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The Agency and Effect of Technical Equipment on Animation Production in Studios Se-Ma-For and FS Kudlov in the 1970s and 1980s

Abstract
This study examines the animation studios FS Kudlov in Gottwaldov and Se-Ma-For in Łódź in the 1970s and 1980s through the lens of Actor-Network Theory (ANT). The goal is to demonstrate ANT as a tool for understanding the role of human and non-human actors (such as equipment, materials, and spaces) in shaping work processes. In Se-Ma-For, the "reprojector kit" used by Zbigniew Rybczyński for the Oscar-winning *Tango* (1981) prompted innovative techniques, while in FS Kudlov, a work process supplementing a copy machine influenced Karel Zeman's work.

Both studios faced constraints due to limited technology access in the Eastern Bloc, relying on creative adaptation. Se-Ma-For formed new working groups around the reprojector kit, whereas FS Kudlov integrated new equipment into existing networks, aided by in-house laboratories. ANT offers a broader perspective, where the human actors (directors, cameramen) and non-human actors (equipment, textured paper, darkrooms etc.) were equally crucial, highlighting their interdependence. By analyzing archival materials, oral histories and equipment, materials and spaces themselves, this study underscores the synergy between human and non-human actors, which was essential in shaping the unique innovative work processes of both Se-Ma-For and FS Kudlov.

Keywords
Actor-Network Theory, The Kudlov Film Studio, Gottwaldov, 'Se-Ma-For' — Studio of Small Film Forms, Łódź, animation

Introduction

The Kudlov Film Studio near the Czechoslovak town of Gottwaldov and the 'Se-Ma-For' Studio of Small Film Forms in Łódź, Poland, became renowned in the last century as important centres of animated film production in their respective countries. The state-operated film industries in the Eastern Bloc faced many limitations during the 1970s and 1980s, with technical restrictions being a primary obstacle, particularly when compared to their foreign competition. Despite these limitations, both studios developed specific networks of actors to overcome their constraints. To demonstrate this issue, we focus on the "reprojector kit" used in Se-Ma-For by Zbigniew Rybczyński to create the Oscar-winning film *Tango* (Zbigniew Rybczyński, 1981). In Gottwaldov's case, a work process supplementing a copy machine actively used in Karel Zeman's films will be examined.

Methodology

These case studies aim to examine the similarities and differences between selected working groups at Gottwaldov's Film studio Kudlov (FS Kudlov) and Łódź's Se-Ma-For studio, with a focus on the newly established work processes in the production of animated films. These work processes function as networks comprising both human and non-human actors. The Actor-Network Theory (ANT) approach, developed by Bruno Latour, Michel Callon, Madeleine Akrich and John Law,[1] serves as a valuable research tool for defining and examining the elements within these networks. ANT is a theoretical and methodological approach that views social structures as ever-changing networks of relationships. The general concept of a heterogeneous network, i.e. a network that contains many heterogeneous elements, is the basis of this method. The agents within these networks can be various entities. According to this approach, no network is purely technological or purely social.

The controversial aspects of ANT mainly stem from its concept of *actors*. In ANT, an actor is any element within a network that performs an activity.[2] This approach differs from other sociological theories by considering not only human actors but also non-human actors. Non-human actors can include objects, organisations, infrastructures, urban architecture, technical equipment, or even ideas, processes, or concepts.[3] According to one of the fundamental principles of the method, *generalized symmetry*, human and non-human actors are considered absolutely equal.[4] In ANT, actors are not assumed to have preconceived motivations. Instead of "motivation," it is more appropriate to use the term "agency," and we will also use the word "effect" to refer to the resulting outcome of an actor's actions.

We acknowledge that using ANT for film production analysis comes with a certain methodological baggage that needs careful vetting. Czech sociologist Tereza Stöckelová

1) Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network-Theory* (Oxford: Oxford University Press, 2005).
2) Bruno Latour, „On actor-network theory: A few clarifications," *Soziale Welt* 47, no. 4 (1996), 371.
3) Latour, *Reassembling the Social*, 10.
4) Ibid., 76.

in her introduction to *Stopovat a skládat světy s Brunem Latourem* (Czech translation of selected Latour's texts)[5] highlights one of many possible dangers: "Instead of the desired analytical thoroughness and reflexivity, reference to 'theory' is often used as a shorthand or fetish, and in the case of ANT, the term 'actor' is inserted before every other word."[6] Rather than simply assigning agency to all present non-human elements, we employ ANT in this text as a tool to discover acting in dynamic interactions among the collectives of entities.

Jan Teurlings, in his text "What critical media studies should not take from actor-network theory," outlines several key issues with using ANT in critical media studies, which are also relevant to contemporary film studies. Besides the excessive reliance on description,[7] one problematic aspect of ANT is its tendency to describe things from the perspective of "the victors."[8] As noted in Collins and Yearly's paper, ANT is ontologically radical (putting humans and non-humans on an equal footing) but epistemologically conservative.[9] Despite its principles of generalized symmetry, we acknowledged that ANT can still be very human-centred. As Milan Fujda points out, "[H]umans' testimonies are always respected and taken seriously within ANT."[10] A common criticism of ANT is its failure to consider human intentions, morals, backgrounds, previous experiences, or political stances.[11] This issue is also present in our study, as many of our sources rely on the artists' accounts of the working processes under examination. We concur with Fujda on respecting, yet questioning, human testimonies.[12] We attempted to address this by gathering information from several interviews with different members of the working groups (including some artists peripherally linked to the networks), by framing our interview questions to also focus on non-human actors, and by examining the blueprints of non-human actors (such as the layout of ateliers and complex equipment) as well as the non-human actors themselves (including cameras, reprojectors, paper-puppets, masks, tapes, etc.).

An even more relevant characteristic of ANT, criticized by Teurlings, is its rejection of the notion of structure.[13] From the inception of ANT, Latour saw "no need to go search-

5) Bruno Latour, *Stopovat a skládat světy s Brunem Latourem: Výbor z textů 1998–2013*, trans. Čestmír Pelikán (Praha: Tranzit.cz, 2016).

6) Ibid., 8.

7) Teurlings, "What critical media studies should not take from actor-network theory," 69.

8) Jan Teurlings, "What critical media studies should not take from actor-network theory," in *Applying the Actor-Network Theory in Media Studies*, eds. Markus Spöhrer and Beate Ochsner (Hershey: IGI Global, 2017), 66–78.

9) Harry M. Collins and Steven Yearley, "Epistemological Chicken," in *Science as Practice and Culture*, ed. Andrew Pickering (Chicago: Chicago University Press, 1992), 301–326.

10) Milan Fujda, "Zakázaná slova, etnometodologické inspirace a náboženství jako modus existence: recenzní esej ke knize 'Stopovat a skládat světy s Brunem Latourem'," *Religio: revue pro religionistiku* 25, no. 2 (2017), 155.

11) E.g.: Langdon Winner, "Upon Opening the Black Box and Finding It Empty: Social Constructivism and the Philosophy of Technology," *Science, Technology, & Human Values* 18, no. 3 (1993), 362–378; Reijo Miettinen, "The Riddle of Things: Activity Theory and Actor-Network Theory as Approaches to Studying Innovations," *Mind, Culture and Activity* 6, no. 3 (1999), 170–195 or Chris McLean and John Hassard, "Symmetrical Absence / Symmetrical Absurdity: Critical Notes on the production of Actor Network Theory," *Journal of Management Studies* 41, no. 3 (2004), 493–519.

12) Fujda, "Zakázaná slova, etnometodologické inspirace a náboženství jako modus existence," 155.

13) Teurlings, "What critical media studies should not take from actor-network theory," 69.

ing for mysterious or global causes outside networks,"[14] thereby rejecting sociological abstractions such as structure, patriarchy, racism, or capitalism, as they present possible deus ex machina that are too easily invoked. According to Teurlings and others, this leads to the delegitimization of studying these structures altogether.[15] This is a crucial issue for our study, as the production of animated films (and indeed any form of media) operates within an economic mode of production. In our cases, it is not the capitalist mode of production (whose existence is occasionally acknowledged even by Latour)[16] but rather the state-socialist mode of film production, as defined by Petr Szczepanik:

> The state-socialist production systems of East-central Europe products of the centralization and nationalization that took place after 1945. They were supervised by a central administrative body, were the subject of communist party control, state censorship, and bureaucratic production plans and norms, and were required to issue permanent, as opposed to short-term, contracts of employment. At the same time, they were recipients of the material and symbolic benefits of modernization, which included the establishment of new studios, laboratories, distribution networks, film schools, clubs, and film festivals.[17]

The state itself was equivalent to the owners of a major Hollywood studios and was therefore responsible for the production infrastructure, labour division and the general flow of the capital.[18] This caused, among other things, many specific constraints regarding the available equipment. Let us use the Xerox copy machine as an example. In the Western Bloc animation studios, like the Walt Disney Studio, there was generally no political reason to monitor the copy machine which therefore could have been used as a production tool. Since the 1950s, photocopying was revolutionising both American offices and Disney's animation,[19] but an unsupervised copy machine in a film studio would be inconceivable in East-central Europe during this time.

