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CONNECT 2021-2024

Connecting universities-industry through smart entrepreneurial cooperation and competitive intelligence of students in Moldova, Georgia and Armenia

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TRAINING MODULE ON ARTS SKILLS / PHOTOGRAPHY

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The module: A training Module on Art/Photography education, for trainers, early stage and incorporated startups and teachers to use in non-formal education settings.

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Project: CONNECT - Connecting universities-industry through smart entrepreneurial cooperation and competitive intelligence of students in Moldova, Georgia and Armenia

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Photography Course

Introduction

The main goal of this introductory course is to facilitate a better understanding of the aesthetic and technical rules which will guide the user through a series of steps towards achieving a good final product, either that being a photograph or a video. It can be said that photography is actually one of the most modern of arts, not just in terms of its contemporary nature, but through the fact that it pulls together parts of the modern world, as a communication medium, and in its reliance on the technology of making pictures. From the early days of photography, in 1839, and until now, after the introduction of digital imaging, one thing can safely be said about the person behind the camera: to be a master photographer/ imager one must learn a high level of technology alongside the sophistication of the artist.

The end product of photography is a visual language. The comment that "a picture is worth a thousand words" reinforces the concept of the photograph as a means of communication. And just as any written piece has multiple parts in the construction of its story, a photograph has multiple parts in constructing the image. A verbal language has thousands of words and an image has thousands of image elements. Where the written language uses pencils or keyboards to enter the words, photography uses its processes and technologies to capture the parts of the picture. In these two examples we see that the verbal language, as well as the photographic language, use tools to create their elements for meaning. In this way, we can see that to effectively teach photography, we need to teach both a technique and a concept of meaning.

While the technology of making an image can stand by itself, the technology by itself does not necessarily create meaning. The meaning comes from the way the artist utilises elements to communicate intent. The image maybe a product of the technology, but the meaning is a product of the artist. True mastery in photography is accomplishment of both technique and aesthetics. If we look at photographs in museums we will see that they exhibit the mastery of technique but also that they have an exquisite artistic value. Throughout the course, we'll use the professional terminology regarding the process and the tools used to take

a photograph on an exterior shoot (for leisure or professional purposes) or a studio shoot for a portfolio, product or fashion shoot.

The course will go through the technical and aesthetic photography and video shooting approaches, among which we'll point out the technical issues which are helping both the aesthetic and visual structure. Keywords such as shutter speed, ISO, T-Stop, lighting ratio, dynamic range, colour contrast, compositional rules, colour space, tips and tricks will be explained in depth. Before we go into that though, we will start with a quick look at the history of image and language.

Visual language is the main communication language going all the way back with to the cradle of humanity almost 40.000 years ago. In the Upper Palaeolithic, humans started to use storytelling throughout sketches and drawings on the cave walls. The cave paintings amaze us even today through their expressivity and beauty. Working with a limited colour palette, the ancient artists succeed to stylise some everyday activities like hunting and tribe celebrations. The expressivity of the figures and actions depicted is astonishing and show that the power of human imagination when we look at a drawing is similar to that when we listen or read a story.

Nowadays, social life is closely linked with the image significance, and the way we produce and disseminate the visual content depends on how skilful and talented we are, no matter how the present vogue and trends influence the looks of the photographs, art and audio visual products. The basis of the visual language has its roots in the ancient art, rules which today have been changed by the technology and world connectivity, the world wide web.

Producing and delivering the visual products is mediated by the channels we wish to use at this stage. The ubiquity of the Internet makes the traditional media channels look obsolete and the classical analog techniques even more outdated. Nowadays, immediacy is the new must, the most important factor being quick delivery of a product no matter how much of an artistic value it contains. The digital revolution, started in early 2000, changes the way we prepare, produce and distribute the visual art products. This productivity acceleration means a higher density of final art works (movies, photographs, video installations and even more home movies), an impressive amount that unbalances the human needs and attention to important everyday matters. The continuous assault is fulfilled by social media channels which become dominant in today’s advertising, private life, fashion, politics and so on. This

avalanche swallows all the relevant and meaningful art works together with insignificant video and photo products which, caught in the "ocean" of daily information, are passing unobserved. The visual artists of today need either an aggressive promotion or great and inspired new elements of visual language to stand up from and become visible in the crowd, as a mainstream art.

For a common language, the artist and the consumer use the same visual cues, the more basic of which are seen all around us throughout the day. The problem which both the artist and the viewer are facing is the novelty of elements (visual innovation) infiltrated within different artworks. Decrypting this approach is becoming more and more complex because of the recent lack of aesthetic and cultural education, which seems to dissipate seamlessly within the massive, meaningless visual information flux. The masterpieces are harder and harder to acknowledge since the consumer energy and attention are drawn into a massive tornado of fake news, non-values and useless debate.

The number of devices we use for producing and disseminating the visual artwork is exponentially growing. The miniaturisation of screens has changed and will continue to affect the way we see movies and photos, from the cinema hall to a laptop or tablet and from the museum or art gallery to the habitual smart phone. The virtual world conquers the real one where the time spent in art galleries and cinemas seriously dropped in the past decade. The attention span decreased drastically from 12 seconds in year 2000 down to 8 second nowadays. This means that the shots duration for a movie or an A/V production (short movie, documentary, scientific documentary etc.) has to be reduced. There's a weak opposition from the filmmakers which are trying to keep the editing and narrative structure untouched by the teenagers and young people accelerated perception, using long takes with a slow pace action and actors interpretation. Despite the unstoppable way of converting the reality into a meta-reality or hyper-reality mediated by the digital medium, the film and photography tries to adapt to our days.

Controlling time is the first step into a deeper understanding of compositional elements and their visual interdependency. The difference between seeing a series of photographs in an art gallery versus watching them on a laptop, comes from the scale and the spatial relation imagined by the artist, where the dimension disappears in the virtual realm. Imagine looking at a series of photographs in an art gallery where we can watch them from a

distance, get up close, feel the atmosphere and gallery mood, see the light spots and walls colour in harmony or disharmony with parts of the displayed photographs. The emphatic value of involvement and participation on the artist journey is priceless, none of this will happen if we decide to rapidly check the photos on our smartphone while traveling on the subway. Understanding the hidden meanings of an artwork needs time, time spent in front of the cinema screen or inside the art gallery, in a peaceful and undistracted state by exterior buzzing elements. The internal rhythm controls the emotional response and, eventually, shapes the experience which spiritually enriches us.

Using the two dimensional surface of a digital sensor or of the film plane (raw stock Black&White or Colour), forces us to organise the elements within the frame within a certain hierarchy. A number of rules, making the composition proportional, harmonic and with an internal rhythm which will please the viewer, have been settled in art (painting) starting with the Renaissance. Some of the roots of those laws go back to the Greek and Roman antiquity when the sculptors created a set of common proportions for the human representation (full figure statue). Further on, a Roman architect, Marcus Vitruvius Pollio, conceived a set of rules regarding the proportions and harmonic representations within a building, based on an irrational number: The Golden Number, also known as Divine Proportion. This number, discovered by Archimedes, set the harmonic proportions between the whole and the part and is expressed by a ratio of one to 1,61803398(…). Phi, another irrational number besides Pi, is the representation of Golden Ratio, also found as the basic structure for some biologic and celestial representations. Another way to get to the same proportional response is the Fibonacci number, which is a series of numbers within which we discover the logical proportions from the Phi.

The Fibonacci sequence starts off as: 0 - 1 - 1 - 2 - 3 - 5 - 8 - 13 - 21 - 34 - 55 - 89 - 144 - 233 - 377 - 610 - 987 and continues on following the rule $a_n = a_{n-1} + a_{n-2}$: 13 = 5 + 8, 144 = 55 + 89 and so on. Dividing two successive numbers we have a close representation of Phi, 987:610=1,618027(…) and the further along we go in the sequence, the closer to the golden ratio number we get 6765:4181=1,61803363(...). The representations in living or mineral structures are shown in Figure 1 where we also see how a cyclone follow the same path when growing into a tropical storm or a hurricane (above right). Among the golden number representation we also find a galaxy structure developed using the same ratio.

Figure 1. Various Fibonacci representations within a structure of a shell, aloe plant, cyclone cloud, leaf succession on ivy, sunflower seeds and a galaxy.

One of the first rules used in paintings is that of the linear perspective, which is fundamental in projecting a three-dimensional reality onto a bi-dimensional surface (digital sensor or negative). In both photo and video, the focal length of the lens influences how the composition is made. The factor which modifies the perception in depth of these overlapping structures is the lens' convergence. The convergence influences the perception of space due to the value of the focal length. This value defines the structure of the lens, wide, normal or telephoto lens being the main representations of optical systems. To explain the rule, we'll have to first go over a short introduction into optics. The focal length is defined by the distance between the intersection of optical rays and the focal plane (digital sensor or film plane) where the image is focused. A sketch of this process is shown in Figure 2.

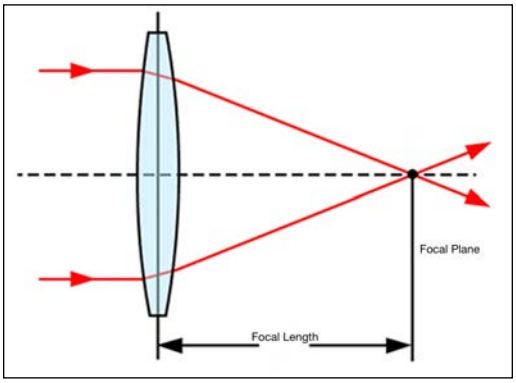

Figure 2. Definition of the focal length of a lens

That means that the field of view and the spatial relations between the objects shown in composition are dependent on both the lens and the format we are shooting on. Linked with the size of the capturing format is the value of the depth of field, the space between the focused and blurry portions of the picture. The link between format and depth of field is as follows: the bigger the capturing format, the shallower the depth of field is. Also, the crop factor applied when we convert the formats is influencing the focal length. Therefore, a 24mm lens on APSC is equivalent to a 12mm lens on 2/3" and 36mm lens on Full Frame (Leica, 24/36mm). The three lenses have similar fields of view (the horizontal angle of view) but different depth of field values (for the same T-Stop).

The aesthetic values of depth of field can be highlighted when we use a shallow depth of field on portraits or inserts shots (objects details, Extreme Close Up etc.). There is also a misconception regarding the depth of field value related with the focal length we use. Some photographers think that as a direct consequence of choosing a wide lens, this will automatically influence the camera's depth of field (having a larger one) or a comparing one when using a longer lens which will have a shallow depth of field. The rule should actually read more like this: In the case of a similar composition, the depth of field is virtually constant on identical T-Stop. Therefore, by framing on similar subject sizes, the depth of field remains fairly constant even if we use different focal length lenses. On same subject magnification, the camera position has to be closer (for wide lenses) or further away (for telephoto lenses), that proximity or distance influences the depth of field value. An example is showed in Figure 3.

