TAMPERE UNIVERSITY
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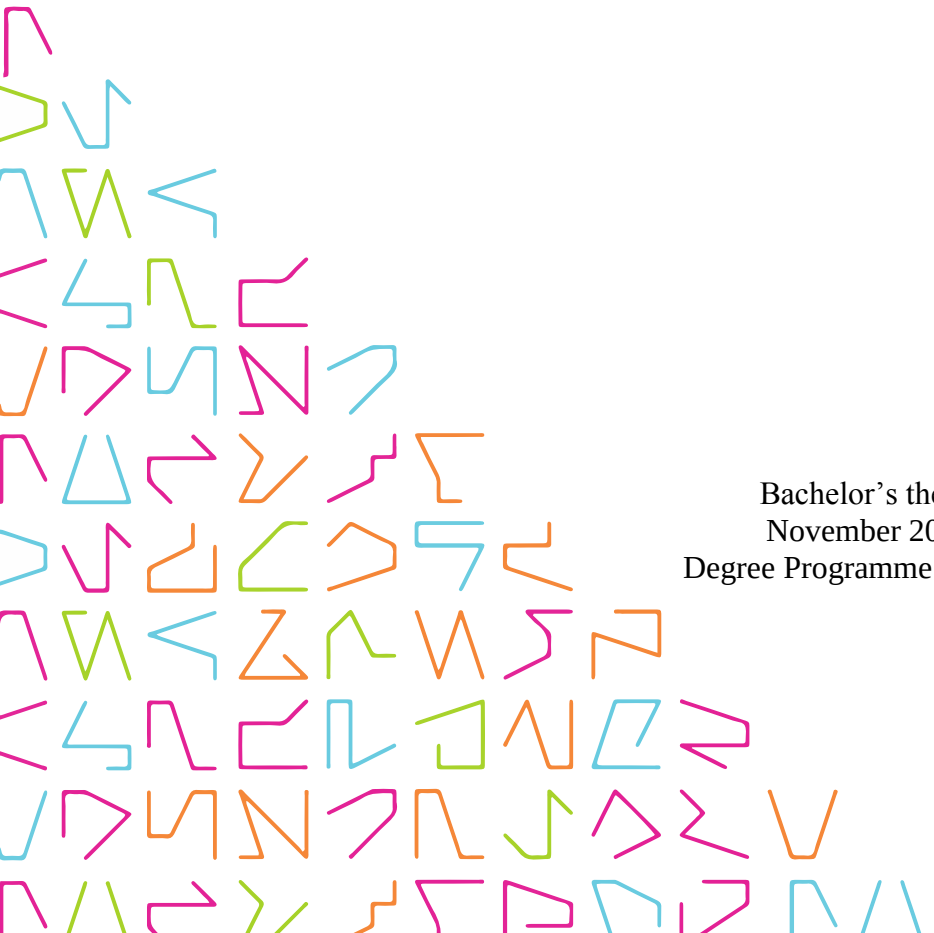
The Hand Drawn Animation Process

Traditional and Contemporary Methods

Venla Linna



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ABSTRACT

Tampereen ammattikorkeakoulu
Tampere University of Applied Sciences
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The rate of technological development in the past two decades has left a devastating mark in the world of hand drawn animation. Computer animation dominates the movie theatres and the hearts of the audience with ever more impressive 3D animated full feature films, having essentially made popular Western 2D cinema a thing of the past. The purpose of this thesis is to examine the state of the hand drawn animation industry from its traditional past to the digital possibilities of the present, to compare the methods that best retain its core principles, and to consider its continued relevance in the era of 3D animation.

In order to come to a thorough understanding of the industry, I undertook research into the history of hand drawn animation and its pioneers, in addition to conducting two expert interviews with present-day animators and creating two experimental animations to better understand the differences between traditional and paper-free animation workflows. Further research was done on the technology that supports the digitalisation of hand drawn animation, and the opinions of the animators that facing it were also charted.

The interviews and research showed that even while in decline, the traditional hand drawn process conducted by pencil and paper is still viewed as the benchmark, with technological advancements such as digital drawing displays being judged by how closely they approximate the experience and results of the traditional workflow.

My findings suggest that even as the industry drifts further away from the processes of the past, the standards they set continue to dictate the future of animation and the animators who carry the torch into the digital format.

Key words: hand drawn animation, digital animation, animation history, drawing display

CONTENTS

GLOSSARY

inbetweening	the act of drawing intermediate animation frames between two key poses to generate a smoother movement
flipping	flipping animation frames in their correct order to preview the movement
rolling	previewing animation by placing the fingers between the frames and rolling the papers away from each other in order, especially useful for animating and short actions
pencil test	also known as line test; animation frames that have been captured with a camera or other input device, and can be played in the accurate framerate for a clear idea of the timing and the animation
exposure sheet	also known as dope sheet; used in animation to mark down timings for various movements, dialogue and sometimes camera instructions
xerox	credit
life drawing	drawing models, environments and objects from life, just as they appear at that time
rigging	a digital skeleton within a 3D object consisting of bones and joints used as handles to manipulate a 3D character into poses
cel	short for celluloid, refers to the transparent celluloid sheets used in traditional animation to maintain a visible background in filming when layering the animation frame on top

1 INTRODUCTION

I first told my father I wanted to become an animator at five years of age. All children love animation, but without exaggeration, I was obsessed with it – Cartoon Network was periodically banned at home because I could not tear myself away from the television set, mesmerized by the animations even when I could not understand the language. Anything drawn and moving would have my absolute undivided attention, from Disney classics to obscure Music Television cartoons like Aeon Flux.

I was 21 when I rediscovered my love of hand drawn animation, finding illustration insufficient for need to tell stories through my drawings. I fell in love with the difficulty of it all, from the study of movement and form, to the mathematics of timing the drawings. The process was gruelling and often tedious, but the moment of playback was always worth it; with my own hands, I had given life into a once static creation.

By this time, however, 3D animated full feature films had long replaced hand drawn animation in the movie theatres. I could not turn around without being told about the decline of the industry, and how soon it would cease to exist altogether – yet after moving to the United Kingdom, I began working as an assistant animator in projects that were not only hand drawn animation, but animated on pencil and paper. The rarity of something like this still happening in a world of digital animation cannot be emphasized enough. It was especially poignant because after 2 years of struggling to animate on a graphics tablet, I had upgraded to an interactive drawing display just a few months before, specifically to replace paper entirely in my animation workflow; now I spent my evenings in front of a lightbox, with pencils and paper.

With this thesis, I will introduce the reader to the birth and the development of the method of animation that laid down the foundation for an entire industry, and how the technological landscape changed it throughout the years. I will explain and compare the technology that is digitalizing hand drawn animation through my own experiences, and that of two professional animators working in the industry digitally and traditionally. By creating an overall picture of the past and the present of this industry, I hope to answer one question; does hand drawn animation have a place in the future?

2 ANIMATION TECHNOLOGY

Creating a sequence of changing images helps us to tell a story, be it every day humdrum or extraordinary things we cannot come across in our world. The history of animation runs parallel with the history of motion picture in general, the old-fashioned attempts to animate pictures representing common ancestors that developed into photographic motion pictures. (Crafton 1982, 26-28.)

2.1 Stone Age to Film Age

This chapter will outline the early development of animation production and introduce the people who pioneered it. The beginnings of animation are still shrouded in mystery – it sprouted from many corners of the world almost spontaneously with varying success and quality, widely ignored by film scholars as trivial in comparison to other early filmmaking (Crafton 1982, 25). In the century before becoming an industry of its own, animation began to develop but still lacked organization and was based on individual experimentation rather than the collaborative efforts we see today. The influence of animation spread from stage illusions to toys, mesmerizing comparatively limited audiences before the dawn of the film age.

2.1.1 Ancient Animation

Archaeologist Marc Azéma and French artist Florent Rivère (2012) discovered that Paleolithic cave artists may have used torches to animate their drawings, which could explain the presence of multiple deconstructed overlapping limbs and heads often found in cave paintings of that era. According to Azéma, the animated drawings achieve their full impact when viewed by flickering torchlight. The researchers also found a more concrete animation invention by the Palaeolithic humans – a disk with changing drawings on each side, which by threading a string through it would combine the two drawings and create an animated drawing, like a prehistoric Thaumatrope. (Rossella Lorenzi, 2012.)

Static images depicting movement was common all through the early stages of human civilization, used to tell a story through visual means, much like animation. From 5,200

year old pottery bowls in Iran to ancient Eqyptian murals, humans have drawn animation frames to tell the stories they couldn't otherwise visualize. (Animation History 2016.)

2.1.2 Pre-Film era Animation

The Magic Lantern, a predecessor to the modern projector invented by a disputed party around the middle of the 17th century, was the first example of projected animation in the world. It worked by reflecting candle or oil lamp light through a lens and a translucent oil painting, most commonly used to project frightening images on to the walls in theatre to create phantasmagoria – some of the slides had moving parts, which loosely sets it into the bracket of an animation device. (Toy Theatre: Magic Lantern.)

While we know now that there is evidence of them possibly existing even in the Palaeolithic era, the Thaumatrope's invention was credited to Sir John Herschel, and popularized by John Ayton Paris in 1824 (Thaumatrope 2016). The Thaumatrope was a popular toy in the 19th century which created the perception of movement by spinning a disk by two strings, with a corresponding drawing on each side of the disk. The toy made use of the then popular theory of persistence of vision, in which the human perception of motion was based on the eyes being centred – disproved in 1912, the current more accepted theories are the two perceptual optical illusions of beta movement and phi phenomenon. The persistence of vision is also the basis for the set limits of framerate in drawn animation, 12 frames per second being the minimum for lifelike motion (Future Learn: Persistence of Vision.)

The first clear animation device used by a wide audience that created a fluent impression of motion was the Phénakistascope, invented in 1831 simultaneously by both Belgian Joseph Plateau and Austrian Simon von Stampfer (Wikipedia, History of Animation). It was a disk with a series of images drawn equally spaced along the radius, with slots cut out at a different distance from the centre – the device would then be placed in front of a mirror and spun. Watching through the slots at the reflection of the image, the viewer would then see a fluent movement loop. (Jobson 2013.)

The Zoetrope, invented in 1834 but marketed in its name approximately 30 years later, worked under the same principle as the Phénakistascope. It consisted of a cylindrical

spinning device with the drawn images attached to the inner walls in succession. Like its predecessor, slits would be cut out the of the outer wall to enable the viewer to watch the movement on the opposite side of the shape. Due to its shape, many people could view the animation at once. (Early Cinema: Zoetrope.)

A common toy even today, the Flipbook, was patented in 1868 to John Barnes Linnett in the name of kineograph, although its invention is often credited to the French Pierre-Hubert Devignes under the name folioscope (Flip Books, 2016). A flip book is a small book of somewhat stiff papers with drawn frames in the outer edges of the pages. By bending the small book and releasing pages gradually with a finger, the operator can see a moving picture. Despite the lack of a shutter effect, the flip book achieved the perception of movement with the quick replacement of the images. The flip book was an improvement from its predecessors in that while being small, it could accommodate many more drawings and therefore longer, more fluent animations could be created. Despite being regarded as a child's toy in modern times, flip books were used to advertise things like cars and cigarettes back in the day, and were key in the development of the motion picture (Flip Books, 2016). According to Crafton (1982), it was this invention that inspired many of the pioneers of animation (26-28).

In 1877, a French science teacher called Charles-Émile Reynaud invented the Praxinoscope, the successor to the zoetrope. It improved on its predecessor in replacing the slits on the cylinder with a mirror inside the device, which enabled a clearer picture and more stationary viewing. He went on to further expand on his invention by creating the Théâtre Optique which could project images onto a screen from a longer reel of pictures. In 1892 Reynaud projected the first animation film to a public audience at the Musée Grévin in Paris. In 1900, more than 500,000 people saw 'Pauvre Pierre', one of the first animated films ever made, drawn directly on transparent strip by Reynaud. (Crafton 1982, 27 – 28.)

2.1.3 Early Film Era

”One certainty is that animated cinema could not have existed before the cinema came into being around 1895.” – Donald Crafton 1982, 26–28.

In 1896 Stuart Blackton interviewed Thomas Edison, who had been demonstrating one of the first film projectors; the Vitascope. Inspired, Blackton and his partner Albert Smith bought the latest film and nine others made to be played by the Vitascope, and the device itself to play the films in their stage show. Eventually Blackton and Smith, now working as the American Vitagraph Company, went on to create the first film that included animated sequences, 1900’s *Enchanted Drawing*, followed 6 years later by the first entirely animated film; *Humourous Phases of Funny Faces* in 1906. In both films, Blackton uses a stop-motion technique of stopping the film, making a change, and resuming filming. When played back, the object appears to move. According to Crafton (1982), the technique is significant when speaking of animation history, as the iconography and primitive narrative structures of animation grew out of this kind of film-making (28–31). This process had already been used by French film director Georges Méliès and others, but nevertheless earned Blackton the title of “father of American animation” (Wikipedia, History of Animation.)

In the 1890’s, the Lumière brothers created a superior motion picture camera to Thomas Edison’s Vitascope and its successor Kinetoscope, the Cinematograph. The cinematograph, despite its competitors, was the device that ultimately inspired filmmakers and changed the animation industry forever by popularizing motion picture. (Crafton 1982, 27.)

