

TOM SITO

# Moving Innovation

A History of Computer Animation



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Tom Sito

The MIT Press  
Cambridge, Massachusetts  
London, England

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This book was set in Stone Sans and Stone Serif by Toppan Best-set Premedia Limited, Hong Kong. Printed and bound in the United States of America.

Library of Congress Cataloging-in-Publication Data

Sito, Tom, 1956–

Moving innovation : a history of computer animation / Tom Sito.

pages cm

Includes bibliographical references and index.

ISBN 978-0-262-01909-5 (hardcover : alk. paper) 1. Computer animation—History. I. Title.

TR897.7.S48 2013

777'.709—dc23

2012038048

10 9 8 7 6 5 4 3 2 1

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For Shamus Culhane  
1911–1995

In 1977, a day after visiting NYIT, he looked up from his typewriter and said to me, “Ya know, computers are comin’. Gonna change everything. The Business [animation] won’t ever be the same.”



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## Acknowledgments

Trying to write a book about computer animation reminded me of art historian Robert Hughes's observation about trying to carve a marble statue of a motorcar. It is an old technology saluting a young one.

I am truly grateful for the generous help of Dr. Deborah Douglas and the staff of the MIT Museum. Thanks to Doug Berman, and Tom & Ray Magliuzzi of the *Car Talk* radio program, for introducing me to the MIT folks; the Computer History Museum in Mountain View, California; the Center for Visual Music ([www.centerforvisualmusic.org](http://www.centerforvisualmusic.org)), the repository of the works and papers of Oskar Fischinger, Mary Ellen Bute, and Jordan Belson; Larry Cuba and the iotaCenter; the library of the UCLA Animation Workshop; the Doheny Library of USC; The Los Angeles Chapter of SIGGraph; J.J. Sedelmeir; Professor Kelly Loosli of Brigham Young University; Professor Larry Loc of California State University, Fullerton for his notes on computer game development; and Professor Ellen Besen of Sheridan College for her information on Canadian universities. Thanks also to Kristof Serran and Evander Reeves for helping me with research on French and other European CG studios.

My deepest debt of gratitude is to the heroes of CG who gave me their time and put up with my questions: Jim Hillin, Larry Cuba, Mike Amron, Tina Price, Bill Kroyer, Tim Johnson, Aaron Simpson, Dave Sieg, Chris Wedge, Jim Blinn, Ed Catmull, Rex Grignon, John Hughes, John Whitney Jr., Alvy Ray Smith, Philippe Bergeron, Dan Phillips, Bil Maher, Mike Wahrman, Dave Seig, Sunil Thankamushy, Lance Williams, Jesse Silver, Tad Gielow, Bill Perkins, Steve Segal, Sherry McKenna, and all the other interviewees. Thank you to my colleague at USC, Dr. Richard Weinberg, for his valuable notes and suggestions.

Also, thanks to my UCLA research assistant Sharon Burian, and to Joy Margheim who did a wonderful first edit of the manuscript. And to Marguerite Avery of MIT Press, for rescuing an orphan in a storm.

And my wife, Pat, my lifelong partner and proofreader.

Without all their cooperation and generosity this book would not have been possible.



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## Introduction

Invention in the twentieth century was a messy process.

—Dr. Deborah Douglas, MIT

Deep down in the bowels of the museum archives of the Massachusetts Institute of Technology (MIT), behind gray stone walls and row after row of oak shelves and metal file cabinets, in a box sits an old doctoral thesis bound in dark-brown construction paper. The fading title page reads,

Technical Report No. 296, 30th January 1963

Sketchpad: A Man-Machine Graphical Communication System

By Ivan Sutherland

On page 66 is a small paragraph that ends, “Sketchpad need not be restricted to engineering drawings. Since motion can be put into Sketchpad drawings, it might be exciting to try making cartoons.”

