Bending **N** towards the light (**N**$_{\text{to Light}}$) or shadow (**N**$_{\text{to Shadow}}$)

Shadows
'Light Bending'

2

The result of **Light Bending** depends on whether an object is front-lit or back-lit. There could even be a need for different bend settings for both cases.

The top row shows standard lighting on two front-lit and two back-lit spheres, one uses a **toon-shaded material** the other a standard '**Lambert**' material.

The bottom row shows the same objects but uses **Light Bending**.

This creates artistic lighting results, which are physically impossible.
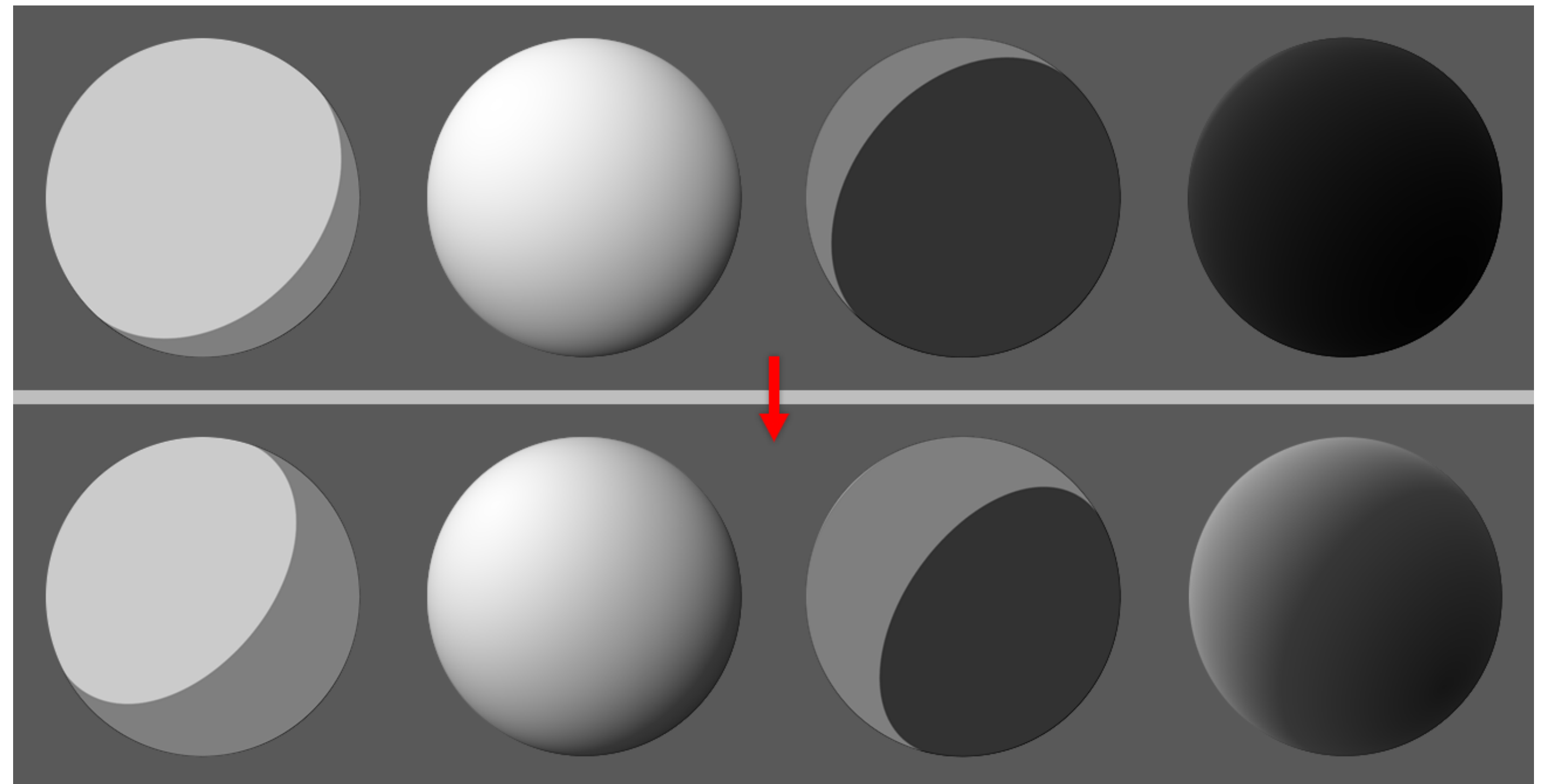
Toon- and 'Lambert'-shaded spheres with and without **Light Bending**

Shadows
Separate Bump for Light / Shadow

Darker areas typically want less detail, which applies to bump as well - while specular highlights typically want stronger detail.