Focal Length (mm)	Focus Distance (m)	Depth of Field (m)
10	0.5	0.482
20	1.0	0.421
50	2.5	0.406
100	5.0	0.404
200	10	0.404
400	20	0.404

Figure 3. The variation of Depth of Field on the same aperture with different focal length lenses

The difference between the lenses' depth of field is minimal, the influence of focus distance erases the misconception of bigger depth of field of a wide lens versus shallow depth of field for a telephoto lens. The field of view is therefore different, having a bigger convergence on a wide lens, the composition behind the subject will be wider than on a smaller convergence lens (telephoto) where the area behind the subject will be tighter comparing with the wide angle lens. The shallow depth of field is used as opposed to deep focus approach, used sometimes in feature films. Aesthetically, a shallow depth of field will isolate the character (actor, model) from the background we project him onto. We can further explore the interdependence between the T-Stop, Sensitivity and Shutter Angle. Called Exposure Triangle, those three factors influence the depth of field, the feeling of motion and noise.

Before we decide what camera will use for a job, we need to decide on the look we're going for. If we have to shoot with a shallow depth of field, we choose a lens with a wide aperture (1.4, 1.8) which, combined with a base ISO (camera or film sensitivity), will determine the shutter speed. A linked relation between those three items is shown in Figure 4.

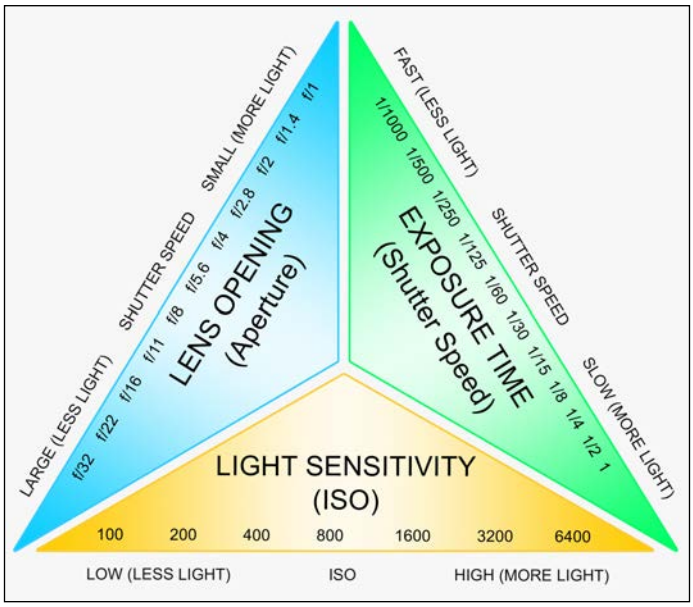

Figure 4. The relation between ISO, Shutter Speed and Aperture

The reciprocity law works within this triangle: if we decide on a fixed aperture, we have to choose a sensitivity and a shutter speed which will not compromise the noise level (bigger sensitivity) or the motion blur effect (longer shutter speed with motion in frame).

Back in the days of the analog medium (film negative or slide), one of the parameters was fixed, that was the sensitivity. The film negative or slide (a film which after the process will show a positive picture), had a unique sensitivity so in this case the versatile factors of exposure have been reduced to two: aperture and shutter speed. Usually, the sensitivity was around 50-64 ISO (for a fine grain negative) but went up to 400 ISO (with 2 stops push process the negative can even reach 1600 ISO). Any process intervention had a big influence on graininess and contrast, but the size of silver halides within the film emulsion also played an important role in determining the base sensitivity.

Nowadays, digital cameras are hugely versatile. The user can change the sensitivity and white balance values to the ones she/he wish to use without compromising the final look of the photography in many cases.

Another important feature of digital and analog cameras alike is the dynamic range. Dynamic range defines the maximum interval from the brightest white to to darkest black which camera can capture and is expressed in T-Stops. Depending on technology, manufacturer and colour profiles we use the nowadays, digital cameras have a dynamic range of 14 to 15 T-Stops, which means the brightness difference from the darkest level (D-minim or digital threshold) to the brightest point captured is huge. As an example, one T-Stop difference set on the lens means doubling or halving the amount of light which enters to expose the sensor of film strip. This light exposure ratio is transformed into a logarithmic ratio which is harmoniously accorded with the human visual perception. In human physiology, the difference between two discernible intensities is proportional to the logarithm of the stimulus intensity change. Which means that the transformation of an exponometric value (doubling or halving the intensity) into a logarithmic one, gets in harmony with the physiological response of human ear and eye.

The digital transformation of the linear picture capture or the signal levels, is changed through an analog-digital module to a logarithmic proportionality to match the human vision response. The camera or computer displays are calibrated for a specific colour space with a fixed gamma value, specific for different deliverables screens, HDTV/Internet, SDR Cinema, HDR TV and HDR Cinema.

White Balance is an another important value to have in mind before we start shooting either video or photo. This value is related to the Black Body Radiation law which states: "A

Black Body heated on a certain temperature will start emitting light with a similar spectrum of a source with an equal colour temperature". The usual colour temperature of a light source starts from the candle or flame value (1700-1800K) and raises up to 5500K, for the daylight sources used in professional shootings. The K in 5500K stands for Kelvin, value named after Lord Kelvin, the British physicist who first discover this law.

Let's now take a closer look at light and the visible colour spectrum. Modern light sources have a range of colour temperature starting from 2000K and going up to 10000K. We are talking here about LED sources with which we can easily change this value by turning a knob. Otherwise, the vast majority of light sources are based on fixed colour temperature and different powers related with the size of the light (projector). There's three types of light sources: Tungsten, Daylight and LED. The tungsten lights use an incandescent filament which radiates light with an equivalent colour temperature of 3200K. The power starts from that of a household bulb (40W, 60W etc.) and goes up to 20000W (20KW) or 24000W (24KW) for the professional used lights. The daylight sources are Metal Halide Discharge lamps, with an equivalent colour temperature of 5500K. The photo flash is one example of a daylight source which can be used both in exterior daylight or interior studio shoot (with flash soft-boxes). The importance of setting the white balance value on a photo camera before starting the shoot, is showed in Figure 5. This horseshoe shaped graph shows the visible light spectrum and is called CIE 1931. Within this visible spectrum representation, we find all the visible spectrum colours as well as Magenta, which is a synthesis hue obtained by the mixture of blue and red spectrum colours. On an electromagnetic visible spectrum, Blue is the first visible colour (380nm wavelength) with Red at the other end at 700nm. The visible Blue is placed next to UV (ultraviolet) and Red next to IR (infrared) electromagnetic wavelength. Combining those two light spectrum extremes, we obtain Magenta. Another important element of this graph is the white balance locus, or the Planckian locus (named after Max Planck), which defines the positions of a source with the colour temperature equal with 1500K, 2000K, 2500K and so on, up to 10000K. This graph is also used to define the colour spaces of a medium (capturing or delivering images), triangle within which a display or a camera is able to capture a limited or a wider gamut colour space. Another use of this graph is to establish the white points for a capturing system (camera, scanner etc.) or the display we see the image on. For example, the HDTV white point is placed at 6500K, higher that the

white balance value of a camera (photo or video). The colour space mapping is done in the postproduction stage, when the camera and deliverables white points are calibrated. One example of this is the REC709 colour space (for HD signal television) which is the narrower one between the available deliverables colour space. On a next level gamut, we have P3 colour space (for digital cinema projection) and the most recent REC2020 (the colour space for HDR television)

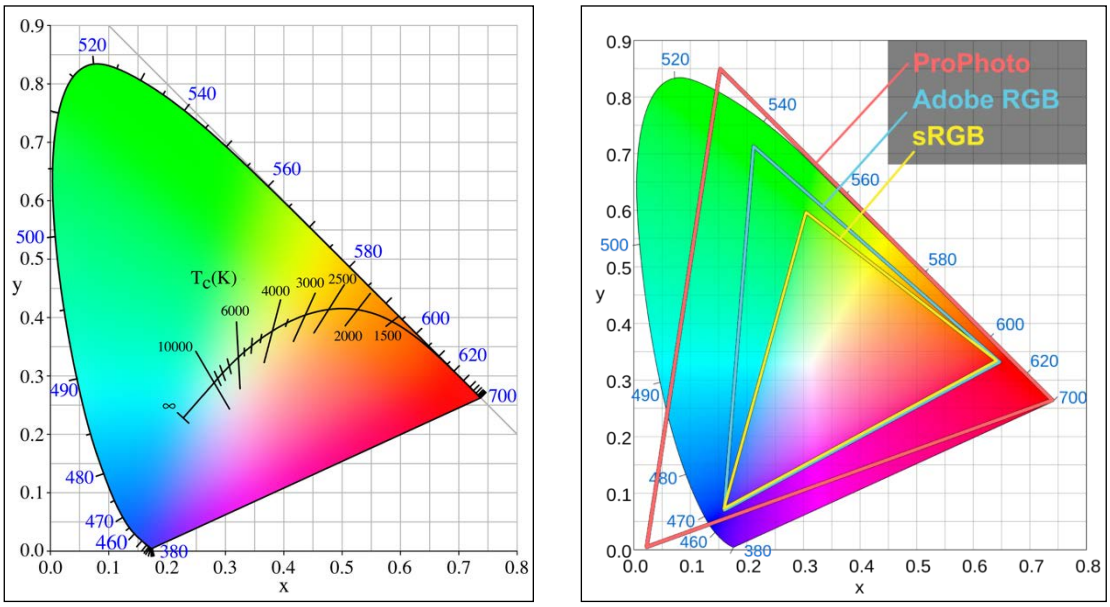

Figure 5. The visible spectrum and the Planckian locus of White balance values (left) and the photo colour spaces

For photo and print colour space we have, in order from small to big gamut, sRGB, Adobe RGB and ProPhoto RGB.

Due the structure of today's digital sensors, the colour synthesis is based on Additive mixture. That means that any colour from the visible spectrum is obtained from a mixture of three primaries Red-Green-Blue. By combining two primaries, we obtain the complementary colour or the third primary. For example, if we combine Red and Blue we get Magenta which is the complementary colour of Green. Same for Blue + Green = Cyan, the complementary of Red, and Green + Red = Yellow, the complementary of Blue. In print we use four colours, pigments of CMYK, **C**yan-**M**agenta-**Y**ellow and Blac**K.** The addition of K in this structure is used to get a deeper blacks without the use or massive quantities of pigments.

The perceptual world and composition

The space we're trying to capture is governed by organisational rules, perceptual norms which mediate the transfer between reality values and aesthetic values. The photography and the composition is the base of this organisation, the meaning of it being how the viewer will understand the subject and how easy they would empathise with it. At the base of this structure is the figure-ground relation which is mediated by overlapping the successive layers of action or elements on a background, finally defined as a ground. The usual example is the brightness relevance when defining the figure (subject) versus ground (background) with a denser, darker, value. That means the figure is always brighter than the ground, a specific approach is when we switch this rule and use the subject silhouetted on a brighter background.

When we photograph a landscape we are facing multiple questions, some of the most common ones are: Do we need to organise the heterogenous field into a homogenous one? How are we going to make the space work for us in order to make a meaningful photograph? Everywhere we look, the composition has to contain only the important elements, the ones which the artist uses to transcend into a different feeling, emotion or experience. When some of those elements are fulfilled, the basic sense and finality through which photography can be expressed are composed.