With this sentence a multibillion-dollar industry began. An industry that forever changed the way we experience the art of moving images. Using an obsolete, 1950s Cold War computer, built to track a Soviet nuclear attack, graduate student Ivan Sutherland created the first true animation program. For the first time, instead of presenting a series of numbers, a computer drew lines, and the lines formed recognizable images: a bridge, a leg moving, a face winking. Sketchpad is one of the first of many baby steps for the art of computer animation. Called computer graphic imaging, CGI, or just CG, it is the artistic edge of the information age, the arts and entertainment front of the digital revolution.

Without CG the Titanic in the movie *Titanic* could not sink; the armies of Mordor could not march on Middle Earth. We would never have known the Na’vi, Buzz Lightyear, or Shrek. By the end of the first decade of the twenty-first century the very concept of film had become an anachronism. The Hollywood of today is not the Hollywood I first came to in the 1970s. The studios today would be unrecognizable to Cecil B. DeMille, and Walt Disney. Much of that is due to CG. CG has redefined how we watch movies and broadcast media, how we teach, how we play games.

This book is an attempt to gain an overview of the complete history of computer animation. I began it when I noticed there were not many serious histories of the medium yet written. Any nods toward the history of CG were usually either a brief review in a how-to book or website, or a history of a popular software package. There are many books about the Walt Disney Studios, Pixar, and Industrial Light & Magic (ILM), but by their very nature these focus on their central subject, to the exclusion of most else. This book will show that scientists and artists were working on computer graphics when George Lucas was still a teen racing hot rods in Modesto, Steve Jobs was riding his bike by the Stanford Artificial Intelligence Lab, and John Lasseter was clutching his mother's hand as he watched an ailing Walt Disney wave from the Grand Marshal's float in the Pasadena Rose Parade.

Some CG books can be an endless litany of mechanical innovation, "tech talk." To the uninitiated it all seems like a bewildering blizzard of acronyms—DARPA, PDP-1, NYIT/CGL, DEC VAX 11/750, and more. What I found fascinating are the men and women who conceived this brave new digital world. Starved-shirted scientists, dope-smoking hippies, and insular math nerds, all united in a common goal, dreaming audacious dreams, with the mental acumen to carry them out.

These oddball scientists looked at the huge mainframe computers of IBM and Honeywell and thought, let's make cartoons with them. They created something no one asked them to and made something no one wanted, which they then built into a universe parallel to Hollywood. A universe that ultimately engulfed the older one.

As my research progressed I noticed the same names appearing at key points in the story. A small group of unique scientists and engineers who followed their dream back and forth across the country. Names like Ivan Sutherland, Dave Evans, Ed Catmull, Alan Kay, Jim Blinn, Alvy Ray Smith, Vibeke Sorensen, Jim Clark, and more. They walked away from tenured professorships, scholarships, and government posts, secure positions that would have suited any average person for the rest of their career. Wherever the cutting edge was, they had to be there. Where there was no social culture to share information on what they were creating, they created one.

Today the Digital Revolution is a historical fact. The barbarians have stormed the gates. The digital Visigoths intermarried with the analog Gallo-Romans and spawned a new society. Some of the original leaders have passed on: John Whitney, Dave Evans, Bob Abel, Lee Harrison, Bill Kovacs, Steve Jobs. When I first approached him about this project, Jim Blinn looked off thoughtfully, and said, "Yes, it is time to start writing the history."

The lack of a comprehensive history of CG up till now may be because it's a difficult subject to approach in its entirety. The history of traditional cartoon animation, what we call animation done with tools like pencils and brushes, had followed a simple linear track: flip books, zoetropes, trick films, the peg registration system, cels, rotoscope, sound, color, improved motion and acting, motion pictures, and television.

Luminaries mark the track of animation's growth—Winsor McCay, Walt Disney, Chuck Jones, Ray Harryhausen, and Hayao Miyazaki.