It is important to recognise that FS Kudlov and Se-Ma-For operated within a specific, partly self-supporting system. The working groups we studied might be reminiscent of the so-called "units"[20] – semi-autonomous groups of writers, directors, production managers, and other personnel.[21] However, we seek to overcome the traditional focus on "personnel"

14) Bruno Latour, *We Have Never Been Modern* (Cambridge: Harvard University Press, 1993), 130.
15) Teurlings, "What critical media studies should not take from actor-network theory," 70.
16) Latour, *Reassembling The Social: An Introduction to Actor-Network-Theory*, 167–168.
17) Petr Szczepanik, "The State-socialist Mode of Production and the Political History of Production Culture," in *Behind the Screen: Inside European Production Cultures*, eds. Petr Szczepanik and Patrick Vonderau (New York: Palgrave Macmillan, 2013), 115.
18) Ibid.
19) See Hannah Frank, *Frame by Frame: A Materialist Aesthetics of Animated Cartoons* (Oakland: University of California Press, 2019), 211–256.
20) Szczepanik, "The State-socialist Mode of Production and the Political History of Production Culture," 117.
21) Szczepanik works with the "dramaturgical unit," where dramaturgs coordinated screenplay development but were largely isolated from the production process and answered directly to Central dramaturgy. This was typical of live-action film production during the studied period (1970–1982). However, in animation production at both Gottwaldov and Łódź, directors often took on multiple roles, including screenwriting and serving as liaisons with Central state dramaturgy. As a result, the smaller working groups in animation

and the exclusion of non-human actors is precisely why we believe that combination with ANT has merit, as we will try to demonstrate in this text.

In this approach, the studied working groups and ateliers are viewed as *hybrids* — combinations of humans, nature, and technology. Rather than considering humans and non-humans as separate categories, ANT highlights the necessary entanglement between the two.[22] In the working groups, we examined at both studios, skilled human workers interacted with specific non-human elements such as facilities, equipment, and materials, creating networks of newly established working processes. Actors within these networks are not fixed points; rather, they contribute dynamism to the network through their flexibility.[23] The process of *enrolment* of an actor into the network is, in simple terms, a series of attempts to position the actor in a desired role within the network's dynamics. This is a crucial aspect of "translation," during which all the actors must agree that the network is worth creating and maintaining. If this process is successful, the actor becomes indispensable to the network. However, it is common for the original form of the actor to change throughout this process.[24] From a Latourian perspective, it is essential to understand not only the actors and their actions but also their effects on other actors. The concepts of *intermediaries* and *mediators* are useful in exploring this dynamic. An intermediary does not alter inputs; that is, inputs are exactly equal to outputs.[25] It works with input information predictably, so its role may be somewhat neglected. It may be distributed over multiple elements by the principle of assemblage, but to examine its actions and network effects, it can be considered as a single actor. In contrast, the mediator transforms and translates the input, often introducing various distortions or changes in meaning, making the output unpredictable. Both human and non-human actors can serve as mediators or intermediaries within networks.

As this research focuses on the networks formed around newly established work processes — comprising people, equipment, materials, and even spaces within the studios — we frequently encounter significant changes to previously established networks. Therefore, it is crucial to trace which actors functioned as mediators and which as intermediaries, and to understand the effects that new actors brought into the network. Indeed, even something as detailed as a particular type of paper with a specific surface finish can have an impact on the functioning of the animation production network.

Another key concept in ANT is the *black box*. A black box is a tool, object, or system that works with inputs, outputs and transmissions. We lack insight into how the black box operates internally or how it processes incoming inputs, and consequently, we cannot fully understand how the transfer of information takes place. We therefore have no information on how and by what the output has been affected. However, the input is not necessarily always transformed.[26] In these studies, we are primarily locking into the black box the

were more integrated with the production process, unlike their counterparts in live-action film production. Szczepanik, "The State-socialist Mode of Production and the Political History of Production Culture," 121.

22) Mike Michael, *Actor-Network Theory: Trials, Trails and Translations* (London: SAGE Publications Ltd., 2017), 40–43.

23) Latour, "On actor-network theory: A few clarifications," 371.

24) Michael, *Actor-Network Theory: Trials, Trails and Translations*, 38–39.

25) Latour, *Reassembling the Social: An Introduction to Actor-Network-Theory*, 39.

26) Ibid.

production and development of other departments within FS Kudlov and Se-Ma-For studios. This includes other working groups within the studios as well as the development of FS Kudlov's laboratories. While it may be touched upon peripherally, our primary focus remains on the working group led by Karel Zeman at FS Kudlov and the groups working with the reprojector at Se-Ma-For.

Much like Teurlings,[27] we conclude that the appropriate application of the right dosage of ANT can enhance our understanding of film industry networks. Although this may appear as a "methodological crutch," ANT's descriptive nature often falls short in providing clear guidelines for analysing network dynamics. However, it remains an invaluable tool due to its ability to capture the myriad entities that shape the network. Employing ANT enables us to detail the processes that create and sustain the dynamic behaviours within these networks. We believe that an ANT-enhanced comparative study can deepen our understanding of the selected subjects — working processes affected by human skills, spatial environments and technical equipment.

While ANT has naturally been seen as more suitable for the studies of technology rather than culture, this notion has been challenged several times over the past two decades. In the field of film and media research, the use of ANT in production studies offers relevant examples. Markus Spöhrer, for instance, explores ANT's potential as an approach to production studies based on a detailed production log written by producer Paul Lazarus.[28] Similarly, Oli Mould, through a case study of the Australian feature film *Three Dollars*, demonstrates how ANT can be employed to describe the project-based mode of film production, which is sensitive to the freelance workers involved.[29] Furthermore, Björn Sonnenberg-Schrank's *Actor-Network Theory at the Movies: Reassembling the Contemporary American Teen Film With Latour*[30] represents one of the first major publications applying ANT to film studies.[31]

This text seeks to continue the discussion of ANT's method in film studies and to test its possibilities and limitations. The significant presence of non-human actors and their agencies cannot be overlooked, and ANT is the most effective tool to fully account for these factors.

ANT's approach allows us to consider this duality, enabling us to explore it in all its complexity. Our primary focus is on the role of equipment and spaces. In both cases, spe-

27) Teurlings, "What critical media studies should not take from actor-network theory," 74.

28) Markus Spöhrer, "Applying Actor-Network Theory in Production Studies: The Formation of the Film Production Network of Paul Lazarus's *Barbarosa* (1982)," in *Applying the Actor-Network Theory in Media Studies*, eds. Markus Spöhrer and Beate Ochsner (Hershey: IGI Global, 2017), 114–141.

29) Oli Mould, "Lights, Camera, but Where's the Action? Actor-Network Theory and the Production of Robert Connolly's *Three Dollars*," in *Production Studies: Cultural Studies of Media Industries*, eds. Vicki Mayer, Miranda J. Banks, and John T. Caldwell (New York: Routledge, 2009), 203–213.

30) Björn Sonnenberg-Schrank, *Actor-Network Theory at the Movies: Reassembling the Contemporary American Teen Film with Latour* (Cham: Palgrave Macmillan, 2020).

31) The author of this text has also previously examined the possibilities of ANT as a methodological tool in the context of Gottwaldov film culture. Tereza Bochinová, "FABrika Kudlov: Studie působení aktérů na produkční kulturu FA Kudlov mezi lety 1945–1952" (Masters's thesis, Faculty of Arts, Masaryk university, 2020) and Tereza Bochinová and Kateřina Šrámková, "Možnosti využití ANT ve výzkumu materiálů gottwaldovského animovaného filmu," in *Lidé — Práce — Animace: Světy animovaného filmu na Kudlově*, ed. Pavel Skopal (Brno: Host, 2024).

cific pieces of equipment were newly introduced into the production process in the 1970s, reestablishing working procedures that continued into the 1980s. In FS Kudlov's working group, these included a darkroom, photographic apparatus, textured papers, and soft-metal wires. For the Se-Ma-For working group, the primary elements were the reprojector and intermedia tape.

We have examined interviews with the human actors conducted by ourselves and our colleagues for this project,[32] as well as studied the available non-human actors: spaces and their historical blueprints, production documents, equipment itself, paper-puppets, masks, and tapes.

Gottwaldov — FS Kudlov

Cutout animation is one of the oldest animation techniques and is often regarded as one of the simplest and most cost-effective to produce. Unsurprisingly, this technique gained popularity in Czechoslovakia, particularly when there was a demand for television animation programmes. By the 1970s, the tradition of animated bedtime stories on television had become firmly established when the programme "Večerníček" became an integral part of Czechoslovak television broadcasting. The film studio Kudlov (FS Kudlov), located near the town of Gottwaldov (now Zlín),[33] became the main producer of these animated bedtime stories for the Czech television studio in Bratislava. FS Kudlov employed cutout animation in numerous projects. However, another already-established department at FS Kudlov developed an even more intriguing relationship with paper-puppets.

During the 1970s, director Karel Zeman returned to animation production after achieving worldwide acclaim for his adventurous feature films such as *Journey to the Beginning of Time* (Cesta do pravěku, 1955), *Invention for Destruction* (Vynález zkázy, 1958), *The Fabulous Baron Munchausen* (Baron Prášil, 1962), among others. For his next project, Zeman adapted the stories of Sinbad the Sailor, incorporating elements from other *Arabian Nights* tales, using a new animation technique that was similar to, but distinct from, cutout animation.

