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# First Steps Towards Digital Formalism: The Vienna Vertov Collection[1]

"Digital Formalism: The Vienna Vertov Collection" aims at a computer-aided analysis of the films of Soviet avant-garde filmmaker Dziga Vertov (1896-1954). Besides the development of tools for the digital analysis of films by Vertov, the project focuses on describing the function of cinematic elements in Vertov's work in relation to film form and the perception of the cinematic: what specific cinematic elements affect the audio, visual, haptic, and synaesthetic aspects of perception and how can innovative, high-level media analysis help identify, describe, and analyse (contextualise) these. The collaboration between science (media engineers) and the arts (media researchers) produces an interdisciplinary approach exploring the integration of film theory, advanced digital technology, and conservational/museological principles. The participating institutions include the University of Vienna's Department for Theatre, Film, and Media Studies, the Austrian Film Museum, and the Interactive Media Systems Group at the Vienna University of Technology. The Vertov Collection preserved at the Austrian Film Museum forms the material for analysis.

In the following we will present a few of the more significant theoretical and technical aspects of the project.[2] After an introduction to the goals and prospects of "Digital Formalism" from the perspective of the project partners, we delve deeper into the fundamental questions of our research. What common ground do formalism and digital technology share? How can the formalist method be defined in the age of digital media? What is meant by identifying Vertov as an "ancestor of Digital Formalism"? What specific challenges does this project pose for automatic film analysis? What kinds of tools must be designed to deal with archived material? And what is needed in order to implement them in uncovering hitherto hidden formal patterns in Vertov's films?

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1 This paper was composed in 2007 and is now partly outdated. An overview on the current state of affairs at the Digital Formalism project can be found in the forthcoming publication *Digitaler Formalismus* (*Maske und Kothurn* 4.2008).

2 We would especially like to thank Barbara Wurm (Humboldt University, Berlin), Andrea Braidt, Klemens Gruber (Vienna University), Michael Loebenstein (Austrian Film Museum), Christian Breiteneder (Vienna University of Technology) and all other participants of the project for contributing their ideas, knowledge and advice.

## Goals and Prospects of "Digital Formalism"

We aim to establish Digital Formalism as a theory *and* as a method. We advance the concept of formalism for film and media theory as a way to make comprehensible contemporary digital media and digital art. Our intentions are not only to contribute a formalist position to the discussion of new media, but also to propose a certain set of theoretical and analytical tools. The formalist method is to be translated into a digital framework.

The history of digital technology forms another important area of research. Assuming that theory and technology interact culturally and inspire each other, we conjecture that there is a significant historical connection between formalism and the digital. In this sense we want to trace the development of digital technology against the backdrop of the history of twentieth-century formalist thought.

The film historical focus is on analysis of selected films by Dziga Vertov. The exceptionally complex structure dominant in his œuvre makes providing a detailed analysis an equally complex task. Our computer-aided analysis tools can help to uncover currently hidden formal structures in Vertov's work. Since we argue that Vertov's highly elaborate techniques of filmmaking anticipate digital media, the digital tools developed in this project form a method that is contained implicitly in the material itself.

The digitization of the Vertov Collection preserved at the Austrian Film Museum offers the possibility to conduct a large-scale and in-depth analysis of the formal construction in Dziga Vertov's filmic work and makes the collection accessible as a resource for investigating the aesthetics and politics of film production in the Soviet Union of the 1920s. In addition to the benefits that this brings for Vertov research in general, and the benefit of public accessibility of the collection, we also aim to utilize digital tools for film archival purposes. Digital analysis excels in terms of speed and the volume of data to be processed. Thus, tools that allow an automated comparison of multiple versions of one film as well as automated surveys can facilitate restoration work and provide restorers as well as educators with the means for the visualization of an otherwise "invisible" field of work.

The complex structures contained in Vertov's films, such as accelerated montage and multiple exposures, pose major challenges to automatic film analysis. The core of the project is the development of tools for the computational understanding of media aesthetics; in other words, the automated extraction of high-level film elements such as rhythm, types of dialogue sequences, and use of black film, etc.

Within the computer science part of the project several key areas for research have been identified. Content-based retrieval techniques will be used to

identify specific structures in Vertov's films, such as shot cuts, shot rhythm, and camera motion. These techniques will help generate annotations from the films, a very time consuming and error prone task when performed manually.

Data mining techniques will help reveal patterns and correlations in the films that have not yet been analyzed by film experts, e.g. the use of black frames, patterns of black and white contrasts, and patterns of montage. Additionally, data mining is a powerful approach for revealing hitherto unobserved structures in the films. Data mining allows the creation of new perspectives on the material.