Separating bump is expensive, because the whole light loop calculation needs to be run once for each bump.
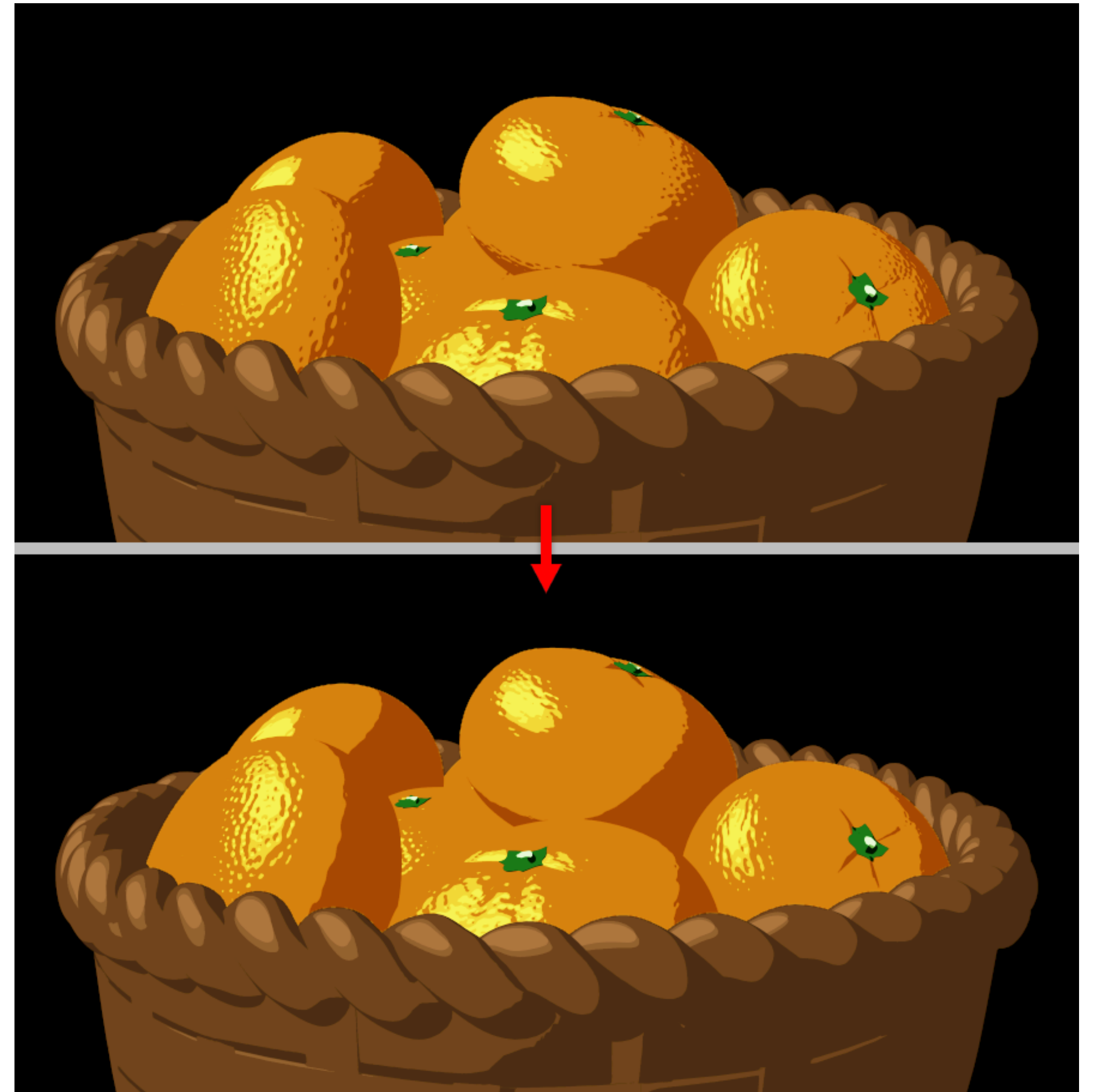
Separate bump for specular and shadow line

Shadows
'Distance Fade'

Unlike real shadows which become blurrier with distance, '**Distance Fade**' affects only the shadow's transparency.