In the 1960s, the two key animation working groups in Gottwaldov — Hermína Týrlová's group and Karel Zeman's group — were relocated to a newly built building. The division of the floors was strategically planned according to the specific needs of each working group. At the time, Zeman required high ceilings for filming scenes with live actors and lights for his films combining live-action actors and animation. Consequently, he was allocated the top floor, which offered the necessary studio space with high ceilings. In contrast, Hermína Týrlová and her group were placed on the third floor, where the rooms

32) This text is a result of the implementation of the CEUS-UNISONO project funded by the National Science Centre entitled "Film Animation Studies in Gottwaldov and Łódź (1945/47–1990)" No. 2020/02/Y/HS2/00015. This publication was created with the financial support of the Grant Agency of the Czech Republic (GF21-04081K). The project was implemented at the Faculty of Arts of Masaryk University in the Czech Republic and the Faculty of Philology of the University of Łódź in Poland.

33) The town was renamed Gottwaldov between 1949 and 1989 when the name changed back to the original name Zlín.

were more office-like in design. The high ceilings on Zeman's floor served as intermediaries, ensuring the efficient shooting of films that required large set pieces. Another intermediary was the floor itself, made of wooden cubes, which allowed for easy nailing of set pieces.[34)]

The space on the top floor also introduced several mediators — entities that brought unpredictable dynamics into the newly established network. One such mediator was the unreliable cargo elevator, which was designed to transport large set pieces from the top floor to the exterior of FS Kudlov. Additionally, the uninsulated ceiling created uncomfortable temperature conditions for workers in this large space. The workshop section of the atelier was located near the uninsulated windows to take advantage of natural light, which, while beneficial for lighting, also contributed to temperature fluctuations. A crucial actor in this new space was the darkroom, which will be examined in greater detail later.

The network of the studied working group also enrolled many human actors. The well-established collaboration within the "trick department," as Ludmila Zemanová referred to the group in her book,[35)] encompassed a range of professionals, including animators (e.g. Arnošt Kupčík, František Krčmář, Sylvie Sedlářová and initially also Jindřich Liška and Jan Dudešek), art directors and background painters (Zdeněk Ostrčil, Zdeněk Rozkopal), carpenters and woodworkers (Antonín Buráň), lighting department staff and camera operators (initially Antonín Horák and Bohuslav Pikhart, with Zdeněk Krupa joining in the 1970s) and a prop workshop of 2–3 workers (e.g. Alena Vicherková, Marie Mazůrková, Antonie Horáková). This group of actors formed a mostly pre-established working network, which gradually enrolled the new atelier space and, as a result, was able to implement a new working procedure.

This new working process involved several meticulous steps to create the animated characters:

1. Crafting a 3D model: The process began with sculpting a three-dimensional model of the character using wood or Modurit clay. This model often took the form of a classic puppet, and in some cases, only the head of the puppet was created.
2. Photographing the model: The next step involved capturing numerous photographs of the model from all angles and at various stages of movement using a camera.
3. Creating animation phases: The photographs were then transformed into animation phases. This involved developing, enlarging it to the required sizes, and editing the images using photographic methods.
4. Transferring phases to paper: The animation phases were then developed on paper multiple times (as shown in Fig. 1).
5. Hand-tracing the lines: The next stage required going over the faded lines of the paper images by hand to enhance clarity and detail.
6. Constructing cut-out puppets: Multiple cut-out "puppets" were created simultaneously (as illustrated in Fig. 2). These paper-puppets were reinforced with tape for durability and fitted with wire joints to provide the necessary mobility for stop-motion animation (as depicted in Fig. 3)

34) Zdeněk Krupa, interviewed by Pavel Skopal, August 20, 2021.

35) Ludmila Zemanová and Linda Zeman-Spaleny, *Karel Zeman a jeho kouzelný svět* (Brno: CPress, 2015), 36.

7. Animating the paper-puppets: Finally, the mobile paper-puppets were used for stop-motion animation. The reinforced and jointed puppets allowed for intricate and dynamic movements, bringing the characters to life in the final film.

Fig. 1: Uncut paper phases are visible behind Karel Zeman, *The Birth of Film Puppet* (Josef Pinkava, 1982, Czechoslovak Television). Source: The Czech Television Archive

Fig. 2: Paper phases of Master's head, *Čarodějův učeň* (Krabat — The Sorcerer's Apprentice, 1978). Source: Private archive. Photo: Tereza Bochinová

Cameraman Zdeněk Krupa recalls the specialized equipment in Zeman's atelier: "Zeman as a national artist was given a trick-film camera 'TK-3'(meaning 'triková kamera' — trick-film camera, type 3), the first of its kind, you see. So the film industry made a prototype of the camera and it didn't stay in Prague, but Zeman in Gottwaldov got it. Then we also got a photographic camera with a huge number of various lenses of the Linhof brand, that was the inheritance from Hanzelka and Zikmund (Czechoslovak travellers and filmmakers). So we had quite a bit of equipment for that time."[36)]

The "trick-film" camera mentioned was capable of simultaneously reeling two film strips at once. This enabled the integration of pre-recorded elements like rain, snow, bliz-

36) Zdeněk Krupa, interviewed by Pavel Skopal.

zards or splashing water into animated scenes, similar to the reprojector used in the Se-Ma-For studio. Additionally, the camera was instrumental in incorporating archival live-action film footage as backgrounds for animated sequences.

Krupa emphasised the skill required for these trick shots, particularly in mastering the correct exposures and the complexity of two-strip technology.[37] However, the process could become unpredictable, especially when the film strips passed through the camera mechanism multiple times,[38] making the camera a mediator in the production process. As Krupa explained, "Now, take into consideration the risk. Anything can happen. The material is delicate. Poorly formed loops on the strip or mechanical damage and then you don't know what they're going to do with the footage in the film lab and so on."[39]

This was similar to the multiplane camera used at Walt Disney Studios and a differently modified trick-camera used at Se-Ma-For, where comparable unpredictability could be found. Gottwaldov's trick-film camera was also modified for vertical shooting, but there does not seem to be such an emphasis on the number of vertical planes, nor the illusion of depth caused by having several layers of artwork moving at different speeds. Instead, the stationary animation table beneath the camera, with the movement of papercuts, produced a panoramic effect.[40] This setup required close collaboration between the cameraman, the director and the animator, with the non-human actor of the trick-film camera acting as a crucial connector within the film crew.

The goal of this intricate process was to counteract the flatness typically associated with cutout animation while striving to achieve the fluidity of hand-drawn films.[41] Leveraging his extensive experience with puppet film, Zeman began by creating three-dimensional models of his characters' heads. These models were then photographed from various angles. The darkroom, located conveniently on the same floor as Zeman's atelier, was a critical non-human actor enabling quick, controlled development of the images independently of the studios' main laboratories, though primary development of the photographic material (pictures of the 3D model) could still be done in the in-house laboratories of FS Kudlov if necessary.[42]

During darkroom development, the phases could be adjusted — whether resized, toned photochemically, or altered with analogue filters to disrupt the line drawing on the photographed models. Zdeněk Krupa recalls working closely with the props workshop in this stage of the process since in Zeman's working group, the cameraman also participated in the workshop preparation:

> I used to use photo papers with a matte natural surface finish, I used a raster pasted to the negative to distort the drawing, or I prepared tinting baths, etc. Several film cameras were used at the same time during the shooting and the actual shooting at

37) Zdeněk Krupa, "Kamera v animovaném filmu" (Bachelor thesis, Faculty of multimedia, University of Tomáš Baťa), 25.
38) Zdeněk Krupa, interviewed by Pavel Skopal.
39) Ibid.
40) Sylvie Sedlářová, interviewed by Tereza Bochinová, July 28, 2022.
41) Ibid.
42) Ibid.

> such a project took about two years, with an eight-member film crew directly involved.[43)]

The photographic and chemical materials were provided by the production department,[44)] with the final photo paper on which the animation phases were enlarged typically sourced from the Czech brand Foma due to its matte surface.[45)] Thanks to this, it could be further modified after development, for example by redrawing the line with pencil by animators and prop makers, making the Foma paper a seemingly reliable intermediary. The process capitalised on the camera operators' photography skills, a practice shared with the Łódź studio, as will be discussed later.

This workflow effectively compensated for the absence of a photocopier or printer — tools commonly used in similar contexts at Walt Disney Studios. In the state-socialist environment, access to such machines was restricted due to fears they could be used to print and copy anti-communist propaganda. The employees at FS Kudlov were aware of the Walt Disney studio's practices as Disney animated films were included in "study projections" which were a part of the job for Kudlov's animators.[46)] If our interviewees mentioned Xerox, they noted only the impossibility of their ownership leading them to improvise other time-saving methods.[47)] However, the studied process was not regarded as an imitation of the Xerox machine, but as a method with distinct artistic results.[48)]

Hannah Frank extensively discusses the Xerox photocopy machine and its effect on the Walt Disney studio.[49)] While stylistically the Xerox machine acted as an intermediary, faithfully transferring drawings onto celluloid with the same artistic intent since the late 1950s,[50)] it was actually quite disruptive to the studio's operations. The introduction of the Xerox machine eliminated the need for manual tracing, and consequently, led to the dissolution of the predominantly female ink and paint department at the Disney studio.[51)] In contrast, FS Kudlov's technique still necessitated the work of artists. This involved manually tracing lines lost during the process with a pencil, reinforcing paper-puppets with paper tape, and adding joints to paper-puppets made from thin copper wire, which provided them with mobility (see Fig. 3). This work was carried out by animators and props makers at workbenches positioned around the windows to take advantage of natural daylight. According to several testimonies, prop maker and art director Alena Vicherková[52)] was the most prominent figure in this post-process work.