Finally, we will develop interactive visualization techniques for presenting the results of the analyses. Visualization techniques allow the user to study sophisticated spatio-temporal patterns and create and verify hypotheses. The combination of interactive data mining and visualization techniques enables the creation of a powerful set of film analysis tools.

## The Formalist Method in the Digital Age

In our definition, Digital Formalism becomes a platform for interdisciplinary exchange. The intertwining of technical and theoretical approaches to film demands a concept that is capable of combining both. The formalist tenet – *that art is defined by form* – serves as an interface. Keeping in mind that formalization can be seen as a theoretical method *and also* as a technical method it can be understood both ways – as the basis for an analytical approach in the humanities and as the heart of digital technology. This is why we assume that there is a strong coherence between the digital and the formalist that can be summed up in the principle of film analysis. The double meaning of the word "formalization" is also the starting point for our research on the historical interaction between the emergence of computer technology and that of formalism in the twentieth century.

What role does the formalist method have in the age of digital media? Around 1915 formalism began as a movement in literary criticism by the OPOJAZ in St. Petersburg and the Linguistic Circle in Moscow.[3] In the 1920s, the Russian formalists also applied their method to the "new" medium of film in a series of essays published in 1927 by Boris Ejchenbaum under the title *Poetika Kino*.[4] Despite being practically eliminated in the Soviet Union after 1930, formalism became a major intellectual influence in the twentieth century –

3 For an overview of the history of Russian Formalism see Erlich (1955), Hansen-Löve (1978) and Grübel (1996).

4 Recently reprinted in Beilenhoff (2005).

amongst others, the formalist ideas were fundamental to French structuralism. In the 1970s formalism was prominently revitalized for film theory by neo-formalism (the so called "Wisconsin Project"[5]), which emerged to become one of the major tendencies in film studies through to the present day. Digital Formalism is our answer to the current changes in the perception and production of media due to digital technology, which demand a further rethinking of the formalist tenets and method.

Formalism is not a rigid theory but rather a theoretical *approach* and a set of analytical tools that have to be adapted to the material that will be analyzed. While the notion that form is the "particular something without which art is impossible" (Boris Ejchenbaum, 1927) could be read as a very general statement, it in fact points to a very specific method of precise examination. In formalist terms *form* is not an abstract idea but must be understood as a set of artificial devices (*priem*), which comprise a given artwork. Formalism thus turns against narrow and arbitrary interpretations of so-called "content" by arguing that it is necessary to examine the specific structures of an artwork *before* one can talk about its meaning.

Victor Šklovskij's influential text "Art as Procedure" (1916)[6] defines an artwork as a composition of artificial procedures. While some of them are familiar to the recipient's perception there are others that defamiliarize conventional structures known by the recipient. This process of defamiliarization (*ostranenie*) marks the purpose of art: the sharpening of senses by breaking down the habits of everyday perception. Choosing specific artificial procedures enables the artist to establish a new view of formerly unknown structures and of new meanings. Based on the idea of human perception attuning to widely-used artificial procedures, film history can be seen as a chain of alternating links of familiarization and defamiliarization.

Just as digital technology opened the field of formal possibilities for the film medium and lead to an explosion of new artificial devices, it has also altered habits of perception. The criteria of artificial conventions have changed so greatly that it is difficult to trace and estimate the degree of their familiarity. For this reason the age of digital media makes it necessary to reconsider the ideas of Russian formalism.

Even in the digital age the films of Dziga Vertov are alienating. They contain procedures that reach and breach the neurological limits of human perception and thus give the whole artwork the tendency to defamiliarize. For that reason Dziga Vertov can be considered a formalist filmmaker, interested in

5 See Bordwell/Thompson/Staiger (1985) and Thompson (1988). For an overview see also Hartmann/Wulff (2003) and Hahn (2006).

6 Reprinted in German in Striedter (1971: 4-35).

exploring the formal possibilities of the new medium, and using them to create a cinematic experience that goes beyond everyday perception, uncovering the procedures of filmmaking within the artwork itself.