The first animated film that used what we now know as traditional animation methods was the 1908’s *Fantasmagorie* by French artist Émile Cohl, who is considered to be the father of all animation by many. The film was created by drawing each frame on paper, which were then shot onto negative film – this gave *Fantasmagorie* its blackboard look, heavily inspired by Blackton’s similar films. In many ways, Cohl may have been the man to have invented the traditional animation technique: for Fantasmagorie and its two successors *La Cauchemar du Fantoche* (The Puppet’s Nightmare) and *Un Drame chez las Fantoches* (The Love Affair in Toyland), Cohl would photograph his drawings on a lightbox he had constructed, trace slight changes onto the next sheet on paper, remove the

first drawing and repeat. However, because each drawing had to be photographed before tracing the next one, there was no way for Cohl to flip the drawings to preview them. Cohl had to calculate the timing of his animations mathematically or by "animator's intuition". (Crafton 1990, 140.)

Another important animation technique surfaced when Raoul Barré, a Canadian and American cartoonist together with his colleague Bill Nolan came up with the idea of punching two holes on the bottom of their animation sheets so they could be stacked onto pins and kept perfectly in place. This technique is still in use in traditional animation, and is called the "perf and peg" system. (Crafton 1982, 194.)

One of the first to famously use hand drawn animation methods was Windsor McCay, who created animation frames that were far more detailed than that of his predecessors, featuring complex backgrounds and characters. He also invented the 'McCay Split System', the act of doing some of the less important intervening drawings only after establishing major poses and positions first, now known as inbetweening. Beside inbetweening, McCay also pioneered the practice using tracing paper, numbering his drawings to maintain order and even used a rotary to flip his frames, enabling him to check his animations (James 2014, 1). Like many before him, McCay advertised his animations as illusions that he would include in stage acts to astonish the crowd, appearing to be interacting with the animated projection as with his 1914 piece *Gertie the Dinosaur*. McCay animated his films almost single-handedly, often dedicating an entire year to drawing the thousands of frames required to create a mere 5 minutes of film (Crandol 1999, 1.)

By this time, the most basic staples of traditional hand drawn animation had been established: the lightbox, the peg bar and the corresponding hole-punched paper (Figure 1). These three items have been the foundation for the art form ever since – even used by me to complete the practical portion of this thesis.

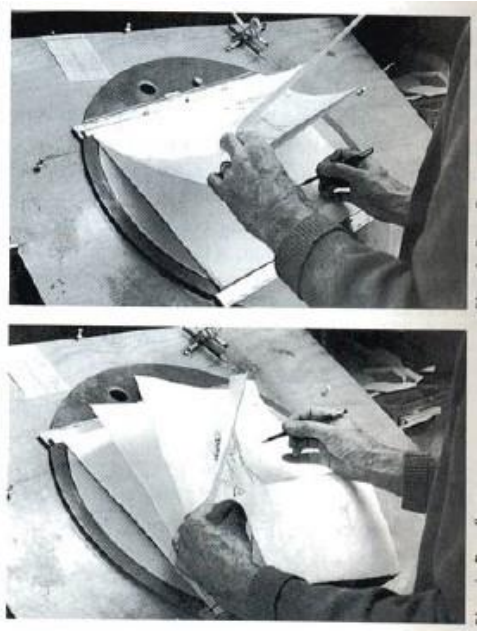

FIGURE 1. Traditional hand drawn animation is created by using a lightbox (sheer glass or plastic with a light underneath), a peg bar and paper that has been hole-punched to fit it. (Thomas & Johnston 1987, 33.)

In a move that truly revolutionized the burgeoning animation industry, John Bray opened John Bray Studios and his employee Earl Hurd patented the cel technique – a method that would be in use for most of the century (Crafton 1982, 154 – 155). Drawn animation frames would be copied onto transparent sheets made from celluloid and pictured on top of static background paintings. The popularization of the cel technique also gave birth to the idea of using assembly lines in production, in which different jobs within production were delegated to team members, maximizing efficiency and enabling John Bray Studios to create the first animated series, Colonel Heeza Liar (James 2014).

Notably, the following year of 1915 the Fleischer brothers invented rotoscoping, the art of using film as reference point for animation. Using this method, they went on to create some of the most famous cartoons of the early 1900's like Betty Boop and Koko the Clown. (Fleischer Studios 2016.)

2.2 The Rise of the Animation Industry

The arrival of the Walt Disney's *Steam Boat Willie* (1928) was undoubtedly a game changer in the history of animation, effectively erasing all earlier influencers from public memory, silent era animation now made obsolete by the arrival of the first sound cartoon. (Crafton 1982, 26). This portion focuses on the methods developed throughout the growth of Disney as a company, which solidified the processes of animation production that persist to this day.

This portion of the thesis discusses the technological advancements in hand drawn animation throughout the ages and as such focuses mostly on the American animation industry, which was a hotbed for developing the methods. However, it is important to note that the European continent also has a rich history in animation development – much more experimental with technique and subject matter, European animation has varied from the masterful puppet animation of Eastern Europe to the psychedelic visuals of George Dunning's iconic 1968 film *Yellow Submarine* (Kehr 2016). Since German animator Lotte Reiniger's *the Adventures of Prince Achmed* (1926) – the oldest surviving animated feature film – there have been over 400 full-length animation films produced and released within the continent (Animation Europe 2016). These films may not often reach American circulation but European animation continues to enjoy a market, with 2D animation being no exception.

2.2.1 The Golden Age of Animation

Arguably the culmination of hand drawn traditional animation was the work of Walt Disney, who started his own animation studio with his brother after the bankruptcy of his previous firm, Laugh-O-Gram studios (Robb 2014, 2). Disney's contribution to the world of animation is perhaps the greatest of all studios in the animation game at that time or indeed since, having housed some of the most legendary animators in the world and facilitated massive leaps in animation technology. Whether these ideas were all conceived in-house is questionable, but undoubtedly the Walt Disney Company has created a vast amount of the content that popularized animated cinema, and in doing so, created the demand for better animation technology.

FIGURE 2. Animator Wolfgang Reitherman acting out a storyboard for the sword in the Stone (Lee 2015).

The Walt Disney Company during Walt Disney's time was the breeding ground for many of the practices in the film industry still used to this day. Although originally attributed to Georges Méliès, the concept of the storyboard was developed into its final form in the hands of Walt Disney and most likely scripter Webb Smith. It enabled animators to edit and otherwise correct scenes before they went too far into production (Whitehead 2004, 47). To this day, the storyboard and the following animatic are essential parts of an animation production, without which the industry would arguably never have reached the level of organization required to create a full feature film, let alone thrive in the manner it has.

'Industry' truly is a keyword here, as it is possible that without the birth of the Walt Disney Company the world of animation would not have ventured into the feature film industry. In many ways, Disney pioneered the current method of animated film production, tackling the near impossible task of balancing micromanagement, delegation and creativity to create pure cinema magic. A key feature of this was splitting the production into teams, each dedicated to a specific part of production to maximize efficiency. The teams were divided into story, animation, colour, inking, scene design, stylists, layout, special effects and filming. Delegating the workload between them meant that each facet of production could focus on their respective task, resulting in much more timely and efficient production and a better quality of work. From a production standpoint, thorough preparation of the storyboard by the Story Department proved to make the biggest savings in

the budget, as a well-planned scene was much less likely to get scrapped or be redrawn (Thomas & Johnston 1997, 87, 90). The new method was necessary to put in place, as the studio's workforce expanded from a mere six employees to over 1,600 between the years 1928 and 1940 (Whitehead 2004, 48).

Disney's growing workforce was also trained in animation by the company itself, as more seasoned animators of that time were wary of Disney's often demanding work ethic (Whitehead 2004, 48). Young animators learned the business of animating by 'assisting' a more experienced animator – they would finish the detail in the keyframes and draw in-betweens determined by the key animator (Thomas & Johnston 1987, 41). This gave birth to a tradition of mentoring within the Disney Company, with all the most legendary animators having learned the art under the best animators of the 30's (Thomas & Johnston 1987, 169). To a smaller extent I have personally met this phenomenon in my own life while assisting Elroy Simmons, an English freelance animator who continues to work in traditionally hand drawn methods.

Walt Disney himself was not a great animator – his strengths in storytelling were far superior – but he stayed at the cusp of the film development by being in constant contact with the production team and often having heated arguments, a testament to the crew and Walt's passion for the films. This interaction gave birth to yet another animation industry staple, the pencil test. While flipping and rolling the animation frames on their pegs was an effective way to preview short bursts of motion, a true presentation of the action as it would appear in the film can only be studied in its correct framerate. Therefore, Walt Disney always had the drawings filmed before inking and painting, giving him and the animator ample opportunity to make any corrections. (Thomas & Johnston 1987, 83.)

The production of hand drawn animation at Disney was a complex process from the conceptual design to filming. By the time the project reached the animators, the overall style of the film had been established by the story and design people – it was up to the animators to add their own personal touch to the film with motion. After receiving the storyboard, sound and layouts for the scene appointed to the animator, the animator would do a pose test, which was a collection of rough key poses filmed with long exposures to test if the overall action worked in the scene. Afterwards, the animator would animate the rest of the movement, often in very rough drawings, all the while timing it correctly into the exposure sheet and jotting down guides for in-betweens drawn by the assistant animator.

The assistant would then draw the in-betweens and clean up the drawings before the scene was tested and sent to the ink and paint department and final post production. (Thomas & Johnston 1987, 185 – 240.)

Walt Disney organized visiting ‘experts’ to come guide young animators through life-drawing classes and give them nightly ‘action analysis classes’ where they would be walked through live action film clips, pointing out observations that could be made of the movement. Walt Disney did not scrimp when it came to educating his animators, always striving to be the best in the business, and would go to great lengths to achieve what they call “the illusion of life”: the pursuit of life-like and believable quality in animation that had the ability to immerse the viewer. The illusion of life set Disney apart from all other animation of that time, elevating it from a vehicle for comedy to a true cinematic art form. (Thomas & Johnston 1987, 76.)

Life drawing classes are still a common practice in animation studios around the world to this day perhaps for this very reason – in the Animator’s Survival Kit (2001), Richard Williams calls it essential for any animator who wants to truly achieve great draftsmanship; a skill which became an important attribute for an animator under Walt Disney’s reign of the animated feature film industry in the first half of the 1900’s (Thomas & Johnston 1987, 71). What started as mere ‘gags’ and humorous shorts, now became a pursuit for not realistic, but believable cartoons with roots in every day human life, and required good draftsmanship from its creators – and understanding of the life around them. Films like *Bambi* (1942) were loved, not because the characters themselves were true to their real-life counterparts, but because they moved like them. The studio premises themselves had an enclosure solely for keeping animals like deer, making it possible for the animators to study the natural movement of the animals before animating. Fresh deer carcasses were brought to be studied, and the team even attempted to attend a birth at the Zoo to catch the very first moments of the fawn before it learns the proper use of its limbs. (Thomas & Johnston 1987, 75 – 76, 333 – 341.)

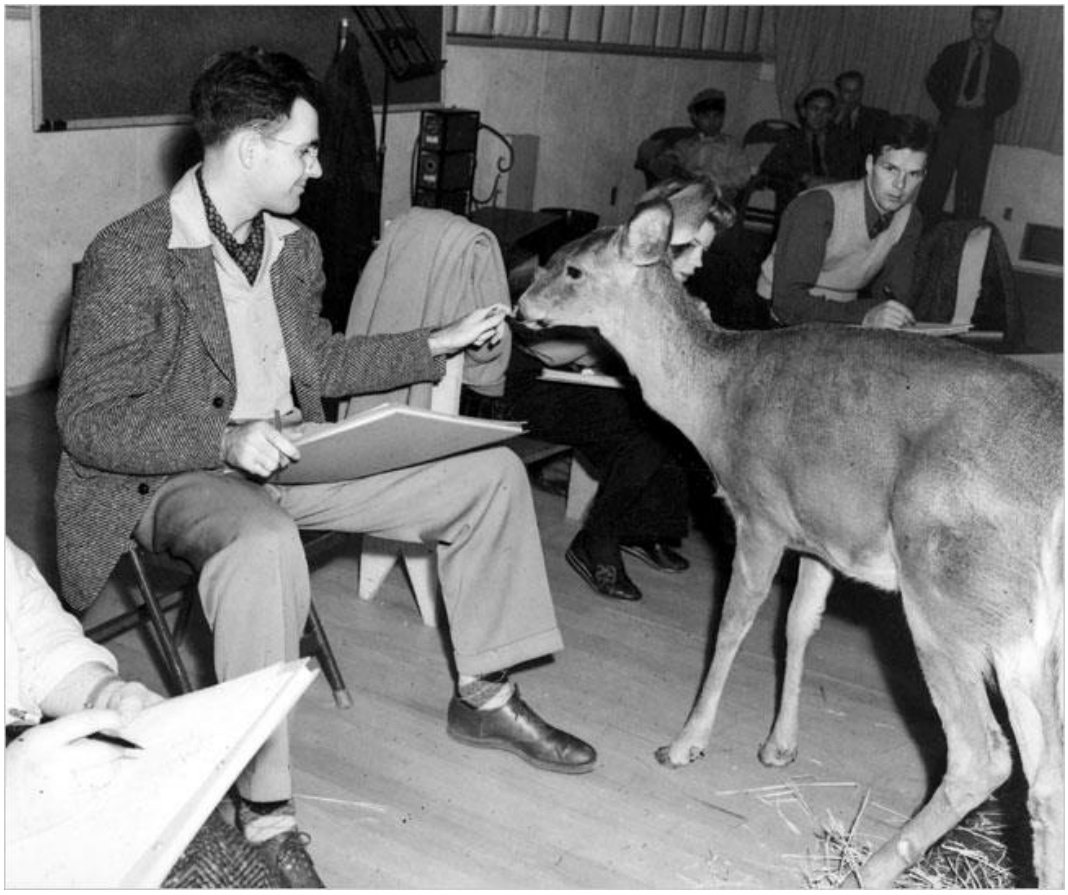

FIGURE 3. Frank Thomas studying a deer in preparation for *Bambi* (Disney Film Project 2010).