43) Zdeněk Krupa, interviewed by Pavel Skopal.
44) Sylvie Sedlářová, interviewed by Tereza Bochinová.
45) Zdeněk Krupa, e-mail correspondence with Tereza Bochinová, July 22, 2022.
46) Petr Novotný and Ljuba Novotná, interviewed by Tereza Bochinová, June 5, 2021.
47) E.g. Sylvie Sedlářová, interviewed by Tereza Bochinová; Jaromír Hasoň, interviewed by Tereza Bochinová, February 17, 2022; Jaroslav Navrátil, interviewed by Tereza Bochinová, March 2, 2022.
48) E.g. Zdeněk Krupa, interviewed by Pavel Skopal; Zdeněk Krupa, e-mail correspondence with Tereza Bochinová; Sylvie Sedlářová, interviewed by Tereza Bochinová.
49) Hannah Frank, *Frame by Frame: A Materialist Aesthetics of Animated Cartoons* (Oakland: University of California Press, 2019), 211–256.
50) Hannah Frank, *Frame by Frame*, 216.
51) Ibid., 217.
52) E.g. Sylvie Sedlářová, interviewed by Tereza Bochinová; Zdeněk Krupa, interviewed by Pavel Skopal; Jaroslav Navrátil, interviewed by Tereza Bochinová, March 2, 2022.

Fig. 3: Detail of wire joints on Master's paper-puppet, *Čarodějův učeň* (Krabat — The Sorcerer's Apprentice, 1978). Source: Private archive. Photo: Tereza Bochinová

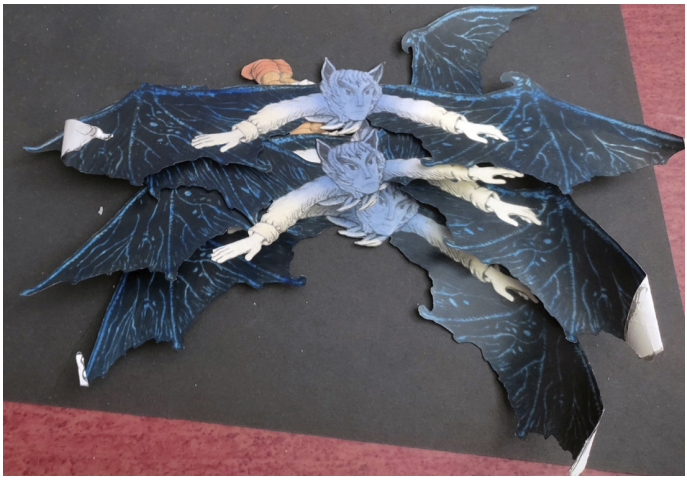

Fig. 4: Curled-up wings of paper-puppets from *Pohádka o Honzíkovi a Mařence* (The Tale of John and Mary, 1980). Source: Private archive. Photo: Tereza Bochinová

Used paper, however, acted as a mediator in certain animation scenes, particularly in the depiction of flight in *Pohádka o Honzíkovi a Mařence* (The Tale of John and Mary, 1980). The paper exhibited curling along its edges (see Fig. 4), an undesirable characteristic that animators had to address. This curling had to be factored into the animation process, as the paper's unique properties influenced the overall appearance of the scenes, imparting a distinct visual effect.[53)]

Animators and cameramen could simultaneously work at three animation tables within the atelier space.[54)] Ivan Matouš, an editor working for FS Kudlov, described the versatility of editing equipment:

> Some trick effects or mistake fixing could be done during the editing process. Once Zdeněk Krupa came to me with one of the directors and they needed to make some sequences longer which could not be done by animation in time. The animation and laboratory work would have taken 10–14 days. So, we came up with a solution to make a copy of the negative for the sequence and I could elongate it because it was repeating multiple times, and the audience would not notice.[55)]

53) Jaromír Hasoň, interviewed by Tereza Bochinová; Jaroslav Navrátil, interviewed by Tereza Bochinová.
54) E.g. Zdeněk Krupa, interviewed by Pavel Skopal; Sylvie Sedlářová, interviewed by Tereza Bochinová.
55) Ivan Matouš, interviewed by Pavel Skopal, July 16, 2022.

These mistakes-hiding techniques highlight the effects of hybrid actors enrolled in the network. According to the creators, the described working process was both time-saving, labour-efficient, and particularly effective for feature-length films.[56] The working process was developed for both short and feature-length film production in Karel Zeman's department. These films were designed for domestic cinema distribution as well as international festival circuits. This distribution model, prevalent in the state-socialist mode of the production environment, provided significant revenue and prestige, frequently emphasized in film periodicals as a selling point of the film.[57]

The production of serialized animation bedtime stories for the "Večerníček" TV programme at FS Kudlov was done by the unenhanced method of cutout animation technique, prioritising cost-effective production and different artistic characteristics.[58] This is of course not to say that these projects were lacking quality. Nevertheless, the approach did not aim to simulate the fluidity of hand-drawn films. Photographing 3D puppets was not necessary as the effect would have been invisible on smaller TV screens. Additionally, this method did not show strong cooperation between the director and the cameraman typical of Zeman's working group.[59]

However, a notable development occurred when the studied process, initially reserved for feature films, was adapted for TV production in the late 1970s.[60] A prime example is the second season of the serialized animation *American Indians Tales* (Indiánske rozprávky, 1983–1988), commissioned by Czechoslovak television in Bratislava, Slovakia, in the 1980s. The project, led by Ludmila Spálená-Zemanová and Eugen Spálený — both collaborators and relatives of Karel Zeman — utilised the studied process, ending the feature-film production exclusivity.[61] In 1984, following the illegal emigration of Ludmila Spálená-Zemanová and Eugen Spálený to Canada, Karel Zeman was given the roles of screenwriter and art director for the series, with Ladislav Vlk as director.[62] Consequently, the effect of the studied process persisted in the studio until the end of the nationalized film industry.

56) E.g. Zdeněk Krupa, interviewed by Pavel Skopal; Ivan Matouš, interviewed by Pavel Skopal; Sylvie Sedlářová, interviewed by Tereza Bochinová and Reconstruction blueprints of film school, source: Archive of the Municipality of Zlín, Department of Construction and Traffic Procedures, Department of Construction and Administrative Procedures (Construction Office), folder "Miscellaneous."

57) E.g. -tp-, "Čarodějův učeň," *Filmový přehled*, č. 11 (1978), 3; Jan Hořejší, "Čarodějův učeň a jeho mistr," *Kino* 33, č. 6 (1978), 9.

58) Sylvie Sedlářová, interviewed by Tereza Bochinová; Ladislav Vlk, interviewed by Kateřina Šrámková, February 2, 2023.

59) Ladislav Vlk, interviewed by Kateřina Šrámková.

60) Ibid.

61) Zdeněk Krupa, interviewed by Pavel Skopal; Sylvie Sedlářová, interviewed by Tereza Bochinová; Ladislav Vlk, interviewed by Kateřina Šrámková.

62) Zdeněk Krupa, interviewed by Pavel Skopal.

Łódź — 'Se-Ma-For'

Reprojection, also known as rear projection, is an in-camera cinematic technique that combines a pre-recorded background image with an image captured in the foreground.[63] Ray Harryhausen was one of the earliest animators who started using it in the 1950s, using rear screens in miniature sets with stop-motion creatures.[64] Later, in order to mechanize the process, one of the devices that used the rear projection technique in animated films was a trick table produced by Crass Company. This type of tables were also utilized in the 'Se-Ma-For' Studio of Small Film Forms in Poland.

In this analysis, I would like to show on the example of the production of the film *Tango* (Rybczyński, 1981) directed by Zbigniew Rybczyński that the use of experimental techniques available thanks to reprojection kit in the animation process, can bring measurable benefits to the studio.[65] In the central point of the considerations, using the approach of Actor Network Theory, I will place the trick table — "reprojection kit"[66] to show how it generates new ideas in human network working with it.

The studio began planning to acquire a trick table for developing such special effects in animated films following Edward Sturlis's initial use of the reprojection technique[67] in 1963. To implement reprojection on a larger scale, specialized equipment was necessary. In 1971, the studio's records indicate purchasing a reprojector kit, referred to as a "trick table" and a "Crass" camera for PLN 1,260,900.[68] This was a significant investment compared to the studio's capital expenditures in the period 1965–1973, which amounted to: 1965 — 55,000; 1966 — 256,000; 1967 — 294,000; 1968 — 696,000; 1969 — 140,000; 1970 — 598,000; 1972 — 528,000; 1973 — 102,000.[69] In 1977, the studio further invested

63) Charles Galloway Clarke, *Professional Cinematography*, 2nd edition (Los Angeles: American Society of Cinematographers Press, 1968), 153.

64) Robert Sellers, "Ray Harryhausen: Pioneer of special effects hailed as the master of stop-motion animation," *independent.co.uk*, accessed March 14, 2024, https://www.independent.co.uk/news/obituaries/ray-harryhausen-pioneer-of-special-effects-hailed-as-the-master-of-stopmotion-animation-8608340.html.