The figure ground relationship is transferred into a composition as a positive and negative space. The balance or the harmony of the composition is the main tool that the photographer uses to compose and draw the viewer's attention to the photographed subject. Sometimes the harmony and balance is boring, the symmetry or the frontal, dead centre, compositions are anything but interesting. That's why, when composing a subject or an action, the photographer organises the space and the relations within the composition in a harmonious, balanced or unbalanced manner, in such way to underline his or her aesthetic intentions. We tend to organise the perceptual world following a set of rules discovered by the members of Gestalt psychology. Through experimental psychology they established a hierarchy of compositional structures based on couple of basic rules. These are: proximity, similarity, symmetry, continuation and closure.

Proximity is the human disposition to organise the visual space by finding a meaning for the volumes, surfaces lines and dots viewed inside the "composition". We group together related objects and volumes by their sizes and shapes.

Similarity refers to the tendency to group together individual visual elements with similar proprieties (shape, size, spatial orientation, colour or movement etc). Grouping together those individual elements, we'll form a new compositional form structured by columns, volumes and colours seen together.

Symmetry is all around us and, sometimes, we tend to organise the composition based on symmetry approach. Using a frontal point of view with symmetric elements spread both left and right, we achieve a balanced and symmetric composition.

Continuation is the tendency to fill an irregular or unfinished form by continuing it with the main directions and structures and giving it another meaning to a new final form.

Closure is the organising the shapes and forms into a new one, by closing the space (figure-ground or dark-bright space) into a different shape and volume. The Notan graphic design is based on this human tendency of closure and companies' logos are usually made following this approach.

Closely linked with the capturing format (Portrait or Landscape), all those perceptual mechanisms and rules are used to make meaningful composition where the viewer's attention can easily be caught and drawn to the compositional attention points.

Transferring the three-dimensional reality onto a bi-dimensional surface, requires the photographer or cinematographer use depth cues. These cues are transferring the illusion of three-dimensionality on the cinema screen or photo print, keeping the senses of depth from our every day stereoscopy. The depth cues are: Relative size, Overlapping, Linear perspective, Aerial perspective, Texture and Contrast gradient and Movement parallax.

The relative size, despite the lack of other elements which can structure the perception of space, transfers the feeling of how far or close the compositional elements are. This perception is modulated trough the successive positions of visual elements placed in depth from the point of view we shot from.

Overlapping is one of the main element of depth cues used to give the feeling of compositional depth. Having other elements which overlap the compositional elements, from the camera point of view is giving the viewer the feeling of three-dimensionality. Therefore the compositional depth feeling is achieved trough the relation between foreground (overlapping elements), middle ground (usually action plane) and background.

Linear perspective is used to structure a composition with one, two or three vanishing points. The shooting position (camera height and lens) influences how we underline each of the compositional elements. If we need to feature a specific linear perspective we can choose between making a shot with the vanishing point in the composition or outside of it. The composition with one vanishing point are the one with a frontal, straight on view, where all the elements are organised following the symmetrical frame approach. Wes Anderson is one of the current directors which intensively uses the compositional perspective with one vanishing point.

Aerial perspective can be highlighted in exterior day shoot, when the successive layers of air influence the saturation and the contrast of the picture. Mentioned for the first time by Leonardo Da Vinci in *Tratato della Pittura*, his application in painting involved the control of colour composition and contrast. Leonardo statued how the saturation and tint is changed by the aerial perspective and the importance of using more saturated colours on the foreground action and desaturated and more bluish tinted colours if the subject is further away from the staged action, in the background.

Texture and Contrast gradient is used to highlight how close or far from the action plan the elements seen in the composition are. On low resolution ratios (30 to 40 lpm - lines per millimetre) the eye is attracted to the areas with high texture and contrast. The texture also indicates the space between two or several action plans within the compositional depth. By evaluating the relative size of the minimum seen details from the textures spread all over the composition, the viewer realises the interposition between individual action planes and the distance from the camera to each textured detail of the described elements.

In photography and cinema we control the aerial perspective using mechanical effects, smoke, rain, snow and steam in order to segregate the overlapping action plans and underline the lighting effects present in the composition. Usually the ray of lights and special lights

effects (backlight, lasers, flashlights, car headlights etc.) are highlighted when we use smoke in location or studio shooting.

Movement parallax is effective in cinema only (motion pictures) and is the effect shown when we change the camera shooting position. This movement parallax is also changing the linear perspective and the point of view of the environment we are shooting on. We see the motion parallax because of different perceived objects speed placed in several position within the frame (closer and further away from the camera). That means, the further from the camera an object is, its relative motion is slower than an object closer to the camera. An important element which might influence the motion parallax is the lens convergence. If the convergence is big (wide focal length) the motion parallax is also big and the perceived speed between the close, medium and further away action points is significant. The effect is reduced if the lens convergence is small (telephoto lens), therefore the speed between different action plans is small or insignificant as we increase the focal length.

In cinema we sometimes use an optical effect which combines the zoom with the camera movement applied in opposition: if we get close with the camera we zoom out and when we get further away from the subject, we zoom in. The effect is strong and, in the English film terminology, is called Spielberg dolly (Spielberg used this effect in *Jaws*, 1975). The first filmmaker however who used this effect was Alfred Hitchcock in *Vertigo*, 1958.

In photography and cinema an important element is the aspect ratio and the format (portrait or landscape) we shoot in. The aspect ratio is the area we compose in and, therefore, the composition is influenced by the aspect ratio. The cinema and television aspect ratios are linked with the distribution formats so, these are inherently limited to just a few compared with the almost limitless possibilities of creating unusual aspect ratios in photography. The main formats are derived from the analog film formats and, most recently, from the sensor sizes in digital cameras. The most used format is Full Frame (24/36cm), also known as Vistavision in 35mm film. Declinations of the formats also change the aspect ratio which, in digital, can be adjusted to any new ratio by cropping the capturing format. In cinema, because of the digital distribution, the shooting formats range from 1:1,33 (4/3), 1:1,5 (full frame), 1:1,66, 1:1,77 (16/9), 1:1,85, 1:2 (Netflix screening aspect ratio) to 1:2,40. Inside the deliverables format (1:1,89) all this aspect ratios must be adjusted. In photography the aspect

ratio isn't restricted but the composition has to be coherent in relation with it. Framing means selecting a relevant portion from the reality (either filmic or photographed), space within which the composition has the key role to express what the cinematographer or photographer imagined for that shot. In this algorithm we include the point of view (normal-eye level, high angle or low angle), the lens (wide, normal, telephoto), the lighting contrast, colour or black&white contrast, overlapping and the compositional meaning expressed through forms, dots, lines and volumes. Choosing the lens and the camera point of view will influence the perception of the compositional space. When we use a wide or an extreme wide lens, we'll influence the perception of space and the feeling of depth. The scale of the objects (through their relative size) shows how the space will be illustrated into a compressed or expanded perspective. The perceived distance between two successive objects seems to increase or decrease when we change the focal length, actually neither will happen, is just an optical illusion mediated by the lens convergence.

Figure 6. Three lenses and the difference in perceptual space mediated by wide (18mm), tight (100mm) and telephoto (200mm) lenses

In Figure 6 we can see the difference between fairly identical compositions (with the foreground chair) composed with three lenses: 18mm, 75mm and 200mm (APS-C format). The compositional space and the distance between the chairs seems totally different on each photograph and that's because the lens convergence, combined with three different camera positions, applies a different factor of relative size (increasing or decreasing).

The importance of linking the focal length with the format is crucial, an 18mm lens will have a different field of view on 2/3', APS-C or Full Frame format. In Figure 7 we have a comparison between different capturing formats starting from 1/2,6' to Full Frame.

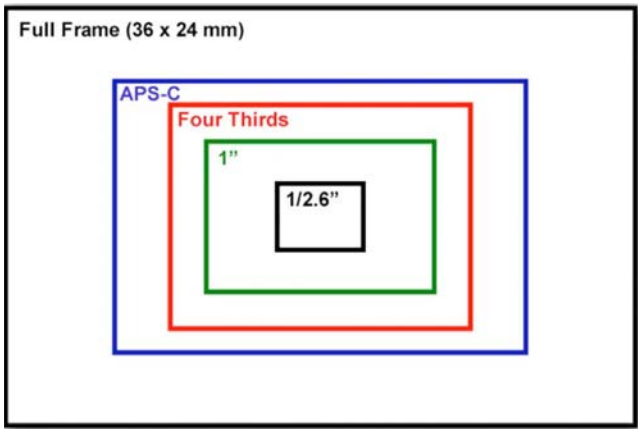

Figure 7. Comparison of digital sensor sizes

In Figure 6, the changes of the perceptual distance related with the linear perspective rules happen because the camera position was different from each shot. The composition was adjusted for the foreground chair, which means the field of view and the lens convergence gave that illusion of space extrusion and contraction when we looked at the photographs. The 18mm lens has a big convergence factor which, trough the relative size factor, gives the sensation of deeper compositional space and a bigger distance between the chairs. On the longest lens used, 200mm, the feeling is opposite, we feel the compressed depth and smaller distance between chairs. If we crop the picture shot with 18mm we discover an identical relations between the compositional elements even if we shot with three lenses from the same camera position. The field of view is the only difference between the shots, no feeling of compression or expansion depth is present.

Only when we change the camera position, closer or further away, we influence the factor of relative size of the objects shot. As we can see in the photos below (cropped from the original 18mm, 100mm and 200mm shots at the same camera position), the only difference is the depth of field concreteness from the widest to the longest lens used. This difference is due the fact that the focus point position and perceptual depth of field changes from the lens constructive specifications which leads to a different rendering of depth of field related with the T-Stop and focus point position. On the wide lens (18mm), the focus was set on the closest chair, for the 100mm and 200mm the focus point was similar but the perceptual depth of field difference comes from a narrower depth of field for the 200mm compared with

the cropped frame of the 100mm. In Figure 8 we see this explanation on perspective and the lack of space conversion when the camera position remains the same.

Figure 8. The factor of relative size captured from the same camera position with 18mm, 100mm and 200mm (right) lenses. On the 18mm (left) and the 100mm (centre) the crop reveals the same spatial positions between the chairs

The crop factor also changes the field of view and on different formats the focal length is adjusted by this number. A 24mm on Full Frame will be 16mm on APS-C and 8mm on 2/3', as we've already mentioned, the depth of field of the lens is influenced by the size of the sensor and the T-Stop.

Compositional structure and forms.

Starting from the reference of the format (either vertical or horizontal), we tend to organise the composition inside the aspect ratio based on a set of basic rules which determine the main aesthetic appearance. A composition based on geometrical shapes will need to be organised by grouping the elements on their basic shapes and density. An open or a closed composition, balanced or unbalanced, is the feeling we give the viewer when she or he sees the picture. Besides lines, volumes, contrast, light and colour we also need to pay attention to how we structure the relations between big-small, bright-dark, high contrast-low contrast and so on. The negative and positive compositional space is based on alternation, in a personal visual key, of all the components which will eventually form the composition. "Good composition reinforces the way in which the mind organises information (…) Composition

selects and emphasises elements such as size, shape, order, dominance, hierarchy, pattern, resonance and discordance in ways which give meaning to the things being photographed"[1].

