

The Animation Guide



Pascack Valley Regional High School District

www.team1676.com





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I. Introduction

Hello! This document is a how-to-guide on things animation. It is a lot of information to take in, but we hope your team can use it as a guide to succeed in the exciting world of animation. It consists of everything from technical aspects for mentors such as recommended software and general team management, to the nitty gritty tips for beginning animators.

To create this guide, Team 1676 has collaborated with their alumnus, Cindy Lin. Cindy was on the Animation Sub-Division for 4 years and was leader for 3 years. Currently, she studies game design and animation at NYU Tisch School of the Arts. All of her personal comments regarding each section are *italicized*.



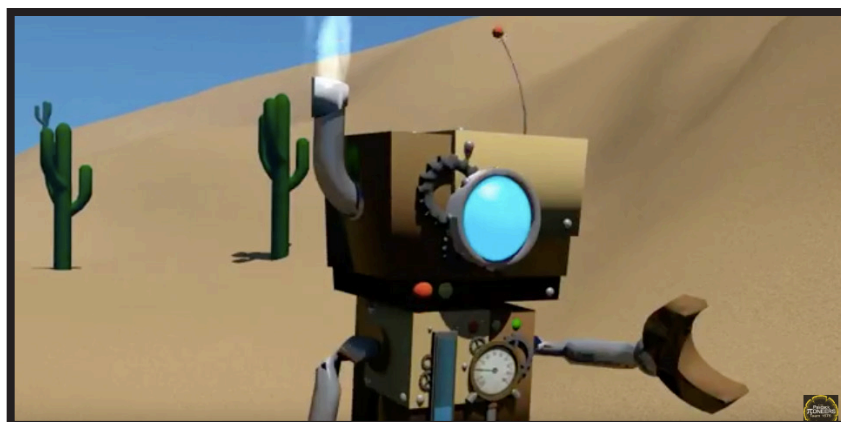


II. What Is Animation

What is Animation, and Why Do I, an Artist on a Robotics Team, Claim It's Just As Difficult As Building A Robot?

Animation is essentially the illusion of movement created by flipping through still images very, very quickly. One image is called a frame, just as in regular video and film. Having more frames means there is smoother movement. This means that someone or something has to create every single image - when you're trying to match standard feature film, that usually means needing to create 24 frames for a second. That's 24 different images for one single second, 1,440 images for a minute, and 172,800+ images for a 2 hour film.

With modern computers, this process has become easier, but not by much, and not at all for traditional hand-drawn animation or stop motion. Imagine trying to draw 1,440 highly detailed pictures all with the same level of quality without getting tired. It's a lot of work!



In addition to needing so many images, you also want them to correlate to each other - if you want a ball to bounce, you can't just draw the ball at the top of its arc and bottom of its arc, you need to:

- Draw every image of it in between
- Change its position to make it look like it's accelerating instead of moving at constant velocity, while making sure it looks natural
- Make sure the way it deforms while in motion gives it the appearance of whatever material it's made out of
- If you have perspective, you must make sure it shrinks relative to distance
- The possibilities are endless:
 - What if it's interacting with something?
 - What if it's actually a sentient ball?
 - What if you're trying to emulate a particular style?

Et cetera, et cetera. It's a lot to think about, and it's hard!

Animation takes just as much time, effort, blood, sweat, and tears as building and operating a full robot. Please lend your fullest support to your new animation team - treat them just as you would treat your electrical or mechanical teams.

They will definitely need it, and your team will be far richer for it!

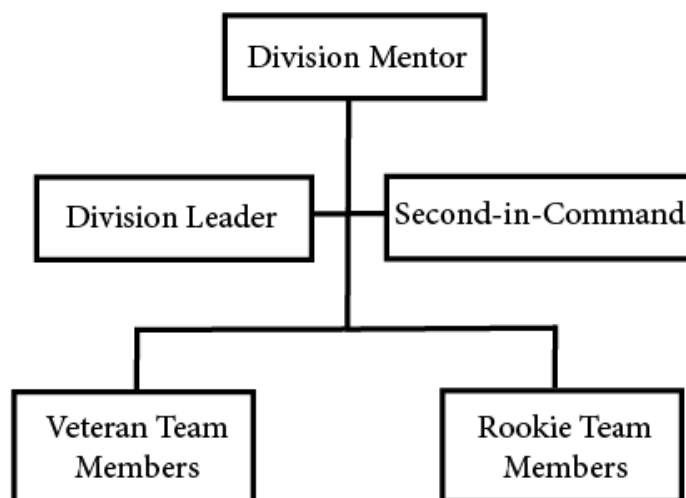


III. General Team Structure

Please note that this is what worked for us. It is by no means the de facto way to run a team, but it's a good start. This is also the structure for a team of 4+ people - a small team of 3 or less won't need something as rigorous as this, and will likely just delegate the necessary skills among themselves.

Mentor

- Adult supervisor/teacher/overview
- Checks in on work progress
- Approves of general visual choices, story, and final product
- Preferably has history of visual design or art in general
- Looks over animation to find anything that needs to be changed, edited, or added
- **POSITIVE MORALE SUPPORT**



Team Leader

- Preferably junior/senior student, although sophomore will work too
- Good team manager
 - Can delegate work, check in regularly on other team members, push the team to remain on task and turn in work on time, and report to mentors
- Someone with unshakable quality standards
- Good eye for visual and aesthetic design, composition, and action
 - Experience in any kind of animation is **definitely preferable**
 - Critique and give feedback to other members on their work
- Able to both learn and teach at the same time
 - Learning the ins and outs of animation software takes a very, very long time, and animation itself is a lifelong discipline. Team leaders will need to continuously learn the software and also teach to younger members
- **PASSIONATE ABOUT THEIR WORK**



Second-In-Command

- Preferably someone who the team leader works well with
- Can help the team leader
 - Step in as leader when the team leader is unavailable
 - Perform delegation, management, and reporting to mentors when necessary
- High quality standards
 - Preferably has visual or technical skill approaching or similar to that of the team leader, but it's not necessary
 - Can also give critique and feedback to other members
- Able to learn and teach at the same time

Veteran Members of the Team

- Able to help younger members of the team with problems or questions
- Preferably can remain on task and meet deadlines
- Good team attitude
- Can give and receive critique and feedback

New Members

- Passionate about their work
- Readiness to learn
- Can give and receive critique and feedback

IV. Different Types of Animation

Different Types of Animation Team Members May Want to Do

3D Animation

- This is the animation most widely used by other teams, because it's the fastest way to create a variety of high quality content that looks nice and moves nice, without members needing a lot of visual or technical skills. It's also linked to the STEAM aspect of *FIRST*, as the skills and programs required can easily be transferred to CAD, and coding is occasionally used within the software.
- Students interested in 3D animation are often inspired by big budget feature films and shorts (Disney, Pixar, Sony Animation) or by game animation (Blizzard, Riot Games, Nintendo).
 - *Examples of cool 3D animation:*
 - *Movies - Spider-Man: Into the Spider-Verse*
<https://www.youtube.com/watch?v=TRZ9DRqNuLI>
Moana
<https://www.youtube.com/watch?v=cPAbx5kgCJo>
 - *Games - Legend of Zelda: Breath of the Wild*
<https://www.youtube.com/watch?v=1rPxiXXxftE>

- *Overwatch*

<https://www.youtube.com/watch?v=U130wnpi-C0>

<https://www.youtube.com/watch?v=swr8rQOnn9I>

- *Music videos - POP/STARS by K/DA*

[https://www.youtube.com/](https://www.youtube.com/watch?v=UOxkGD8qRB4)