65) In 1983, Zbigniew Rybczyński won an Academy Award for Best Short Animated Film for *Tango* (Zbigniew Rybczyński, 1981), which was produced entirely using analogue technology at the 'Se-Ma-For' Studio of Small Film Forms in Łódź (1947–1999) between 1980 and 1981. *Tango* is regarded as the most complex animated film ever created at the studio, largely due to the use of a reprojector kit in its production.

66) Reprojection kit — this will be the name for the whole equipment: reprojector, camera, trick table. Reprojector — this will be named only for special kind of projector which was called reprojektor (*reprojector*).

67) In 1964, Edward Sturlis's working group, including cameramen Leszek Nartowski and Wacław Fedak, made the film *Plaża* (*The Beach*; Edward Sturlis, 1964). This project marked the first attempt to incorporate reprojection in an animated film at the 'Se-Ma-For' Studio of Small Film Forms in Łódź (1947–1999). Though the film is now classified as a combined film, it featured sequences where live-action sets were integrated with traditional drawing techniques. At that time, the studio did not yet have a reprojector kit. Instead, the layering was achieved by photographing the recorded live-action segments onto larger cellulose sheets, which served as backgrounds, onto which the drawn elements were then added. This method bears similarities to the techniques employed by Karel Zeman's working group.

68) "Analiza działalności za rok 1971," Archiwum Państwowe w Łodzi, sign. 39_19430_27, Łódź, Poland.

69) Analyses of the studio's investment expenditures from 1965–1973. Grants for the studio's activities were awarded every year by the General Board of Cinematography (GBC) (Naczelny Zarząd Kinematografi) on the basis of the demand presented by the studio. Subsidies were not always spent in full. Unspent funds were returned or not to GBCs by their decision. Perhaps such a large amount is the sum of unspent funds from previous years, which the studio did not return. This is only a guess, because in the document "Analysis of

PLN 610,000 in additional trick tables with "Crass" cameras and PLN 169,139 in a "Varic" lens for the reprojector.[70)]

The German company "Crass" was a leading supplier of reprojection kits in the 1970s, and some of the studio's equipment may have also been purchased from this supplier.[71)] Andrzej Strąk, an assistant operator at the studio, says that Zbigniew Rybczyński played a role in the purchase of technical equipment from Germany, potentially including the reprojector kit used for *Tango*.[72)] A comparison of the preserved table from the studio (Fig. 8) with images from the company's leaflet (Fig. 5, 6, 7), reveals a notable similarity.

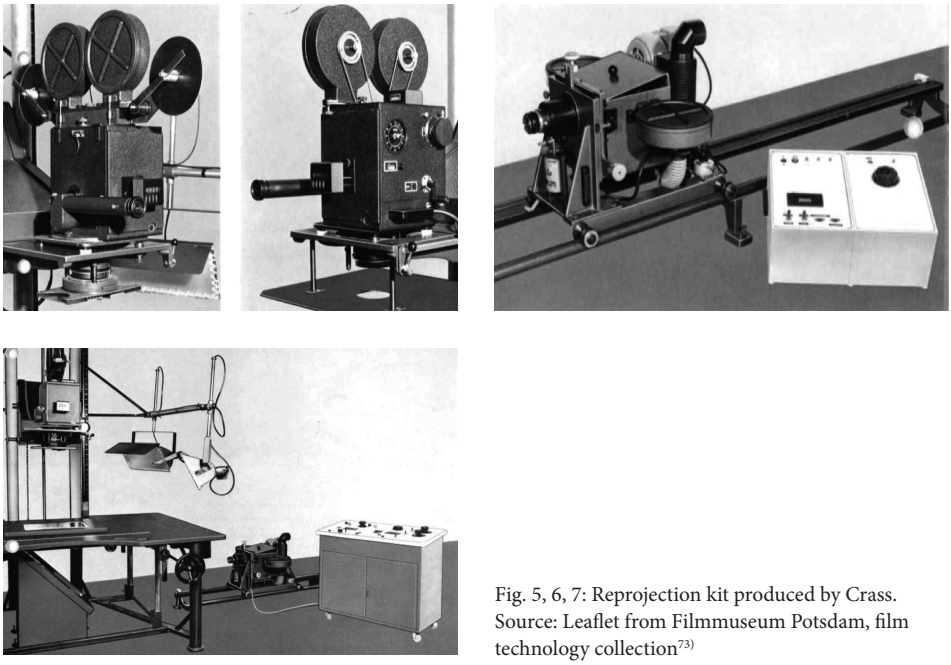

Fig. 5, 6, 7: Reprojection kit produced by Crass. Source: Leaflet from Filmmuseum Potsdam, film technology collection[73)]

activities for the year 1971," from which the information about the amount and purchase of the reprojection kit comes from, it is not indicated where the funds come from. Own compilation — Agata Hofelmajer-Roś based on materials: "Analizy działalności z lat 1965–1973," Archiwum Państwowe w Łodzi, sign. 39_1430_25, 39_1430_26, 39_1430_27, Łódź, Poland.

70) "Analiza działalności za rok 1977 i 1978," Archiwum Akt Nowych, sign. AAN_syg_11_43, Warsaw, Poland.

71) In the studio's documentation, reports reference Crass cameras, trick tables, and a reprojector. However, it's challenging to definitively identify specific equipment. Notably, on a surviving projector (pictured in Fig. 8), there is a label indicating it was manufactured by the "Crass company," suggesting the camera's origin.

72) At that time, Rybczyński was an active member of the Studio's Technical Council, giving him significant influence over the acquisition of new equipment, including the reprojector. According to Hieronim Neumann, Rybczyński was the first person to test the reprojector at 'Se-Ma-For'. His initial experiments with this technology were in the films *Plamuz* and *Zupa* in 1973, which aligns with studio records indicating that the reprojector was first put into service that same year. See the interview with Hieronim Neumann, conducted by Oliwia Nadarzycka on December 16, 2021, as part of the project archiv: Ewa Ciszewska and Szymon Szul, "Animation workers from `Se-Ma-For' Studio of Small Film Forms in Lodz (dataset)," Repozytorium Uniwersytetu Łódzkiego, 2024, accessed November 22, 2024, https://repozytorium.uni.lodz.pl/han- dle/11089/52081.

73) "Filmtechnik in Museen," *kameradatenbank*, accessed September 28, 2024, https://www.kameradatenbank.de/index.php/Detail/Object/Show/object_id/855.

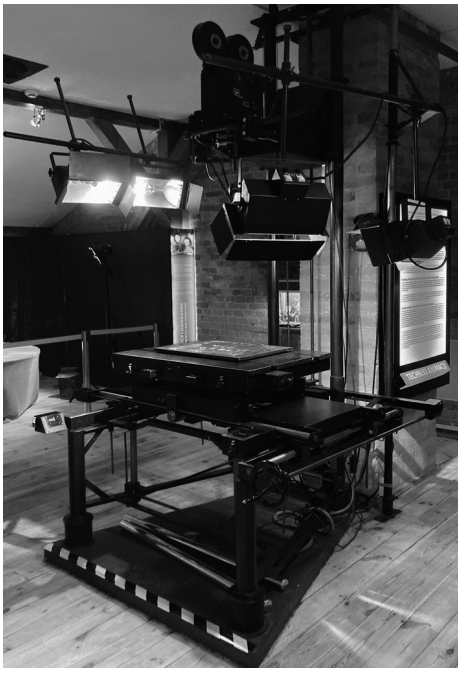

Fig. 8: Reprojector kit. Source: Muzeum Kinematografii in Łódź. Photo: Agata Hofelmajer-Roś

The reprojection equipment produced by the German company "Crass" included a camera for 35 mm, 16 mm, and Super 8 formats, known as "Trickfilm-Kamera"[74]; a reprojection table called "Tricktisch" which featured a mirror placed underneath; and a time-lapse projector, the "Ruckprojektions" available for 36 mm, 16 mm, and Super 8 formats equipped with a rail, a controller and a sound mixer.

Production materials for *Tango*,[75] suggest that the sound editing was done separately from the film's reproduction process. This implies that the version of the reprojection kit purchased by the studio might not have included a sound mixer. Although the surviving equipment from the studio is incomplete, it matches the same model. The camera stands 3 meters high, the table measures 2 meters in length, and 1.60 meters in width, and it is a single-station table, illuminated by four spotlights placed on tripods at its corners.

For 'Se-Ma-For's experimental or combined films, the integration of background images projected by the reprojector with live-action elements, such as recorded actors or other objects, was accomplished through in-camera editing on the trick table, which was part of reprojector kit. These films were:[76]

74) All the nicknames mentioned are taken directly from the "Crass" company leaflet. See: Filmmuseum Potsdam, film technology collection, "Filmtechnik in Museen," *kameradatenbank*, accessed September 28, 2024, https://www.kameradatenbank.de/index.php/Detail/Object/Show/object_id/855.

75) "Brak nazwy [*Tango*, Zbigniew Rybczyński, 1980]," Archiwum FINA Łąkowa 29, Warsaw, Poland.