The problem in chronicling the growth of CG is much like the problem facing those who attempt a history of television. There is not one Edison-like genius inventor you can point to. Not one Walt Disney-type megamind who single-handedly advanced the medium by leaps and bounds. The development of CG was never that dramatic. It occurred slowly, over decades, appearing in many different places. To trace the evolution of CG we need to follow several threads simultaneously:

1. Academia
2. Industrial and defense research
3. Special effects for live-action movies
4. Games
5. Avant-garde and experimental filmmakers
6. Corporate research
7. Commercial animation

Like the plot lines of an old Russian novel, these threads developed along parallel paths, socially isolated from each other, until the vertically integrated media conglomerates of the 1990s compelled them all to converge. Writing the history of CG is not tracing a chronicle year by year as much as sewing a quilt made up of unrelated parts. Occasionally we come upon major inflection points: MIT, the University of Utah, Xerox PARC, the New York Institute of Technology, Pixar. These oases provided an intersection for talent, dynamic leadership and funding. The result was to advance the growth of the medium by several steps. So an important figure like Alvy Ray Smith or Rebecca Allen will pop up in several chapters.

I confess I was never a computer enthusiast myself. Discussions of Lissajous curves and splines are surefire ways to put me to sleep. I began as a traditional animation cartoonist. I worked with many old masters from the Hollywood cartoon's golden age, like Art Babbitt and Hanna and Barbera. I began my career painting characters on acetate cels, polishing them with tissues, alcohol, and spit before they were photographed under an Oxberry downshooter camera. I followed the century old route up the job ladder—inbetweener, assistant, animator, storyboarder, then director.

I came of age at a time when you could see the digital revolution rising on the horizon. I recall going to an ASIFA-East meeting at the old Phoenix School in New York and seeing Peter Foldes's *Hunger/La faim* in 1974. As I was putting in long hours drawing on the Richard Williams animated feature *The Adventures of Raggedy Ann and Andy* (1977) I heard about some scientists at the New York Institute of Technology out in Westbury, Long Island, trying to create a cartoon by computer. I watched *Tony de Peltrie* (1985) and *Luxo Jr.* (1986) when they premiered. While working for the Walt Disney Studios on the film *Dinosaurs* (2000), which contributed to the animation



**Figure 0.1**

The author in his office at Walt Disney Studio in 1992. Note the Apple Macintosh adapted to film animation pencil tests. It also did e-mail.

Courtesy of the author.

software Maya being perfected, I at last began to appreciate what was occurring around me.

I have been a witness to the digital revolution without being one of its devotees. I see my role as not unlike that of the historian Polybius (200–118 BC), who attempted to explain to the rest of the Greek Mediterranean world just who these strange Romans were and why they seemed to be taking over everything.

I don't intend this to be the final word on the history of CG. I'm sure, no matter how thorough I try to be, there will be people and events I will have inadvertently left out. If so, please forgive my ignorance; I shall endeavor to do my utmost to deal with all, evenhandedly. And as any good historian knows, disagreements over the details, and their interpretation, are what make history the living art that it is.

*T.S. Los Angeles, 2012.*

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## 1 Film and Television at the Dawn of the Digital Revolution

Computers ain't here yet. And uh, when they do come, we'll take some night classes.

—Hollywood Union Official, 1993

Motion pictures are an industrial art form. They are dependent on ever-improving technology. Picasso once said an artist can make art even by licking the dust with his tongue, but you need a little more than that to make a movie.

At the birth of cinema, pioneers popped up all around the world, more or less at the same time—Thomas Edison in America, the brothers Auguste and Louis Lumière in France, Alexander Drankov in Russia, Kenji Mizoguchi in Japan. But only in America was the production of motion pictures organized along the lines of industrialized mass production and mass marketing. American movies were cranked out on an assembly line by hundreds of workers as though they were automobiles. By the 1920s Hollywood's output, backed by America's commercial muscle, had come to dominate cinemas around the world. In other nations most film studios were never more than small ateliers of artists. They became hamstrung by the hardships stemming from the world wars and the postwar economic collapse. No other nation could compete with America's output. In 1914, 14 percent of films shown in British theaters were made by British filmmakers. By 1926 that percentage had gone down to 5 percent.