[watch?v=UOxkGD8qRB4](https://www.youtube.com/watch?v=UOxkGD8qRB4)

We Are Giants by Lindsey Stirling

<https://www.youtube.com/watch?v=1yUYvyAY954>

- *Anime - Land of the Lustrous*

https://www.youtube.com/watch?v=l_

[EDBM1tOEo](https://www.youtube.com/watch?v=l_EDBM1tOEo)



2D Animation

- The most common form of animation, and it's everywhere, from feature films to television cartoons to online Flash animations. While less readily used by teams due to how long it takes and team members needing some degree of visual or artistic skill, it's one of the most diverse forms of animation, with massive subsections dedicated to different ways to do 2D animation. It has just as much incredible potential as 3D animation, along with a very long, international history. It's probably the most accessible of any type of animation, due to you only needing pencil and paper to start.
- Students interested in 2D animation are often inspired by Japanese animation (Studio Bones, Madhouse, Studio Ghibli), American cartoons and movies (Cartoon Network, Nickelodeon, Adult Swim), or web animation (Newgrounds, LINE WEBTOON, YouTube).
 - *Examples of cool 2D animation:*
 - *Web - Double King by Felix Colgrave*
https://www.youtube.com/watch?v=w_MSfKZHNi4
Welcome to Kitty City by Cyriak
<https://www.youtube.com/watch?v=jX3iLfcMDCw>



- *Music videos - Jenny by Studio Killers*

<https://www.youtube.com/watch?v=hyj4JFSErrw>

The Wolf by SIAMES

<https://www.youtube.com/watch?v=IX44CAz-JhU>

- *Cartoons - Wander Over Yonder*

https://www.youtube.com/watch?v=xdEo_t-iVbM

Over the Garden Wall

<https://www.youtube.com/watch?v=Q4vryZTr6MA>

- *Movies - Spirited Away*

<https://www.youtube.com/watch?v=ByXuk9Qq>

Qkk&t=47s

Song of the Sea

<https://www.youtube.com/>

[watch?v=HgbXWt8kM5Q](https://www.youtube.com/watch?v=HgbXWt8kM5Q)

Fantasia

https://www.youtube.com/watch?v=l_

EDBM1tOEo

- *Anime - Blood Blockade Battlefront*

<https://www.youtube.com/>

[watch?v=QzMINqdAKLs](https://www.youtube.com/watch?v=QzMINqdAKLs)

Yuri!!! On ICE

<https://vimeo.com/190616091>



Stop Motion Animation

- In our opinion one of, if not the hardest form of animation out there, is stop motion animation. Stop motion is the process of animating puppets by taking a picture, moving them slightly, taking a picture, moving them slightly, again and again. The difficulty lies in the fact that it's completely non-digital - it requires all the same elements needed in live action films, except with jacked up difficulty when actually shooting. Having everything remain completely stable and in place is extremely hard. Accidentally bumping the camera or moving something in the background will result in needing to shoot the entire scene over again, and maintaining a smooth continuity of motion requires massive amounts of time and effort.
- Special effects is very difficult with this type of animation. However, if done right, stop motion animation looks absolutely gorgeous, and has an aesthetic that's unmatched by any other form of animation.



- Students interested in stop motion animation are often inspired by films (Laika Entertainment, Tim Burton, Wes Anderson), and web animation (PES, Guldies).

- *Examples of cool stop motion animation:*

- *Movies - Isle of Dogs*

- https://www.youtube.com/watch?v=IBa2_Q-cil0

- The Little Prince*

- <https://www.youtube.com/watch?v=18xALEX7IPo>

- Kubo and the Two Strings*

- <https://www.youtube.com/watch?v=zjdesHuied8>

- *Music videos - Moving On by Ainslie Henderson*

- <https://www.youtube.com/>

- [watch?v=aWPgJkOdUZU](https://www.youtube.com/watch?v=aWPgJkOdUZU)

- Her Morning Elegance by Oren Lavie*

- https://www.youtube.com/watch?v=2_

- [HXUhShhmY](https://www.youtube.com/watch?v=2_HXUhShhmY)

- *Web - Fresh Guacamole by PES*

- https://www.youtube.com/watch?v=dNJdJlwCF_Y

- FANTASIA by Guldies*

- <https://www.youtube.com/watch?v=1NgRiVb38p0>



Pixel Animation

- A subsection of 2D animation, pixel animation is animation done with pixels, often in the style of old 8-bit or 16-bit games. This is one of the more fun, but surprisingly tedious forms of animation, as the difficulty lies in being able to convey clear information with very little visual space. It's most often used for games, but pixel animation is a massive genre online.
- Students interested in pixel animation are often inspired by games (Sonic Mania, Cave Story, Shovel Knight), or web animation (Dorkly, Paul Robertson, 1041uu).



- *Examples of cool pixel animation:*

- *Games - Kirby Super Star Ultra*

[https://www.youtube.com/](https://www.youtube.com/watch?v=GH9A5A8A79Y)

[watch?v=GH9A5A8A79Y](https://www.youtube.com/watch?v=GH9A5A8A79Y)

Hyper Light Drifter

[https://www.youtube.com/](https://www.youtube.com/watch?v=v07mErbAk7M)

[watch?v=v07mErbAk7M](https://www.youtube.com/watch?v=v07mErbAk7M)

Scott Pilgrim vs. the World: The Game

[https://www.youtube.com/watch?v=E-](https://www.youtube.com/watch?v=E-wWuVc6sLU)

[wWuVc6sLU](https://www.youtube.com/watch?v=E-wWuVc6sLU)

- *Web - gobou*

[https://www.youtube.com/](https://www.youtube.com/watch?v=VneKjsUR1oM)

[watch?v=VneKjsUR1oM](https://www.youtube.com/watch?v=VneKjsUR1oM)