The balance or visual weight of objects and lines of force (eye lines, moving direction or dominant lines within the frame) is based on mixing the symmetric or heterogeneous elements together. Compositional unity is driven and organised on a set of rules based on human body proportions which seem to aesthetically please the viewer. These harmonic proportion have been used since the Antiquity by painters and sculptors. In a compositional space we sometimes use two rules, the rule of thirds and the golden ratio. Each one of those divides the compositional space in a different manner:

- The rule of thirds is based on dividing the composition into 9 identical frames separated by two vertical and two horizontal lines. The rule of thirds is not influenced by the aspect ratio, the section drawn by this rule being constant and equal all through.

- The golden ratio is based on the golden number and its proportion related with the height and width of the aspect ratio. The harmonic proportion is not constantly equal throughout the different aspect ratios we use when we shoot or photograph a composition. Changing the aspect ratio the golden ratio brings the intersection points close to the centre of frame.

A comparison between how the compositional space is divided by the two rules is highlighted in Figure 9. Even if the rule of thirds seems more logical, the inner and organic human feeling is drawn to organising compositional space through the golden ratio. That's because it’s in our DNA to find the more pleasant and harmoniously balanced compositions to be the ones divided based on golden ratio proportions.

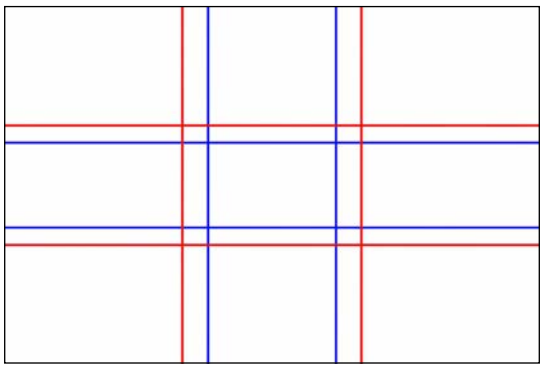

Figure 9. Comparison between the rule of thirds (red line) and golden ratio (blue line) on 1:1,5 ratio

[1] Brown, Blain - *Cinematography Theory and Practice, Image Making for Cinematographers, Directors and Videographers*, Focal Press, 2002, p. 30

As we change the aspect ratio, the proportions also change as we can see in Figure 10 where the aspect ratio is Cinemascope (1:2,40). When applied to a widescreen, both rule of thirds and golden ratio have a totally different proportions related with an usual proportion screen (16/9, 17/9 etc.). As we can see, the harmonious proportions are reversed, the golden ratio division moves outside the rule of thirds which actually multiplies the original ratio. The utility of this division, rule of thirds or golden ratio, comes from the construction of reflex viewing system. Medium format camera ground glasses, used for framing and setting the focus, are usually divided into a grid structure, design which has been adapted to the rule of thirds.

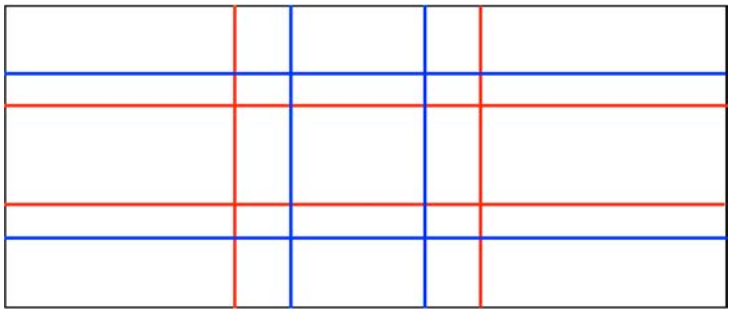

Figure 10. Rule of thirds (red lines) and golden ratio (blue line) applied to a widescreen ratio (1:2,40)

Framing the subject into a portrait or landscape format is decided by the content and forms composed. If the main directions and proportions are oriented onto a vertical direction, then the composition can be framed in a portrait form. On the other hand, if we are trying to communicate a relaxing and peaceful feeling, the horizontal lines and composition must to be framed in landscape.

The lines are giving the direction and structure to the compositional space related with the human perceptual response. Usually when we look at a picture, we scan with our eyes the relevant areas, potentially interesting and attractive points within the composition. On a holistic approach, the lines which help us to build a composition are: vertical, horizontal, diagonal and sinuous lines. The level is also important and draws te attention of the viewer if it's not right. On a neutral point of view, any changes from the horizon level will seem strange and they have to be justified by the compositional content and meaning. One usual approach is the dutch angle, the composition is canted to the left or right, therefore the content (people, actions, landscape etc.) is also caught in this distorted manner. The main compositional

leading lines are compared with the human biped posture, which means we continuously compare the photo reality with the surrounding reality we live in. The gravitation and the ground-sky separation determines two out of four main compositional lines (vertical and horizontal). Also using it within any composition as main expressivity, a sinuous or zig-zagging line will say two opposite messages about the picture. Because the horizontal is compared with the line of the horizon, it is usually assimilated with serenity and relaxing feeling. Opposed the horizontal line is the diagonal which express dynamism, further more, zig-zagging lines will induce uneasiness and anxiety to the viewer which means the photographer or cinematographer has to order all the details within the frame, building a right message for the spectator.

In the absence of light we can't talk about seeing. The image is formed when three basic conditions are fulfilled: the existence of light, the object being illuminated and the observer or the medium capturing the image. The light also has many features: direction, intensity, quality and structure (hard or soft).

When we decide to shot in exterior day light, we need to synchronise our intentions with the quality, intensity, position and light structure in order to express what we intend to do. The intensity of the light, usually key light, will determine the exposure value. The position of the key light can radically change the look and the mood of the picture. The frontal position will transfer all the compositional details to the viewer but with the frontal stages of key light it is hard to craft a different mood, for instance a low key (chiaroscuro from Italian) in order to get a mystery or a film noir mood. Therefore, the position of key light should be closely related to the character we depict within the scene or shot we want to create the mood for.

Depending on whether the light structure is hard or soft, the message would also be different. The main visual separation between the two is the shadow structure. In photography and film, the opposition light-shadow will build the scene mood, and the structure of shadow will make the distinction between hard and soft light. When we use hard light, the shadow is well defined, without any gradient, in opposition with a soft light which has a shadow gradient depending on how big the emitting surface of the source is. When we use hard light we want to emphasise the distinction light-shadow and the distinct separation between the two areas. The own shadow formed on the object itself, will emphasise the three-

dimensionality of the object. The cast shadow will make visible the direction, quality and structure of the key light, the source which projects the shadows into the composition. If the shadow gradient is big, the separation between light and dark areas is fairly soft, therefore the overall contrast also is influenced by the structure of the key light.

Another important feature of the key light, besides being hard or soft, is the position for the subject or character we light. The feeling of depth is achieved by separating the subject from the background. The three-dimensionality is highlighted if the position of the key light is at least sideways from the subject, as far back as the edge of the key light is, the bigger the volumetric feeling within the composition will be. The German Expressionism period had one of the biggest influences in film craft and film aesthetics which highly influenced the noir, mystery and neo-noir eras in world movie history. For the first time, the expressivity of light was in the centre of the story, the character and his shadow (always hard shadow) were inseparable and the norms of placing the key light in relation with the character were differently expressed than in mainstream cinema. Nowadays, the style and the norms of lighting a scene or a portrait differ from any storyteller or visual artist to another, but the basics are always the same.

In addition to the first norm of key light visibility, which is to cast shadows inside the composition, the position of the light in relation to the subject is also describing a variety of parameters. For instance, as we will further explore, the frontal key light positions for a character or portrait will flatten the face volumes. One of the favourite key light positions in baroque painting era was the so called Rembrandt lighting, a light effect which will draw a triangle pointed down on the opposite character's cheek. This style is used also in film and photography, in this case the position of the key light is about 3/4 of the way in front of the character. An example of this lighting position is shown in Figure 11 where we see the Rembrandt lighting scheme with a hard and soft key light, the only thing changed between the two examples is the structure of light. Changing the relevance of the light (hard and soft) will also change the feeling of dynamic range, contrast and shadow value. With the same exposure value for the both photos, the range from the darkest black to the brightest white is different when we use a soft light. This problems occurs because of the shadow definition. When the shadow is well defined, with no gradient between light and dark area, the feeling of depth, texture and density differs.

Figure 11. Two portraits lighted in Rembrandt style with harsh and soft light, the shadow definition and the overall contrast are different

An important feature of Figure 11 (left and right) is the key light structure which influences the value of shadow and the gradient; the position is therefore similar for both photos. As we can see on first example (left), the shadow is well defined and the black value it's placed at the bottom of density graph or between value I and II on Ansel Adams zone system (Figure 12).

In Figure 11 we see how the value of black, the level which define the overall contrast, is influenced by changing the structure of light (from hard to soft), neither picture has additional fill light.

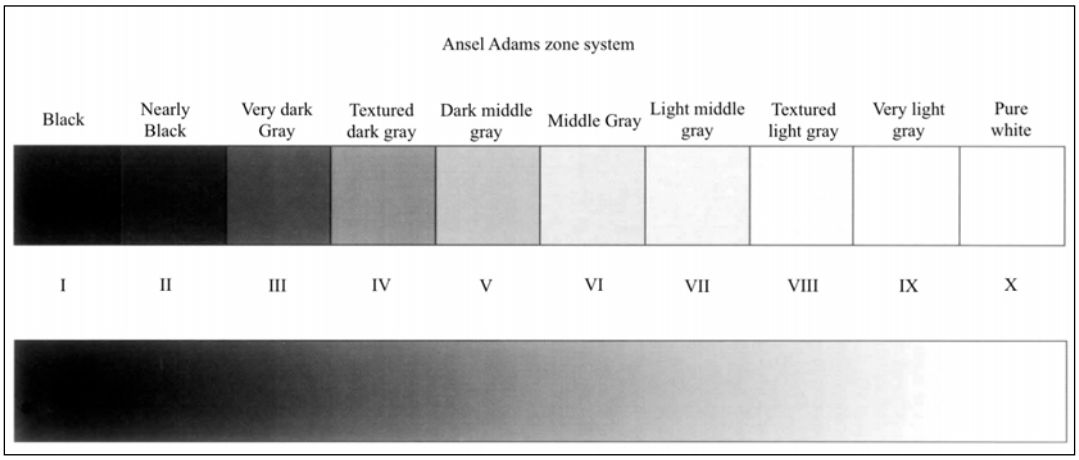

Figure 12. Ansel Adams zone system defining the distinct exposure areas of a scene

The definition of a hard or a harsh source is this: a pointed source which has a parallel light beam and projects on the proximity surfaces a well defined object shadow, with no gradient.

The soft source is a source with a wide emitting surface, source which will cast a shadow with big gradient on the proximity surfaces. Usually we use a fairly big surface, compared to the size of the subject, and with a rectangular shape. For instance, the soft version of the portrait in Figure 11 (right) was illuminated with a soft panel with a square surface of 1/1m placed at 1,5m distance from the subject.

Three point lighting scheme.

One of the basics of film and photography lighting is the three point scheme which involves placing the lights in three different positions related with the subject. Those are: the key light, fill and effect. On a single source lighting scheme, we usually use at least two sources, key and fill. The feeling of single direction lighting, either from outside or inside the composition, will emphasise this lighting scheme. When the key light is inside the composition, we refer to a practical or an effect light, which will generate a specific direction, intensity and quality of light.