The pursuit of having believable visuals did not stop with the character animation. Filming the inked and painted cels on top of a static background worked well, but appeared flat to the eye. The development of the multiplane camera made it possible to layer the background attributes on top of each other on multiple different glass planes (Figure 4) which could then be moved and even rotated at varying speeds, giving the film a three-dimensional feel of depth. The most famous multiplane camera was created in 1937 by William Garity to produce *Snow White and the Seven Dwarfs* (1937) (Multiplane Educator Guide, 4, 8) but the credit for the first use of the technology belongs to animator Lotte Reiniger in the development of her cut-out animation feature, *The Adventures of Prince Achmed* (1926) (Schönfeld 2006, 175).

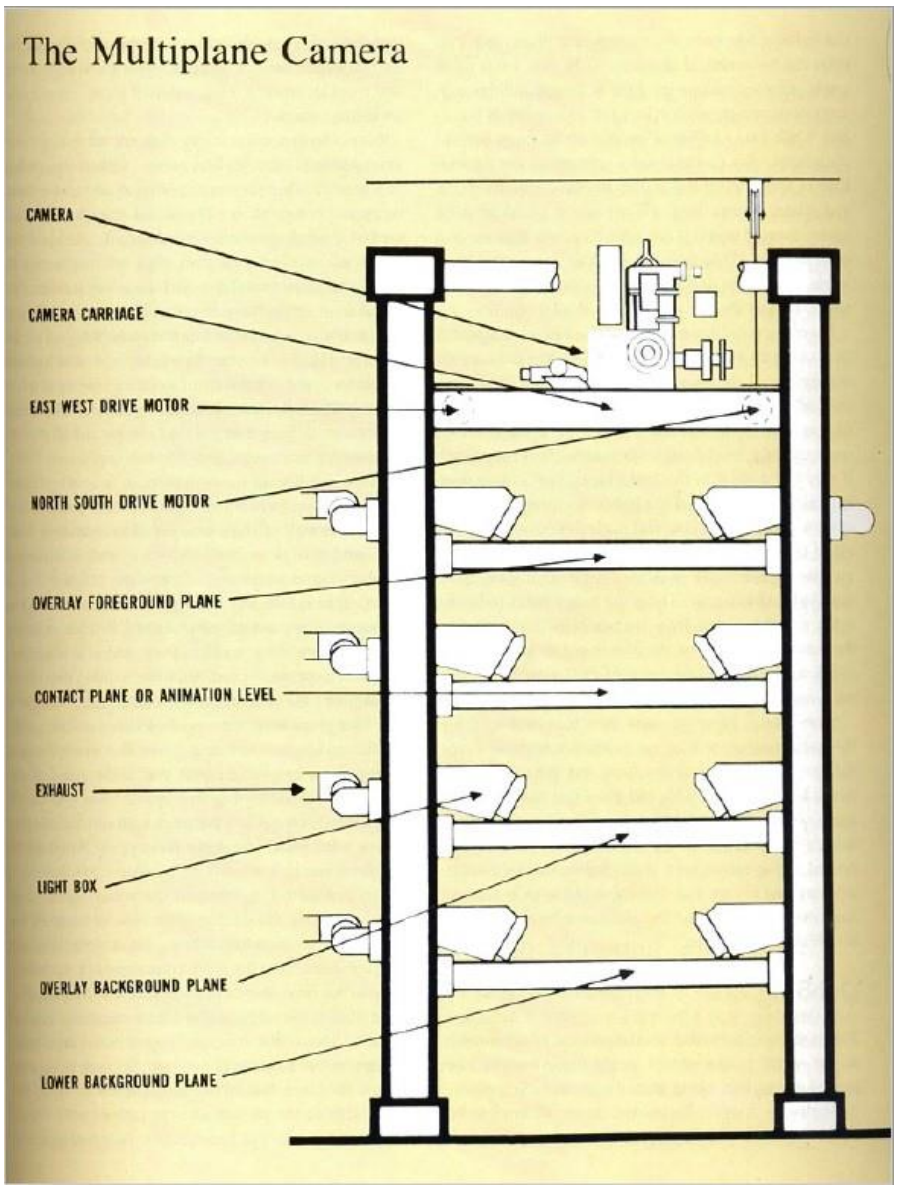

FIGURE 4. The Disney Multiplane Camera (Thomas & Johnston 1987, 312)

The intense growth of the Walt Disney Company from its birth to all through the 30's and 40's made it the optimal place for technological advancement, as artists, engineers and animators went about turning a grueling and difficult medium into a team effort of individuals, whose passion for animation matched that of Walt Disney's. Walt Disney gave the creative personnel incredible leeway to express themselves, even if it meant that a few hours here and there were dedicated solely for pranking the animator next door (Thomas & Johnston 1987, 147). This interaction and teamwork ethos set the foundation for the rules of animating, a theory of creating motion as determined by legendary animators who were constantly improving their art. They called them the 12 principles, and although they are not the focus of this thesis, they are considered a main guide to creating believable animation and are listed as follows; squash and stretch, anticipation, staging, straight

ahead action and pose to pose, follow through and overlapping action, slow in and slow out, arcs, secondary action, timing, exaggeration, solid drawing and appeal (Thomas & Johnston 1987, 49). Many animators had lists of their own, but it was this one that was passed down to new generations and is still in use when teaching aspiring animators how to animate.

Despite being the great giant of animation of our time, many of Walt Disney Company's most memorable animated films were financial failures, often breaking even at best (Byrdseed 2016). This made animated film a constant financial risk for the company, and led to many structural changes within the company itself. According to two of Disney's 9 old men, Disney's core animators and later directors now known as animator legends, Frank Thomas and Ollie Johnston (1987), it was the instating of order within the animation production line that ended the phenomenal growth in animation (156). Multiple supervisors and managers now stood between the animator and the original visionary Walt Disney, and for many animators it was the loss of being able to brainstorm ideas for a character's animation that turned the workroom from a place of bold exploration to that of safe animation (Thomas & Johnston 1987, 156 – 157.)

2.2.2 The Xerox Era and the Dark Era

The Xerox era, coinciding with what is known as the Dark Era of animation, refers to a period of economic uncertainty and strife for the animation industry between the late 1950's and early 1980's (TVTropes, The Dark Age of Animation).

After World War II the world was rife with economic problems, with especially the fall of the studio system in Hollywood drying up the Golden Age budgets and making productions much more selective (TVTropes, Fall of the Studio System). The inking department in animation productions was staffed by a multitude of women who despite their skill in film (as they did not only ink the work of the animators, but improved upon it for better flow) used most of their work hours tracing endless frames that, according to Frank Thomas and Ollie Johnston (1987), could still not achieve the vitality of the original drawings (282). There was a need to get the same feeling as before but with less cost and more efficiently.

Ub Iwerks, the man who had designed the Disney Multiplane Camera, adapted the Xerox process of photocopying for animation use, by the way of an electrically charged plate that copied drawings – but with very little delicacy. This forced the animators to revert back to the black strong line work of the 1920's, as the new technology offered no alternatives in terms of colour to bring the softness of the older films like *Bambi* (1942). In its first full feature use in *One Hundred and One Dalmatians* (1961), the animators used the strong black lines as the whole style of the picture. They were proud of the result, but many audiences and Walt Disney himself thought it lacked the elegance and care Disney was known for. It was not until the emergence of the CAPS system in the late 80's that the animators perfected a grey tone line for a softer effect, and just that little change made critics rave that they had invented a new style for the film. (Thomas & Johnston 1987, 282.)

FIGURE 5. *One Hundred and One Dalmatians* (1961) with Xerox technology, and *Bambi* (1942) with traditional coloured ink and paint.

The time between the late 50's to the 80's is often called the Dark Age of Animation; the focus moved from theatrical releases to television, budgets weaned and limited animation became the reigning style of motion – heavy with dialogue and light on character animation, limited animation was a technique that saved money and was in heavy use by television animation giants like UPA and Hanna-Barbera. Hanna-Barbera can be credited on inventing the technique, having stock cataloged reusable movements since the early 60's (Sito 2013, 219). The re-use of motion was not a technique limited to television, however, as familiar movements can be found across many of Disney's films of that era – though according to animators of that time, this was not to save money, but a habit of Disney legend Woolie Reitherman when he wanted to play it safe by re-using movement he already knew worked (MacQuarrie 2015).

The move to television with its lower quality animation and the subsequent 'Saturday morning cartoon' culture worsened the ruling image of animation as purely "children's entertainment" – a trope Disney had catered to with its family oriented content. The stereotype hit some animation studios hard as traditionalism and conservatism grew in the 50's and 60's and resulted in waves of content restrictions, that all but removed the drama and conflict out of animated media (TVTropes, The Dark Age of Animation). It was a time of great decline in the studios themselves, but paved the way for the popularization of animated television series.

2.2.3 Renaissance, the Birth of Digital Animation

CAPS (Computer Animation Production System) can be called the first digital ink-and-paint system used in a major studio – but to just describe it as merely an ink-and-paint system would be understating its impact. Created at NYIT (New York Institute of Technology) in the 70's (Whitehead 2004, 132 – 133) and further developed for use in 1987 by Disney and Pixar engineers (Robertson 1994), CAPS digitalized the tedious traditional animation process and in doing so replaced the need for traditional inking and painting and the multiplane camera: the system enabled the artists to use an unlimited palette capable of colouring enclosed areas with just one click, with possibility to instantly undo slight changes if deemed mistakes. The exposure sheet became digital, with instructions on layer compositing and special effects. While all frames were still scanned (in resolutions the scene demanded), the film could essentially now be built entirely digitally. (Robertson 1994.)

CAPS had its first full feature use on one of the final scenes of Disney's *Little Mermaid* (1989), and went on to replace its traditional counterparts entirely for the very next film, 1990's *the Rescuers Down Under*. Disney could now recreate, and possibly even improve the visual style Disney was known for before the switch to Xerox in the 1960's made many of their developed techniques impossible to do – namely, the coloured line work and airbrush. (Robertson 2004.)

It was also in the eve of the Renaissance of animation that Disney adopted the use of Wacom pen technology into their production, for the first time in *the Beauty and the Beast* (1991) (Wacom Investors Report). The film was also a significant leap in that it was the first time a Disney feature used digital animation, combining digitally animated 3D graphics with their traditional character animation to create the boisterous sweeping camera motion in the famous ballroom sequence (Chong 2007, 87.) Previously, Disney animators had used rotoscoping for particularly difficult human movement and items (Disney Avenue 2014).

FIGURE 6. The CG rendered Ballroom for the traditionally animated dancing scene in *Beauty and the Beast* (1991).

Disney continued to develop the CAPS system throughout the 90's, producing a multitude of successful animated films with their new technology. The decade also marked the entry of adult oriented cartoons to the western market, ushered in by series like Matt Groening's *The Simpsons* and MTV content like Mike Judge's *Beavis and Butthead*, and the popularization of Japanese animation. The industry looked for ways to ease the expense of hand drawn animation and found a solution in outsourcing some of the work to Japan and later South Korea – a practice still in use today by television animation giants like Cartoon Network (Levin 2015).

2.2.4 Computer Generated Imagery

CGI, or Computer Generated Imagery, is arguably the ruling animation method in today's animated full feature film industry in the form of 3D animation. It had its beginnings in special effects, but branched out in 1984 when John Lasseter left Disney and joined Lucasfilms (Whitehead 2004, 126). It was there that he went on to create *the Adventures of André and Wally B* (1984), which employed innovative techniques that opened the film

industry's eyes to the possibilities of computer generated animation (Wikipedia, Adventures of André…). Two years later, the CGI department of the company in charge of Lucasfilms' special effects, Industrial Light & Magic, split from the company to form the animation powerhouse Pixar (*Toy Story*, *Finding Nemo*) (Whitehead 2004, 136 – 137).

The nature of 3D animation, like stop-motion, has the benefit of not having to rebuild the object repeatedly to make it move. Instead the model already exists, and can be manipulated near infinitely to fit the motion's purpose. As the medium operates in the 3rd dimension, it is significantly easier to build full sets and environments that can be used for multiple shots and perspectives, without a need to create a variety of separate backgrounds for a scene. The medium is constantly pushing the art of animation to new levels of the believability that Walt Disney strived for, with capabilities to accurately depict realistic lighting and effects; immersing the viewer into a world built entirely digitally. Lasseter stunned his fellow CGI artists with his 1986 animated short *Luxo Jr*., which had a quality of animation unprecedented in the world of CG – in reality, Lasseter had not invented anything new, but applied his knowledge of the 12 principles of traditional animation into digital medium (Chong 2007, 73.)

According to Tom Sito in his book, Moving Innovation (2013), the world of traditional animation was initially sceptical about the use of computers in animation, as it seemed a wasteful to spend money on new technology to create what they had already been creating with pencil – as such, computers were first adopted rather into the administrative side of things rather than in creation (222-223). Although Disney began to integrate 3D into its films quite early on, it was still relatively slow to catch on to the 3D animation boom that resulted from Pixar's smash hit *Toy Story* (1995) – an event that could be perceived to be the start of the decline of hand drawn cinema, and the subsequent birth of 3D animated film.

In the last decade, 3D software has also opened the possibilities for amateur animators wanting to learn by themselves, with free software like Blender available for anyone to download, and the possibility to share and download ready built 3D characters and rigs – this is especially helpful, as character modelling, rigging (building the inner skeleton manipulated in animation) and animation are typically separate jobs within 3D animation studios (Sito 2013, 268.)