<https://www.youtube.com/watch?v=sHuoauaZ2Hk>

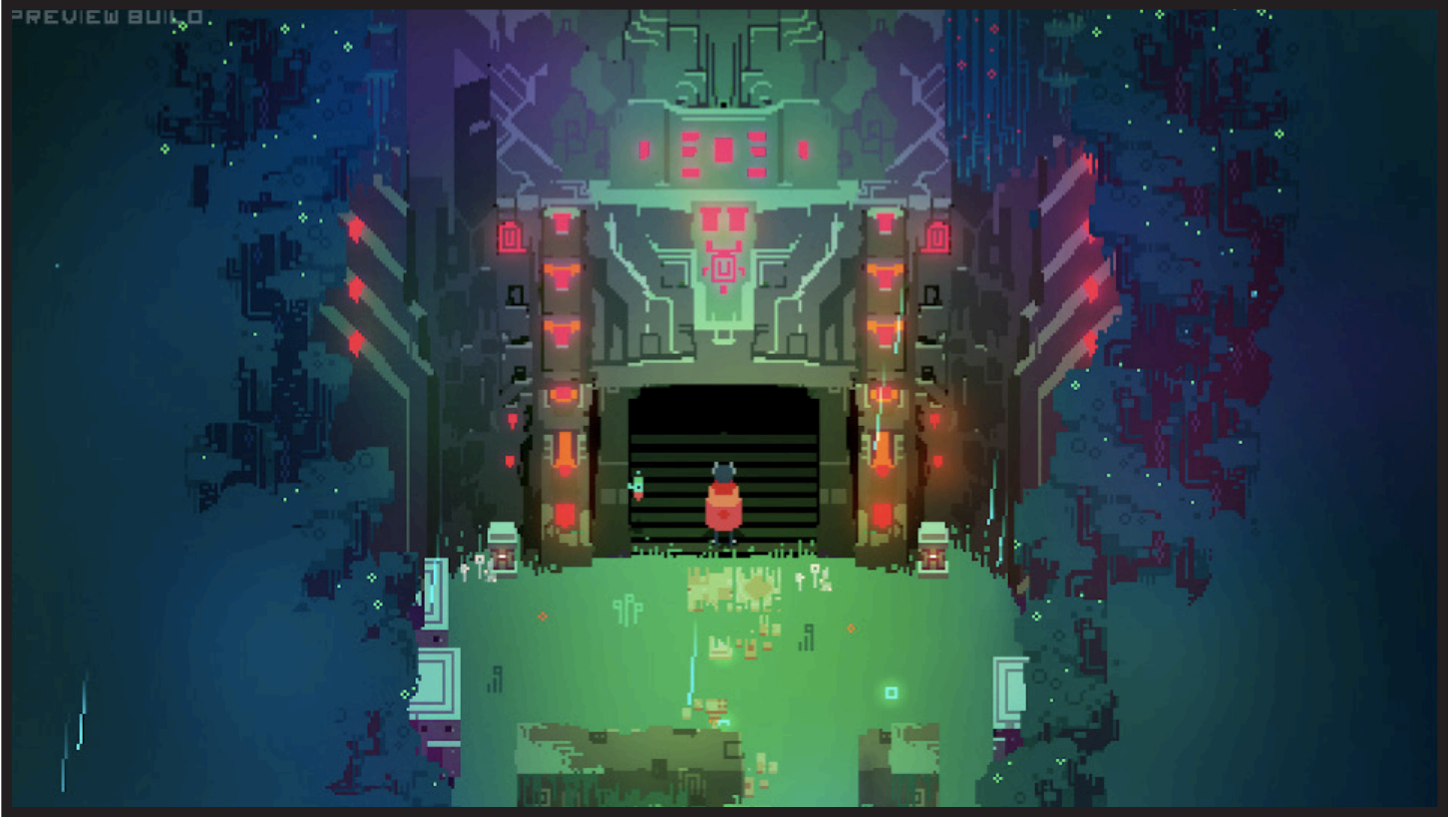
The Simpsons Opening by Paul Robertson

https://www.youtube.com/watch?v=FIZ_gDOrzGk

Super Mario Bros Z by Alvin Earthworm

[https://youtu.be/z0oO86-](https://youtu.be/z0oO86-MgZc?list=PL01B6FBE8898E1535&t=215)

[MgZc?list=PL01B6FBE8898E1535&t=215](https://youtu.be/z0oO86-MgZc?list=PL01B6FBE8898E1535&t=215)



Motion Graphics

- Motion graphics covers a wide range of different types of animation, but they all mostly relate to clean and aesthetic design-based animation. This can range from the various ways film studios animate their logos, to short narrative animations, to simple Instagram videos designed to feel good to the viewer. There's really no set way to do or define motion graphics, but once you see it you'll know it.
- Students interested in motion graphics are often inspired by films, TV, and web animations.

- *Examples of cool motion graphics:*

- *Web - Tokyo Gifathon by James Curran*

<https://vimeo.com/223080635>

Dumb Ways to Die

<https://www.youtube.com/watch?v=IJNR2EpS0jw>

Welcome to Night Vale - Carlos's Speech

(Condos) by ZeNami Design

[https://www.youtube.com/](https://www.youtube.com/watch?v=yNNuvRkRgdU)

[watch?v=yNNuvRkRgdU](https://www.youtube.com/watch?v=yNNuvRkRgdU)

Kurzgesagt

<https://www.youtube.com/watch?v=yS1ibDImAYU>

Andreas Wannerstedt

<https://www.instagram.com/p/BZxtpSXAHLI/>

- *Movies - Thor: The Dark World End Credits*

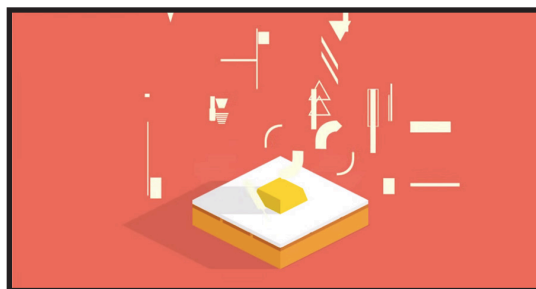
Sequence

<https://vimeo.com/105366602>

Captain America: The Winter Soldier End

Credits Sequence

<https://www.youtube.com/watch?v=7jpnBs0DkXg>



V. Recommended Software

V.a. Recommended Software for 3D Animation

Autodesk Maya

- The full version costs money, but the student version is free
- The industry standard - everyone wants and expects you to know Maya, no matter what you're doing. It is not particularly beginner-friendly, but once you have the basics down, it's truly one of the most user-friendly, clean, and versatile 3D animation and modeling softwares out there. Did I mention it's the industry standard? After I got into college and started looking for internships that's all anyone asks about and teaches in class.
 - *Personal Note- I like this one most, because you can animate diagonally, and also animate weird little effects (like a fish flopping) very easily. It also simulates cloth and hair very well and very fast, and YOU CAN ANIMATE DIAGONALLY. You can also do really cool, realistic (or unrealistic) lighting very quickly. Works very nicely with UV texturing.*



Blender

- Free
- This is the main program I used for my entire time on Team 1676. Very beginner friendly, and contains most of the tools Maya has, just in a slightly less accessible but more intuitive interface. An excellent program to start off with.
 - *Personal - Animation in this one is very simple and very intuitive, but more clunky compared to Maya. You cannot animate diagonally very well, and after four years of using it I never found/used half the things readily available on the main menu in Maya. Doing nice lighting and texture remapping is a bit of a struggle. It's like Maya Lite.*

Cinema 4D

- Trial version is free
- A program used primarily for clean, aesthetic-based, motion design 3D animation and modeling.
 - *Personal Note- I've personally never used this software before, but what people generate from it looks very cool. Google "cinema 4D instagram," and you'll see what I mean.*

Autodesk 3ds Max

- Student version is free for 3 years, free trial version available for 1 month
- Don't know too much about this one, but it's also another widely used software, and worth looking into.

Blender

<https://www.blender.org/>

Cinema 4D

<https://www.maxon.net/en-us/products/cinema-4d/overview/>

Autodesk 3ds Max

<https://www.autodesk.com/products/3ds-max/overview>



V.b. Recommended Software for 2D Animation

Toon Boom Harmony

- Discount for students
- The industry standard - very versatile for every kind of animation project, decently beginner friendly. Very easy user interface, fairly intuitive. Excellent for frame-by-frame animation, although it can also do puppet/cut out animation.
 - *Personal Note- I've worked with this software a little bit, and I like it quite a lot. Would also recommend Toon Boom Storyboard Pro, which is a separate software from the same company, but geared primarily toward making storyboards and animatics.*

TVPaint Animation

- All costs money
- Another widely used animation program. Very versatile.
 - *Personal Note- Very unfamiliar with this one, but also looks nice, and has been used to create some truly stunning films.*

Adobe Animate

- Adobe's dedicated animation program, and one of the most popular 2D animation programs out there. Was previously Adobe Flash.