76) The list of films is composed based on information from interviews with the crew members including: Hieronim Neumann, Zbigniew Kotecki, Daniel Szczechura, Ryszard Szymczak, Edward Strąk, Stanisław Lenartowicz. See database: Ciszewska – Szul, "Animation workers from 'Se-Ma-For' Studio of Small Film Forms in Lodz (dataset)." Additional information is sourced from the filmpolski.pl portal: https://filmpolski.pl/fp/index.php.

Table 1

Title and director	Trick's crew
Mozaika (Janusz Połom, 1975)	cameraman: Janusz Połom, editing: Henryka Sitek awards: 1976, Moscow (FF Trick and Technical) — Honorable Mention
Śniadanie na trawie (Breakfast on the Grass; Stanisław Lenartowicz, 1975)	co-director: Anna Ziomka, cameraman: Stanisław Kucner, Andrzej Teodorczyk, editing: Barbara Sarnocińska awards: 1976, Linz (International Film Festival) — Second Prize
Portret (Portrait; Stanisław Lenartowicz, 1977)	co-production: Anna Ziomka, cameraman: Ryszard Waśko, Lechosław Członowski, Wacław Fedak, editing: Barbara Sarnocińska; co-production: Anna Ziomka awards: 1977, Kraków (International Film Festival) — CIDALC Award (UNESCO Commission for the Dissemination of Art and Literature through Film)
Plamuz (Zbigniew Rybczyński, 1973)	cameraman: Zbigniew Rybczyński, Janusz Olszewski awards: 1985, Wrocław — (International Film Festival "Jazz Film Saloon") — I Prize
Zupa (Soup; Zbigniew Rybczyński, 1974)	editing: Barbara Sarnocińska awards: 1978, Chicago (International Film Festival) — Golden Badge
Nowa książka (New Book; Zbigniew Rybczyński, 1975)	cameraman: Zbigniew Rybczyński, Jerzy Zieliński, Janusz Olszewski, Andrzej Teodorczyk awards: 1976, Oberhausen (MFFK) — Main Prize; 1976 — Kraków (KFF) — Bronze Lajkonik; 1977 — Huesca (International Short Film Festival) — Honorable Mention; 1977 — Melbourne (International Film Festival) — Third Prize
Lokomotywa (Locomotive; Zbigniew Rybczyński, 1976)	cooperation: Janina Dychto, Janusz Olszewski, Andrzej Teodorczyk awards: 1977, Poznań (International Young Audience Film Festival "Ale Kino!") — Brown Goats
Tango (Zbigniew Rybczyński, 1981)	cameraman: Zbigniew Rybczyński, Andrzej Teodorczyk, Janusz Olszewski; co-director: Andrzej Strąk, Halina Krajewska, animation: Janina Dychto, editing: Barbara Sarnocińska awards: 1981, Kraków (KFF) — Bronze Lajkonik; 1981 Oberhausen (International Film Festival) — FIPRESCI Award; 1981, Huesca (International Short Film Festival) — Special Jury Award; 1981, Annecy (International Animated Film Festival) — Main Prize "Annecy's Crystal"; 1983, Academy Award for Best Animated Short Film
Fatamorgana I (Mirage I; Daniel Szczechura, 1981)	cameraman: Andrzej Górski, editing: Henryka Sitek awards: 1982, Oberhausen (International Film Festival) — Award of the FICC Film Clubs
Fatamorgana II (Mirage II; Daniel Szczechura, 1983)	cameraman: Zbigniew Kotecki, Andrzej Górski, co-production: Anna Kopeć, Halina Krajewska, Ewa Stańczuk, Anna Ziomka
5/4 (Hieronim Neumann, 1979)	cameraman: Jerzy Zieliński, Janusz Olszewski, Andrzej Teodorczyk, editing: Barbara Sarnocińska
Blok (Block of flats; Hieronim Neumann, 1982)	cameraman: Zbigniew Kotecki, editing: Henryka Sitek, co-production: Andrzej Strąk, Janina Dychto, Janusz Olszewski, Ignacy Goncerz, Ewa Stańczuk awards: 1982, Huesca (International Short Film Festival) — Second Prize in the feature film category; 1983, Oberhausen (MFFK) — FICC Film Clubs Award

Table 1

Zdarzenie (Event; Hieronim Neumann, 1987)	cameraman: Zbigniew Kotecki, editing: Henryka Sitek, co-production: Janina Dychto, Janusz Olszewski, Piotr Jaworski, Zygmunt Smyczek, Krzysztof Kowalski awards: 1988, Oberhausen (International Film Festival) — Main Prize; 1988, Kraków (KFF) — Award for cinematography; 1989, Lausanne (International Film Festival on Architecture) — Press Award for the best animated film

In animated films made using traditional cartoon animation techniques, only the reprojector from the reprojector kit was utilized. Ryszard Szymczak, an animator and director of animated films at the studio since the 1960s, notes that the teams of cartoonists used the projector as an auxiliary tool to trace the movements of animals.[77] The projector displayed an image from below onto the drawing desk, with tracing paper placed on the top. The cartoonists then drew the successive phases of the movement of the displayed figure, such as an elephant, on the tracing paper. This method allowed them to accurately capture each stage of movement, akin to drawing from nature. However, a challenge was that the film in the projector heated up quickly, requiring the artists to work rapidly.

For cartoon animators, therefore, the reprojector kit served as an intermediary similar to the Xerox machine, not altering the final output. The technique involved a series of repetitive actions aimed at achieving consistent results. The cartoonists did not experiment with exposure times or use masks and counter-masks. Instead, the reprojector was used to streamline production, rather than to innovate the visual style.

In contrast, the methods employed by the working group responsible for the films listed in Table 1 were experimental, characterized by their uniqueness. The new reprojection technique allowed crew members to develop their skills in innovative ways. The reprojector kit enableds various tricks, such as creating repetitions, comparing effects, changing colors and textures, and integrating live-action elements with animated sets. The artistic effects achieved were a result of the deliberate use of the reprojector kit, which guided the choice of effects based on the specific capabilities of the device.

However, the reprojector's complex design, large size, and other physical attributes imposed significant constraints on film production. These limitations affected both the mental and physical well-being of the filmmakers. In the below-mentioned examples from the trick's crew, the reprojector kit acts as a mediator, causing several production failures and sometimes changing the final output. Hieronim Neumann, a film director, described the process as follows: "It was hard, arduous work. You sat in a dark room for weeks and it wasn't really attractive to the cameramen, neither financially nor artistically."[78] Consequently, only a few operators or assistants were willing to take on this type of work.

Zbigniew Kotecki, a cameraman who worked with the reprojector kit, highlighted the challenges of maintaining proper orientation and color intensity.[79] With no ability to preview the completed material, errors often resulted in dark images, lacked contrast,

77) Ryszard Szymczak, interviewed by Oliwia Nadarzycka, July 28, 2021, see database: Ciszewska – Szul, "Animation workers from 'Se-Ma-For' — Studio of Small Film Forms in Lodz (dataset)."

78) Neumann, interviewed by Oliwia Nadarzycka.

79) Zbigniew Kotecki, interview by Agata Hofelmajer-Roś, August 31, 2022, SAFGŁ, sign. SMFF_AHR_0004, Łódź, Poland.

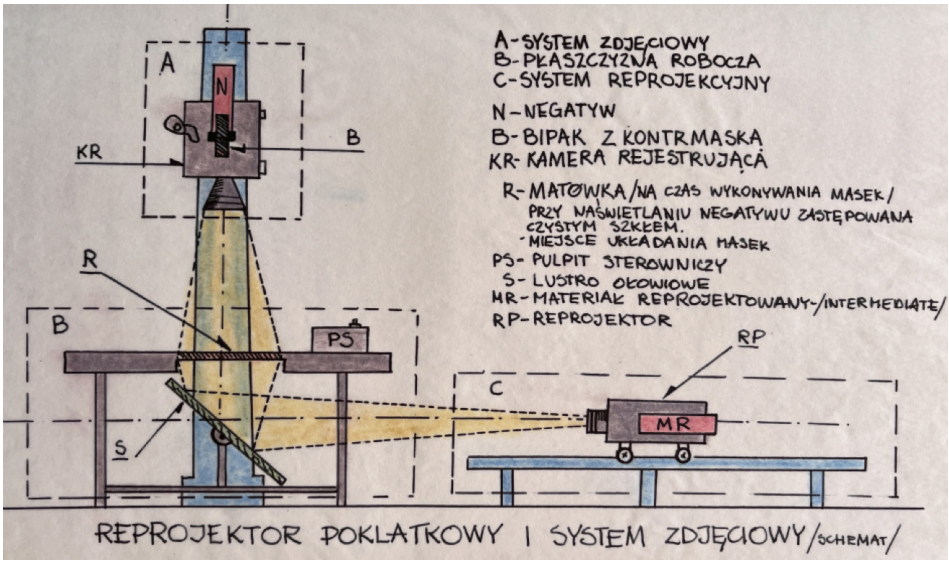

Fig. 9: The light path. Source: Zbigniew Weresa. Photo: Agata Hofelmajer-Roś

and had misaligned layers. The live-action part of the image from the reprojector (RP) was projected through a lead mirror (S) onto the working surface of the shooting table (R), ultimately landing on the focusing screen (Fig. 9).