2.2.5 Japanese Animation, Anime

Japanese animation developed very much alongside western animation, but is widely considered a genre of its own in the west due to its significantly different styles and themes. The term anime (an abbreviation of the Japanese pronunciation of "animation") refers to all forms of animation in Japan, but only animation produced in Japan for the western world.

Anime caters to many different age groups, and as such is not affected by the often times stifling image of animation as "children's content". In fact, the anime itself may be labelled by its target demographic, featuring themes and tropes popular within that specific group – a good example of this is "shoujo" (girls') anime, which heavily features more romance oriented plots. According to Napier (2001), anime has the variety the west is used to seeing in live-action cinema – it deals with romance, comedy, tragedy, adventure, even psychologically intense themes which are rarely seen in popular western animation (7).

Heavily influenced by the dawn of Disney in the west, the style of Japanese animation can be credited to post-WW2 cartoonist Osamu Tezuka, who saw the expressiveness of the pre-war Disney characters and adapted them into his own work. This eventually led to the very distinct yet varied look of Japanese animation (O'Connell 1999). However, it would be a mistake to attribute much of anime's growth to its early western influences, as the culture exists as it's separate entity even today when the internet has bridged the gaps between societies. Many of the same elements remain – the use of limited animation specifically. But anime compensated the limited motion with extremely complex visual styles and storylines that can often be challenging for the westerners who have grown up with a comparatively restrictive environment.

Curiously, Japan is also possibly the last bastion of traditionally animated media – it still produces a mass amount of paper and pencil animated content with computerised work flow. It is difficult to deduce just why the method remains popular in Japan despite its decline in the rest of the world, but it can be somewhat explained by the structure of the industry itself. Japan is home to over 430 production studios, with the majority of the profit coming in from DVD sales (Brenner 2007, 16) – it is considered Japan's main export since the 90's, with studios producing around fifty new animation series and

OVA's (Original Video Animation, released without a theatrical release or television broadcast) per year (Napier 2001, 7). A vast majority of this animated content is based on popular light novels and the Japanese form of comics, manga – this popularity then crosses over to television anime, which in turn results in spin-off films (Ashcraft 2015). To the western eye, the Japanese industry may seem brave due to the varied content of the anime produced, but in terms of revenue it is very much based on already established popularity.

The Japanese animation industry runs on much less money than its western counterpart – in 2002, the amount of invested money in the western animation industry would typically be between 10 to 20 times more than in Japan per film (Leach 2002). This results in a more generalist approach to animation, where an employee is often expected to work in many facets of the production, which is a stark contrast to the split production structure pioneered by Walt Disney. In an interview by Andrew Osmond (2013), animator Aya Suzuki remembers Japanese animation director Satoshi Kon's explanation of the Japanese industry's way of working: "He said the industry was like a bunch of people trying to form a circle. The way the European and American industries work is that they put a lot of people together, shoulder by shoulder, and if there's a space, then they'll put another person in that gap. In Japan, what everyone has to do is reach out their hands and join them, because they don't have any more people."

The lower budgets also result in infamously bad working conditions, animators often being paid well below the minimum wage and worked until exhaustion, often resulting in illness and hospitalization. (Meth 2015.)

Despite its clear problems, the influence of the Japanese animation industry on its western counterpart in the age of the internet cannot be underestimated – the popularization of anime is a clear factor in the slow fade of the stigma on western animation, and as a result, a benefit to the survival of hand drawn animation.

3 INTERACTIVE DRAWING DISPLAY

Graphics tablets and interactive drawing displays are computer input devices, that allow the user to draw with a pen-like stylus to a surface that directly transmits it onto the graphics software of the user's choice – they imitate traditional approaches to drawing, and with the full range of digital art technology available, enable the artist almost unlimited control and editing possibilities over their art.

3.1 A Brief History

The tablet with graphics properties, the Telautograph, was invented in 1888 by Elisha Gray. It enabled written communication over long distances using recorded electrical impulses that transmitted to the receiving telautograph, which had an attached pen that copied the writing it received. It was primarily used by banks and doctors for sending signatures over long distances. In 1957, Tom L. Dimond created the Stylator, which input directly onto a computer and as such, became the first graphics tablet to resemble the ones in use now. (Rose Harbert 2014)

The RAND tablet in 1963 was similar to the Stylator, but became much more popular due to its relatively low price. Its surface area was 10"x10", and would accurately record anything written by a pen or stylus within its grid. In 1975 Summagraphics Corps produced the Bitpad, the digitizer tablet that popularised graphics tablets for commercial use – later reworked as a OEM (Original Equipment Manufacturer) version to be sold by Apple, as the Apple Graphics Tablet (Figure 7), that was intended as the accessory to the Apple II computer 6 years before the Apple Mouse was invented. (Rose Harbert 2014)

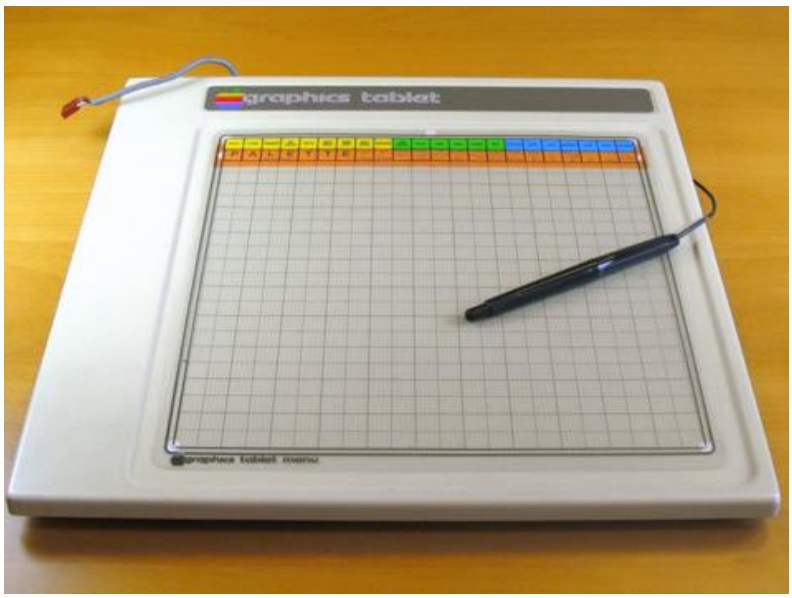

FIGURE 7. The Apple Graphics Tablet made in 1979 (Raymond 2011).

The first ‘true’ graphics tablet is considered to be the KoalaPad, invented by Dr. David Thornburg for Koala Industries and released in 1984 for 8-bit home computers. It came equipped with two extra programmable buttons and a pressure-sensitive stylus, though the screen could also detect pressure from fingers making it the first touch tablet (Koalapad: The Mother of Them All 2011). The screen also featured a transparent sheet- which enabled the user to enclose a drawing to trace from, and its own simple bitmaps graphics editor for creating pixel art. Although it was originally designed for the Apple II computer, it soon became available for near all home computers with graphic support at the time. Eventually other companies like Atari produced competing tablets. (Wikipedia, Koalapad).

Over the last decade a Japanese company, Wacom, has near monopolized the market with affordable and highly sensitive graphics tablets, and its products are preferred by digital art industry professionals all over the world. Wacom technology first emerged in the screen of the Compaq Concerto Computer in 1992, making it one of the first tablet computers (Wikipedia, Wacom). Wacom originally held many of the key intellectual property patents for graphics tablet properties (Wacom co., Ltd. Patents), forcing other companies to either license Wacom’s patents or use other technologies – a notable one of these is the Wacom stylus pen, which is active on both ends (the pen tip and an eraser at the end) and wireless without needing to ever be charged. This is a key factor in its near unchallenged rule over the market, suspecting to own 88% of the global pen tablet market share in 2015

(Wacom Investor Report 2016). In many ways going unchallenged for this long has enabled Wacom to sell their most high-end products for steep prices, the cost of a Cintiq ranging from under a 1000 to beyond 2000 dollars.

Many of Wacom's key patents for tablet technology expired in 2011, resulting in a sudden influx of more competitively priced graphics tablets and displays (TabletPCReview: Wacom Competition 2013). However, many of these competitive devices, produced by companies such as Huion and Microsoft, do not possess the reputation in digital art devices that Wacom maintains and as such fly under the radar despite having improved their technology to possibly even match the quality of the often doubly priced Wacom equivalent. Wacom products are also known for being extremely durable for digital devices, and it is not uncommon for a customer to be using the same tablet for years without any real need to upgrade (SweetMonia 2016).

3.1.1 Graphics Tablets

Graphics tablets are the most affordable and the most common digital art machinery available, with prices ranging from around 50 to a few hundred dollars with varying quality, size and sensitivity. Graphics tablets do not have an embedded LCD screen, forcing the artist to look at their computer monitor when drawing instead of being able to see the nib of their pen. This disparity from the traditional ways of drawing can make it harder for some artists to get used to drawing tablets as the accuracy may suffer (Utti 2016).

Graphics tablets (most notably, Wacom tablets) boast a high pressure sensitivity of up to 2048 levels, enabling the artist to see a corresponding effect on their line weight and density when changing the pressure of their stroke. Graphics tablets come with a compatible stylus, usually shaped like a pen or a pencil for a more natural feel in drawing. Many professional level graphics tablets also feature a touch sensitivity feature which makes finger gestures possible despite the lack of embedded screen. (Wacom, Intuos Art.)

Graphics tablet technology can be perceived as less than ideal when working with line art heavy artwork like animation and clean illustration, where the accuracy of a drawn line is very important – having a drawing not come out as you intended has the same effect as animating without knowing how to draw. However, there are solutions around this, such

as built in line stabilization features in digital drawing software and plug-ins like Lazy Nezumi, which work within the preferred drawing program and offer multiple options for smoothing out any quivering lines that might come with digital drawing, especially when working without an embedded screen (Lazy Nezumi 2016).

Before moving on to my Cintiq 13HD, I did all my digital art (and to a much lesser extent, animating) on a Wacom Intuos 4. For me the only reason the Intuos could not meet my requirements was the lack of screen technology. Having learned how to draw with pencil and paper, and still very much preferring that, graphics tablets felt like drawing by remote control and I often found my art to suffer because of it.

3.1.2 Drawing Displays

Drawing Displays are a step up from the standard graphics tablet in that they have an embedded screen with equal or higher pressure sensitivity as their graphics tablet counterparts. They also predominantly work using a stylus pen, but more recent models have also implemented touch recognition – a technology already widely in use in smartphones and more importantly computer tablets like the Apple iPad. With this technology, the user no longer needs to use hotkeys and a computer mouse or a stylus to move and zoom around the canvas when working with digital art, but can simply use finger gestures. Most displays come with buttons on the side of the device for ease of use – however computer accessories like the mouse and the keyboard are still preferred by many.

All three of the top names in artist displays – Wacom, Microsoft and Apple – sell their products as being limitless, intuitive and above all else, imitations of traditional approaches (Wacom Cintiq 2016, Microsoft SurfacePro 4 2016, Apple Pencil 2016). They are drawing artists' tools in that they cater to that specific market with their products more than other professionals, boasting incredibly responsive and sensitive pen technology (no lag, more realistic), true colours, and ease of use. Therefore, it is safe to assume that interactive drawing display technology tries to mimic or is at least inspired by traditional media, and tries to offer a similar drawing experience but within a digital ('limitless') environment.

The newest trend in drawing display technology is the portability factor: older versions of drawing displays, namely Wacom Cintiqs, have been essentially extensions of the computer, connected through a USB and a HDMI cable to work as a second monitor, but one that you can draw on. This enables the user to get the full power of the computer when running often heavy graphics programs, as the display itself is more of an accessory than a computer itself.

Wacom first released their pen displays in 2007 with earlier models 12WX and 20WSX (Chie 2014), having expanded their Cintiq range since then. Ever since Wacom's expired patents allowed for competition to finally arise, however, computer companies like Apple and Microsoft have begun to improve on their already interactive computer tablets to include a higher sensitivity and a stylus, transforming their portable tablet computers into

what could be described as digital sketchbooks. Wacom also offers portable options with the Cintiq Companion series that run either Android or Windows 8 as their operating systems (Wikipedia, Wacom). The portable computer tablet pen display lets the artist work from anywhere at any time without a need to plug the tablet into a computer, but cannot yet offer the sort of power and memory a dedicated computer could – this may be a deal breaker for some, as industry software like Adobe Photoshop and AfterEffects can often require a lot of computer memory to run. As such, portability is a feature that's importance depends completely on the user's needs.

3.2 Comparison

The ease of use in a drawing display in animation comes down to how well the drawings can be executed onto an application through the screen and the availability of applications in the operating system. By this time a vast amount of aspiring animators are already used to digital drawing, be it on drawing tablets without an interactive screen or not, so the intuitiveness of drawing on a screen rather than on paper may not be as important as it is for more senior animators with a more extensive background in traditional animation – however, many of us, myself included, do far prefer the feeling of a pencil on paper and as such it factors in to which technology we lean towards when creating our art.

Portability is a relatively new requirement for digital drawing technology, as the human of today is always on the go. The question with that seems to be whether the portable machinery can handle the heft of many of the applications of today, especially in animation where we are not working on just one drawing or frame, but hundreds at a time. The comparison is much like that between a laptop and a desktop computer: high functionality and capacity comes in much heavier and clunky packages than its all-around lighter counterpart. For a fair comparison, all three of the drawing display types are a portable version.