Adobe After Effects

- Excellent for cut out and puppet animation, although frame-by-frame is a little more difficult. Comes with the Adobe Suite, and has a ton of fun effects to play around with. Very clean, nice interface that's easy to learn.
 - *Personal Note- Fairly intuitive for animation, and allows for some excellent puppetry. There are also additional plugins to make puppet animation even easier.*

Adobe Photoshop

- Good for frame-by-frame animation, although quality drops a lot during playback, which can become an issue. The interface when trying to do quick edits between frames isn't very forgiving, otherwise excellent.
 - *Personal Note- Not my preferred software for animation, but it works. The different frames are essentially different layers, which makes switching between them when using the timeline very tedious, as layers are locked unless you're specifically on them.*



V.c. Recommended Stop Motion Animation Software

Dragonframe

- Costs money, but students get a discount
- The industry standard - this software is very intuitive, and very easy to use. It utilizes DSLR cameras instead of digital, which allows for more precision in lighting.
 - *Personal Note- Easiest stop motion software I've ever used. It's much better than trying to import a few hundred images into a video editing software and hoping for the best, and it runs fast. Also has audio playback so that you can time your animations correctly.*

Stop Motion Studio

- Free, available for iPhone and Android
- A phone app used by the video production team when I was on Team 1676. Probably the most accessible and easiest way to embark on your first stop motion video, as it's right on your phone.
 - *Personal Note- I asked a 1676 video production alumni his thoughts on this app. "It's good for a free software because it has onion skinning and lets you set the frame rate but it makes you rely on your phone's camera." If you have a terrible or broken phone camera, then this one's not for you.*

Adobe After Effects

- Probably your best software to use if you don't have any dedicated stop motion software - importing image files is very easy, and editing frames and timing is simple.
 - *Personal Note- It's quick to learn, and bonus: you get all the fun editing and effects right away! Would definitely recommend putting your image files into a separate composition than your overall editing composition though.*

Dragonframe

<https://www.dragonframe.com/>

Stop Motion Studio

https://play.google.com/store/apps/details?id=com.cateater.stopmotionstudio&hl=en_US

Adobe After Effects

<https://www.adobe.com/products/aftereffects.html>



V.c. Recommended Video Editing Software

Adobe Premiere Pro

- THE video editing software - basically does it all. Very, very good for sound editing. Not very beginner friendly, although once you have the basics down it's just a matter of experimentation.
 - *Personal Note- Excellent sound editing and beautiful green screen/ultrakey effects Would recommend to use in conjunction with Adobe After Effects.*

Adobe After Effects

- Excellent for video editing - super intuitive and user friendly, has a lot of different effects to work with. Not too great with sound.
 - *Personal Note- I use this software the most for editing videos, because it's primarily visual based. It does compositing very well, although it doesn't have a lot of options for sound. Would recommend to use in conjunction with Adobe Premiere.*

iMovie

- It gets the job done and it's very simple for very beginning video editors, sound mixers, or composers. Also comes prepackaged with royalty free music (always a plus) and sound effects, as well as snazzy text effects.
 - *Personal Note- I used this one for most of high school. It isn't anything amazing, but gets the job done.*

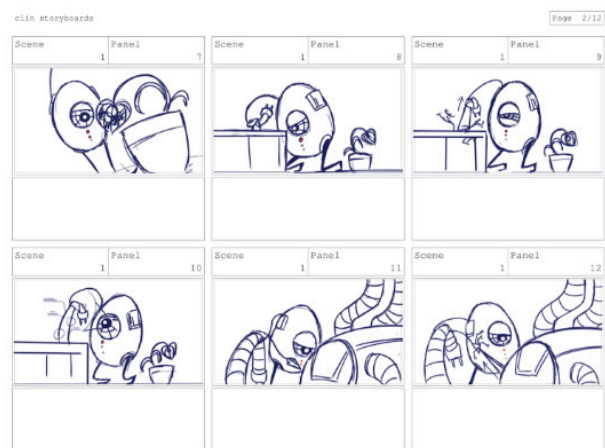
VI. 3D Animation Production Pipeline

This is the general pipeline for creating and producing a 3D animated video - it's essentially a very, very simplified version of an actual animation studio's production pipeline. For a 2D animated video, everything stays the same except for modeling, texturing, and rigging, which are replaced with 2D asset creation if applicable.

Pre-Production

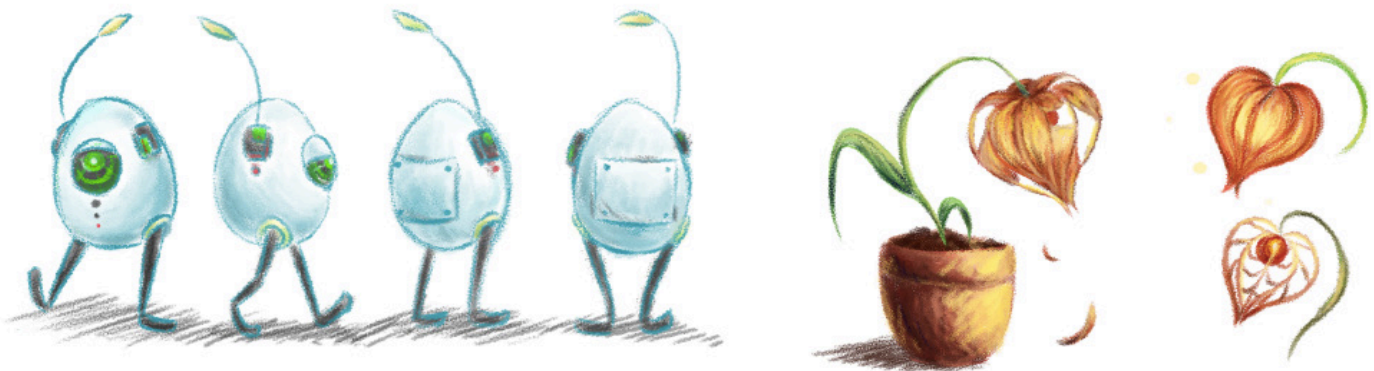
- Creating the story
 - After the prompt is given, outlining the necessary parameters that the animation must fall into, the animation team will get together and brainstorm a story that fits within the criteria.
 - *Personal Note: A big downside is TIME TIME TIME. Make sure your story is short enough to fall within the timeframe given!*
- Storyboarding
 - Once the story is agreed upon by all members of the animation team, a storyboard artist will draw out the main parts of each scene on paper, which the team will then either agree upon or make changes to.

- *Personal Note: A storyboard is essentially an animation in comic form - you only need to draw just enough that anyone looking at your boards will understand the action going on. Don't spend too much time on this part!*
- *This helps all team members know exactly what they're making, it gets everyone on the same page, and also comes in handy when delegating scenes to people!*



- Visual Conception
 - The storyboard artist may also (or not!) be the person who designs the various characters, props, and backgrounds necessary on paper.
 - *Personal Note: This mostly depends on the person, the other people on the team, and how much time is given. If the storyboard artist is up to it, go for it! If not, someone else can do it.*

- *The main characters are the mandatory items to design. The design of other props can be taken from existing references from the internet - it's not necessary to design every nut and bolt on a robot.*
- *Again, don't spend too much time on this part, we still have a lot to go!*



Production

- Deadline setting
 - SET DEADLINES. If you let it, every part of production will drag on forever. Set dates for when team members turn in their various assets, for when they finish animating, for when they finish rendering, and for when the editing is done. Leave time for revisions.
 - *Personal Note: Setting both hard and soft deadlines help give people leeway in case something goes wrong - which it inevitably will.*