The reprojector kit from the "Crass" company was highly regarded by 'Se-Ma-For' cameramen as one of the best available. However, achieving consistent light intensity across all points was crucial. This required precise illumination of the projection material and careful alignment of the axes. Even light distribution over the image surface was essential; while the centre of the image was the brightest, brightness and sharpness diminished towards the edges. Proper lens fitting could mitigate these imperfections, but this demanded a deep understanding of optics and photography principles, a skillset that characterized teams working with the reprojector kit.

To maintain accurate color reproduction, the 'Se-Ma-For' studio used an intermediate film strip. However, this was imported with limited availability, typical of the state-socialist production environment. The Supreme Board of Cinematography (Naczelny Zarząd Kinematografii — NZK) established the Film Production and Technology Team which set standards for the wear of the film and allocated an annual limit for ordering different types of film. Intermediate, Eastman, and high-contrast black-and-white tapes were very expensive and usually procured from abroad using foreign currency. Consequently, filmmakers had to estimate their needs very precisely. In 1975, one combined film required between 220 and 240 meters of film.[80] Despite the high costs, NZK approved orders for these materials to increase competitiveness and chances for awards.

Since Se-Ma-For, unlike FS Kudlov, did not have its own laboratories, film development was outsourced to various external laboratories, including the Feature Film Studio,

80) "Informacje o produkcji 1946–76," Archiwum FINA Łąkowa 29, Warsaw, Poland.

the Film Rental Headquarters, or laboratories abroad, such as in Czechoslovakia. The development process took two to three weeks, causing long delays between film production stages. These delays significantly affected production time, as reprojector kit settings had to be repeated by different working groups, while waiting for film development.

The reprojection kit enabled the superimposition of multiple image layers within a single frame. It facilitated the transfer of pre-recorded footage, such as live-action scenes, onto various backgrounds or other prerecorded material. The technique itself suggested the choice of effects for the film, as it allowed for the combination of multiple live-action elements within a single frame. The mask system was a supportive technique, with the reprojector kit enabling the layering of different images, akin to superimposing multiple tapes with varying materials. These layers could be resized and combined into a single video using a camera that captured the composed layers.[81)]

This process is akin to layering different images on top of each other. A film with one set of material can be overlayed onto another, with the option to reduce or enlarge the layers as needed. By stacking these layers, a camera can capture a composite image of the combined layers in a single shot.[82)] In *Tango*, twenty-two layers were used. To prevent images from overlapping, some layers needed to be masked or revealed selectively. To achieve this, cinematographers and directors created masking tapes (Fig. 10).

Creating masks[83)] and maintaining the cleanliness of the work surface on the table required continuous, uncomfortable hours spent half-bent over the table, often under the glare of four incandescent spotlights. Additionally, many hours were spent in the darkroom preparing counter-masks on light-sensitive material, which led to spinal injuries, as noted by Zbigniew Kotecki.[84)]

To illustrate how complicated process it was, I will describe the production of *Tango* by Zbigniew Rybczyński, which we can split into four phases:[85)]

1. Shooting live-action material: Multiple shots were taken of individuals moving along painted paths on the floor within the same set design. These images were recorded on Kodak intermediate tape (slide) at a fixed focal length.
2. Creating masks: Separate masks (Fig. 10) were made for each character, and frames showing character movements were reduced to minimize masking. The masks were painted with tempera paint and Mowilith[86)] on celluloid, with perforations and dimensions matching 35 mm film. Approximately six thousand masks were created.
3. Making counter-masks: Celluloid masks were used to produce counter-masks on black and white High Contrast film (Fig. 11). These counter-masks facilitated exposure of the background on the High Contrast film. The entire length of the film was used for this masking process, employing bipack attachment that allowed simultaneous movement of two tapes: a negative and a counter-mask.

81) Kotecki, interviewed by Szymon Szul, November 18, 2021, see database: Ciszewska – Szul, "Animation workers from 'Se-Ma-For' — Studio of Small Film Forms in Lodz (dataset)."
82) Kotecki, interviewed by Agata Hofelmajer-Roś.
83) The masks were made separately by hand, putting ink directly on a tape with a rapidograph pen.
84) Kotecki, interviewed by Szymon Szul.
85) This description is based on a work: Zbigniewa Jerzego Weresy, op. cit.
86) Paints with coalescent agents, low emission paints, exterior coatings, facade paints (mineral substrates).

Fig. 10: Mask of a girl. Source: Zbigniew Weresa. Photo: Agata Hofelmajer-Roś

Fig. 11: Live-action footage — intermediate film stock, mask for background-high contrast, background exposition, black and white copy for sound. Source: Zbigniew Weresa. Photo: Agata Hofelmajer-Roś

4. Reeling the image: The final image was recorded on Eastman colour negative. The process involved reprojecting the material through the projector (containing the live-action shots), applying the masks on the table, and using the negative in the camera and the counter-mask in the bipack.[87)]

The reprojector kit was integral to every stage of this animation process, enabling the combination of numerous live-action elements within a single frame. This meant that errors could occur, such as the one related to the film *Tango*. During it production, the reprojector kit experienced several failures. After about a month of shooting, the grippers[88)] in the tape moving mechanism were damaged, resulting in the destruction of 600 meters of intermediate tape. This setback extended the production time and increased costs, as masks had to be recreated and the film redeveloped. The malfunction was attributed to the

87) I described this process based on: Daniel Szczechura, interviewed by Ewa Ciszewska and Agata Hofelmajer-Roś, September 5, 2023, SAFGŁ, sign. SMFF_ECAHR_0001, Łódź, Poland, Kotecki, interviewed by Ewa Ciszewska and Agata Hofelmajer-Roś and books: Zbigniew Rybczyński, *Traktat o obrazie* (Poznań: Art Stations Foundation, 2009); Grodź Iwona, *Synergia sztuki i nauki w twórczości Zbigniewa Rybczyńskiego* (Warszawa: Wydawnictwo Naukowe, 2015); Zbigniew Jerzy Weresa, "Twórczość filmowa Zbigniewa Rybczyńskiego na tle rozwoju polskiego filmu animowanego" (Unpublished Master thesis written under the supervision of Kazimierz Sobótka at the Institute of Literary Theory, Theatre and Film, University of Łódź, Łódź, 1985).

88) Using a reprojector kit, recorded footage on tapes could be played back in time-lapse, enabling the working group to meticulously construct each scene within the frame. This technique is exemplified by the detailed frame-by-frame calculations for Zbigniew Rybczyński's film *Tango*, which were meticulously plotted on graph paper. As a result, the masks precisely obscured selected areas, allowing 22 figures to seamlessly coexist in a single shot.

excessive wear of the mechanism due to repeated masking activities. After approximately six months, the camera malfunctioned, complicating focus adjustments. Consequently, the film's production spanned from February to December 1980. The unpredictable issues with the reprojector kit led to a production cost of PLN 962,850 for *Tango*.[89] Additional challenges included a shortage of standard celluloid, the need for precise cutting of capacitors and undersized perforation pins. Masks also required two coats of paint to ensure impermeability,[90] necessitating the work of three extra people for twelve hours a day over three months to complete these tasks.

Access to film sets for recording live-action material was facilitated by the placement of reprojector kits at Bednarska 42[91] and Pabianicka Street,[92] and the Wytwórnia Flmów Fabularnych on Łąkowa Street. As Hieronim Neumann notes: "[…] to use something like reprojection, to combine these live-action photos with animation, you need to have access to a real film set. And it worked very well in Łódź."[93] In contrast, FS Kudlov's working group utilized both archival and new live-action footage, but Karel Zeman's atelier, which was well-equipped with a spacious filming set, had less spatial dependency for its footage.

The reprojector kit fostered a network of specialists — human actors with expertise in optical phenomena, film development and stop-motion animation. Despite the presence of dedicated departments like the Combined Photography Department, Trick Workshop, and Animated and Special Photography Department, film teams working with the reprojector kit were not always recruited from these specialized units. Expertise in optics, photography, and art history was crucial for employing the advanced techniques provided by the reprojector kit. The selection of team members was often influenced by the director's preferences, as working with the reprojection technique required a unique skill set. Knowledge of photographic and film equipment mechanics, film exposure and development, lighting, lens optics, mask usage, and meticulous photographic material handling were essential.