	Weight	OS	Applications	Stylus	Price	Screen
Wacom Cintiq Companion (4.5h battery life)	1700g	Windows 8.1	All Windows compatible Mac when attached	2048 pen pressure levels No charging Eraser Buttons	1399 - 1599€	13.3” 2560 x 1440 resolution
Microsoft Surface Pro 4 (9h battery life)	766g	Windows 10	All windows compatible	1024 pen pressure levels Requires charging	1029 - 2099€	12.3” 2736 x 1824 resolution
Apple iPad & iPencil (10h battery life)	713g	iOs	Mac compatible	Undisclosed Requires charging (12h battery life)	919 – 1289€ + Pencil 109€	9.7” 2048 x 1536 12.9” 2732 x 2048

FIGURE 8. Comparison between the Wacom Cintiq Companion 2 (Cintiq Companion 2 2016), Microsoft Surface Pro 4 (Rigg 2015, Microsoft Store) and Apple iPad Pro/Apple iPencil (Apple iPencil 2016, iPad Pro 2016).

For me personally, the capabilities of the machinery matter far beyond any portability, as it is unlikely that any large animation project would be done in transit. It seems to me that portability has the benefit of a digital sketchbook to jot down ideas and designs rather than producing content from start to finish, especially animated content. Even the Wacom Cintiq Companion 2, with the combination of having an operating system compatible with most drawing and animation programs and smooth stylus interaction, only has the battery life of up to 4 and a half hours (Wacom, Cintiq Companion 2). Microsoft’s Surface Pro 4 offers the windows operating system too, but lacks in pressure sensitivity and is more prone to lag – for portability the iPad surpasses both of its competitors, the lightest

in weight comparatively to its quality (Nugent 2015). The selection of applications is limited when working without being connected to a laptop, as many of the programs supported by Windows systems or Macbooks are not adapted for the iPad. Utti (2016) notes that the iPad lacks in applications, and even some of the available ones are difficult to work on due to lag.

According to Nugent (2015), the Wacom Cintiq Companion 2 has the most traditionally textured screen of the three, almost imitation traditional drawing – it handles software well and has the best stylus interaction of the three, but is prone to heating up quickly and as such will potentially be quite noisy due to the fans on the side of it trying to cool it down. It is also the heaviest of the three (Figure 8).

The requirements of the device very much depend on the need of user, and as the technology continues to develop, it is likely that the decision between the competing drawing displays will be based on the necessities of the individual's workflow – not on any perceived faults of the machinery itself.

4 THE HAND DRAWN ANIMATION INDUSTRY

The best understanding of the place hand drawn animation has in today's industry can only be achieved by interviewing the people who produce the content. Therefore, for the creation of this thesis I interviewed two animators from opposite ends of the technological spectrum: one working entirely in digitally hand drawn 2D animation, the other persisting with traditionally animated content. The interviews were conducted via e-mail in the Fall of 2016.

4.1 Interviewees

Joonas Utti is the creative director, owner and co-founder of Gigglebug Entertainment (of tablet game and television series fame), and the owner and co-founder of animation studio Anima Boutique in Helsinki, Finland. Utti has extensive knowledge of hand drawn digital animation; his work is predominantly done with interactive drawing displays, from a Cintiq 22HD to Apple iPad Pro, and digital software ranging from TVPaint to the Adobe Suite: however, he started with pencil and paper.

Elroy Simmons is on the traditional side of the industry: he is a freelance animator, director, storyboard artist and a teacher of 2D animation principles at a university in England. He has over 20 years of experience working in traditional hand drawn animation, and was the lead animator and director for two projects I assisted on in the past year. He relies mostly on a more traditional workflow, animating almost entirely with pencil and paper, with the colouring and compositing computerized with the help of Adobe Photoshop and After Effects. He does, however, have some professional experience with interactive drawing displays and TVPaint, and as such is an ideal candidate to present a view from both perspectives of the hand drawn animation industry.

4.2 Drawing Displays in the Industry

As the 2D animation industry becomes increasingly more digitalised, it only makes sense that animators – especially those with a love of traditional animation – would seek out

the easiest transition to adapt their workflow to the new technologically advanced world. This is where interactive drawing displays come in.

For Utti (2016), the Cintiq is imperative for the frame-by-frame workflow of his studio: “It gives a natural feel of drawing when drawing on the screen when compared to a Wacom tablet, where you do not have the tip of stylus where you draw”. This feeling is shared by other animators, notably by ex-Disney animator Aaron Blaise who remarks that it is “the closes to feeling as if I’m working traditionally because I’m able to draw right on the screen” (Orin 2014).

When Disney decided to try 2D animation again with The Princess and the Frog in 2009, they wanted to replace the outdated CAPS system which by that time had not seen use for 5 years – a relatively long time in today’s technological growth. The production attempted a digital approach, testing a combination of Toon Boom Harmony and Wacom Cintiq as workflow for a short cartoon called How to Hook Up Your Home Theater (Desowitz 2007) – however, the character animators found the method hard to get used to, and so the production returned straight back to pencil, paper and scanning (Robertson 2010).

So, what are the key issues for the new digital workflow when attempting to cater to perhaps an infamously stubborn and sensitive group of artists when it comes to medium? According to both Simmons and Utti, the smoothness of the screen itself lacks the texture of traditional media, with Simmons likening it to “skating”: “I missed the 'friction' of pencil against paper - but was working with paper in the evening/mornings/weekends when not at the studio. I missed paper 'full stop', actually.”

This statement is corroborated by animators Ian Harrowell and Patrick Smith in a survey done by animation webzine Flip! (2009), both mentioning the loss of the friction of paper being a distracting factor, with the first of the two using an acetate protective film on the screen to protect it and give it a quality more like traditional paper.

Similarly, the absence of paper can also be alleviated on the Wacom Cintiq by buying alternative pen nibs to the default hard plastic nibs the Cintiq comes with, for example the more fibrous “felt tip” nibs by the same company – other more psychological needs

can often be met in the animation programs themselves, with software like TVPaint offering built-in paper textures that can help simulate the look of drawing traditionally. (Nethery 2012.)

Of course, the Cintiq itself is only a portion of the task when moving from traditional workflow to digital – it is also a case of having to learn one or more animation software that may be difficult to grasp when coming from traditional processes. Simmons (2016) notes that the instant playback of the footage creates an urge to animate in singles – the standard is to animate in twos (meaning that each of the frames has the exposure of two frames) which alleviates some of the workload from the workers assigning colour to the frames.

"The accuracy of the display and stylus pressure is already as good as needed for tradigital (a mixture of traditional and digital methods) 2D animation," says Utti, but continues to note, "In an artistic point of view, it sort of relies too much on the software and digital colour spaces." Simmons also comments from the intuitive standpoint, "I'll always think timelines being on screen perpetually disrupt your intuition," he says, "but that's likely my age or experience drawing on paper."

From an industry standpoint, Simmons expresses worry that the fast turn-over rate of technology is a means to effectively eradicate one vintage and replace it with another: "From around 2000, the private cost of computer purchase and their use to animate replaced traditional means at great speed, leaving a lot of animators with a lot of experience unemployed, and brought in new animators who were largely separated by those previous animators by technology – and its removal." This certainly happened in Hollywood, after the box office failure of Disney's Home on the Range (2004), which caused Disney to effectively scrap the entire hand-drawn department as it felt that the audience's tastes had changed – however, three years later, many of the animators left unemployed by that decisions were brought back to work on the Princess and the Frog (2009) as their expertise in hand-drawn animation was key in the creation of the film (Adams 2010).

"I think a lot of newer means to animate make traditional animation production look unwieldy, costly and slow - but allow the again 'convenient' and unfair impression that time spent working digitally is 'cheap' - because it is time or labour saving. Or that traditional

work is 'cheap', because it 'doesn't even use new technology' – when it invariably does." (Simmons 2016.)

Utti is more optimistic: "I think [the Cintiq] is an easy entry for traditional artists – it's still a very different tool and so it should be. It is natural and comfortable as it is, but it won't replace traditional media altogether."

5 SAMPLE ANIMATIONS

No matter what the medium is, the workflow for hand drawn animation remains more or less the same. Any hand drawn animation should be started with a strong roughing stage to establish a strong sense of movement, even if we were to tone it down for consistency. Only after establishing the strongest poses, or the lay outs – in this case, taking the place of a full-blown storyboard – can I move on to animating and timing.

5.1 Traditional

For my traditional animation, I will use the techniques used in the two animation projects I assisted and animated for with Elroy Simmons. It is not fully traditional, in a sense – if anything, it is a further revamped version of the Disney CAPS system, where cels and painting is replaced by digital means of colouring, in this case Adobe Photoshop. The frames are drawn on paper with pencil, and scanned as is. As such it is reminiscent of the Xerox era, where the line art will remain black. This is a choice of efficiency rather than necessity, as most digital programs would allow me to recolour the scanned lines if I chose to – however, I decided to follow the workflow of the previous projects.

The animation is done with pencils, animation paper (which is slightly thinner and larger than normal copy paper), a peg bar and a lightbox.

5.1.1 Roughing

For this movement, I referenced a side-to-side step Ginger Rogers does as part of a dance routine with Fred Astaire in the film ‘Swing Time’. I put the clip’s Youtube link into online service Rowvid, which allows you to play videos in lower framerates or skip through the frames. Slowing the video to half its original rate, I lay out some gesture poses from the extremes of the movement. These will act as the guides for the action itself.

I feel much more comfortable drawing traditionally. The combination of the texture of the paper and the feeling of the pencil in my hand, with its long range for angles to draw

from – there is something intrinsically intuitive about it, which for me makes up for all the editing possibilities digital animation software offer in the roughing stage.

5.1.2 Animation

I started by sketching out a few rough gestures from the original clip I used as reference. I didn't want to fully copy the movement as I was looking for inspiration rather than a full reference, and the animation needed to loop.

With my layouts, I start drawing rough keyframes while rolling the paper between my fingers every now and then to check the movement (Figure 9). The numbering on them is not finalized until the timing is set and the inbetweens are drawn.

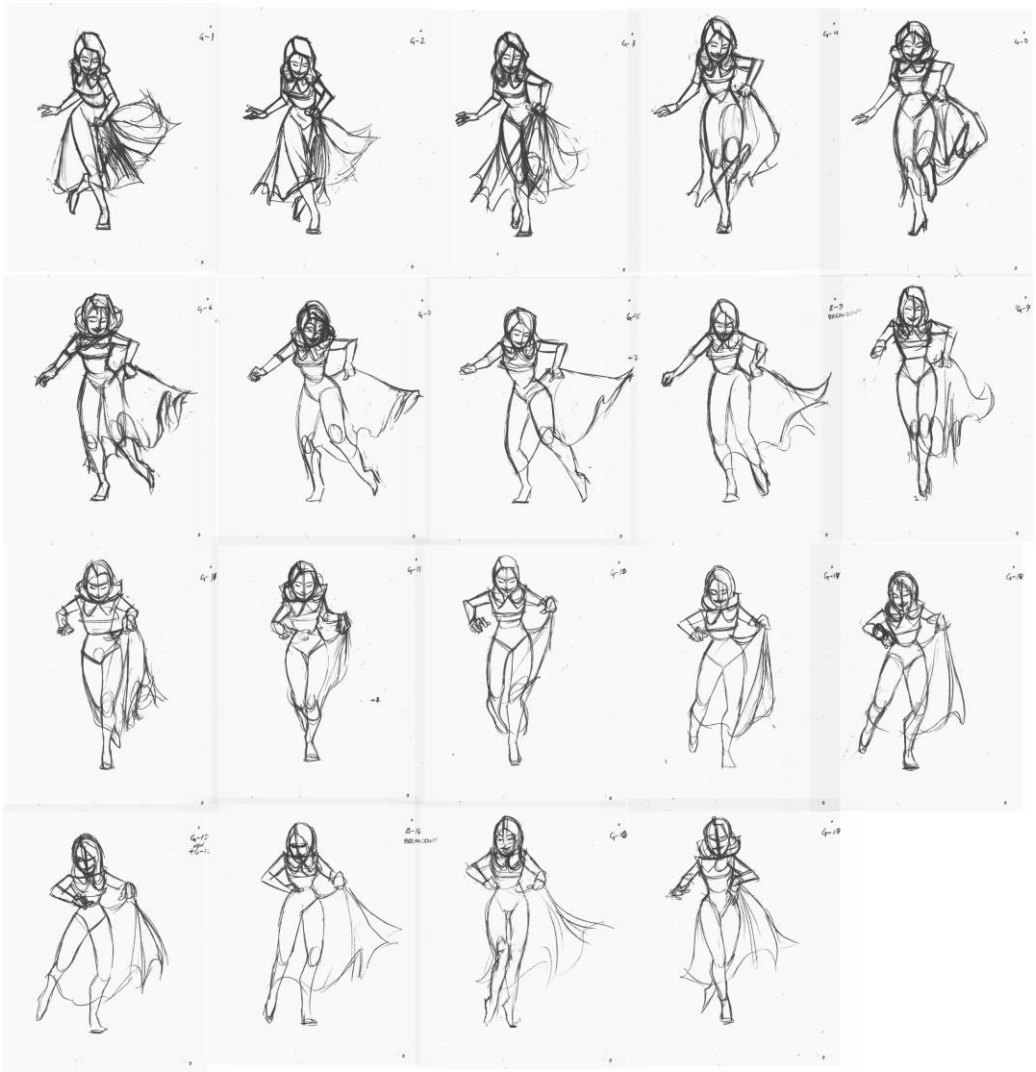

FIGURE 9. Rough keyframes without in-betweens (Linna 2016b).