Those who pioneered this new technology often did so out of necessity. They were the dispossessed of mainstream society. Many were immigrant Jews from Central Europe, who back home had been barred from owning property and entering genteel society. When Wall Street banker Joseph Kennedy Sr. came out to California to meet all the studio heads, he came away with the impression that they were “all just a bunch of Austrian pants-pressers”<sup>1</sup>: Louis B. Mayer, Irving Thalberg, Adolphe Zukor, Carl Laemmele, Harry Cohn, Darryl Zanuck, Sam Goldwyn, Charles Fox, and Jack, Abe, and Harry Warner.<sup>2</sup> They fled the festering tenements of eastern U.S. cities to move west to a small town among some orange groves at the edge of the great American prairie. These small-time hucksters, through instinct, collusion, luck, and a touch of ruthlessness, made themselves rich by holding the keys to a kingdom of dreams.



Their movies not only defined our fantasies, they came to define our image of ourselves. They educated the public on what was important and what was not. No one remembered the 1797 mutiny on the HMS *Bounty* until it was in a movie. Until movies were made about them, not many had ever heard of Wyatt Earp, and Herman Melville's *Moby Dick* was just another dusty old novel. Political leaders like Franklin Roosevelt, Adolf Hitler, Josef Stalin, Mahatma Gandhi, and Winston Churchill understood that being seen weekly in the cinema house created a bond of trust with the common citizens that leaders of the past had never been able to enjoy. For better and worse, the movies not only entertained, they created idols for us to worship, villains for us to hate, fashions for us to buy.

Hollywood does everything on a grand scale. It's not about getting funding for making a little film, it's about making an epic, a season of twenty-four episodes for TV, the three-picture deal. Hollywood's unquenchable thirst for talent and product drew in the finest people and best ideas the world could offer.

By the 1940s the studio backstage workers, aware that they were the ants that made things run, got together collectively and unionized. After a decade of threats, blacklisting, picketing, and street fights, all of Hollywood backstage production came under closed-shop union agreements. This enabled them to build the highest standard of living of any media workers in the world. That part of Hollywood was no more glamorous than a steel-mill town. Each day hundreds of workers clocked in, ate lunch in the commissary, clocked out, and went home to an early bedtime. They were awarded gold watches when they retired. A few wrote books about what it was like in the heady days of Hollywood's golden age. The system tolerated an occasional nonconformist like Erich von Stroheim or Orson Welles, yet the steady pattern of the creative assembly line chugged on for years, picture by picture. If the general public cared to peek behind the magic curtain at all, it was to see the after-hours shenanigans of their favorite movie stars, as presented in colorful detail by gossip reporters in the studio-supported press corps.

Jobs titles became specialized, held in place by narrowly defined job classifications. These positions were held not by merit but by strict seniority clauses in contracts. A film director was not allowed to look into a camera lens; that was the domain of the cinematographer. A cameraman could not move any chairs; that was the responsibility of a grip. Actors' agents would haggle over the size of their client's name on screen credits. Since a lot of the alliances in Hollywood were based on trust and personal favors, the front office put their relatives in positions of responsibility. Louis B. Mayer put so many members of his immediate family in key positions, a joke in the 1930s went, that MGM meant not Metro-Goldwyn-Mayer but Mayer-Ganz-Miszpochen, Yiddish for Mayer-and-his-whole-family.<sup>3</sup> At the same time, the backstage unionized force began to hand their steady positions down to their children. Dave Snyder recalled "I went to the USC film school for sound systems classes,

and soon realized I was the only guy there who wasn't someone's son or relative."<sup>4</sup> By the 1960s the same film workers who had embraced the young technology in the 1930s were still on the job, gray hair and all. And woe to anyone who attempted to disturb the system. Steven Spielberg recalled, "When I did my first director job, the TV series *Night Gallery*, I noticed all my backstage crew were over sixty. I looked like a kid, so they hated me!"<sup>5</sup> A new director who did not come up through the ranks, doing some time as an A.D. (assistant director) or second unit director, would have his life made miserable by a hostile crew. By the 1970s the studio production system had ossified into something resembling the protocol of the Manchu Court in the Forbidden City.