## "Digital Vertov" and the Formalist Approach to Filmmaking

The Vertov Collection of the Austrian Film Museum includes numerous film copies and related material such as sketches, manuscripts, and diaries, which reveal new insight into Vertov's working methods. The Austrian Film Museum will digitize the film copies frame by frame in the course of this project. Of special interest for our analysis are the *Kinopravdas* (a series of newsreels, 1922-1925), Vertov's "opus magnum" *Celovek s kinoapparatom* (*Man With A Movie Camera,* 1929), *Kinoglaz* (1924), his first sound film *Entuziasm* (1930), *Odinnadcayji* (*The Eleventh Year,* 1928) and *Šestaja čast´ mira* (*A Sixth Part of the World,* 1926), as well as all other feature films he produced between 1926 and 1931.

What is striking about this project is that – for the first time in more than 40 years – it is possible to actually compare all existing versions of Vertov's films by using the international network provided by the Film Archive Federation FIAF and through the use of digital technology. For decades this was virtually impossible due to export restrictions from the USSR. The fact that the tradition of Soviet films is often fragmentary, that films are impaired by censors' interventions or due to the natural decomposition of master materials poses a considerable challenge to researchers. In this regard, "Digital Formalism" is the first truly "philological" project focusing on Vertov's film work.

But what does Vertov have to do with Digital Formalism? Our line of argument is based on the assumption that Vertov must be considered a formalist filmmaker at the same time as an ancestor of digital working techniques from an "analogue era".[7] Vertov does not use the moving pictures recorded by the camera to tell a story, but rather treats them like bricks to construct films on the montage table. He thus creates a distinct kind of formalist film-language, a purely cinematic means of expression through associative montage, playful experimentation with formal elements and rapid visual rhythms, a film-language in many ways anticipating the aesthetics of today's art and popular culture, like video clips. Vertov's invention – film as a composition of visual patterns – is the result of highly experimental and unconventional working techniques. Today, comparable effects are easily accomplished with the aid of digital produc-

7 Parallels between Vertov and the Digital are also addressed by Lev Manovich (2002: xv-xxix) in "Prologue: Vertov's Dataset".

tion tools. Since Vertov realized the aesthetics of New Media way ahead of their time, we call him a "digital artist" *avant la lettre*.

Vertov's innovative working techniques correspond with his "holistic approach" to film. As an investigator of the aesthetical, theoretical *and* technical dimensions of cinema he calls for a deliberate integration of these aspects. The constructivist Vertov sees himself as a kind of film engineer who experiences the world through his Camera-Eye (*Kino-Glaz*). Thus, his formal experiments not only aim at aesthetic innovations but also explore the specific quality of the medium film from a technical point of view.

## Numeric Transcription


Figure 1. "Numeric Transcription of a montage piece of a film by Dziga Vertov – the moment of the flying of the flag on the day of the opening of a pioneer camp".

The drawings, schedules, diagrams and sketches shed the most light on Vertov's unconventional working methods. The schedule in Figure 1 is an outstanding example that vividly illustrates what we call Vertov's "formalist approach" to filmmaking.[8]

8 We would like to thank the Austrian Film Museum and Barbara Wurm for providing the photograph reproduced here. The schedule was first published in Aleksandr Belenson's *Kino-segodnja [Film Today]: Ocerki sovetskogo kinoiskusstva* (Moskva 1925) – a book dedicated to Kuleschov, Vertov and Eisenstein. It is part of the

It is, as the title says, a "Numeric Transcription" of a montage sequence from *Kinoglaz*. The recorded scene takes place at the opening of a pioneer camp and shows the moment of the flying of the flag. The numbers on top of the schedule (from 1 to 52) refer to the "succession of the parts" or the *shots* in the order in which they are edited in the film. The left column contains a list of the "acting persons and objects" – the head of the pioneer leader (1), a female pioneer at the pole (2), pole and flag (3), Intertitle: "Fly the flag!" (4), a trumpet player (5), Face No 1 (6), Face No 2 (7), et cetera. These are what we call the *motifs*. The numbers inside the schedule display the *number of frames* or the length of each shot. The column on the right side contains the *total number of frames* for each motif.

The schedule that was first published in 1925 was very likely drawn up after the finishing of the film. We don't know whether Vertov actually made a transcription of his own movie or if he used notes or editing lists compiled earlier. For our line of argument it is insubstantial if this transcription is 'correct' in comparison with the film itself or if Vertov actually used this kind of diagram in the working process. The crucial point is that he *made* this schedule – which must have been a lot of work as it is handmade – as this reveals a strong interest in film as a systematic technical construction. The process of montage is literally translated into a numeric system. In this regard one could even argue that Vertov treats the filmstrips digitally – although the schedule is perfectly 'analogue' in the common usage of the word.[9]