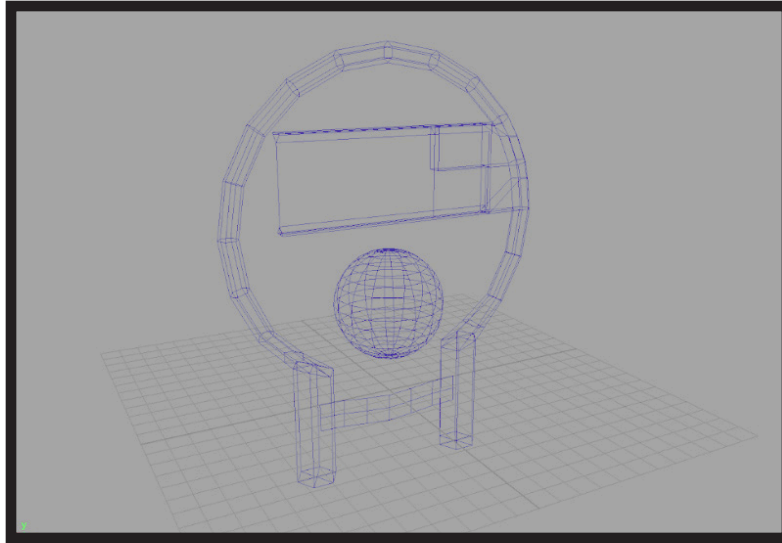


-
- *Team members who regularly go over deadlines affect the rest of the crew. Make sure to keep people to their deadlines, or else the entire project will lag behind due to one person.*

- Modeling

- When the storyboard and character designs are approved, the team leader will need to generate a list of props, characters, and sets that all need to be modeled and textured. They will then delegate each member of the team their share of assets to create.

- *Personal Note: Try to keep the models looking cohesive in terms of level of detail.*
 - *I personally delegated based on a mix of skill, experience, and interest. Someone with high skill in modeling locomotives would receive all the trains, planes, and boats. Someone with low general experience would receive simpler models that have a lot of references and are stand alone (a book, a screwdriver, a chair). And if someone is particularly interested in modeling something and have enough passable skill, I would give them what they ask for.*



- Texturing
 - Models will then need to be textured, usually by the modelers themselves.
 - *Personal Note: Assigning textures / materials is to give your model color. A standard, untextured model is whatever default gray your program uses.*
 - *Textures can range from solid colors to an actual photograph - keep the style consistent across all your models!*

- Rigging
 - Team members with characters that need rigs will also need to rig up their models, or otherwise have a dedicated rigger do the job.
 - *Personal Note: Rigs are the skeletons that models attach to - like muscles to bones. Animators then animate the rigs to make their models move. Rigs can be very very simple, or extremely complex. Making a rig that is easily usable by all members of the group is also a good skill to have!*



- Animation

- Here's what you have been waiting for! After all the assets are created and shared among all the members, the team leader will then delegate the different scenes from the storyboard to every member. Each member will then animate their scene.

- *Personal Note: A Google Drive with unlimited storage is one of the best ways to share assets across the team, along with creating a cache of models and textures for future use. Otherwise, USBs and hard drives work fine.*
- *Make sure that scenes don't run too long or too short - you can predetermine how long certain scenes last in order to not go over your time limit.*

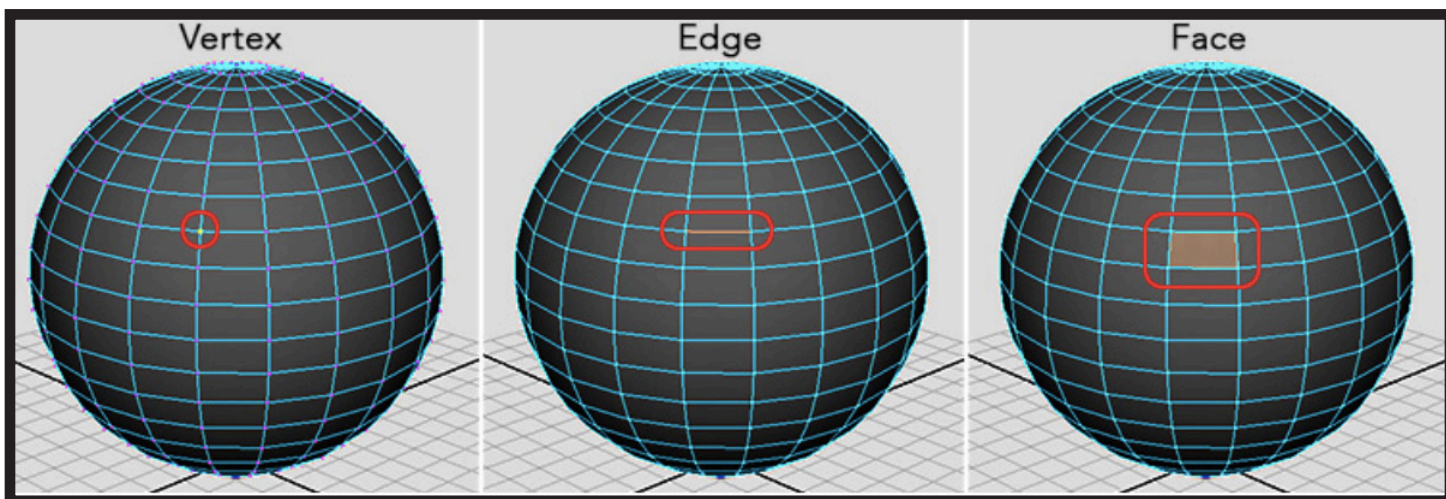
- Rendering

- Once you've finished animating (including any special visual effects you can do within the program), render your animation out.
 - *Personal Note: Make sure the type of file, the codec, frames per second, and resolution are all the same across everything! It'll make editing much easier.*

Post Production

- Editing
 - Edit together all of your footage in whatever program of your choosing. This includes sound, compositing, and any other special effects you didn't do in your animation program.
 - Fix up any mistakes that slipped past the animators, or have them fix the issue within the animation program and re-render.
 - Format your final video file to be viewable by normal computers and usable by social media.

And you're done!



VII. Animation 101

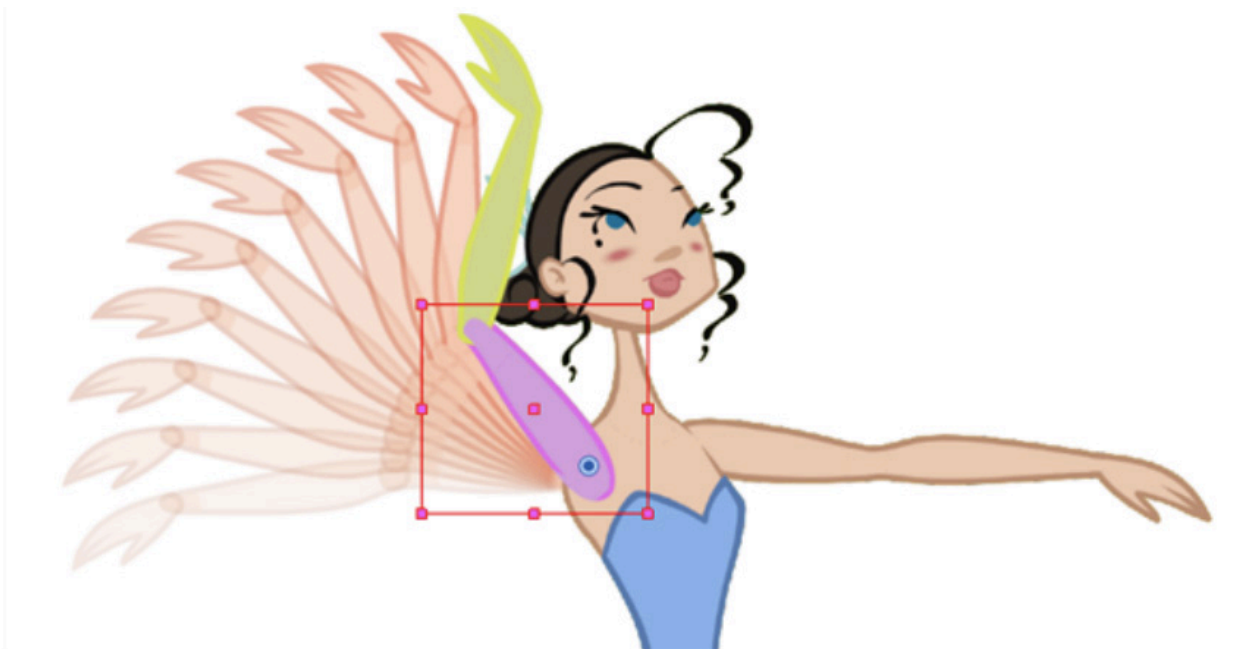
Welcome to Animation 101 - here's an outline of some things that beginning animators will want to know. Most, if not everything listed here can readily be found online.