The ratio between those three lights involved in three point lighting scheme is as follows: the brightest is the key light which also sets the exposure value, the fill establishes the lighting ratio with the key light and the backlight, kicker or edge light, will add some separation between the character and the background. If the densities of the background are similar with those of the character, this backlight eases the separation of it. In classic Hollywood movies, the backlight is always placed on the opposite side from key light. In the modern lighting style, the backlight is on the same side but with a different structure than the key (hard vs soft). Depending on key light position and softness, the fill light, with which will help set the lighting ratio, is included in the lighting scheme. The lighting ratio is important to set the mood of the scene: a big lighting ratio (3 or 4 stops between key light and fill) used for a low key scheme, will set a high contrast ratio. The structure and direction of key light is also important when we look for a low key atmosphere, usually the direction is sideways or

backlit for the character and camera position, the dark areas in the frame are predominant on this lighting mood style. In direct contrast with this mood is the high key atmosphere where all the areas within the frame have to be bright and placed above middle grey (from the Ansel Adams zone system), which means the overall contrast is compressed, the ratio between the brightest and darkest area in the shot is small. In Figure 13 we have two examples of low key and high key moods made only from the ratio (big or even), direction, exposure value (under and over expose) and key light structure (hard or soft).

Figure 13. A low key and High key mood made from key light direction, structure and key to fill ratio

The portrait photo shoot has a different approach, with aesthetic norms used when we set a scene mood that don't apply for a portfolio or fashion photoshoot. One of the big differences is the structure of the lights we use. In cinema, we use continuous lights versus photography studios where discontinuous lights (flash lights) are the norm. Using flash lights for a photo shoot means we can adjust the shutter speed of the light accordingly with the camera shutter value. The intensity of a flash can compete with the sun intensity on an exterior day. Creative use of a flash can involve multiple exposures on the same shot (using a long time camera exposure and multiple flashes). The flash shutter speed (just the head or

with soft box) can be shorter than the camera shutter speed which can help us photograph liquids or different short time events. With a medium format photo camera (up to 60/45mm sensor area), the shutter speed can't be faster than 1/2000s while the flash can go up to 1/40.000 s. Some spectacular drop splash shots (liquids like milk, beer, vine etc.) have been realised with flashes at short shutter speeds which can freeze the actions photographed. Strobe lights are also used to shoot high speed events such as bullet time, explosions an so on. The mood we wish to create for a scene or composition is closely dependent on the lighting ratio, exposure, overall contrast and the textures we highlight in the composition. As already explained, the frontal key light position will flatten the framed volumes and textures. Both, volumes and textures are underlined by a composite lighting scheme, within which some projected shadows will add texture from the hard lighting structure of the key light.

In the following examples in Figure 14 we see the relevance of texture when we are trying to build a deep space composition. The compositional three-dimensionality is a visual structure within which using the depth cues will add perspective and volumes.

Figure 14. Same lighting scheme with two different key to fill ratios, smaller on the left, bigger on the right

Let’s now compare the same composition and lighting scheme but with two different lighting ratios (between key light and fill). With a smaller ratio, the overall contrast is changed and the details we wish to hide or show in the shadows can be blocked. Another difference between the photos in Figure 14 is the background relevance. On the left we have an extra texture on the background compared with the right photo where this texture disappeared, it’s been soften up. The compositional depth feeling is more present on the left picture even if the basic exposure value doesn't change at all. Another important aspect of

giving an extra feeling of depth is the camera's point of view and character position in relation with the camera axis. This composition is a typical two vanishing point shot, the linear perspective emphasised here helps build the three-dimensionality illusion on a screen. The relation with the camera axis is also tremendously important because a flat character position (perpendicular on the camera axis) doesn't underline any volumes and depth. In the following Figure 15, the position of the character is the same but the mood changes because of the lighting scheme; the key light is frontal. The mood we imagined before (left picture) is now radically changed just by moving around the key light, which is the only lighting source in the right photo. By placing the lights (within the tree light point lighting scheme) in relevant positions in relation with the subject, we can build a believable atmosphere and an appealing look for the character. Reducing the three point scheme to a single source doesn't assure a nice and properly build mood. The single source scheme is sometimes used for portrait shoots. In that case the key light position and softness is adjusted for the subjects' needs.

Figure 15. Changing the mood and the depth illusion of the shot, three point scheme-left, single source-right

The key light position, relevant for a portrait shot (Rembrandt lighting), is inappropriate for a wide shot where we want to build the shot atmosphere. Almost the same change happens when we light with soft sources only, the subject and set volumetry will seem totally different on both pictures. The structure of some lights has been changed from hard to soft. Even if this softness of light is appealing for shooting portraits, in this specific case, changing the lighting structure makes a big difference.

The overall visual perception of contrast as well the local contrast is thus affected. Comparing the values (brightness and density) within both compositions, we see that the back wall value looks the same, the cupboard interior as well and the lighting ratio on the character face, identical. Only the hard light accents (on boy's face and background) makes the difference between the two photos. The overall feeling is that the left picture, through emphasising the textures, looks more appealing for the viewer.

Figure 16. Same set-up with two different lighting keys, mixed hard and soft-left and soft only-right

Another stylistic approach in photography and film is the silhouette style with its derivations, projected and illuminated silhouette.

Each approach has to be harmonised with the aesthetic values of the picture and the message we wish to send the viewer. The illuminated silhouette was intensively used during the Hollywood golden era when the female character were specially illuminated with this light effect. The contour light, used to add a continuously rim light to the silhouette, added that extra glamour to the female character on movies or portraits photograph. Given that era's norms and technical restrictions, some of the big divas head shots were done with hard light sources, placed almost frontal for the portrait. That style imposed a specific lighting technique, style which is sometimes used today as well, the butterfly style. The single light technique has been a favourite close up key light for numerous star: Greta Garbo, Rita Hayworth and Marlene Dietrich being just a few.

The symbolic power of the silhouette comes from Antiquity where the similarity between the human figure and its cast shadow was the first representation of a living person.

The most used position was the profile which keeps the recognisable features of a human face. The head and forehead line, the nose, lips and chin are the elements which were later composed into an effigy as a first identifiable element on coins and official seals.

The art of photography and cinema is governed by the same compositional rules that were first used in painting. The frame we compose will determine the spatial relations between human figures and the perimetric edge. Setting the right distances and spaces among the compositional elements we build will lead to a balanced, harmonious composition or, on the contrary, an unbalanced one. The artist's intention to express quietness, serenity or immediacy and excitement will also be expressed through composition. The basic compositions are related with the human size in the frame, starting with the widest one, which we call **Extreme long shot**. This shot is usually composed for landscapes and actions with people of tiny proportions and will feature the environment as a description of the place more than human illustration. The objects featured in this extreme long shot are far from the camera's point of view and highlight the mood and time of the moment.

- Long shot is the next one as the camera gets closer to the action. In this frame, the people are seen in wider composition than a full figure (head to toes) and we underline the space and environment for the action or the moment we want to express. This is also called an **Establishing shot**.

- **Wide shot** includes the subject's full body and some of the surroundings. Also the mood and overall contrast of the scene is continued from the long shot and establishing shot.

- Cowboy shot was introduced on western movies where the hero had to be seen with the guns in frame. This frame comes in two sizes, wide cowboy shot and tight cowboy shot. The wide one is cut under the knees and the tight one over the knees (including the gun holster).

- **Medium shot** from waist up, **Close Up** from the shoulder (head and shoulder) and

- **Extreme Close Up** the face only (from eyebrows to lips). Sometimes, the **ECU** (extreme close-up) features some tight areas from a face (eye, eyebrow etc) or some insert shots, details of an object or parts of it.

In photography we have the freedom to frame both portrait and landscape. In this case, the sizes we've mentioned above are adjusted to the character's/human's size or to the

compositional content (architectural, history, sport or leisure). Therefore, the main directions, proportions and geometrical weights determine the shooting format, portrait or landscape.

Going further with compositional space structure, the cuts within each of the sizes mentioned above are dependent on the compositional dimension of the people we photograph. There are some rules to follow when we frame a single person or more. Getting down to the basics, framing a single character implies some head room and "nose room". The head room is referring to the space we leave above the subject's head. When the composition is tight (from medium shot up) we have to pay attention to the top line which might be touching or intersecting some "painful" body areas. Therefore, the cuts at any arm or leg joints are nasty and the subject's limbs look amputated. On the same "not to cut" list we also have: fingers, wrists, elbows, ankles, the neck and so on. The head room is usually proportional with the forehead or the size of the character's head in the composition. In the case of close-ups we have a rule of keeping enough space over the head in a such proportion that the eye line is always placed above the frame's mid horizontal line (Figure 17 - left).

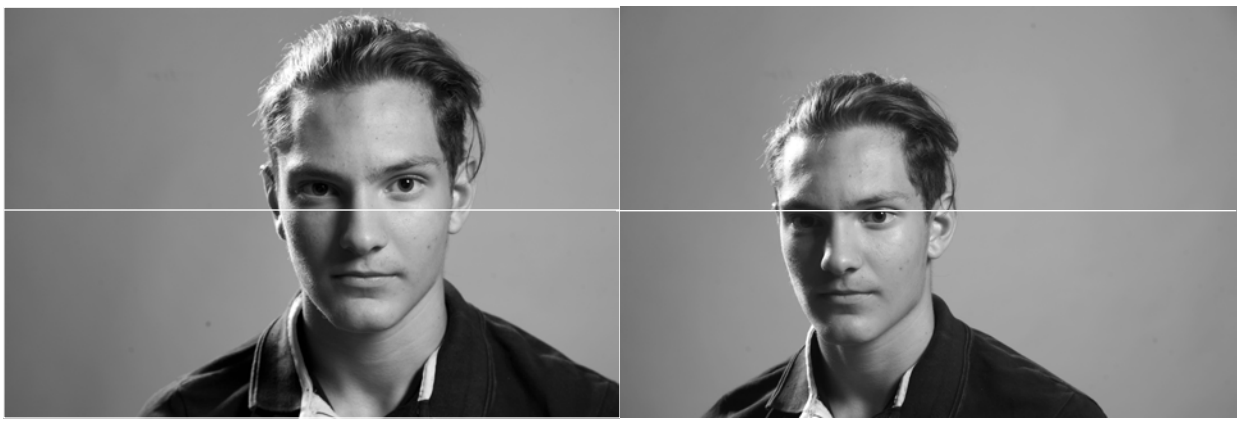

Figure 17. A close-up with right (left) and wrong (right) headroom

This rule is more effective on portraits, close-ups and extreme close ups. In Figure 17 we have two close-ups where the headroom is correctly and incorrectly balanced, following the median compositional axis in relation with the subject's eye line. The headroom proportion comes from the daytime exterior ratio between dark and light space (ground/dark and the sky/light). To properly balance an exterior landscape we frame 1/3 ground and 2/3 sky. Placing the horizon in the middle of the frame looks odd, the reversed rule is even more

unbalanced, 2/3 ground and 1/3 sky. The same perception applies when we frame a full figure subject, the harmonious headroom size it's a 2/3 over the head and 1/3 under the feet (Figure 18 - left).

Figure 18. Three headroom versions for a Full figure shot, Cowboy shot and Medium shot

In the above examples we adjusted the headroom accordingly with the size of the subject. Choosing a landscape or portrait compositional version will also change the look and the proportions within the frame. In videography and cinema, the aspect ratio is landscape, compared with the photography where the artist can choose whichever ratio will be appropriate for the subjects she or he is framing.