A close look at the schedule reveals enough to give a clear idea of the recorded scene even without actually seeing it in the film. Regarding the rhythm of montage in general, one can see that the changes from one shot to the next are edited in rapid succession. Most of the shots last only a couple of frames (respectively fractions of a second) – a kind of accelerated montage, which is typical for Vertov. The plot of the scene – the flying of the flag – is thus organized in a complex assembly of fragments. A look at the right column reveals that motif no 3 "pole and flag" has the most frames (208) followed by motif no 2 "female pioneer at the pole" (183) – this fact alone shows that – unsurprisingly – the flag itself is the dominant motif in this scene containing 905 frames in total (which is less than a minute, as the film is projected with 18 frames per second). Moreover, it suggests that it is the pioneer from motif no 2 who is actually flying the flag since she is the person with the most frames.

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collection of the Austrian Film Museum [V 39] and was recently reprinted along with other formerly unpublished work sketches in: Tode/Wurm (2006: 105).

9 The discussion of the terms 'digital' and 'analogue' forms a fundamental research issue in our project. For different aspects of the topic see Schröter (2004).

A number of different rhythmic patterns can be gathered from the schedule: in the beginning of the scene the montage alternates between shots of the pioneer leader, the pioneer, and the flag with varying shot lengths. In the next sequence different shots of faces (motifs 6 to 9, the spectators) are alternated with shots of flag (3) and pioneer (2), all of these shots having a length of 10 frames. This periodic 10-frame-rhythm is repeated again later on and dominates much of the scene. Towards the end of the flag-scene there is a sequence of longer shots showing the pioneer (motif no 2, 93 frames), the shadow of the flag (motif no 15, 65 frames) and the legs of the pioneer (motif no 16, 60 frames), suggesting that the flag is finally being raised. The scene is concluded by a succession of short shots of faces followed by a longer shot of the flag (motif no 3, 48 frames).

A detailed analysis of the schedule reveals that it contains a considerable amount of information about the film in the form of numeric data. The fact that Vertov made such an elaborate transcription of a scene from one of his own films shows his efforts to advance techniques of filmmaking in a very radical way. With perfectly analogue methods he thus anticipates a digital view of film.

## Automatic Film Analysis

Vertov is a filmmaker who stresses formalistic principles in his work. His films can be considered an assemblage of numerous visual patterns, with particular importance given to rhythmic patterns of montage. The high degree of structure in Vertov's films makes them well suited for automatic content-based analysis.

### The Material

The Austrian Film Museum supplies the films on 35mm triacetate film. The films are several decades old and multiple-generation copies (mainly backup copies) of the master material. The films are black and white and mostly do not contain sound. Only a few of Dziga Vertov's more recent films contain sound (e.g. *Enthuziasm*). The frame rate for playback of the films is not clearly specified. Usually, a frame rate of 18 frames per second is used for playback.

Prior to working with the material it needs to be digitized. High quality frame by frame digitization will be carried out by scanning each frame separately. The result is one grayscale image for each frame in standard definition or higher. This approach avoids the production of interpolated frames. Inter-

polated frames are introduced during digitization when the material is converted from one frame rate to another frame rate. Digital videos usually have a frame rate of 25 or 30 fps**.** If the material originally had 18 fps, the process of digitization would insert interpolated frames in order to convert the film to the higher frame rate. However, interpolated frames represent information that is not present in the original film. Consequently, this information is not suitable for analysis and would falsify the results of the automatic analysis.

After digitization each film is represented by an image sequence. This format is well suited for further processing and the generation of digital videos.

## Challenges in the Context of the Material

The films provided are all black-and-white films. Furthermore, most of the films are silent. This makes the automatic analysis much more difficult since neither colour nor sound information may be used in the analysis. Colour is important information for recognition tasks, such as face recognition and shot-cut detection. Audio is a modality complementary to video that contains orthogonal information. The audio track of a film contains speech, music, and environmental sounds that provide important semantic information. For example, music reflects excitement and the temper of a scene and speech allows the identification of distinct people.

Another important issue is the quality of the provided films. The available filmstrips are multiple-generation copies of the master material and are several decades old. There are numerous artefacts that result from copying, storing, and playback of the films.

The material of the films is organic. That means that the material changes its structure over time. The most important artefact that is generated in this context is the evidence of the filmstrip's vertical shrinking. When a shrunken filmstrip is copied, the frames in the old film do not match with the frames in the new filmstrip. This results in misaligned frames in the new filmstrip, as shown in Figure 2. Another artefact introduced by misaligned frames is the displacement of the frame line. For example in Figure 2, the frame line is not positioned between the current and the next frame. Due to the shrinking of the material the frame line is positioned inside the visible area of the frame and produces a dark horizontal bar. Another artefact resulting from storage is caused by the horizontal shrinking of the filmstrip. Horizontal shrinkage is usually not as strong as vertical shrinkage. However, it may result in frames where the perforations become visible at the left and right side of the frame.