Typically it is used for cast shadows on the ground, and therefore implemented in the shadow receiving material.

Typical '**Distance Fade**' shadow

（model）
Knights of Sidonia
© TSUTOMU NIHEI・KODANSHA／KOS PRODUCTION COMMITTEE

Shadows become more transparent with distance

Shadows

'Sharpen Soft Shadows'

The '**Holy Grail of Shadows**' is the ability to cast a simple, rounded shadow from a square or highly detailed object.

Shadows should ideally not be sharp and never reveal tiny object details.

Ronja, the Robber's Daughter
© NHK • NEP • Dwango, licensed by Saltkråkan AB, The Astrid Lindgren Company
Title Calligraphy by: Toshio Suzuki

Standard ray-traced shadows look sharp and 'CG-like' - the shadow of the hand reveals every single finger

Shadows
'Sharpen Soft Shadows'

1

Start by casting a very soft, uniformly smooth shadow.
The smoother - the more shadow rays - the better the effect.

2

In the shader (or in post-production) re-sharpen this soft
shadow via thresholding - a selectable grayscale intensity
used as cut-off value.
Any intensity lower than that threshold value is considered
'shadow' - any intensity higher 'not shadow'.
This again produces a sharp shadow line, but thanks to the
blurriness of the original soft shadow, the resulting new
shadow line lost a lot of its detail - it is much rounder.

Depth map shadows work best as they are uniformly blurred.
Ray-traced shadows change their blurriness with closeness
to the object, resulting in a shadow that is not as round.