The television industry began on the East Coast as pet projects of the radio broadcasting network heads William Paley of CBS and David Sarnoff of NBC. At the World's Fair in 1939, Paley predicted that one day there would be a TV set in every home. Television financing was allotted by selling advertising airtime to commercial sponsors like Lux dishwashing liquid and Twenty Mule Team Borax. Studio executive Pat Weaver (the father of actress Sigourney Weaver) came up with the idea of leasing commercial airtime in thirty-second slots. As the fortunes of nationally broadcast radio declined, the networks—CBS, NBC, and ABC—became known primarily for their television.

In the 1980s they, too, became part of vast corporate media giants like Viacom and Time Warner.

The digital imaging revolution coincided with the larger information revolution. Until the late 1980s television was seven channels—three networks, CBS, NBC, and ABC; three Metromedia<sup>†</sup> or regional stations; and one PBS public station on the UHF frequency. Many would shut down after twelve hours of airplay. But television concentrated the public's attention. In a nation of 140 million in 1964, it was possible to have an audience of 80 million watch Elvis on the *Ed Sullivan Show*. In the twenty-first century, despite a doubling of the population, with hundreds of channels and Internet options, a TV viewing audience of 8 million is considered huge.

Animation began as trick films shown on vaudeville theater circuits. The big newspaper chains paid to make films of their famous comic strip characters to boost sales of newspapers. Felix the Cat, who first appeared in a short in 1919, was the first animation character that did not originate in a printed comic strip. The innocent charm of capering anthropomorphic cartoon animals, a favorite theme since Aesop, grew in popularity, and most mainstream movie studios opened their own cartoon units. By 1941 the animation workers came together and unionized with most of the mainstream Hollywood workforce.

As the fortunes of the great movie studios waned, the television industry created new demand for cartoon entertainment, and from 1966 to 1988 the bulk of the Hollywood animation industry turned out low-budget TV shows and commercials.

In the 1960s and 1970s the most advanced technology in entertainment seemed to be videotape. Film departments of universities were considered cutting edge if they offered courses on video editing. The immediacy of playback, the handheld drifting focus, the guerrilla nature of it all was considered very cool. Doing smears on tape, distortions, and chroma-key traveling mattes were real hot stuff, all under the label of New Media.

For the first thirty years of CG development, you needed at least a PhD in mathematics or engineering to know what you were doing. For most of the twentieth century, Hollywood workers were rarely required to possess more than a rudimentary public school education. Sure, the studios would occasionally call on the services of an F. Scott Fitzgerald or William Faulkner, but to movie people it was considered a waste of time to extend your education beyond a rudimentary degree. Even Hollywood's acknowledged geniuses, like Orson Welles, Charlie Chaplin, and Walt Disney, were self-educated autodidacts.

As an industry, motion pictures began as adjunct entertainments on the bill of theatrical variety shows, collectively known as vaudeville. Their popularity slowly came to push all the live acts off the stage, so by 1934 the press was calling vaudeville dead. First funded by inventors like Thomas Edison, then newspaper barons like William Randolph Hearst, moviemaking evolved into a system of independent studios with ties to national theater chains. They were self-funded through public stock offerings, floating loans from big financial institutions like the Bank of America.

Except for the occasional industrialist wanting to play Hollywood, like Howard Hughes, the movie moguls were pretty much on their own. They made the pictures they wanted to make. Taking the risk of making a picture they knew would be too artsy to make big box office was their decision alone. Films like John Ford's *The Informer* (1936) or Vincente Minnelli's *Lust for Life* (1956) were written off as "prestige pictures," since they attracted favorable press coverage from snooty East Coast critics and earned the studio Academy Awards. The moguls came to own every facet of filmmaking, from the concept, through production, to the viewing in a theater.

In 1938 a coalition of smaller independent studios challenged the majors in court.<sup>6</sup> They said that the Big Five (Paramount, MGM, Warner Bros., Columbia, and Universal) were engaging in monopolistic practices that violated the Sherman Antitrust Act. The case wound through the courts for several years, finally reaching the U.S. Supreme Court in 1948. In the landmark ruling known as *United States v. Paramount* (Paramount representing the interests of all the other major studios), the high court declared that the major studios were indeed a monopoly. They were ordered to sell off their movie theater chains and other ancillary facilities like film processing and supply. This ruling coincidentally came the first year that television started to seriously affect movie-ticket sales.