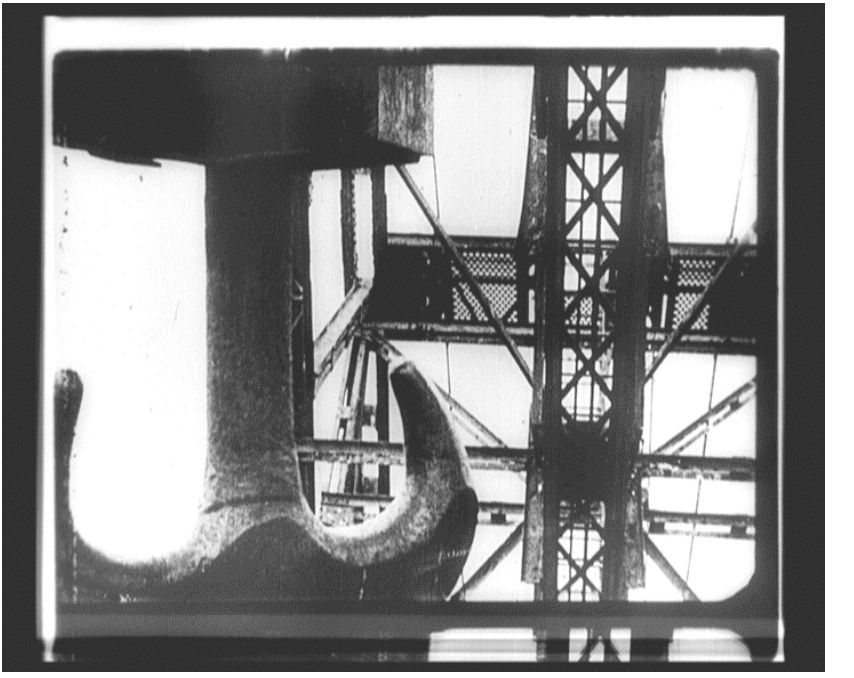

Figure 2. A misaligned frame in a filmstrip of Vertov's *Kinopravda 21*. The top of the next frame is visible on the bottom edge of the frame. Consequently, the frame line becomes visible inside the frame.

The misaligned frames produce an unstable image. When the film is played back we observe that the frames move especially in vertical direction. The reason for this is that shrinking influences the aspect ratio of the frames and distorts the proportions. The displacement of frames is not very disturbing for the human observer because we are able to compensate for it. However, a computer system is highly disturbed by such displacements. Prior to working with the material, we need to correct the distortions and register the frames in order to enable frame by frame comparisons, which are an important part of digital film analysis.

Another issue is that the process of copying introduces dirt when the film is copied under suboptimal conditions. Dirt highly disturbs the observer and occludes information in the film that is important for film analysis.

Further artefacts are scratches, especially vertical line scratches, which are mechanical defects introduced during the play-back of the films. The amount of dirt and scratches increases with each generation of a copy. Figure 3 shows two frames that illustrate different types of artefacts.


Figure 3. Two frames with a number of different artefacts (shadows, scratches, etc.)

Finally, the process of copying degrades the contrast of the film. With each copy the frames become more saturated. That means that intermediate gray values are lost while the portion of saturated (totally black and totally white) areas increases.

In addition to the numerous artefacts we have thus far identified, the material provides us with information that may be helpful in automatic analysis. The filmstrips contain labels inserted by cutters and archivists, that indicate shot cuts. The labels represent numbers that are references to entries in a montage list (shot list). The labels have been inserted in the intermediate area between two successive frames (the border line). Figure 4 shows an example of such a label.

The labels help to enhance shot cut detection, since each shot cut is labelled consistently by number. The labels are not positioned directly at the cuts but in most cases two or three frames after a shot cut (see Figure 4 for illustration). The labels can be useful for two purposes. We can integrate a label detection algorithm into the shot cut detection in order to improve the quality of shot cut detection. Another possibility is to use the labels as a ground truth that forms the basis for the evaluation the quality of a shot cut detection algorithm. In this case, the labels are not incorporated into shot cut detection, instead, we compare the positions of the detected shots with the positions of the labels in the filmstrip.