Some Things You May Want to Know

- Vertices, Edges, and Faces
 - These are the basic components that make up the geometry of a 3D model. A vertex is a point, an edge is made up of two points, and a face is made up of three or more edges. The smallest unit you can have is a triangular face.
 - Faces can also be referred to as polygons - the more polygons you have in a model, the more detailed it is.
 - The term polygons is more often used for game models.
 - A four-sided face is usually referred to as a plane.
- When modeling, you never want to have more than four sides to a face. This reduces the risk of weird geometry or rendering issues.
- Always start from basic shapes with very few polygons. Rough out the shape you want, then slowly get more detailed. This helps keep you from getting overwhelmed, and makes the models predictable to work with.

- Onion Skinning

- In various software, there is a view mode that allows you to see your current frame with your previous and next frames overlayed on top, either with lowered opacity or in a different color. This is onion skinning.
- This mode allows for you to keep track of how and where an object moves, and is a very necessary asset for any type of animation. It especially helps with acceleration and smooth animation.
 - Generally, 3D animation software don't require onion skinning as much as 2D due to how it works, but many programs do include it or offer plugins and extensions.



- FPS
 - Frames per second, or the amount of images within one second of animation. Most feature animation will try to meet the film standard of 24 frames per second. However, you can have less frames, or different FPS at different times, without sacrificing the quality of your animation.
- 1s, 2s, 3s
 - This ties back into FPS. Animating on 1s refers to animating 24 frames per second. Animating on 2s refers to animating 12 frames per second - you have half the amount of frames, which will result in noticeably choppy animation, but not by much. Having good animation on 2s is just as good as any animation on 1s - lots of times it's even preferable, either due to style or time! Animating on 3s refers to animating 8 frames per second. This results in very, very choppy animation, although it's still applicable in certain situations. You can also animate on 4s, 5s, and so on.

- Feature films usually animated solely on 1s.

American cartoons are usually on 2s, occasionally on 3s. Japanese TV anime, however, is interesting.



Because of the sheer volume of anime being produced, the insanely tight production deadlines, and its long history, the industry has had a lot of time to find shortcuts in animation. A lot of Japanese anime is animated on 3s, even 4s. Limited, choppy animation has even become a trademark style of certain studios, notably Studio Trigger. Only higher budget anime and anime films tend to have scenes animated on 1s, and the increase in quality is always noticeable.

- *Personal Note: For beginner animators, animating on 2s is recommended, as it's the easiest to adjust to 1s or 3s to suit your needs. Of course, if you're doing 3D animation, everything will already be in 1s unless you specifically edit the footage.*

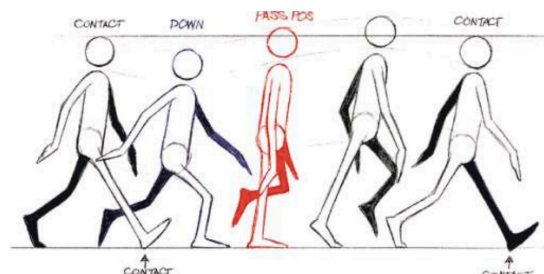
- 1s is used for very smooth, very clean animation. 2s can be used for pretty much anything. 3s are very good if you're trying to do very slow and/or very subtle animation. Anything higher than that is usually used for stills where nothing is moving.

- Keyframes

- Keyframes are the important frames that an animator wants to have.

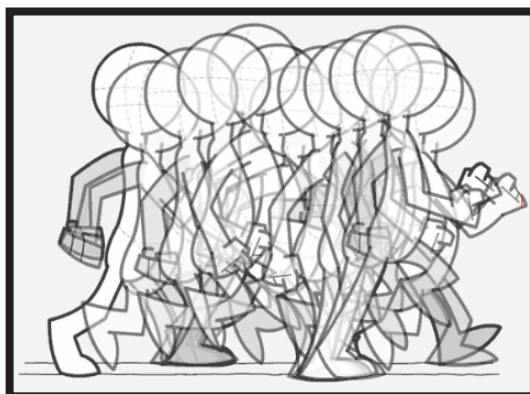
They are often the most extremes of certain actions, and usually the start and end of the action.

- For example, if a person is jumping, the keyframes would be at:
 - The person standing normally
 - The person with their knees bent, arms back, head down
 - The person up in the air in the pose they're making while jumping
 - The person back on the ground with their knees bent, absorbing the impact of landing
 - And the person standing back upright again
- Keyframes are usually what senior animators do, while they have junior animators or interns fill in between keyframes in a process called tweening.
- In 3D computer animation, keyframes refer to set points along a timeline where the animator specifies an object's position and information. The difference here is that you can have every frame be a keyframe, whereas in 2D animation keyframes are merely the important frames.



- Tweening

- Tweening, or inbetweening, refers to drawing all the frames between keyframes. How you tween decides the timing and the performance of the action.
- Having a lot of in-betweens between keyframes makes the action slower, while having a little makes it faster. In addition, having a lot of frames at the start of the action makes it accelerate, while having a lot at the end makes it decelerate.



- Composition

- Composition is how an image is staged in order to create an interesting, visually pleasing arrangement. Good composition guarantees that no matter what frame you stop on in a film, it'll look gorgeous and poster worthy.
- There are certain techniques that help create good composition, but the easiest way is to look at what other people are doing, and dissect their work.
 - Hint: A lot of the times it has to do with specific ratios

- Rendering
 - Rendering, specifically in the context of 3D computer animation, refers to compiling everything within your scene into a usable file, usually video or image. This process generates the final look of your models, any special effects like fur or physics simulations, how the lighting looks, and your animation. The program then goes through all the calculations of how they interact with each other - how your realistic lighting looks on cell shaded fur that's being tousled by a hand, for example - then puts everything into a file.
 - Rendering takes FOREVER. The more special effects and objects you have in your scene, the longer it takes for it to render.
 - It took 29 hours to render a single frame of Pixar's Monsters University. Big animation studios usually have massive renderfarms and thousands of processors in order to handle the workload, and even then, things can go wrong.
- Codec
 - A codec is a piece of code that determines how your data is compressed and encoded for storage, or how it's decompressed for playback and editing.



Different types of codec work in different ways, so make sure that the codec is standardized across all of your videos in order to reduce any problems.

- Resolution

- The quality and clarity of the image or video, usually determined by how many pixels are in it. Generally speaking, any kind of video these days don't fall below 1080p, or High Definition, which is 1920x1080 pixels. 4K, or Ultra High Definition, is 3840 x 2160 pixels. For feature films, 2K, or 2040x1080, is the bare minimum
 - It's recommended that any assets you create for animation fall at or above 2K resolution.
 - For printing high quality images, always have a resolution of 300 dpi or above.