Besides headroom, in photo and cinema there's another proportion we need to address, nose room, or the space which we allow the character in their looking direction. Usually we divide the space in front and behind the character using harmonious proportions, similar to the headroom ones. So if our model is looking camera right, the room in the looking direction has to be bigger than behind the character. In a way, we allow an extra

space to possibly include another character in the composition without changing the spaces already composed. In cinema, this space is used for the eye lines and when the subject walks left or right and she or he needs an extra space in the moving direction.

We have two rules to follow, the rule of thirds and golden section and as we've already mentioned, each of those two are appropriate when we compose the moving direction space and headroom. In Figure 19 we have two examples of headroom and nose room applied accordingly with the norms (bottom picture) and ignoring the compositional rules (top picture).

Figure 19. Same headroom and two versions of look room on a widescreen ratio

When the subject is alone in frame, the compositional rules are easier to follow; when we deal with more than one character, we need to pay attention to more limited factors among which we name: the hight of the camera position in relation with the point of view and compositional proportions in the frame. The exposure value on each one of the subjects is also important if we want to draw attention to a specific character or action; we will need to highlight that area according extra attention to it. That means we need to frame it properly,

expose and place it on a proper position for the viewer. If the compositional depth is important and the action takes place on the middle ground area, we have to control the foreground and background brightness and texture in order to have them placed below the action plane values and textures. In this evaluation ratio we need to set the right exposure in order to fulfil the expressive and aesthetic objectives. By underexposing or overexposing a shot, we will try to get an emotional and empathic response from the viewer, which looks for the relevant details and compositional elements within the frame. If this first element is under our control, all successive actions and visual expression key elements are successively checked.

Controlling the compositional content can be painful sometimes. When we take a series of snapshots we cannot pay attention to all the rules and aesthetic norms but we assume the risk of having annoying elements close to the subject or in the background just for the sake of keeping the memory alive. An easy method to change the perception of background concreteness is by using the depth of field feature, a shallow depth of field will smooth out the unwanted interactions between the subject and the foreground and background textures and colours. In Figure 20 we have two examples of a shallow depth of field, approach through which both the foreground and background are blurred.

Figure 20. The influence of compositional depth of field, the colour contrast also helps to this approach

As we have already mentioned, the depth of field value is dependent on two factors: the format size and the T-Stop value. If the format is Full Frame (24/36cm) and we shoot at 1.4 T-Stop, the lens depth of field at 1 meter focus point is 3cm. An important issue when we want to use a shallow depth of field is the focal length and the focusing point. Having the

focusing point closer to the camera will influence the lens depth of field by decreasing its value. Also, choosing a wider lens wouldn't increase this depth of field value if the subject is framed identically with different focal length lenses (see Figure 3), therefore, to keep the same size of the subject, we have to change the camera position closer or further away.

Colour is another key stylistic element to be used in photography and cinema. The lack of it, black & white, is a stylistically limited option because it’s clashing with the normal, everyday human colour vision. The colour is a sensation mediated by the reflected light from the surface we see. The hue and saturation of the colour depends on several viewing conditions among which we mention: the light colour temperature, the surface reflection proprieties and the simultaneous contrast influence.

The spectral composition of incident light will influence the hue and saturation of the reflected colour. The visible spectrum, the narrow part which we see, is bordered by blue (380 nm) on the short waves rays of light and red (700 nm) at the other end. From blue to red we have all the visible spectral colours, outside the visible spectrum there's infrared and ultraviolet. The phenomenon was discovered by an English physicist, Sir Isaac Newton in 1666. He experimentally showed the light dispersion caused by the refraction through an optical glass prism. The spectral, rainbow colours, are Red-Orange-Yellow-Green-Blue-Indigo-Violet.

They're two colour synthesis used for capturing images, one based on light subtraction and the second one based on the additive process of light. The colours we perceive around us are resulted from light subtraction, which means that from a white luminous flux which falls on a coloured surface, the colour is obtained after a subtracting-reflection process. So from the full visual spectrum a red coloured surface (pigment), will absorb all the light waves except the red which is reflected back to the observer. The saturations and the hues of the colours are shown in Figure 5 where, on the outside perimeter of the horseshoe shaped graph we find all the spectral colours plus Magenta which is obtained when we mix red and blue (the both ends of visual spectrum). As the light wave increase (from 380nm to 700nm) the hue changes. The colour saturation is also another variable, the 100% point is placed on the exterior perimeter and as we move toward the white point (in the middle of the graph) the colour saturation decrease to 0. All the colours shown in the CIE 1931 graph are used in the additive synthesis, the base of capturing and producing colours with digital devices. Starting

from the capturing moment, on the surface of a digital sensor we have three tinted photosites (the smallest picture element from the sensor) grouped in four blocks; one Red, two Green and one Blue. The system and the space we produce colours in is called RGB from the abbreviation of Red-Green-Blue. All modern digital displays are also built on the same philosophy, the optical mixture at different intensities of red-green-blue will produce all the existing colours of the spectrum, plus magenta. The screens have three pixels (Picture Element) at the base of the full raster or resolutions. So, the actual resolution of a displays (TV, laptop, smartphone etc.) or video projector is composed from three RBG pixels. The individual colour being obtained through the mixing Red Green and Blue pixels of various values.

The reason for having two green photosites in the sensor structure configuration is related with the human eye's spectral sensitivity. The cells responsible for human colour vision are the cones which are specialised at capturing three distinct lightwaves, short (for blue light) medium (for green) and long (for red). The global human spectral sensitivity has a peak at 555 nm (green-yellow radiation) in the visual spectrum so, this is the reason why we feel the colours brightness differently depending on lightwave or hue. In this order the brightest is yellow followed by orange and yellow-green, then cyan, red and blue. Because of this brightness perception, painters made a set of proportional balance between the colours based on this hierarchy. The colour visual weights, divided into pairs are: 1 to 3 for yellow and violet, 1 to 2 for orange with blue and equal parts for red and green[2].

Getting deeper on colour synthesis, beside the additive synthesis we also have the subtractive synthesis which is used in print. The link between the two versions is done through the primary colours, therefore mixing two additive colours we obtain the complementary colour for the third one. When we mix Green and Blue the result is Cyan, the complementary colour of Red, mixing Green and Red equal Yellow, the complementary colour of Blue and finally, mixing Red and Blue equal Magenta, the complementary colour of Green. To resume the essentials, the primary RGB have their pairs the primary CMY, which are used in colour print. The full spectrum of colours and densities from white to black needs a fourth component in subtractive synthesis which is Blac**K**, so the used colours in this synthesis are CMYK.

[2] Itten, Johannes - *The Elements of Color*, Van Nostrand Reinhold, New York, 1970, p 61

The colour application in art is based on multiple choices which combine the colour theory of contrasts and harmony, the cultural colour meaning and the psychologic impact of colours.

The power of colour has been used throughout the centuries in painting and decorative art. The way of combining and harmonising the colour contrast is based on human attraction to certain hues according with the world hemisphere they live in and in hierarchal order of primary, complementary and tertiary mixture of colours.

In painting and cinema we have two sets of primary colours. The painting theory says that a primary colour is the one which cannot be obtain by the mixture of any other two hues. Therefore the painting primaries are Red-Yellow-Blue which clashes with the set of additive colours Red-Green-Blue, used in cinema, TV and other image displays. This difference changes the relevance of complementary colours and the contrasts within, which are different in the two colour spaces as we can see in Figure 21.

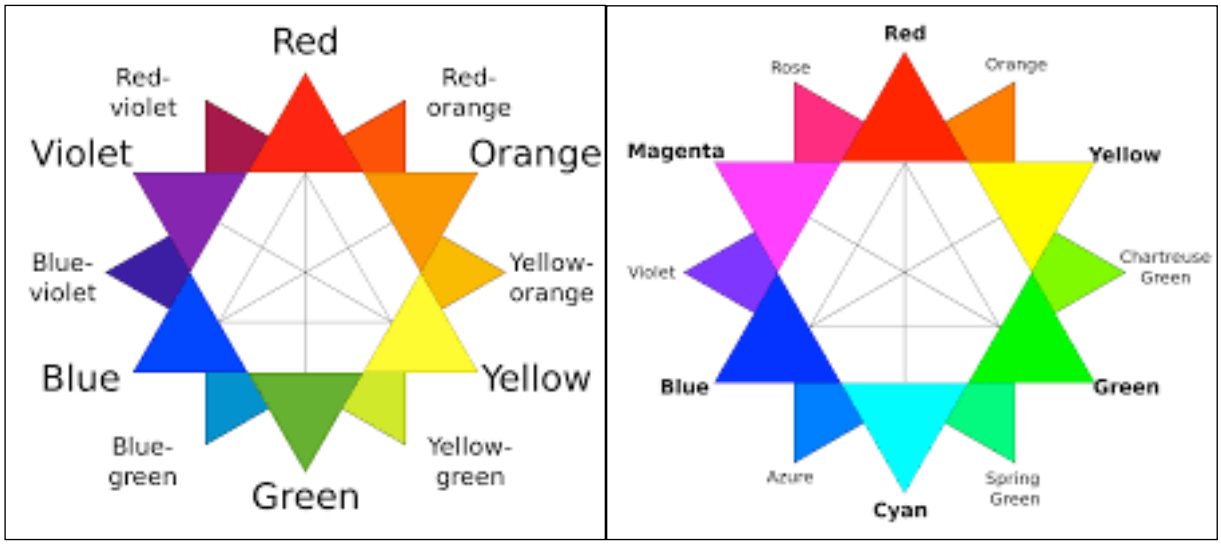

Figure 21. The primary and complementary colours in painting (left) and cinema (right)

As we can see in the two above figures, the colour contrast is different in painting and cinema (TV and other additive based colour synthesis deliverables) which means the colour contrast theory is also different in painting (pigmentary colours synthesis) and cinema and print (additive and subtractive colour synthesis).

The discoveries on colour application made in the XIXth century, add even more value to colour contrasts applications and to the efficiency of colour perception. Michel Eugene

Chevreul, a French chemist hired at Gobelins Manufactory in Paris, studied the interaction of dye colours for the famous Gobelin tapestry factory. He discovered an optical interaction (mixture) of colours which influenced the hue, saturation and brightness of the colour dyes they used in tapestries. The effect was called The Law of Simultaneous Contrast and means that a highly saturated colour placed next to another saturated colour will interfere with both hues reducing the hue, saturation and brightness. In other words, each colour will be polluted by the hue of the neighbour colour which, due the optical mixture, will borrow from its hue. A saturated blue patch will look green if is placed next to a yellow area, the same effect happens with yellow as well, it will look a bit greenish next to a saturated blue area. The reciprocity works with neutral areas placed next to a coloured one where, if the neutral patch is tinted in the complementary colour of the neighbour area, the saturation and brightness of this looks higher. In Figure 22 we see this application with three grey areas tinted on a complementary colour (left) neutral (centre) and with a similar hue (right). The best separation and contrast is with first left square because of the additional complementary tint within.