The trouble with traditional animation, for me, is the extreme level of thinking involved when the line testing isn't instantaneous. With character animation, the amount of detail and limbs to control leaves you vulnerable to not seeing the small jitters and jolts you may have inadvertently animated – rolling the frames or flipping the entire stack in your hands is often not sufficient to see these little detail mistakes if you are not a veteran animator, as the actual motion of the paper moving can distract from the movement. This stresses the need for a good pencil test, which obviously was a major problem for me due to my lack of a scanner. As such, I had to take pictures of the drawings on my phone – a less than ideal solution due to the inconsistency of placement and lighting. (Linna 2016a).

I animated the keys straight ahead from layout to layout – I felt that this was the best way to maintain the fluidity of the movement, and the easiest way to express what I wanted to do with it. The problem with straight ahead animation is that it plays into one of my biggest weaknesses, which is the character shrinking towards the final frames.

At first I was sure I would have to add an inbetween frame between all the keyframes, but when I doubled the exposures of the frames in the pencil test I realized that this would needlessly slow down the movement – often, using inbetweens to 'cushion' movement rather than smooth it out results in more believable motion. As such, with my keyframes as close apart as they were, I ended up timing only 6 inbetweens altogether at separate points into the motions where she stretches her leg to the side, and two transitions.

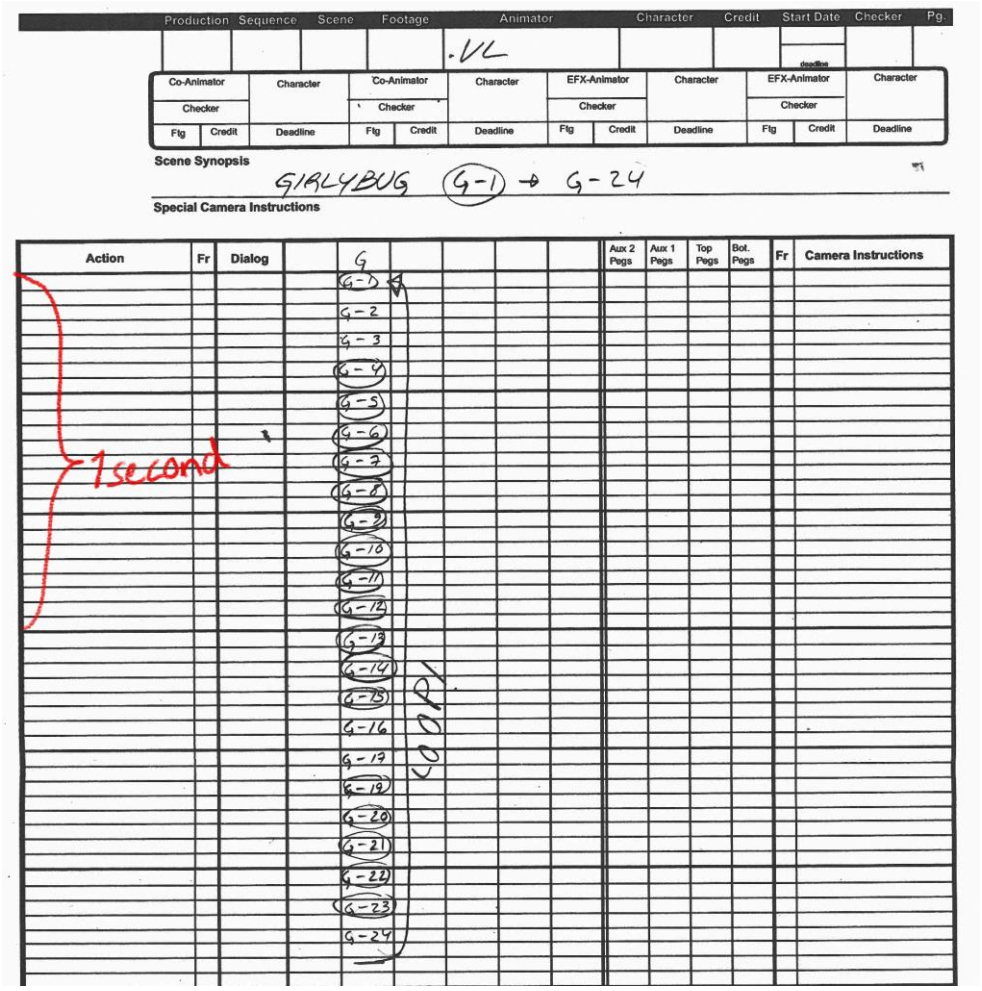

FIGURE 10. A traditional exposure sheet

After all in-betweens were done, I drew the dress – I didn't have the confidence to key the dress right at the beginning as I was sure I would not be able to make it loop without having the body's motions down first. In hindsight, drawing them when I drew the initial keys might have been better and forced me to think about the dress a bit more. However, with the lack of proper pencil testing tools, it was risk I wasn't willing to take.

The importance of good planning in animation cannot be underestimated; I found that having animated the complicated dress movement, any further inbetweening meant that the dress movement would be too slow, and the timing suffered as a result.

5.1.3 Post Production

With my frames cleaned up and tested, I handed all 24 of them over to my partner, who then scanned them with the A3 scanner available at his place of work. As a testament to his meticulousness, 23 of them came back expertly lined up – apart from frame G-24, which was inexplicably zoomed in. This was still fine by me, as the picture still featured the peg-holes in the paper that could easily be lined up with the others on a program like Adobe Photoshop, AfterEffects or any animation software with peg-recognition that automatically lines your scans up by the peg holes – however, in the old times it would have to have been scanned again.

It was time to construct another test before preparing the frames for colour. This pencil test was the one that revealed all those little jolts, jitters and timing errors previously hidden by flipping or messy line tests. Painfully aware of time constraints and the fact that fixing one frame would mean fixing the other 23, which would then have to be scanned and tested again, I had to submit to the idea that if anything, this animation would be a testament to how difficult and time consuming traditional animation can be. (Linna 2016c).

To prepare the frames, I decided to record actions in Photoshop to be performed across all the frames. By using batching, photo editing methods to separate the scanned line-art can be applied to many frames in a row, ensuring a consistency throughout as long as the pictures have the same dimensions.

Separating the line art from the white background was an easy enough task, but as I moved on to colouring I realized that despite adjusting the contrast of the scans to get the cleanest result, the scanner had picked up a lot of little jitters that ended up even in the separated lineart – as such, mere clicks with the paint bucket tool would not do this job. I would have to paint underneath the line art layer, freehand.

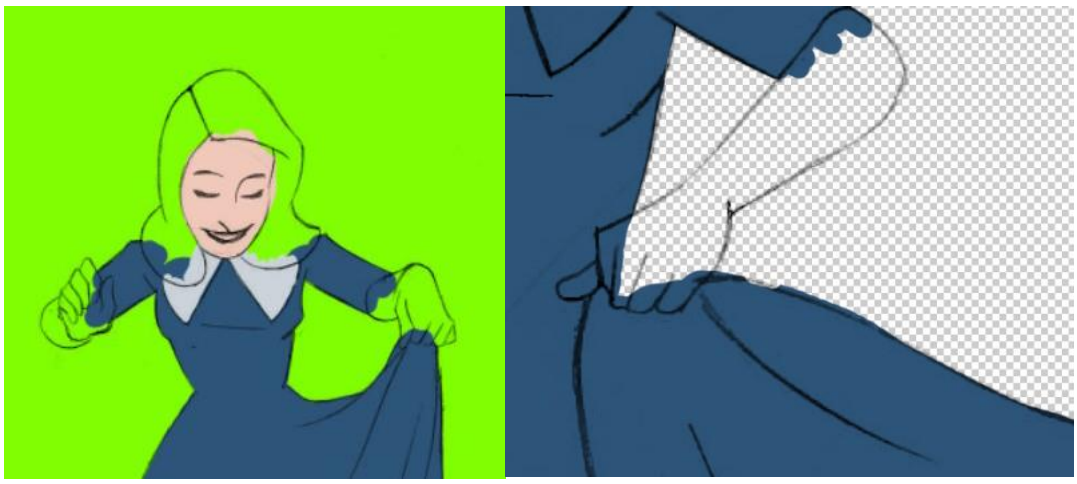

FIGURE 11. Colouring a frame in Photoshop and problems with transparency.

The best way to colour frames is to have a bright green layer underneath. It helps to detect any holes or gaps you might accidentally leave when painting freehand. A problem I found was the fact that the line layer itself is not at its full opacity mostly due to the texture of the pencil lines themselves, so when the colour in the colour layer overlaps it the line seems blacker than before – this may result in inconsistencies in the lineart.

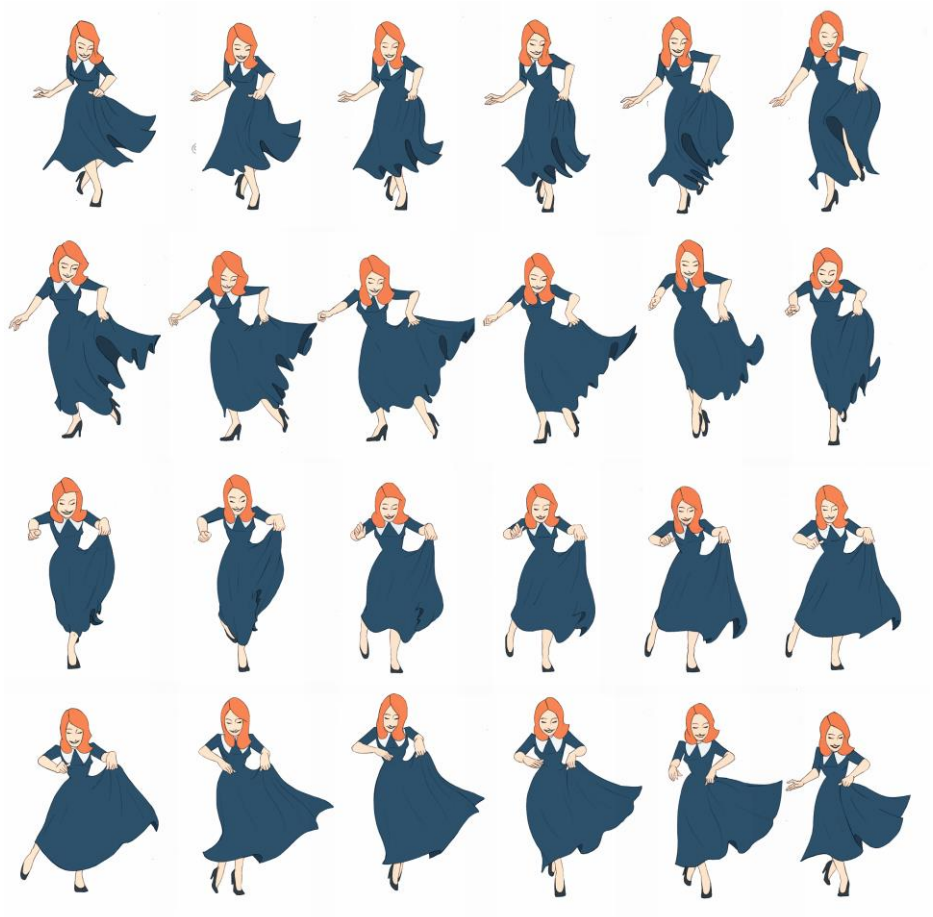

FIGURE 12. The final coloured frames.

After colouring the frames, I saved each of as PNG file to save the transparency of the background and composited them in their correct order in After Effects, allowing each frame 2 frames of exposure to achieve a standard 12 frames per second frame rate. By using the rendering software built into the software itself, I was able to export the animation into a video file (Linna 2016d).

5.2 Digital

One of the deciding factors when choosing between digital animation software for me is whether or not the program offers bitmap graphics. Bitmap graphics are dependent on resolution – meaning there is a risk that they blur or distort when resized beyond the resolution they were drawn in – but excel in producing high-quality grain or spatter patterns (TVPaintWiki 2010). Textures can serve to create drawings that look as if they had been done on pencil, which can lend itself to a slightly more intuitive experience for a traditional artist. Vector based graphics on other hand are resolution-independent and highly editable as each stroke is its separate element, but are limited in more textured patterns, and as such the result doesn't always look as hand drawn as its bitmap counterpart.

For this reason, I have favoured bitmap animation software like TVPaint to create most of my animations – however, for this demo animation I have decided to use a more powerful vector animation program, Toon Boom Harmony, to demonstrate the full power of digital animation while attempting to still maintain a traditional feel.

As my drawing tool, I am using my Wacom Cintiq 13HD, Wacom's smaller drawing display type, retailing at 1000 euros in 2014 when I bought mine – in 2016, the price has gone down to around 500-700 euros.

5.2.1 Roughs

This time my reference was Cab Calloway dancing in the beginning of the Fleischer Brothers' Betty Boop film 'Minnie the Moocher' (1932). Cab Calloway's dancing also appears rotoscoped to a ghost walrus character in the actual animation, but his slow walk intrigued me in the live action beginning of the short – it would be the basis for a faster jig on a character of my own. Same as how I begun with the traditional piece, I laid out key poses as guides from the movement (Figure 13). Animation software comes with its own timeline, where in frames can be added by either assigned hotkeys on the keyboard, by dragging motion, or by simply beginning to draw on an empty slot in the timeline.

After I had drawn the frames into the timeline, the pose test could be played back instantly.