Technical Explanation

Standard 'CG-like' sharp
Ray-Traced Shadow

'Sharpen Soft Shadows'
with Ray-Traced Shadow

'Sharpen Soft Shadows'
with **Depth Map Shadow**
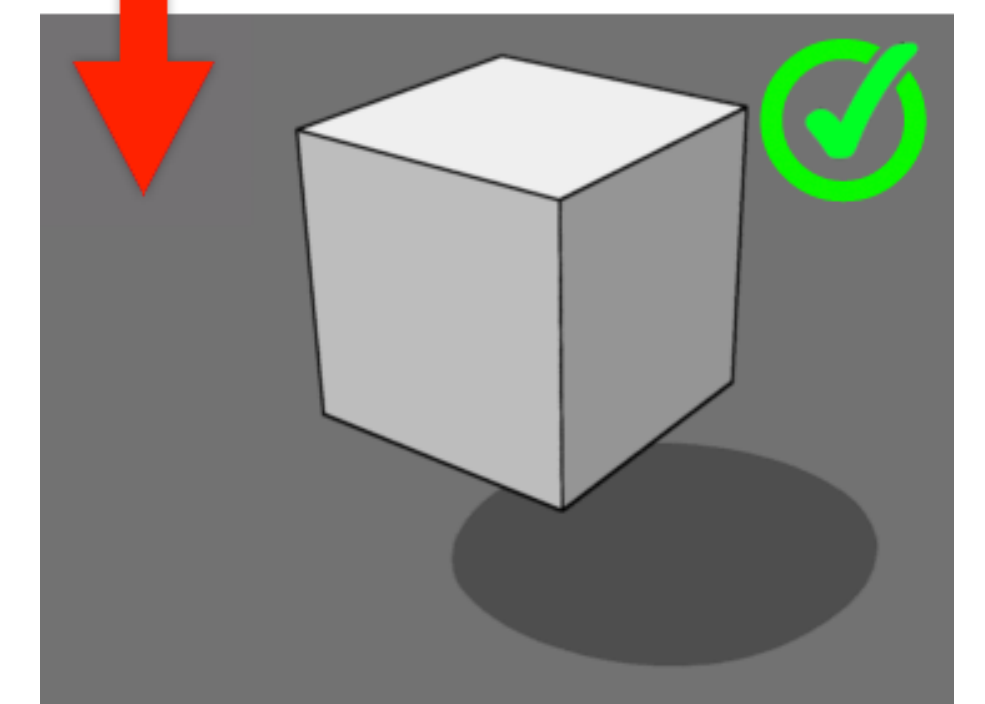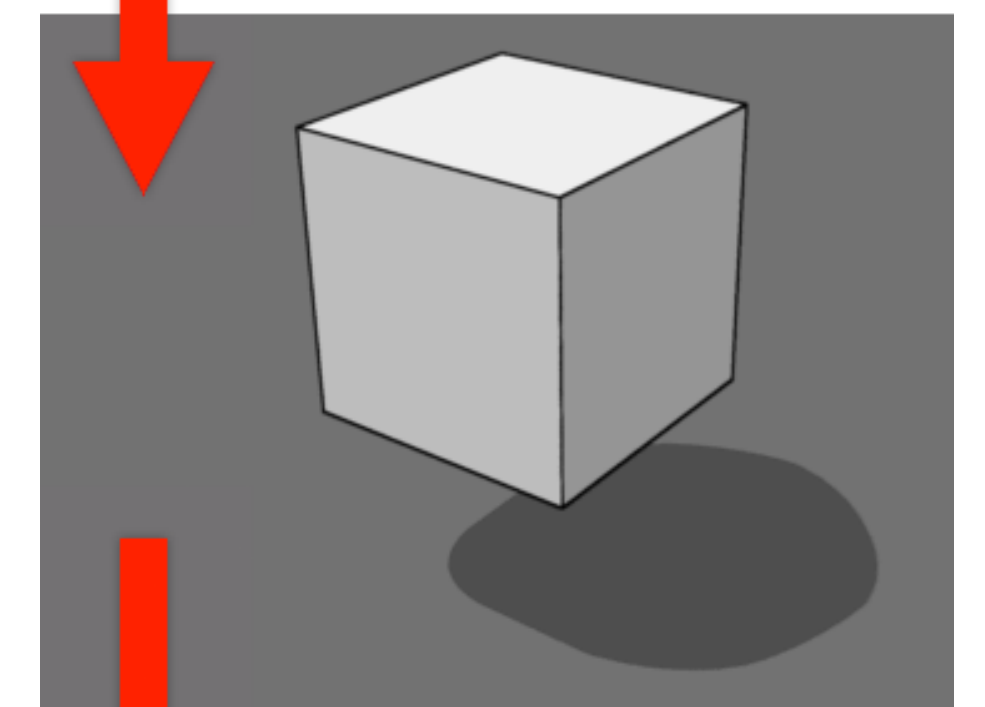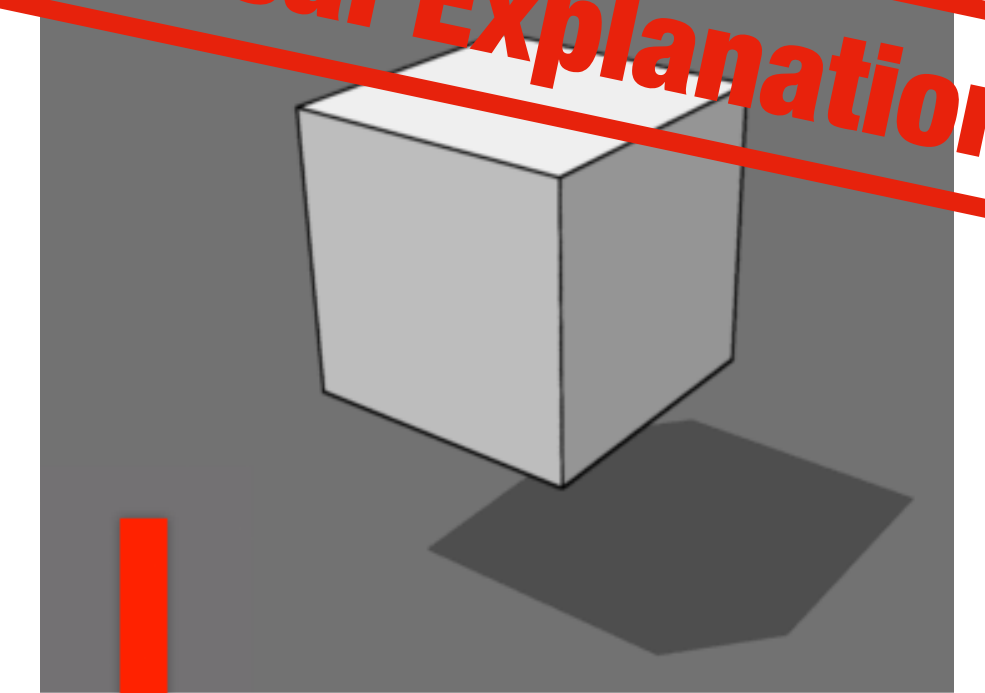
Shadows
Combined Shadows