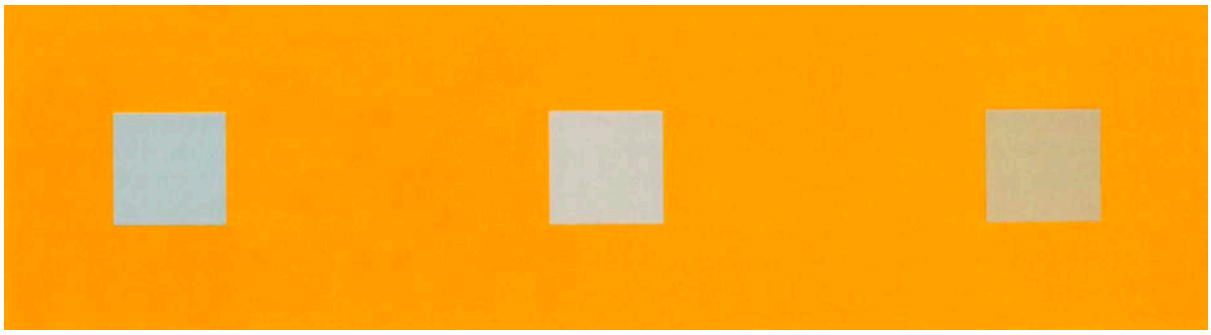

Figure 22. The effect of simultaneous contrast with neutral grey patches, the best separation with the background has the first patch

Studies on colour revealed that preference is related to the geographical birthplace (equatorial, temperate and nordic) of the subjects. For the equatorial and subtropical groups, the favourite colours are from the warm spectrum, orange and red. As we advance to the northern hemisphere, this preference shifts to the opposite end, cooler and neutral colours, blue and blue-green (cyan). Saturation is another factor to be considered, as we move from equatorial countries to the Mediterranean area, the saturation is high and the hues shift to middle spectrum colours (yellow-green). Therefore, on the north coast of Mediterranean sea

we find saturated hues of green and blue, on single accents on mosaics or on house facades. In northern countries, the hues and saturation changes. As we've already mentioned, the favourite colours are on the cool range of the spectrum with less saturation. The colour contrasts are less strong and with an overall bluish tint. Regarding the artworks from this specific areas (equatorial and northern hemisphere) the way of expressing feelings and emotions is closely linked with the hues they use. The look and moods for almost all the Norwegian, Danish and Finnish movies are based on desaturated bluish looks with low contrast and "transparent" blacks, the overall contrast is moderate as well. An explanation comes from the sun position all around the year and the ratio between the whole sky area (blue hue) and the intensity of sun (yellow hue). The incident angle of the light (sun position) is another issue, as the higher the sun gets on a summer day (equatorial and tropical areas), the more desaturated the sky will look, so the bluish tint reference has a minimal influence on everyday colour interaction and preferences.

The psychological colour approach is related to the colour energy and feeling. The warm colours influence the heart rate and the blood pressure so the first colour in visual spectrum, red, is the colour of passion, love, rage and fury. Red also means danger, the traffic light colour for stop is red. The first glimpse of light, when sun rises is red then quickly changes to orange and yellow, red means power impulsive drive, conquer and suffering.
In opposition with the Western culture habits, in China red symbolises fortune and luck, the brides are wearing red dresses on their wedding day. Another difference from the extreme orient area is the symbol of white, which in western and catholic religion symbolises purity and wisdom, in China and Japan is marks mourning and sorrow, the "colour" wear on funeral ceremonies.

Next to red is orange, the colour of fire and warmth, the ripped fruits and the autumn foliage colour dominated by yellow and orange. It is the colour of exuberance and life.

Yellow is the brightest colour because of the eye spectral sensitivity response, and is associated with light, warmth and optimism. The sun is yellow, the base of cool-warm colour contrast is also yellow (tungsten lights, candles and fire). The symbol of wealth (gold), yellow also signifies generosity an intuition, also the colour of youth and enlightened wisdom.

The green colour is the symbol of vitality and nature's rebirth during springtime. Also Green has healing and antibacterial attributes, the surgical rooms are painted in green. Because it is placed in the middle of the visible spectrum, any slight influence of yellow or cyan will change the green neutrality from a yellow-green (warm colour) to a bluish-green (cold colour).

Blue is the colour of thought, liberation, feeling and intuition. The sky is blue, also the ocean. Blue signifies trust, dedication, serenity and eternity. The coolness of this colour resembles with the moonlight and winter time. Serenity, tranquility and intelligence are other blue attributes. As the main colour used in cool-warm colour contrasts, daylight is the base of film and photography lighting.

Cyan, the blue-green mixture and purple, the red-blue mixture are both borrowing the proprieties of the primaries they're derived from. The balance between green and blue, for the cyan, and red and blue for the purple (magenta) will of course lead to different cyan and magenta hues.

Colour contrast and harmonies are used to express and underline a character's mood and narrative evolution. The spectrum of colour contrasts is wide and related with the colour properties. Among those we have a double reference on visual light spectrum, the cool and warm colours balanced by the green which is in between (in the middle of spectrum). One of the most used colour contrast is cool-warm, the pairs from this approach are blue-yellow and red-cyan. Both pairs are primary-complementary, the third one is green-magenta. Green-magenta is the strongest complementary contrast due to the presence of magenta. Being a composed colour not present in the visible spectrum, this mixture of blue and red is a tint sometimes found in the actors skin tone. This pair of colours is also part of the tint component of white balance value, percentage which influences the redness of the skin tone or the unnatural greenish tint of the shadows. This magenta-green value is motivated in WB setting because of the spectral discontinuity of light sources. The professional light sources are standardised and ranked on an index which sets the continuity of light spectrum. CRI (colour rendering index) was the standard before digital capture and distribution became reality, nowadays another index is used, TLCI (television lighting consistency index). In comparison with the TLCI, CRI was effective for more than a century of film industry, this

index measuring the colour continuity (spectral values) for a light source. The most continuously light spectrum sources are the sun light and the tungsten lights (incandescent sources), the CRI index for each of them is 100. After the spectrum analysis, a light source can be ranked with close to 100 CRI or lower. The limit for good colour rendering is CRI 85, below this value the light source is inappropriate for professional shooting, either video of photo. The result of using a poor CRI light source is the colour dominant present in the picture, dominant which is usually from the green magenta spectrum. Removing this tint from all the white and dark levels (also mid tones) is cumbersome and expensive (time consuming process). Selecting and correcting the hue, brightness and saturation of such a picture is counterproductive, so a better choice is to use a proper light source with a high CRI value. Since the digital technologies have been introduced, the spectral sensitivity of the sensor forced the light manufacturers to adopt a new index TLCI. The difference between CRI and TLCI is the wider range of tints compared to the final value, 9 colours for CRI and 15 colours for TLCI. That means the TLCI has better accuracy in spectral continuity than CRI. The new introduced LED lights are highly rated, with low energy consumption and superior white balance versatility. The WB range starts from 2000K and goes up to 10000K but the construction structure of LED lights differ from one manufacturer to another. The LED sources are based on the technology of mixing two, three, four or six different LED. The less expensive and with a poorer spectral continuity are the bi-LED sources (one red and one blue) on which we change the WB. The RGB and RGBW models are more expensive and more accurate on the CRI and TLCI value, mixing an RGB macro block we actually get any hue, saturation and WB value we need, on a continuous range. The latest LED sources are equipped with six LEDs, red-green-amber-cyan-blue and lime, this colour engine covers a wide range of hues, saturations and colour effects. All the LED lights are wirelessly controlled, through an application easy to download and use from a smartphone.

Back to technical issues, shutter speed.

The shutter speed in photo is an important creative element to work with. The perceptual time and the actual process within which the photographed phenomena is taken are totally different matters. The exposure time is influenced by T-Stop, camera sensitivity

and shutter speed. The blur or motion effect is drastically influenced by shutter speed. If the shutter speed is short (1/10000s) the motion is frozen, we're talking about high speed motion like sporting events, car or motorcycle races etc. In this specific cases we shoot on high Sutter speed to try and catch the relevant actions without the motion blur. For a person walking the 1/125s shutter speed is the limit of the motion blur effect so, a higher ratio is needed. In analog and digital cinema, the exposure time is split in two components, frame rates (from couple of frames per second up to 2000 fps) and the shutter angle. The shutter angle can have a value between 180º and 11,2º, as the narrower we get, the smaller or more insignificant the motion blur gets. The exposure compensation is related to the angle of the shutter, changing the angle from 180º to 90º means compensating by opening with one Stop. Halving again we have to adjust with another Stop an so on. From 180º to 11,2º the compensating factor is four Stops. Combining frame rate with the shutter angle will change the perception of motion blur and real speed captured by the medium. So shooting on slow frame rates (under the 24/25, the cinema and TV standard) means we'll do an under-crank shoot which, on regular screening speed, will show an accelerated speed for the protagonists or events pictured. The opposite is true when we over-crank the camera speed (shooting on a high frame rates, up to 2500fps). When we see the footage the event is slowed down with the percentage of the shooting speed. If we shot on a rate of 2500fps and we screen at 25, the event will be 7 and 1/2 times slower than reality (doubling the shooting speed means slowing down a step). This approach is used for special effects shots or specific moments in a scene. In advertising, it is used when we do pouring shots of beer, vine, milk, coffee and so on. Sometimes, in feature films is used as well, when we need to underline a specific stage or a narrative moment. One example is *Inception* (2010), Christopher Nolan's movie (DoP Wally Pfister ASC), where the director intensively used the high speed aesthetics. All the scenes were shot at 2500fps, an extremely high rate for a feature film.

The motion blur or the lack of it, was used in several movies when the hero or the event described has to have an unforgettable approach. The closed shutter angle effect adds a stroboscopic feeling to the shots and it was used on several movies. One of the famous one is the *Saving Private Ryan* (1998), Steven Spielberg's movie (DoP Janus Kaminsky ASC) on the D-day scene, where this approach adds a news reel feeling to the whole Omaha beach sequence. The first value affected by close shutter angle is the acutance. This micro-detail

limit is determinant on local contrast and the detail accuracy. The lack of motion blur will underline the difference between edges and contrast lines which will raise the definition feeling. Less motion blur will improve the acutance value which will help the detail definition perception. The other way of influencing the acutance is by adding sharpening to the picture. Trough the digital De-Bayer algorithm we can add or reduce the sharpening value which changes the acutance perception of the entire picture. The lack of motion blur will enhance the stroboscopic feeling of the motion picture, the key aesthetic approach for Saving Private Ryan D-day scene. In photo, the motion blur can also be used to highlight an effect or the time component size. On long exposure time photos we're using the motion-motionless ambivalence to show the time passing value on a single shot photo. The time exposure range can span from half of second to minutes or hours, for special purpose photographs. In Figure 23 we have an example of longer exposure time, the water dripping down on the stairs is shown differently through this effect.

Figure 23. Long exposure time to highlight the motion blur effect of the compositional elements

The inverse square law and the influence in film and photo

One of the physics laws applied in film and photography lighting is the fall off effect, which states that a light source will lose its intensity proportional with the distance that the light will travel from the point A to B. Also called the inverse square law, the lost intensity is established through a mathematical formula. The intensity of the illuminant source will decrease by the inverse square distance. For example if we have a light with an intensity of 1000 lux at one meter distance, the intensity measured at 2 meters will be 1000 divided by the square of 2 (4) which yields 250 lux. That means that by doubling the distance, the intensity decrease with the square of 2 each time. This fall off effect is used when the light source is close to the subject, therefore the percentage of intensity decrease is big within a small distance.