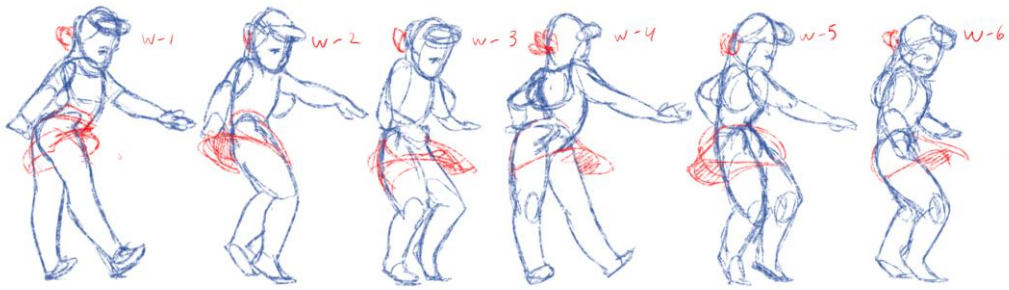

FIGURE 13. Rough keyframes (Linna 2016e).

Drawing on the Cintiq surface is admittedly a wildly different experience from drawing onto paper with a pencil. The relatively smooth surface offers none of the friction I am used to when drawing with a pencil, which I find to hurt the accuracy of my lines despite the effectiveness of the pressure sensitivity. Both bitmap and vector graphics offer stabilization to correct the jitters this can result in, but they do very little to intuitively interpret the original lines in my opinion. It's a case of familiarity and practice, but does affect the overall animating experience. Pressure and tilt sensitivity does help to make the process of drawing (and especially animating) more intuitive, but it does not compare to the efficiency of a simple pencil.

5.2.2 Animation

Animation software usually come with a built-in exposure sheet, which in Toon Boom Harmony is updated real time as frames are added and drawn. As testing is instantaneous, it is easy to just extend the exposure of a frame over multiple frames to test out the flow of the movement before finally deciding on the timing (Figure 14).

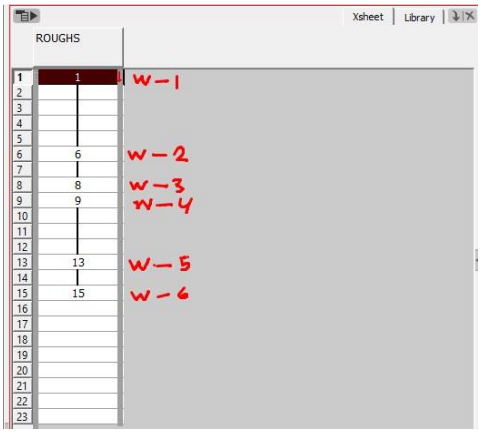

FIGURE 14. Doping the layout drawings in the Toon Boom X-sheet.

After deciding on the timing, I drew out the rough in-betweens and breakdowns (Figure 16). I wanted a fair amount of twist in her hips as she hit her most extreme poses. One of the staples of drawn animation is of course the use of the lightbox, or the digital equivalent of onionskins (Figure 15). Onionskins tend to be highly editable in animation software, letting the animator determine the number of frames displayed and the colours they appear in. In traditional animation, the strength of the light of the lightbox and the thickness of the paper influences the clarity of the lines underneath the paper being drawn on. This is not a problem in digital.

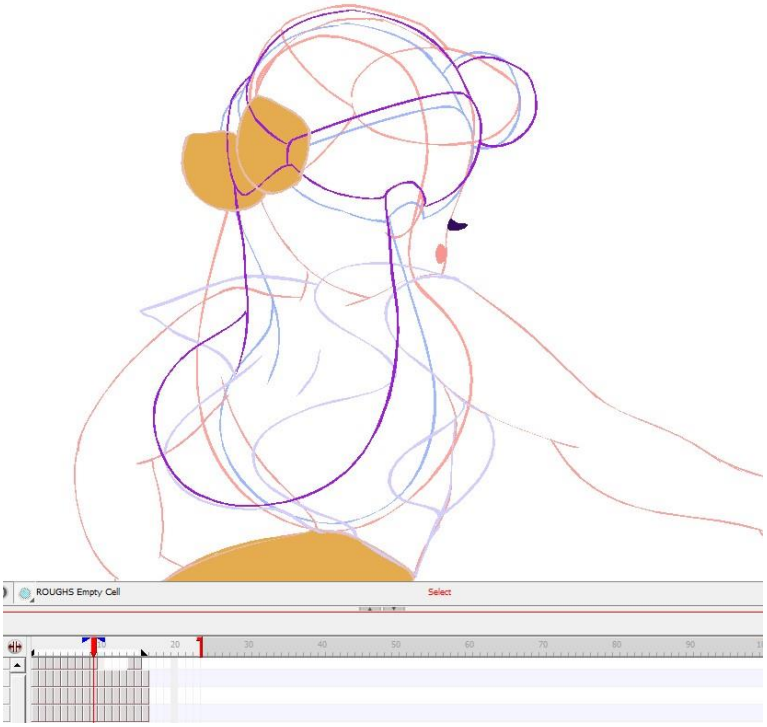

FIGURE 15. The Onionskin displaying the frame behind and in front of the selected frame, coloured blue and orange respectively.

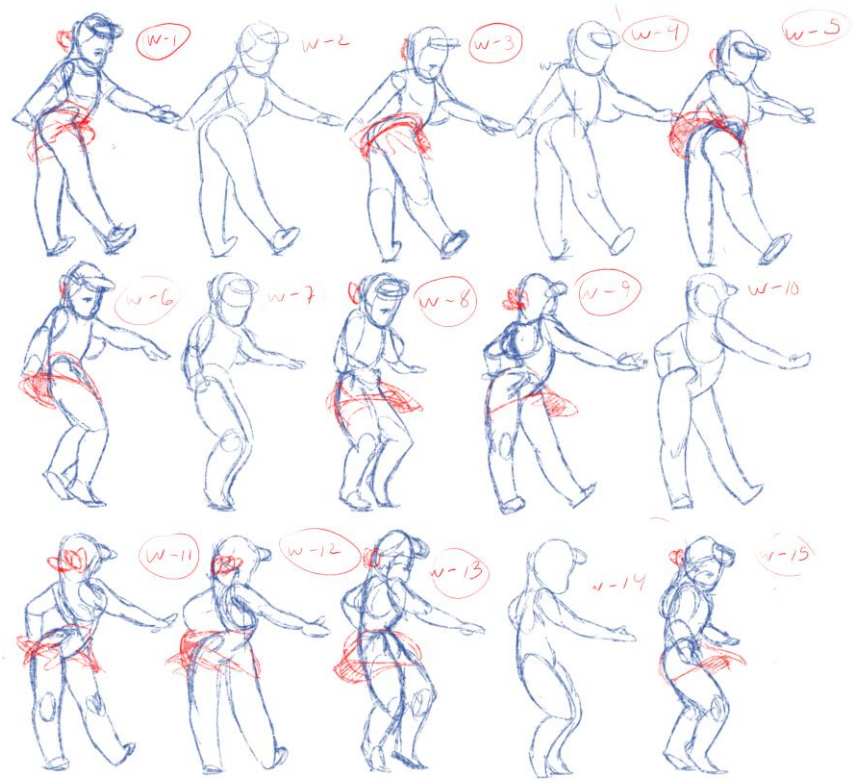

FIGURE 16. The rough poses used as keyframes, with added in-betweens and break-downs (Linna 2016e).

After this, it was easy to just hit play (I had the framerate set at 12 frames per second, which is a standard for drawn animation) and see the movement play out. I find the ease of pencil testing to be one of the key benefits of animating digitally, as compiling line tests from traditionally drawn animation frames with scanning and compositing can take a chunk out of your time and make the task of correcting mistakes a much more daunting task. In fact, line testing was one of the first frontiers aided by computer technology in the animation industry, with a multitude of different camera and pencil test systems adapted for this purpose between 1970-1990's (Sito 2013, 224).

Digital animation software makes it very easy to design secondary movement by creating another drawing layer over the last, and enabling you to draw on top of the previous layer without compromising its visibility or having to be careful about any missteps with the brush or eraser. Separating some of the moving parts of a whole is also useful for adding delay to secondary movement, as just moving the frames forward for that layer on the timeline will allow you to see the movement play out with the delay.

5.2.3 Post Production

Inking or cleaning up and animation digitally is quite like the old days of using India Ink to trace a drawing onto celluloid – but in this case, I just made a new layer and used my rough drawings as a guide for the clean drawing. Toon Boom Harmony automatically lowers the opacity of the previous frames to help with accuracy (Figure 17). It is extremely important to make sure the line art has no gaps in both traditional and digital animation, as it renders the efficiency of filling an enclosed space with the paint bucket tool useless. Programs like Toon Boom Harmony have built in engines that can close these gaps if need be, but the likeliness of a computer completely understanding your intention is slim, and as such it is better to get it right the first time.

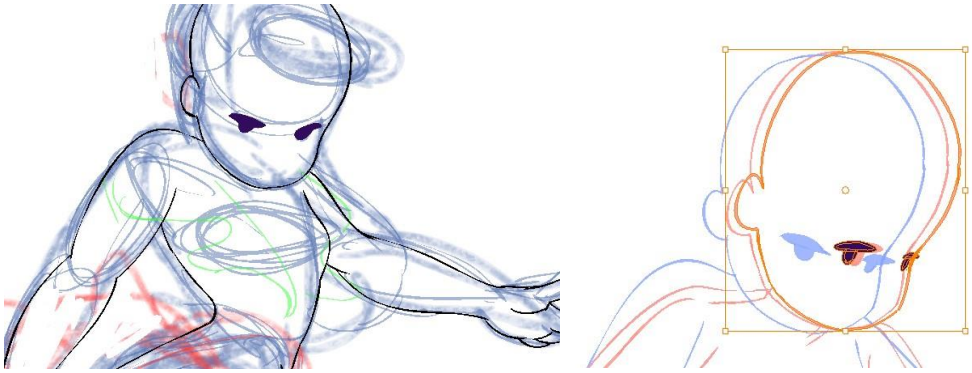

FIGURE 17. Clean lines drawn on a new layer with the rough showing underneath with lowered opacity (left) and editing stroke shape and position with transform controls (right).

I separated the character line art into many parts (Linna 2016f) – by their level of movement and visibility in the layer hierarchy – for better editability. One of the biggest arguments for digital animation before traditional is the ability to edit and duplicate parts of line art to reposition it instead of having to completely redraw it. This attribute also enables the use of motion paths in character animation, where the software creates inbetweens automatically between frames – however, this can be extremely detectable and often results in stiff movement.

After inking each part, I duplicated the clean line art to use for colouring (Figure 18). The duplicate provides us the same enclosed spaces as we had in the original line art layer, but by using the copy we can fill in these spaces with our colours without having to worry about ruining our line art.

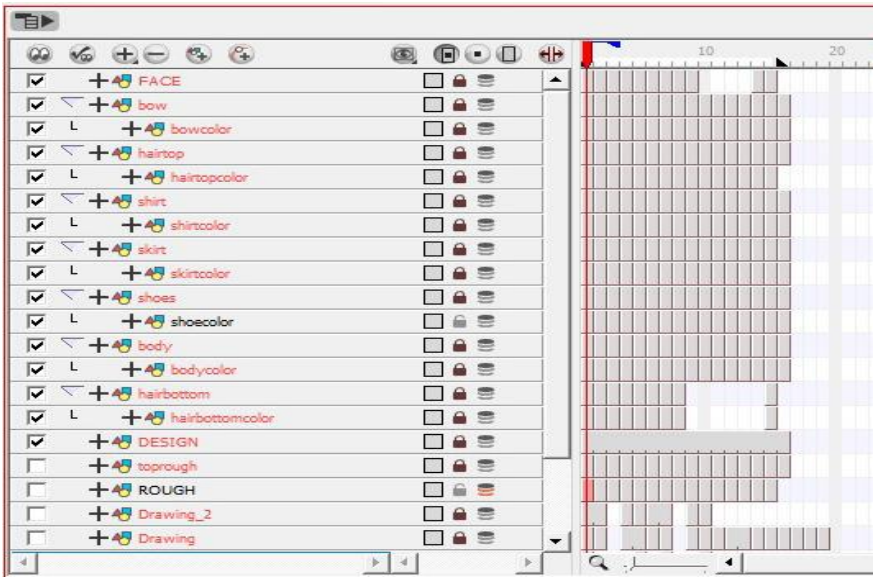

FIGURE 18. The character separated in hierarchy by body, hair, and moving clothing, with a parented duplicate for colouring.

After colouring, I needed to fix issues within the animation as I noticed them. For example, the skirt movement I originally designed did not work as well as I wanted it to, so I redrew and re-timed some of the frames. Digitally, this was a process of an hour or two at the most, as I could simply erase from the existing layer after roughing the new movement in another. (Linna 2016g).

Toon Boom Harmony itself has an engine for rendering out animation, so I didn't have to export the frames into another compositing program, and could directly modify the settings to my liking before rendering out a movie file.

FIGURE 19. The coloured keyframes (Linna 2016h).

6 DISCUSSION

The animation industry is one of constant motion and development. It started from individuals with a vision to make their stories come to life, and did so by inventing techniques and devices to fit these purposes accordingly. The animator was a lone wolf, in a sense, often in charge of the entire production from the conceptual to completion. As animation grew into a popular form of cinema in the hands of men like Walt Disney, it became a group effort, which facilitated the development of technology to make the hand drawn animation process easier – they were often in-house operations between engineers and the artists that would come to make use of the new inventions. As the industry continues to change, however, the technology that was often guarded within studios is now becoming more and more accessible to the private user – opening the possibility of animation to people who may never have accessed it otherwise. The animator is once again a generalist, someone capable of not only having the idea and animating it, but bringing it to its full completion, no longer restricted by high production costs and machinery. Every facet of production is available, right here at home. This does not only apply to freelancers, as many studios expect their animators to have experience in many different methods and software – the digital animator can express their skill in a multitude of ways, from hand drawn animation to motion graphics and even 3D.