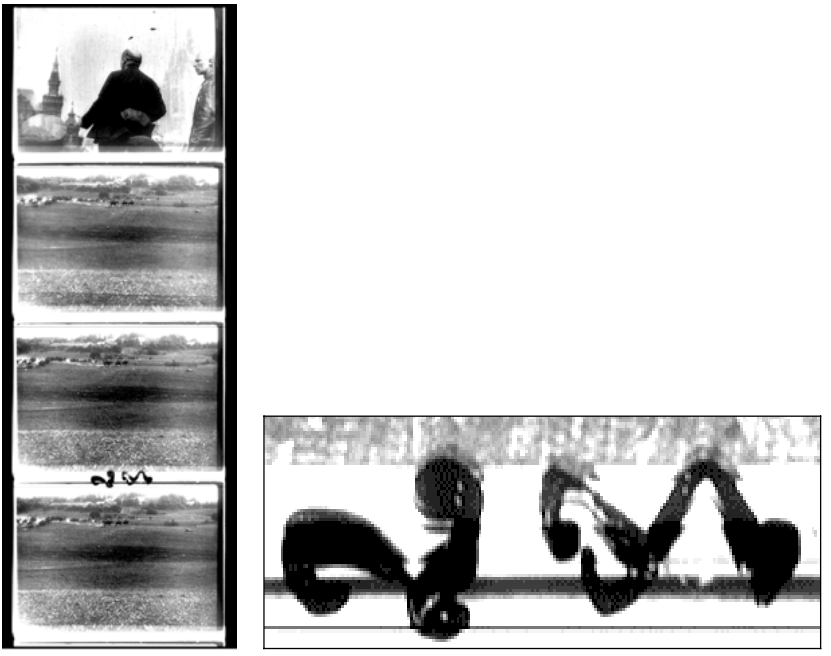

Figure 4: A manually inserted label two frames after a shot cut. The magnification reveals that the label represents a number (the number of the shot).

## Requirements for Automatic Film Analysis

There have been a number of challenging requirements identified for the analysis of Vertov's films. In a first step, shot cut detection will be carried out in order to temporally segment the films. A shot cut is the most important basic entity of a film. Hard cuts and transitions will be detected, such as wipes and (cross-)fades. Shot cut detection is the basis for the computation of shot

frequency, which is an important measure for the rhythm of the film and the progression of tension.

After shot cut detection, each shot can be further analyzed and classified. In this step, we distinguish between different types of shots. Intertitles, very common in silent films, are also detected. They contain text that is related to the content of a film. We can perform text recognition to gain semantic information from the titles. Likewise detected are shots with "multiple image" or split-screen montage. Vertov often employs split-screen montage to illustrate concurrency and to accelerate the rhythm of the film. The frequency of split-screen shots in a film and the number of splits in the shots is important information for film theorists.

The identification of symmetries will be another focus of the automatic film analysis occurring in the context of this project. Symmetries play an important role in Vertov's films. He often employs symmetric compositions in his shots.

In addition to temporal segmentation and the classification of different types of shots, motion in the films will be analyzed. This incorporates camera motion estimation and detection of object motion. Camera motion estimation focuses on the detection of basic camera movements, such as rotations (pan, tilt, and roll), translational movements (track, boom, and dolly) and zoom. The annotation of the camera movements in a film is a crucial but time consuming task in manual film analysis. Automatic techniques can speed up this process significantly. The detection of object motion is much more difficult, especially when concurrent camera motions exist or motion occurs in the background. In general, it is not possible to separate the motion of objects and the camera. Object motion may be computed only under certain assumptions, for example when no camera movements exists or the background is static.

Vertov often reused material in several film productions. Consequently, his later films contain shots and motifs that have already been used in earlier films. Furthermore, there are compilations where material from different filmmakers (including Vertov) has been merged. A goal of this project is to develop techniques to compare different films and identify reused material. This is a non-trivial task, since the reused material is not an identical copy of the original material. The reused material may have been copied several times and may contain scratches, dirt, and other artefacts that are not present in the source material. The comparison of different films will be one of the main focuses of the project. The development of automatic film comparison algorithms is beneficial, since manual comparison by a human user would be much too time consuming.

The strong foundation of the project in media theory offers a perspective that is currently not represented in debates regarding digitization of cultural

heritage. Digital Formalist Analysis will enable scholars, students of film/media studies, and actors in creative industries to study, discuss, and scrutinize audio-visual artefacts and their specific artistic and historical-cultural acquaintance with the senses.

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