'**Sharpen Soft Shadows**' can be further extended by combining soft shadow types (Cast Shadows, Ambient Occlusion) with 'Distance Fade' and a soft noise pattern to create very artistic, naturally round and soft shadows - which do not at all look like computer graphics.

The results are very pleasing.
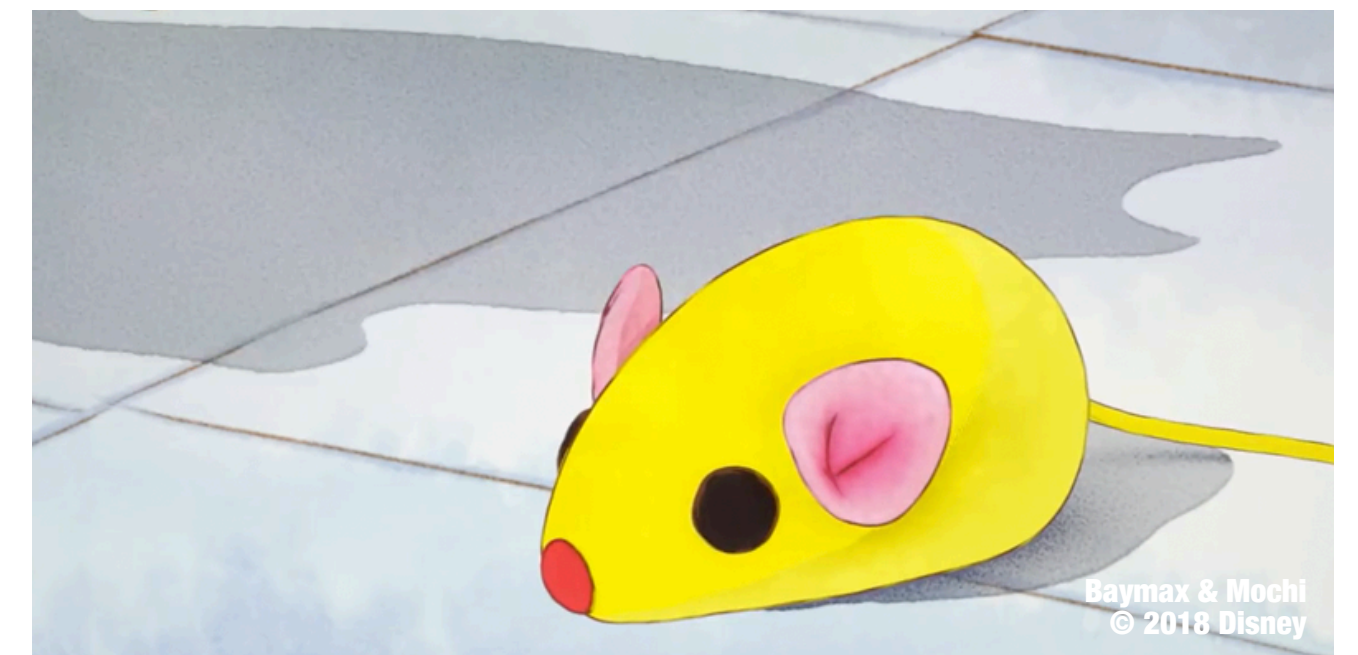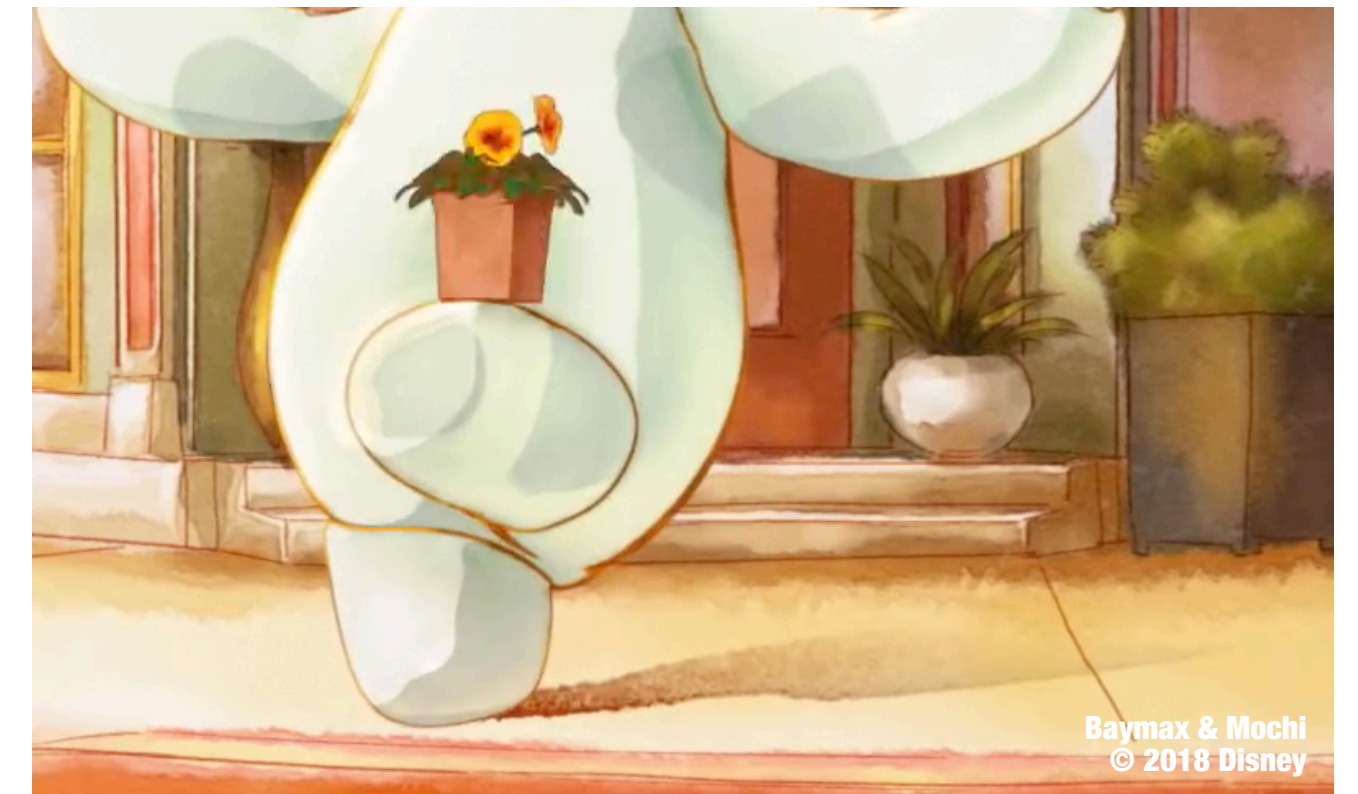
Examples of **Combined Shadows**

Shadows
Combined Shadows

While results look very pleasing and *definitely not* 'CG-like', this method requires finding a delicate balance between the combined elements.

Which may even require per-scene adjustments.

The necessary effort may be too high for a large-scale production.

More examples of **Combined Shadows**

Baymax & Mochi

2018

This '**Combined Shadows**' method was used in three shorts produced by Polygon Pictures for Disney.