On exterior shoots, either photo or video, we sometimes look for an effect shot which might need a special lighting or day time. The most usual ones are shooting at sunrise or sunset, having the subject silhouetted on illuminated clouds or a sun background. Also, the golden hour, the time around sunset or sunrise time, will also give a special feeling to the viewer. Being overlapped on a bright background, the character will need an extra fill, balanced with the light quality for that moment. The light quality means the colour temperature of the source at the shooting moment and the artist can emphasise this colour value or balance it with the medium she/he’s shooting on. When we balance the colour temperature value with the camera WB (white balance), the orange feeling of the sunset light will no longer show as it is, the camera compensates this dominant colour adjusting it to a neutral ambient light. In the same paradigm is shooting with flames, candles and torches which have the same low colour temperature compared with the standard lighting sources (Tungsten and Daylight).

To keep the mood of the moment we shoot, sunrise, sunset or magic hour (the moment before sunrise and after the sunset) we need to keep the WB reference to daylight value, following this path we'll have an effect photo or shoot where the colour temperature of the moment will be highlighted.

The colour temperature is an important feature when we set the colour composition of the source. In theory, the colour temperature is the equivalence of a black body radiator

heated at a specific temperature (measured in Kelvin), which will emit a similar luminous flux of light compared with the source we measure. The main colour temperature for the professional lights and capturing mediums are 3200K, 4300K and 5600K.

- 3200K refers to a colour temperature of an incandescent bulb (tungsten) used also in household appliances. The lights which are using this bulb can be open face or with Fresnel lens. The optical system of the Fresnel projector makes this light highly versatile, we can change the intensity and the lighted area of a light when we flood or spot the light. The spread difference is from 10º (maximum spot) to 55º (maximum flood) beam angle, also the intensity increases three to four times when we spot the light.

- 5600K, also known as daylight, is the standard colour temperature of a metal discharge bulb which emit an illuminant flux equivalent with 5500K. This value was set back in 1930s when the first three layer colour negative films were launched. Eastman Kodak together with AGFA, established this number as a daylight value, equivalent to the negative white balance and nowadays, with digital cameras.

- 4300K is an average colour temperature, initially set for fluorescent bulbs, nowadays is used when we shoot inside a space with mixed colour temperature, daylight - 5600K (in windows) and tungsten - 3200K (practicals on set).

A correlated colour temperature graph is shown in Figure 24.

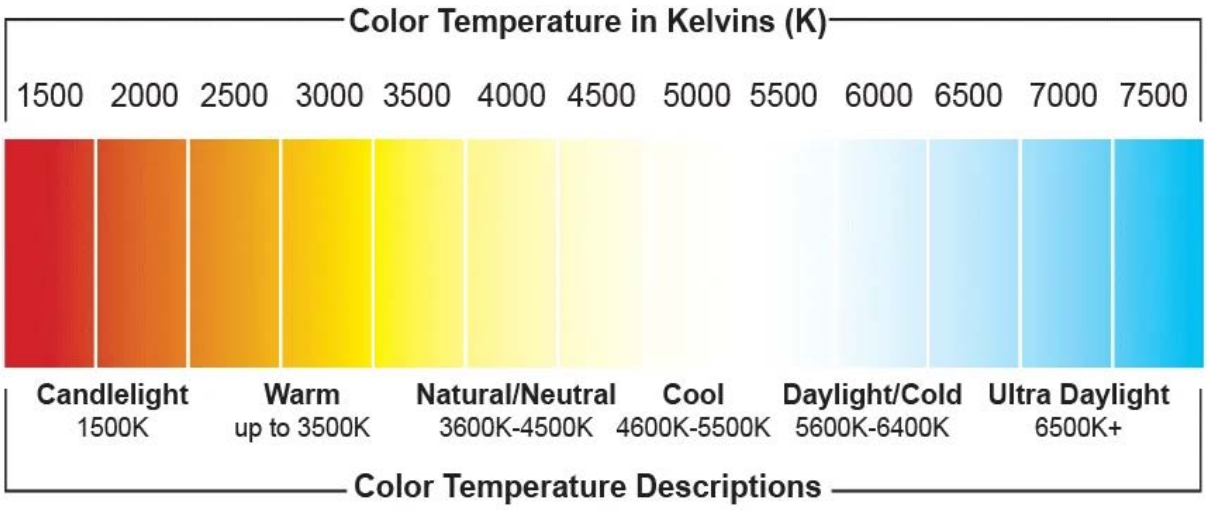

Figure 24. Usual colour temperature values for some lighting source used in film and photo lighting

The colour temperature is important when we shot in an environment with mixed light sources, therefore setting the White Balance for the medium we shoot on is mandatory. The

colours we capture will be shifted if the WB value is wrong. If we shoot in RAW format, all the information about sensitivity, shutter speed, white balance, tint and shooting format are kept in the metadata file. By accessing this file in colour correction software tools, we can adjust all the values from the digital file already shot.

The power of colour or the absence of it will structure a different message for the viewer. Black&white pictures are popular for the portfolios and fashion shoots, where the colour is not mandatory for the job.

When the message has to be structured on two narrative layers, the director and cinematographer will choose two visual expression structures, usually B&W with colour. The B&W option for a movie visual key is sometimes used itself, without any supplemental derivations (colour, sepia etc) for a story within which the spectator will be focused on the story, without any disturbances from an inappropriate colour scheme. Nowadays the option to shoot a film productions in B&W is done to synthesise the story either related to a historical era or to give a strong visual key to the movie. Examples of the recent years B&W productions includes movies like *The Man who wasn't there* (2001) director Joel&Ethan Coen, *The Artist* (2011) director Michel Hazanavicius*, Nebraska* (2013) director Alexander Payne*, Cold War* (2018) director Pawel Pawlikoswki*, Roma* (2018) director Alfonso Cuaron, *Lighthouse* (2019) director Robert Eggers and so forth, some of those have been awarded at big international film festivals, Oscars, Bafta or the European Movie Award galas.

An important step in film and photography final look is the postproduction moment. This is the stage when we achieve the looks we imagined at shooting time and we produce the deliverables for both formats. The values influenced at this stage are related with the look we want to achieve for the final artwork. That includes the contrast, the levels of white and blacks, the overall hue or dominant colour etc. All the colour correction software, either for photo or video, is designed to correct or add additional effects to the image. In Figure 25 we have the DaVinci Resolve desktop where we can see the various modules through which the picture can be enhanced. The correction tools are structured on two levels, primaries and secondaries correction tools.

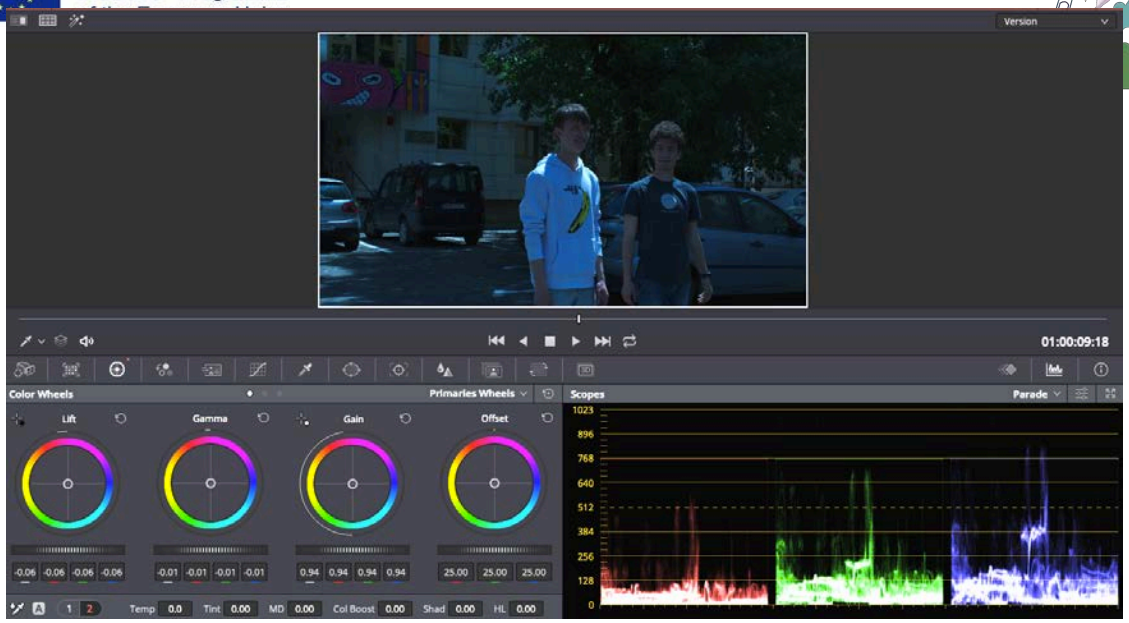

Figure 25. DaVinci Resolve interface with primaries Lift, Gamma, Gain and Offset controllers

With the primaries knobs we can adjust the overall levels for shadows (lift), mid-tones (gamma) and highlights (gain) and change the hue for each one of it. On this desktop, the RGB channels information can be seen on the bottom right where we can visually set the black and white level, according with the look we want. On the secondaries, level we can adjust specific area values through the power window feature which can be animated or tracked for the entire shot. The colour selection tools are used for adjusting the skin tone value and tint and the hue we want in the blacks or highlights.

The artwork is finished when all the aesthetic intentions have been added for the final look. At the colour correction stage we can drastically change the look of the picture from the original shooting mood to a totally different one like we can see in Figure 26.

Figure 26. The overall look changed on colour correction stage from a warm, pleasant mood to a cool, neutral one.

As we can see in the pictures above, the individual colour values and contrast can be adjusted to change the mood and overall feeling which shows the importance of this postproduction stage to fulfilling the cinematographer's or photographer's intentions. Therefore, the video and photo deliverables (screening, prints or Internet distribution) are extremely important and the process of a wrong transformation of colour mapping values can drastically change the artwork look.

The colour can be used as a dominant hue or as an accent in the composition. Adjusting the overall saturation and use a specific colour as a chromatic accent can be a way of achieving a look. Sometimes a little colour separation between blacks and white is done by changing the hue of the blacks on a cooler tint and the whites value to a warmer colour. The contrast separation works best with a worm-cool contrast (yellow-blue, teal-orange, cyan-red etc.). The level of the hue saturation on the blacks and whites doesn't have to be visible. A tiny amount of each hue will do the job, the separation between the bright and dark areas within the frame will be more obvious.

As a video or photo content creator we need to pay attention to all the stages we pass from the capturing the picture all the way to deliverables. The shooting and the viewing parameters are equally important, the aesthetic intentions are completely revealed if what we imagined will be fully transferred onto the viewing support, photo paper, laptops, smartphones of video displays.

The medium we're shooting on has its specificity also, choosing a specific format (analog or digital) a capturing size (medium, full frame, APS-C format) or an individual postproduction chain can drastically change the visual structure and the message. At the end of this course you'll be able to choose the right path for the best final results either in photo or video image capturing.

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