The role interactive drawing displays play in this, in my opinion, is massive. By bridging the gaps between drawing and the software that facilitate it, it enables the animator to work from home or otherwise, even in collaboration with people from across the world. A drawing or a frame of animation can exist in many places at once, with no need for extra scanning or tedious clean up.

Above all else, it continues the legacy of hand drawn animation – perhaps not as we have come to know it, but in its own unique way. Pencil and paper will most likely always have a place in animation, but it is arguable whether it has any practical advantage over drawn animation done on a drawing display; how can we separate nostalgia and familiarity from true unbiased experience?

It’s true that the slow decline of hand drawn full feature film may have resulted in the reigning styles of rendered and vectorised 2D media, much less focused on character animation than its predecessor. But this cannot be blamed on the technology itself, but rather

the industry that favours it, preferring highly stylized visuals to believable character animation and cutting corners by outsourcing the animating to inexpensive South Korean Studios (Levin 2015). The Cintiq and its counterparts are the inventions that, with luck, can apply the old traditions of hand-drawn animation back into the modern world by bringing the technology to the animator at comparatively little cost.

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APPENDICES

Appendix 1. E-Mail Interview Joonas Utti, 17.8.2016

Please describe your current job role and the tools/software you prefer to use in your animation work?

Director, Story Artist, Character Designer

Traditional Tools:

-Felt tip pen + (news)paper

Digital Tools:

-Wacom Cintiq 22” + imac

-Wacom Cintiq 22” + macbook pro

-Apple iPad Pro + Apple Pencil

-TVPaint Animation

-Photoshop CC

-After Effects CC

-Illustrator CC

-Premiere CC

-Dragon Stop Motion (+ camera equipment)

-Flash (Animate ?)

-Mischief

-Forge (app)

-Sketches (app)

-Procreate (app)

-Good Notes (app)

-Trello - (app)

-email

What was your introduction into animation (ie. pencil, paper and lightbox, stop-motion or did you prefer a digital animation program like Adobe Flash)?

Pencil+Paper at first but I picked up digital workflow very early on. I used Macromedia (Later Adobe) Flash, PAP and TVPaint

What were your reasons for adopting the Cintiq in your work, and is it your preferred tool for animating?

It is my preferred tool, I couldn't do much without it. It gives a natural feel of drawing when drawing on screen, (compared to wacom tablet, where you do not have the tip of the stylus where you draw) We work mainly on 2D animation that is usually drawn frame by frame so Cintiq is a must for our workflow.

What were you using to animate before? Do you still use other methods alongside the Cintiq?

Pencil and paper, but I do not do that anymore. Later I tried Wacom Tablets, but I never got used to those. All animation in our studio is drawn on a Cintiq. I'm exploring a chance to use Apple iPad + Apple Pencil for animation but there are no decent apps and the lag in apps such as Astropad is stil unbearable.

What do you think are the pros of the drawing display?

Quicker than pencil+paper+scan. Better accuracy than Wacom Tablets.

What are the cons of the technology, in your opinion?

This technology is going forward all the time, the accuracy of the display and stylus pressure is already as good as needed for tradigital 2D animation. And portability is not an issue anymore with Wacom Companion or Apple iPad.

In artistic point of view, it sort of relies too much on the software and digital colorspaces. Lacking true contact and texture which you can only experience on traditional media.

If we assume that at least part of the reason for the display is to make drawing digitally more comfortable for traditional-oriented artists, do you think it accomplishes this goal?

I think it is an easy entry for a traditional artist. It is still a very different tool and so it should be. It is natural and comfortable as it is but it won't replace traditional media alltogether.

How could the Cintiq and 2D digital technology improve in the future?

It could and will become even more portable. Lighter, smaller energy consumption. The screens could become haptic. Projected screens that could allow any surface to be a digital drawing area. And software improvements are limitless.

If you have experience with working in 3D; are there any benefits to working with the Cintiq in 3D software?

I have worked with Mudbox, 3D Coat and Photoshop for textruring 3D objects. And I've done some sculpting as well. I think it is a natural way to work for me, but I'm not sure about the benefits over a wacom tablet are so crucial as in 2D animation.

Appendix 2. E-mail interview with Elroy Simmons. 20.9.2016.

Please describe your current job role and the tools/software you prefer to use in your animation work.

I've a couple/few job titles, I think. At the moment I'm technically between jobs - but basically I'm an Animator who seeks to design and direct, as well. At present, I'm to prepare classes to teach 2D Animation principles to 2nd Year Film degree students who've chosen to specialise in Animation. I'm also about to apply to study (and to make a short film - as part of that study) and separately, I'm hoping to put together a series idea proposal (it's an idea that's been fomenting/passively 'in development' for some time).

What was your introduction to animation (ie. pencil, paper and lightbox, stop-motion or did you prefer a digital animation program like Adobe Flash) ?

My introduction to animation was seeing it and then seeing it done - on television, when I was a child. I used to make 'flickbooks' from about 7-8 years old to my early-mid teens. I'd exhaust my Mum's books by drawing on/littering the page edges with arbitrary mini animations. I didn't get to animate using a camera until a one day workshop in my mid teens (which was all stop-motion) - and then later, when I took a Foundation (Pre-degree) course in Art and Design, I made models using plasticine and with crude skeletons and filmed them using Super8 film (again, stop-motion). My introduction to producing 2D Animation myself - using the appropriate technology, was on my degree - I didn't animate a model on my degree at all. I finished my degree in 1995. I've only drawn animation since then (for a wage, at least).

Why did you switch to a Cintiq?

I'm not sure that I have. I've had about three weeks experience using a Cintiq; the first three days were for an Animation test and the last 10 or so, were animating a short scene (slowly, repeatedly, over a disturbingly long period for disturbingly llittle remuneration).

What were you using to animate before?

Paper and pencils, sat at a lightbox and either intimate knowledge of a scanner or very patient colleagues at a studio with a feed scanner (with software with peg hole recognition).

What was the hardest thing about switching to a Cintiq?

It's like skating, I think (not enough friction). I definitely can't do that too safely - and would be ambivalent about learning to skate over a prolonged period, too (that's a half-joke; the Cinitq was nowhere near as painful as ice skating). I think I got to a good speed; but that was 'in the end', I suppose - and by then, I think I appeared impractically, misrepresentatively slow (though I thought I'd actually made radical progress, at remarkable speed - and did, eventually look like - and imagined I could draw and animate using it, faster and faster, better and better, after all...).

What do you think are the pros of the drawing display?

The pros on the massive A3 tablets are the relatively practically sized space to draw - and to see your drawings 'full screen' and then zoom in. I imagine the smaller A4 tablets would lend themselves to even more time 'zoomed in'. I like the pseudo Photoshop means to copy/edit elements from drawings (or entire drawings). I like the simplicity of the key ('instance') setting etc. It felt like drawing - after a while. It had a little AfterEffects-yness and is curiously 'old-school'. A lot of people working it were adamant it was the future and spoke in terms of never going 'back' to paper.

What are the cons of the technology, in your opinion?

You have to zoom in - and that removes you from seeing (instantly) the drawing in its actual context, which means you have to remind yourself that you're view of the drawing in close up, is not the same as it is, 'wide' (that's possibly a little opaque - apologies). The temptation to animate in singles is massive, as playback is so instant (be it 'scrolled' or just played). The technology is fine and I would think a real boon; in terms of saving time/work on other processes further down the line. It's prohibitively expensive; so the majority of people who use it either have independent wealth/debt - or are dependent on a studio to afford the means on their behalf (not democatising; and I bet its manufacturers

claim it is democratising. One very experienced (near veteran) animator told me he took 8 months to get to grips with it and hasn't looked back; that opinion - with my knowledge of the expense of the kit and the scarcity of productions using it and teaching animation veterans to use it, made me very aware that its expense was a practical (or impractical) means to eradicate the industry of one vintage (from one payscale, potentially) and replace it with another (who may find themselves in greater debt; certainly paying out greater sums for repairs).

I missed the 'friction' of pencil against paper - but was working with paper in the evening/mornings/weekends when not at the studio. I missed paper 'full stop', actually - and I'll always think timelines being on screen perpetually disrupt your intuition (but that likely my age/experience drawing on paper).

If we assume that at least part of the reason for the display is to make drawing digitally more comfortable for traditional-oriented artists, do you think it accomplishes this goal?

Yes, pretty much. I was relieved that the tablet I used felt more robust than the last A3 Wacom tablet I used (the pressure of my arm against that tablet, felt like I was about to break it, all the time).

How could the Cintiq and 2D digital technology improve in the future?

I think you need more room for the drawing display and the option to 'minimise' the space take up by the timeline etc (if only just to the layer you're drawing on; giving more room to see the drawing). I was glad the Cintiq I used was on a stand; I can't imagine the damage you'd do to your upper back/shoulder/neck if you were drawing on it flat against a table surface. I can imagine that in the future, the tablet will come a glove - that will have 'touch sensitive' fingertips to 'drag' in and out of the way whatever impedes your speed (or to mimic flicking through frames as pages - probably at added, even more prohibitive, greater expense).

Ultimately, a touch sensitive screen (for drawing - that was A3 and 'card' thin) that you could attach to a lightbox - with a separate 'pad' for the 'admin' (copying/pasting/adding/editing instances and the timeline etc) would be a boon. Having the two on the same

space without being able to minimise either, struck me (after a while, actually) as too great a fight for space. It was a good thing to learn though. I wanted to learn to integrate 'trad' method and its 'new' capabilities (i.e. I was sad to not have learned - yet, to import scanned keys and work on from there). Again though, I can only imagine those additions would only add to the expense inherent in the technology.

Appendix 3. Follow-up e-mail interview with Elroy Simmons. 4.10.2016.

You said "with my knowledge of the expense of the kit and the scarcity of productions using it and teaching animation veterans to use it....”
Can you expand on this?:

What do you mean when saying that " its expense was a practical (or impractical) means to eradicate the industry of one vintage (from one payscale, potentially) and replace it with another"?

In my first quote, I meant both the Industry and society more widely has introduced various 'price markers' on means to get by, generally (including the equipment you use, to work). In the context of working 'traditionally', a lightbox and paper are relatively minimal expenses if you're working at home - after a scanner and the means to put together a line test.

From around 2000, the private cost of computer purchase and their use - to animate, and the rapid turnover of 'softwares' popularly used - to animate, replaced traditional means at great speed, leaving a lot of animators - with a lot of experience, unemployed and bringing in new animators, who were largely separated - by technology (and their removal), from those previous animators.

Nowadays, it's normal for studios to expect animators to have all of the equipment to produce animation on their behalf - either at home, or in the studio.

Any Industry that's saturated with mature practitioners may find the means to reduce the costs of employing that workforce - by 'updating their skills' or removing those who'd say "I won't do that (for that)". Many newer animators are unaware of that renewal, (or understandably, glad of it). That's what I meant by eradication. In the decade or so, I've observed the transformation as, a little like a 'cull'. That said, we're all all always learning, if at different rates - with varying success.

By 2003/4, my diffidence concerning learning/adopting digital use (I'd little cash to train myself, and had previously enough traditional drawing work to limit the sympathies of

co-workers) was limiting my 'future'. I took a course in Digital Animation and began to get more animation work from early 2004 on. It's virtually all been traditional, though.

By repairs, do you mean updates or physical repairs to the machinery?

Yes, I meant repairs/updates to the machinery.

What in your opinion is a reasonable cost for animation equipment per small production?

I'm a 'sole trader', so I animate alone (not with a 'workforce' that I manage). Nowadays, it's normal for studios to expect animators to have all of the equipment to produce animation on their behalf - either at home, or in the studio. The price a studio may pay for approved animation, or that a private client may afford the animator/director for 'final picture', won't take into account the cost of the equipment used to produce it, as such. Sound 'business' pricing suggests including those prices in the calculation of a fee - but it's my experience that the buyer will ultimately seek a cheaper price elsewhere (or the means to make your efforts a 'bargain', regardless). I've observed that it's the hiring of a specific space and the relevant insurance etc., that really affords the seller the 'right' to introduce a commensurate (and 'buyer accepted') pricing structure. Sometimes, jobsite pitches to freelancers, for example, sound like they think animators live outside! I'm likewise, totally aware of being so 'squeezed' by budgets, that in turn, I end up looking and feeling like a right Scrooge (or hobbyist), myself.

Do you think owning technology like the Cintiq causes a situation where you cannot charge a client for the cost of equipment per project, and is this something you can do with traditional projects still?

If the job was large enough, then you could factor these costs explicitly into a budget, I'm sure. That is uncommon, though. More often (particularly on really 'Indie' jobs where the buyer has little knowledge of the process), it feels like the buyer thinks you can run off everything in a day, only 'realising' the effort involved (conveniently), when they acknowledge that you're now a 'husk' of your former self. That 'caricature' can, of course, easily be contradicted, anecdotally....

I think a lot of newer means to animate, make traditional animation production look unwieldy, costly and slow - but allow the (again) 'convenient' (and unfair) impression that time spent working digitally is 'cheap' - because it is time/labour saving. Or that traditional work is 'cheap', because it 'doesn't even use new technology' (when it invariably does).

In both (digital and traditional) cases though, there isn't a 'shortcut' for everything - but I see plenty of ridiculous adverts requiring 30 seconds of animation to be completed in a day - and I wonder how that might be achievable. I've also had to complete a comparable amount of seconds (very occasionally) in a similar time frame and only ever felt underpaid for so doing. No fair remuneration for the cost of materials or equipment appeared to be incorporated into the pricing, either.