Despite the small size of the teams working on the reprojector kit, their work was very labor-intensive and precise, which meant that tasks could not be easily divided among many people. Firstly, there were not so many specialists available, and secondly, the set-up for each project was customized without standardized settings, making it difficult for new members to replicate previous configurations. The production method at 'Se-Ma-For' relied on small, specialized group working on unique, technically complex projects involving numerous transformations and effects.[94]

Neumann also mentioned that operators at 'Se-Ma-For' were initially apprehensive about the reprojector kit due to its complexity. The fear of using this innovative device was prevalent until Rybczyński's productions led to a new wave of directors embracing

89) Op. cit.,"Brak nazwy [*Tango*, Zbigniew Rybczyński, 1980]," AFINA.
90) Ibid.
91) Janusz Martyn (animator) claims that the reprojector kits were located on Bednarska 42 Street. Janusz Martyn, interviewed by Szymon Szul, May 25, 2022, SAFGŁ, sign. SMFF_0022, Łódź, Poland.
92) In the production file for the film *Tango*, it is noted that the reprojection kit was utilized at locations on Bednarska and Pabianicka streets. See: Ibid.,"Brak nazwy [*Tango*, Zbigniew Rybczyński, 1980]," AFINA.
93) Neumann, interviewed by Oliwia Nadarzycka.
94) Kotecki, interviewed by Szymon Szul.

the technology. Among them were Lenartowicz and Szczechura, who had previously worked at the studio. Despite this, only a small group of five directors and cinematographers – Rybczyński, Nuemann, Lenartowicz, Połom and Szczechura — became prominent users of the reprojector kit.[95]

The directors and cinematographers who worked with the reprojector kit were mostly graduates of film academies, including Szczechura (1962), Rybczyński (1973), Połom (1977) and Kotecki (1979), from the Cinematography Department at the National Film, Television and Theatre School in Łódź (Państwowa Wyższa Szkoła Filmowa, Telewizyjna i Teatralna im. Leona Schillera w Łodzi — short PWSFTViT). Rybczyński and Połom were also members of the Film Form Workshop during their studies. Neumann graduated from the Faculty of Painting, Graphics and Sculpture at the State Higher School of Fine Arts in Poznań in 1977 (Państwowa Wyższa Szkoła Sztuk Plastycznych) and completed his student internship at 'Se-Ma-For' with Lenartowicz. Rybczyński supervised Neumann's first independent film *Wyliczanka* (1976) and collaborated with Połom on the production of the film *Oj, nie mogę się zatrzymać* (Oh, I Can't Stop; Zbigniew Rybczyński, 1975). Lenartowicz graduated from the Extramural Studies of the Directing Department of the National Film School in Łódź in 1978. The opportunity to work on creative animations at Se-Ma-For provided these graduates with a platform to achieve international acclaim.[96]

Assistants and other staff members such as Wacław Fedak, Henryka Sitek, Tadeusz Strąk, also had experience with tricks and reproductions, including work on the full-length film *Mniejszy szuka Dużego* (The Smaller Seeks the Big; Konrad Nałęcki, 1975). Stanisław Lenartowicz even thinks that the rerojector kit significantly broadened, if not so much in animation, but the possibilities of telling stories, enriching not only animations but also feature films and documentaries."[97]

The introduction of the reprojection kit led to the establishing of a special Technical Council at the studio in 1976. This council, composed of Henryk Ryszka (cameraman), Mieczysław Janik (sound designer), Wacław Fedak (cameraman), Zbigniew Rybczyński (director), Daniel Szczechura (director), Stanisław Kucner (cameraman), and Andrzej Teodorczyk (cameraman), was responsible for assessing photographic technology, making investment decisions in film equipment, developing modernization programs, and keeping abreast of film technology advancements in Europe and worldwide. The directors and crews working on the reprojector kit were instrumental in integrating well-known technologies in new ways, furthering the studio's commitment to innovative filmmaking. Re-

95) Neumann, interviewed by Oliwia Nadarzycka.

96) An important figure here is Jerzy Kotowski, who made his animated films at Se-Ma-For before becoming the rector of the State Higher School of Theatre, Television and Film in Łódź. Hieronim Neumann recalls that despite completing his graduate internships, as a student of the National Film School in Łódź, with Lenartowicz and Połom, he officially made his documentary film debut with Kotowski. It was he who directed him to the studio, where he later completed his diploma film *Wyliczanka* (Hieronim Neumann, 1976) with Rybczyński. Kotowski was therefore the person who directed the students to the studio, which translated into the fact that it was there that they made their own experimental films. The same is true of Janusz Połom, who made his debut *Mozaika* at Se-Ma-For under the pedagogical supervision of Jerzy Kotowski. See Ewa Ciszewska and Dominik Piekarski, "Początki drogi twórczej Jerzego Kotowskiego: szkic do biografii," *Pleograf*, no. 4 (2023), accessed April 25, 2024, https://pleograf.pl/index.php/poczatki-drogi-tworczej-jerzego-kotowskiego/.

97) Stanisław Lenartowicz, interviewed by Szymon Szul, April 16, 2021, sign. SMFF_0002, Łódź, Poland.

projection kit availability in Łódź's animation studios allowed filmmakers to employ modern and innovative techniques. It enabled the creation of complex visual effects, such as repetitions, comparisons, color and texture changes, and the juxtaposition of live-action elements with animated backgrounds.[98)]

According to the studio's management, the reprojection kit was a cutting-edge device that significantly influenced the visual and artistic quality level of the films. Almost all of the listed films in Table no. 1 are awarded winners on internationals films festivals, including one of the most prestigious award an Oscar for Tango. The second film in a studio history, and the last one, which won in 2008 an Oscar was *Peter and the Wolf* (Susie Templeton, 2006). This may be one of the key arguments confirming the role of the reprojection kit in the development of film animation techniques at the Se-Ma-For studio.

Conclusion

The case studies of the two state-socialist film studios reveal analogous constraints due to their production environments. Both studios faced limited supply chains and difficulties accessing new technologies that were not easily available in the Eastern Bloc countries. Consequently, the working groups in both studios had to experiment with existing equipment within the confines of the 1970s production limitations — such as the reprojector kit without a sound mixer and photographic process imitating Xerox technology. The key distinction between the two cases is that 'Se-Ma-For's experimentation was driven by the availability of the reprojector kit, whereas Gottwaldov's experiments arose from a lack of alternative options.

Both studios developed new compositional techniques in animation that integrated both human and non-human actors, with substantial effects which could have been selected and examined as equally important through the ANT framework. In both cases, the techniques relied heavily on the cameramen's expertise in photographic methods — masking actors during shooting in Łódź and manipulating phases of the paper-puppets in the darkroom in Gottwaldov. A major difference was the presence of in-house laboratories and darkroom at FS Kudlov, which facilitated production, compared to 'Se-Ma-For's lack of such facilities, which affected their production timelines.

We observed the enrolment of the new actors into mostly established working groups in Gottwaldov and the forming of fully new working groups in Łódź. In both cases, the non-human actors served as crucial connectors among film crew members. The network of each studio had to adapt and compensate for unpredictable mediators, such as reprojector kit failures in Łódź and issues with curled paper-puppets in Gottwaldov.

One of the goals of this article was to test the possibilities of film production research enhanced by the Actor Network Theory approach. The studied working processes in Se-Ma-For and Gottwaldov were initiated by the introduction of new non-human actors into existing networks: the reprojection kit in Se-Ma-For and the work process supplementing a copy machine Gottwaldov. Ultimately, this network had a hybrid quality, in which it

98) Kotecki, interviewed by Szymon Szul.

would not be productive to clearly determine which of the actors had the greatest effect in shaping the final output. To separate the networks from the existing structure would be similarly unproductive.

The state-socialist mode of film production introduced specific constraints. Where there were limitations: technical (lack of tape or the Xerox machine), financial (uncertainty in obtaining funds for the purchase of equipment), there were skills and resources of employees (technical knowledge allowing to find substitutes on the domestic market). The new possibilities offered by the equipment created new techniques and opportunity to conduct experiments; using tapes for special effects and combining the cut-out technique with a live set, or in the plot layer, as in *Tango*, or negating the flatness of the cut-out animation by the photographic techniques in Karel Zeman's films.

Our primary focus was the role of equipment and spaces. However, the analysis of these networks enhanced by ANT showed several concrete instances how the human and non-human actors were inseparably intertwined in these processes: the darkroom, photographic apparatus, textured papers, and soft-metal wires with cameramen and prop makers of FS Kudlov and the reprojector kit and intermedia tape with 'Se-Ma-For's directors and cameramen.

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Filmography

5/4 (Hieronim Neumann, 1979)
Blok (Hieronim Neumann, 1982)
Čarodějův učeň (Karel Zeman, 1977)
Dobrodružství námořníka Sindibáda (Karel Zeman, 1971)
Druhá cesta námořníka Sindibáda (Karel Zeman, 1972)
Fatamorgana I (Daniel Szczechura, 1981)
Fatamorgana — II (Daniel Szczechura, 1983)
Indiánske rozprávky (Eugen Spálený and Karel Zeman, 1983–1988)
Létající koberec (Karel Zeman, 1973)
Lokomotywa (Zbigniew Rybczyński, 1976)
Magnetová hora (Karel Zeman, 1973)
Mniejszy szuka Dużego (Konrad Nałęcki, 1975)
Mozaika (Janusz Połom, 1975)
V zemi obrů (Karel Zeman, 1973)
Mořský sultán (Karel Zeman, 1974)
Nowa książka (Zbigniew Rybczyński, 1975)
Oj, nie mogę się zatrzymać (Zbigniew Rybczyński, 1975)
Plamuz (Zbigniew Rybczyński, 1973)
Plaża (Edward Sturlis, 1964)
Peter and the Wolf (Susie Tempelton, 2006)
Pohádka o Honzíkovi a Mařence (Karel Zeman, 1980)
Pohádky tisíce a jedné noci (Karel Zeman, 1974)
Portret (Stanisław Lenartowicz, 1977)
Śniadanie na trawie (Stanisław Lenartowicz, 1975)
Wyliczanka (Hieronim Neumann, 1976)
Tango (Zbigniew Rybczyński, 1981)
Zdarzenie (Hieronim Neumann, 1987)
Zkrocený démon (Karel Zeman, 1974)
Zrození filmové loutky (Josef Pinkava, 1982, Czechoslovak Television)
Zupa (Zbigniew Rybczyński, 1973)

Biography

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