- Aspect Ratio

- This is the ratio of width to height of the image or screen. Different mediums require different aspect ratios, and different time periods used different aspect ratios, so it's good to keep in mind, especially when working on multimedia projects.
 - 1:1 is primarily used for social media platforms
 - 4:3 is used for 16 mm film, analog video, and digital video

- 1.375:1 is for 35 mm film, and is the standard feature film aspect ratio
- 16:9 is used for HD video, and is the most widely used online video aspect ratio (YouTube)
- Letterboxing Pillarboxing
 - The practice of putting black bars on the sides of a video so that they fit screens that don't have the same aspect ratio as the video itself. Letterboxing is putting bars at the top and bottom, pillarboxing is putting bars on the left and right.
 - These, along with aspect ratios, can give the appearance of old timey films and TV broadcasts, and help when making multimedia projects.
- Shot Types
 - Camera shot types are the different ways you can position a subject within the frame of your camera. There are many, many different ways you can shoot a scene, all of which are used in various situations to create meaning and cohesive storytelling. Because animation borrows massively from film, it's good to know the various kinds of shots you can employ.
 - Here is one website that goes over different shot types:
<https://www.bhphotovideo.com/explora/video/tips-and-solutions/filmmaking-101-camera-shot-types>



12 Basic Principles of Animation

- Video Tutorials:

<https://vimeo.com/93206523>, <https://vimeo.com/112435401>

- This is the most important set of principles that form the basic foundation for any and all animation, established by the classic old Disney animators. If you decide to go into animation, this will be drilled into your head until its permanently engraved. However, these are not hard and fast rules. Similar to how if you understand how colors complement each other, then you can play around with color theory, these principles can be messed with and broken. Still, knowing these and being aware of them will help make your animation feel better.

1. Squash and Stretch

- Refers to deforming an object to give it an appearance of flexibility. Squashing refers to it being stretching horizontally, and stretching vertically.
- For example, when a rubber ball hits a wall, it will compress and become flatter. After it bounces away from the wall, it will stretch out and become longer.
- It's important that the volume of an object remains the same - if you squash it, its height must decrease, but its length must also increase, and vice versa.
- Squash and stretch gives objects energy, but it's also how muscles and other physical objects actually work.

2. Anticipation

- The movement that allows the audience to anticipate an action - the action before the action.
- Before a pitcher throws a ball, they will wind up first, swing their arm back, then throw forward. The wind up is anticipation - you know that once they're in that position, the next thing they will do is throw forward.
- This allows action to be read clearly and sets up audience expectations.

3. Staging

- This refers to setting up the scene to have clear focus on whatever's important, and directs the audience's attention.
- If you want to show an intense argument as the most important part of the scene, don't have it be very far in the background, or stuck in a small corner!
- Unless it's symbolic - staging is very useful for symbolism within videos, just make sure that it works with whatever themes you're going for.

4. Straight Ahead and Pose to Pose

- These are two different ways to animate - you may like one more than the other, or change between them based on what you're animating.



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- Straight ahead is animating chronologically. You start with the first frame and end with the last frame. This is more fluid, dynamic, and better for action that doesn't need clear shots.
 - Pose to pose is animating based on set points. You have certain poses that you want to hit. Set up those poses first, then animate between them. This is excellent for scenes that need strong composition or strong character animation.
 - Trying to keep a character on model is much harder in straight ahead animation, while pose to pose animation can feel more stilted. Figure out what works best for you!

5. Follow Through and Overlapping Action

- This helps to create realistic action, primarily by giving the illusion of inertia and additional motion.
- When you slam on the brakes in a fast moving car, your body will continue moving forward before being pulled back into your seat. That motion of being yanked forward, then yanked back is follow through - an object will overshoot its intended stopping point before being pulled back.
- Overlapping action is where different parts of the object move at different rates - when you're running, your arms move at a different rate than your head. If you stop abruptly, your arms will take longer to come to a stop than your legs.

- Exaggerating these characteristics will give a more cartoony feel, but realistic motion requires realistic applications of these principles.

6. Slow In and Slow Out

- If you want an object to start moving, it will start moving very slowly, then accelerate. If you want an object to stop, it will decelerate, then stop, instead of abruptly stopping.
- An example would be a pendulum on a clock - when it swings to the top of its arc, it slows down, then stops. As it swings back, it starts slow, then speeds up in the middle of the swing, then slows back down again.

7. Arc

- Any type of movement generally works in an arc - try loosely waving your hand around, and watch how you rotate your wrist and the path your fingers follow.
- Animating in arcs creates clear, clean paths of motion, and generally makes your animation smoother.
- Arcs are absolutely everywhere, from the tip of a character's nose as they enunciate to the full body motion of someone climbing up a ship mast.



8. Secondary Action

- These are additional actions used to enhance the primary action.
- One example is how a ponytail will bob up and down or swing back and forth if a person is running or walking.
- Secondary actions can be as simple as whistling while working, or as complex as fiddling with a stress ball while reading.
- However, it's important that your secondary action doesn't overwhelm or take attention away from your primary action. If it does, try toning down or removing your secondary action.

9. Timing

- This refers to how many frames you dedicate to a specific action, and how you space those frames out.
- Realistic motion requires good timing - the more frames you have, the slower the action, and vice versa.
- Timing is extremely important in creating certain moods and portraying emotion. A sad, depressed character requires a lot more frames and a lot more time to move than a happy, energetic character. You CANNOT put in 50% effort into a good emotional performance - you have to be willing to put in the time to create something moving.

10. Exaggeration

- It's exactly what it says - exaggeration is where you overdo actions in order to emphasize them. It's the bread and butter of animation, as the medium allows the artist to push the bounds of reality.
- If a character is struggling to reel in a fish, don't have him tug lightly at the fishing rod a couple times - have him get up and furiously yank the rod back, accidentally slip on the pier, and nearly fall into the water.
- Of course, remain cohesive in how much you exaggerate, and know when to step back and allow for subtlety. Too much exaggeration can result in confusion or overwhelming the viewer.

11. Solid Drawing

- This refers to drawing objects in a way that gives them three dimensionality. A solid drawing will appear to have weight, volume, and mass. It makes objects interacting with each other and existing within the world look believable.
- A good way to improve solid drawing is to take foundational life drawing classes - having a good understanding of light, proportion, perspective, and anatomy helps immensely in any kind of art.



12. Appeal

- A character is appealing when they pique interest in the viewer - this doesn't mean that they have to be beautiful or sympathetic, it merely means the audience can believe in their existence and is interested in seeing what they do and how they do it.
- Appeal can come from both design and animation.
- Usually the most important part of appeal comes from readability. If the audience has no idea what they're looking at, they may not necessarily be interested in seeing what happens to the character.

Good Exercises For Everyone

- Bouncing Ball
 - Animate a ball bouncing.
 - Everyone's done it. Everyone's sick of it. But it's still one of the best foundational animation exercises out there. It covers most of the 12 principles, teaches beginners how to do timing, the most important part of animation, and allows people to get used to whatever software/medium they're using. It's also a very customizable exercise that allows for creativity and style experimentation.

- Walk Cycle

- Animate a faceless person walking.
- Another ubiquitous foundational exercise, especially for stop motion animation. There's a lot that goes into a good walk cycle - hip and shoulder torque, the swing of the arms, the bobbing of the head. It teaches control, timing, and allows for creative freedom, whether in the design of the person or how the person is walking.
 - You can tell a lot from how a character walks. Are they limping? Are they strutting? Are they sneaking? Little changes in how a character moves their arms or bends their spine can completely change what mood they're conveying. This is especially prominent in stop motion, where little adjustments you may barely notice changes the entire personality of a character.