In 1951 show-biz attorneys Arthur Krim and Bob Benjamin bought United Artists (UA) from aging movie royalty Mary Pickford and Charlie Chaplin. Krim and Benja-

min decided the old dream factory model of keeping all resources—costume making, set building, recording, post, and so on—on one back lot was impractical. Studios had to become engines that provided financing and distribution for films created by independent production entities. As a result UA had a heyday producing films like *Dr. No* (1962), *Goldfinger* (1964), *The Good, the Bad and the Ugly* (1966), *The Pink Panther* (1963), and *A Hard Day's Night* (1964). Their example encouraged studios to shed back lots in favor of contracting with outside service houses and hiring out their remaining studio facilities.

By the 1960s the old moguls' monopoly had crumbled, and by the 1980s the dream factories had all been absorbed into vast multinational media conglomerates. The politics of the 1960s created a taste in the audience for hard-hitting social realism in movies. No room for the Emerald City of Oz or flying carpets of the Arabian Nights. "Almost from the moment film was invented, there was this idea that you could play tricks, make an audience believe they were seeing things that really weren't there, stretch the imagination. But this was completely lost by the 1960s," recalled a young George Lucas.<sup>7</sup> An article in *Look* described Hollywood as a company town where the mine had been closed down.

By 1970 a new generation of filmmakers began to assume control. These young filmmakers—Francis Ford Coppola, Warren Beatty, Peter Bogdanovich, Hal Ashby, Dennis Hopper, William Freidkin, Martin Scorsese, and later George Lucas and Steven Spielberg—were inspired by classic films and global cinema. But they were also interested in introducing new technologies to further the cinematic experience.

At the end of the March 1973 Academy Awards television broadcast, film director Francis Ford Coppola walked up to a plexiglas podium to present that year's Best Picture Oscar. As the creator of the previous year's winner, *The Godfather*, it was his right by custom. But instead of wrapping up the telecast quickly, allowing everyone to adjourn to their parties, Coppola surprised the audience by launching into a manifesto on new technology: "We are on the verge of something that will make the Industrial Revolution seem like a small out-of-town tryout. I can see a communications revolution that's about movies, and art and music and digital electronics and satellites, but above all, of human talent; and it's going to make the masters of the cinema, from whom we've inherited this business, believe things that they would have thought impossible!"<sup>8</sup>

The older studio establishment thought Coppola's rambling outburst as impertinent as it seemed vague. Most were too annoyed to really think about what he had just said. Like an Old Testament prophet crying out in the wilderness, Francis Ford Coppola was announcing to the world the coming age of digital media.

But would Hollywood listen?



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## 2 Analog Dreams: Bohemians, Beatniks, and the Whitneys

It is not the hand anymore, but the spirit, which makes art, and the new spirit demands the greatest possible exactitude of expression. Only The Machine in her extreme perfection can realize the higher demands of the creative spirit.

—Theo Van Doesberg (1883–1931)

Two types of pioneers created the art of computer graphics. One group was the scientist-engineers who longed to be artists. The other group was the artists who yearned to create works that went beyond the traditional medium of paints and pencils. Their muse led them to become inventors in order to realize their vision.

The artists who created CG dwelled on the peripheries of the mainstream media world. Nonconformists, bohemians, beatniks, and hippies—they toiled away in lofts and garages, often with little funding. Their goal, if they would even deign for it to be labeled so, was a melding of human psyche and machine to achieve a new way of experiencing art. They explored the way we experience images, time, and music.

From the time Ice Age humans drew cave paintings of animals with multiple legs up through to Leonardo DaVinci's sketchbooks, artists have tried to create art that moved. The illusion of motion was at last achieved with the development of animated film at the beginning of the twentieth century. To the average person on the street, animation has always meant entertainment cartoons. Anthropomorphized animals with human attributes making absurd faces and bonking one another on the head for Punch-and-Judy-style laughs. But animation always had another, less well-known, side. Early on, artists and composers like Jean Cocteau, Man Ray, Fernand Léger, Paul Hindemith, and Salvador Dalí were intrigued by the possibilities of moving art and by movement itself as art.