Baymax & Mochi shorts on YouTube
`http://tinyurl.com/BaymaxMochi`

Conclusion
Embracing CG Limitations

This presentation attempted to show that it is indeed possible to get very close to 2D hand-drawn designs using computer graphics.

But the closer CG can achieve the look of 2D hand-drawn designs, the more difficult the research, the more complex the tools, and the more development time and effort is necessary.

And this effort grows exponentially - every further incremental improvement requires ever more development time and complexity. It gets *really* expensive.

Conclusion
Embracing CG Limitations

Lacking the same resources as some overseas studios, Japanese animation productions will likely run into budget constraints well before this goal can be achieved.

While theoretically achievable, it is ultimately an intrinsic difficulty for Japanese CG anime to break away from the 'CG-like' look.

Therefore, perhaps a better solution is to adjust the 2D hand-drawn designs to the limitations imposed by computer graphics.

Conclusion
Embracing CG Limitations

Not to expect all 2D hand-drawn elements to be fully replicated in computer graphics - but instead modify these designs in areas too difficult to achieve in CG given the budget limitations.

Somewhat surprising, this approach has not really been used so far in Japanese CG anime. Perhaps too few people understand both sides well enough to be able to identify the required design modifications?

In my opinion **only 3 productions used this approach well**, so to conclude I want to present them, and why I think they were successful.

TRON: Uprising
2012

Polygon Pictures handled this production for Disney XD.

Even though already 10+ years old, its unique design language still stands out today.
The art director, **Alberto Mielgo**, won both an Emmy and Annie award for 'Best Art Direction', not surprisingly.

High-contrast art designs with dark colors and glow effects help cover up all shadows - and their problems.

The equally **high-contrast character designs** cleverly hide potential shadow line issues by using mostly fully black or fully white bodysuits.

Character faces still have shadow lines, but their **rather unusual shapes** help direct the attention away from any shadow line issues.

TRON: Uprising on IMDb (Internet Movie Database)
`http://tinyurl.com/TronUprisingIMDB`

TRON: Uprising, Art Direction
`http://tinyurl.com/TronUprisingArtDir`

TRON: Uprising, Art Examples
Characters, Vehicles, Buildings and Landscapes
`http://tinyurl.com/TronUprisingArt1`
`http://tinyurl.com/TronUprisingArt2`
`http://tinyurl.com/TronUprisingArt3`
`http://tinyurl.com/TronUprisingArt4`

Land of the Lustrous (宝石の国, Houseki no Kuni)
2017

While very different in design to TRON: Uprising this production applies similar tricks to hide potential issues.

Character clothing is mostly black hiding shadow line issues in the low contrast between lit and shadow colors.

Skin tones on all characters are overly bright but equally low in contrast. With lit and shadow colors often almost identical, potential shadow line issues are hidden or at least hardly noticeable.

Hair Tubes are highly refractive glass-like gem stones. This unique design offers no point of reference as most viewers will find it difficult to discern if the refractive glass is drawn correctly or not.
Any **unique design, with no familiar reference point** can successfully get away with a lot of rendering issues.

Land of the Lustrous on IMDb (Internet Movie Database)
http://tinyurl.com/LotLIMDB

Land of the Lustrous official website (Japanese)
http://land-of-the-lustrous.com

Land of the Lustrous trailer on YouTube (Japanese)
http://tinyurl.com/LotLTrailer

Promare (プロメア, Puromea)
2019

This is a hybrid production using both 2D hand-drawn and 3D CG elements - but their integration is flawless. It is the most successful integration example so far.

The art design is bold with bright colors - yet mostly flat shaded, many times using just a single color.
Form is often not conveyed through shading, but only through animation when a shape changes.
A lot of visual effects are built from simple triangles.

Reducing or avoiding shading removes all potential shadow line issues. With little difference between lit and shadow colors 2D and 3D integration is much easier.

Unique object designs with no familiar point of reference, like effects built from triangular shapes, make it difficult to even notice any rendering issues.

Promare on IMDb (Internet Movie Database)
`http://tinyurl.com/PromareIMDB`

Promare official website (Japanese)
`https://promare-movie.com`

Promare trailer on YouTube (Japanese, English subtitles)
`http://tinyurl.com/PromareTrailer`

Thank you!