- Room

- Model a room.
- This one is very fun, as it helps teach beginners the tools available to them in 3D modeling software, and forces them to ingrain it into their heads from repetition. It also gets them into the habit of looking at image references for any furniture or objects they're modeling.



In addition, they can have fun designing the room however they like, and put together a cohesive aesthetic.

- Rigging A Person
 - Make a rig for a humanoid character.
 - Being able to make a rig helps with understanding how they work, and how models and rigs interact and affect each other. This helps streamline the production process, and makes a difference in the way you animate.

General Tips

- SAVE OFTEN AND IN LOTS OF PLACES
 - The number of times we have lost hours of work due to crashes or wipes is uncountable. This is especially important if you're working on very detailed models or long animations - even the most sophisticated software will randomly crash for no discernible reason.
 - Two good habits to get into - save version files or have backups, and learn to compulsively CTRL-S.
- USE REFERENCES. ALWAYS.
 - Art draws from reality - you cannot have good art without having good references. If you don't know how to draw something, look it up.

If you're unsure, look it up. If you're very, very sure, look it up anyways. You might find details you've never seen before. This applies to everything, from basic drawing to animation.

- There is no shame in using references. No one expects you to be able to animate a quadruped moving on your first try, it's HARD, and you won't do anyone any favors by trying either way.
 - We'll tell you a secret - 99% of art is plagiarism. If you think something looks insanely new and unique, it's guaranteed that the creator took inspiration from the art of other people. Artists constantly reference each other, even the very process of pitching new ideas to studios requires you to find and compile references of other people's work to build up an idea of what you're doing in the executives' minds.
 - This is one part of something called a pitchbook - essentially a presentation of your ideas, your work, and the research you've done that you give to studios to try to get them interested in producing your film / cartoon / short / whatever.



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- This is why you will never see a pitchbook being publicly distributed. Because other artists' works are being represented within it, usually without their consent, even if it's only being used as research, it's too easy for them to sue.
 - References also help keep your work cohesive - having stylistic references keeps your aesthetics looking consistent throughout.
 - Find inspiration in any and everything
 - Inspiration comes from very unlikely sources, and there are many, many niches out there waiting to be filled. Do you have a special interest in microbiology, mythology, marine biology, or the life cycle of a bat? Great! Draw ideas from it and put it into your animation. Do you know someone who works at a bookstore? Great! Ask them about their work and interesting customers that come in. Are you utterly obsessed with gems and / or the themes and teachings of Buddhism? Great! Combine them together however you want. What about cryptozoology? What about international figure skating? What about the feelings of a manicurist that she cannot articulate? What if you just really like video games? No matter how strange your interests, there's always something to draw inspiration from, and the more you know, the more you can pull from.

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- Microbiology - Cells at Work! https://www.youtube.com/watch?v=Ek39M_IYUtE
 - Mythology - Monkey King: Hero Is Back <https://www.youtube.com/watch?v=v33o9deALkA>
 - Marine Biology - Spongebob Squarepants <https://www.youtube.com/watch?v=r9L4AseD-aA>
 - Bats: The Bats by Jim Trainor (NSFW elements) <https://www.youtube.com/watch?v=aDizcCTUGdw>
 - Bookstore Employee: Skull-face Bookseller Honda-san <https://www.youtube.com/watch?v=Nmhv4OrWvzw>
 - Gems - Steven Universe <https://www.youtube.com/watch?v=6OWq38TikzU>
 - Gems AND Buddhism - Land of the Lustrous <https://www.youtube.com/watch?v=i4nxEcNrn6M&t=106s>
 - Cryptozoology - Gravity Falls <https://www.youtube.com/watch?v=Z6usKhzL8uI>
 - International Men's Figure Skating - Yuri!!! On ICE <https://www.youtube.com/watch?v=KuhLOnIszok>
 - Manicurist - Agua Viva by Alexa Lim Haas (NSFW elements) <http://alexalimhaas.com/aguaviva/2018/12/3/agua-viva>
 - Video Games - Starbomb (NSFW elements) <https://www.youtube.com/watch?v=And-vdjC71E>



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- Pay attention to the world around you
 - Good animation comes from observing real life. You are giving life to still images - in order to accurately portray life, you must be able to reference it. Little tiny details come together to create a masterpiece, and being able to connect to reality will make it easier to connect with the audience, as it's their experiences and their emotions that you're reflecting.
 - Studio Ghibli is especially good at this. Watch their films and keep an eye out for “extraneous” movement - movement that's not necessary to the plot, but only exists to give personality to the character or make the world more believable. One example would be in Ponyo, where the main character Sosuke is playing on the rocks at the beach. At one point, he cuts his thumb on a rock, and pops it into his mouth. This in no way impacts the story and doesn't build his character, but it makes him more real to the viewer, because every kid has done that.
 - A professor once recalled seeing a boyfriend and girlfriend sitting together on the subway. They weren't paying attention to each other - the man

was staring out the window, and the woman was engrossed in a book - but they were holding hands. At the next station, the man gets up to leave, and the woman doesn't look up from their book, but their hands are still linked together as he walks away. They cling to each other by the fingertips until the very last moment possible, then break contact. The woman pulls her hand back to her chest and does a delighted wiggle, while the man walks down the platform smiling. Little moments like these resonate with your audience, and builds your world into something real.

- Learn to take critique and give constructive feedback.
 - One of the most important aspects of being an artist is the ability to take and give constructive criticism.
 - Being able to gracefully receive feedback is a mark of someone who is an excellent team member with a good work ethic, No one wants to work with someone who reacts badly to criticism.
 - This does not mean you have to take every piece of feedback you get - sometimes the feedback goes against what you're doing, or is not useful at all. In that case, simply thank them and move on.



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- On the other hand, you also want to be able to give constructive feedback. This indicates that you can critically look at someone else's work and articulate your thoughts in a way that allows the other person to improve, or suggest something that the other person can then use to further their original idea.
 - Don't use "I'm just being honest" or "that's just how I am" as an excuse - if you cannot put your thoughts together in a way that's useful to the other person, you're better off just saying nothing.
 - It's ok to be negative when giving feedback. However, if you're going to say something negative, also point out positive aspects of the person's work to let them know what they're doing right.
 - Remember the feedback sandwich - say something positive, say something negative, then say something positive again.
 - Enjoy yourself.
 - While discipline is definitely important, sometimes just the fact that you're excited about your project can motivate you to actually do it. It also gives you that extra UMPH to push the project to its limits.

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- Even if you don't enjoy the project itself, focus on an aspect that you find interesting.
 - Sometimes it really is that bad - in that case, all you can do is put your head down and hope it's over fast.
 - Take breaks regularly.
 - Burnout is real. Health complications from sitting in a chair all day staring at a computer or paper are a thing. Carpal tunnel syndrome is a thing. Get up, walk around, do something that's not animation-related. Eat a snack, drink some water. Your mind and body will thank you for it, and after taking a break, you'll go back to the project feeling re-energized and more motivated than ever.
 - Artists at Pixar, who work on one single film for years every day, regularly work on side projects completely unrelated to their animation work in order to refresh themselves and not experience burnout.



Personal Note - If you'd like to learn even more about animation, I highly recommend The Animator's Survival Kit by Richard Williams, the holy grail of animation how-to guides. It also comes in video format with animated examples!

- Here is a free PDF of the book:

http://www.floobynooby.com/pdfs/The_Animators_Survival_Kit.pdf

- And you can purchase the video copy here:

<http://www.theanimatorssurvivalkit.com/index.html>

...And that's everything you need to start your own Animation Sub-Division!

We hope that this document can assist and inspire you to continue your animation journey. Feel free to email us for any reason (especially if you would like to show off some of your work or have any questions!

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