The advent of motion pictures was also the age of invention, the age of the machine. Long before anyone had ever heard of a computer, artists were trying to use machines to explore their creative possibilities. Just as nineteenth-century photographer Eadweard Muybridge is considered a father of motion pictures, even though he

himself never touched a movie camera, so there were early artists who anticipated the coming of CG, although they themselves may never have clicked a mouse.<sup>1</sup>

Berlin. A cold, gray day in February 1936. A balding man and his wife sat smoking heavily in their chilly studio.<sup>2</sup>

The clatter of car horns, crowds slipping on the slush, and other city noise on the Friedrichstrasse provided a background to their anxiety as they awaited an important phone call. The couple was surrounded with filmmaking equipment as well as beautiful paintings, prints, and sketches in the twentieth-century abstract expressionist style. Much of it explored the relationship between visual art and music, a form that would come to be referred to as visual music.

Oskar Fischinger (1900–1967) and his wife, Elfriede (1910–1999), had been at the forefront of the modern avant-garde since just after the Great War. Oskar's abstract expressionist films were seen on movie screens across Europe. He went beyond the pencil and brush and explored mechanical means of graphic expression. He employed collage, time-lapsed paint strokes, patterns in oil and wax, and more to make geometric shapes dance to music. They were like cubism in motion.

The art scene of the 1930s was booming with modernism, surrealism, and Dada; its soundtrack was the new sound from America called *jazz*. The "Moderns" rejected the conventions of the Old World that had destroyed itself in the madness of the Great War. They extolled the virtues of a new age, symbolized by The Machine as an engine of liberation. To these artists, science was the new progressive faith. Viking Eggeling and Walter Ruttmann were making abstract films as early as 1921. Fernand Léger and Man Ray created a sensation with their film *Ballet Mécanique* (1924), with music composed by American George Antheil. Also influential was Marcel Duchamp's *Anemic Cinema* (1926).

But the postwar economic depression allowed fascist movements to come to power. These regimes sought to reign in artists and harness them to the needs of the state. After the Nazi Party took over in Germany the type of works Fischinger did were declared *Entartete Kunst*, "decadent art," and so forbidden. The Reich Propaganda Ministry of Josef Goebbels began stamping out all art that did not conform to the state's ideal of National Socialist *Kultur*. He closed the Bauhaus, took over the Babelsburg film studio UFA, and caused many cinema celebrities, like Fritz Lang, Marlene Dietrich, and Max Reinhardt, to flee into exile. Book burnings became common, and the beautiful works of Paul Klee, Max Beckmann, and Jacques Lipschitz were removed from art museums. In their place were hung kitschy portrayals of nude Aryan milkmaids and overstuffed Wagnerian heroes.

Oskar Fischinger had been under the eye of the Gestapo, since he had drawn ads for left-wing political groups during the late Weimar Republic. He had been picked up by police and questioned on two occasions. Once for refusing to put the swastika flag



**Figure 2.1**

Oskar Fischinger with panels of his *Motion Painting #1*.

© The Fischinger Trust, courtesy of the Center for Visual Music.

out on his windowsill when some local Nazi party hack was due to drive by. Another time when an informer overheard him say to a friend about the Nazi newspaper, the *Völkischer Beobachter*, "You don't really believe that bullshit, do you?" When the friend warned him he must be more careful and even dissemble if he expected to survive, Oskar replied, "I'm not sure I can. I open my mouth and the truth just comes out."

Luckily, another friend had sent films like his *Composition in Blue* (1935) to the United States, and they wound up at the offices of famed German expatriate director Ernst Lubitsch on the Paramount Studios lot. The brightly colored cubes and tubes dancing to the music of Otto Nicolai's *Merry Wives of Windsor* charmed him. Lubitsch and his fellow émigrés had set up the European Film Fund, an organization that served as a pipeline to smuggle artists and intellectuals out of the Third Reich. That day in 1936 Oskar and Elfriede waited by their phone. Their agent had sneaked a message to them to expect a phone call from America. From Hollywood, no less!



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