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EXPOSURE VALUE IN PHOTOGRAPHY. A GRAPHICS CONCEPT MAP PROPOSAL

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Abstract. This paper is the result of a deep research on photography basic concepts. The author attended several courses and reduces and concentrates them in a unique map, where most concepts are related and interpreted. The effort to summarize those concepts has been worthwhile cause a great amount of time has been saved in class. Students assimilate them without confusion, which use to happen in such courses. Conceptual maps and graphics are tools of real interest that permits the recognition and assimilation of those principles.

1 Introduction

Most courses of fundamentals of photography start with the description of the parts of the camera device: Viewing system, film or light sensor depending if the camera is analogical or digital respectively, the shutter system, lens, aperture or diaphragm, focus control mechanism, film manual or automatic advance if required, camera body, flash light, tripod... After those parts explanation, those are the excuse to introduce the main concepts that involves photography procedures. Depending of the light of the scene and the sensibility of the film or light sensor, the photographer have to control the amount of light entering by the section of the camera's lens (aperture) as well as the time that it is exposed (shutter speed). In this paper, neither the scene nor the photographer is taking into account. It will be discuss the relationship that exists between aperture, shutter speed and film sensibility that controls light flow that reach the sensible medium.

2 Shutter speed

The shutter speed controls the amount of light reaching the film by varying the amount of time the sensible medium is exposed. The shutter speed is primarily a time exposure control mechanism. Increasing the shutter speed decreases the exposure; decreasing the shutter speed increases the exposure. This system mainly controls how long light flows into the lens. It does not control the amount of light flow. The shutter speed setting ranges from seconds to little portions such as 1/12000th of a second in half-periodic intervals. The shutter speed also controls the motion of objects in the scene captured on film. A slow shutter speed of 1/30th of a second blurs an object if the object is moving faster than the speed of the shutter. Blur occurs because the shutter is slower than the moving object. Faster shutter speeds, such as 1/500th of a second, however, capture fleeting moments not noticed by the human eyes. This speed "freeze" the action of a moving object because the shutter is quicker than the moving object.

3 Aperture

Aperture is the size of the opening of the diaphragm. Enlarging the aperture section allows more light to pass through the lens. Inversely, decreasing this section, decrease the caudal of light. This size of the section that permits the light flow, is measured in f-stop (is short of focal stop) scale. This f-stop scale is based on the ratio of the lens focal length with the iris and diameter of the section that is opening. The f-stop is the number that equals the focal length of a lens divided by the diameter of the effective aperture. That is why increasing the numbers of the f-stops yields decreasing the actual section or effective aperture. This simple inverse relation, often confuse students, that waste time until they assimilate this obviousness. The f-stop range from f/1, f/1.4, f/2, f/2.8, f/4, f/5.6, f/8, f/11, f/16, f/22, f/32 and so on. It depends on the camera device to have different range of f-stop, for each use. Note that those numbers are multiples of the square root of two, which means that between two consecutive steps the relation is halved or doubled. So a change of one "stop" means that the aperture is decrease or increase by the factor of two.

4 Shutter speed-aperture

Each change of exposure represents a "step", it does not matter if the change occurs in the shutter speed or in the aperture opening. So, in photography, it is said "open up a step" it means you will double the amount of light

reaching the film, either by increasing the section aperture wider (decreasing the f-stop numbers, f/8 to f/5.6, for example) or by decreasing the shutter speed (increasing time opened) (from 1/250 to 1/125, for example). This close simple relation is acquired by experience for photographers. Students usually have a mesh of those simple concepts doubt to the scale that is used and the lack of well-done graphics that express it.

5 Depth of field

The other way that the aperture affects light is through a change in depth of field. Depth of field is the area region that has the sharpest focus, a kind of bracketed region of sharpness. Two planes focus, the far plane and the near plane, bracket the depth of field. The depth of field should not be confuse with the critical plane focus. The critical plane focus is where the actual focus of lens falls (which is the actual focus that you select, either by turning the focusing ring on a manual camera or by setting the autofocus on an automatic camera selection). The depth of field lies before and after the critical plane focus. The depth of field functions as a regional sharpness compressor and expander, as dictated by the aperture opening. Wide apertures have a very narrow depth of field because the far and near planes of focus are closer to each other. This proximity throws the background and the foreground beyond the two planes into a blur because the light is not focused on those areas. Usually automatic camera has the *portrait* option, giving priority to wider apertures. If, however, the aperture is set to small, the depth of field increases. So, the near and far planes of focus move away from each other, making the sharply focus region deeper. Greater depth of field results in sharper focus, hence giving the impression that there is more contrast as well as a harder light. Lesser depth of field can result in perception of less contrast and, consequently, less light.

6 Exposition value

It is the measurement of the photometer, but instead of been the luminance measured in candles, lumens is measured in terms of aperture and shutter speed under this relation:

$$EV = Log_2\left(\frac{Aperture^2}{Shutter\ speed}\right)$$

Equation 1. Exposition Values for ASA 100 in function of the aperture and shutter speed.

Those values used to appear in examples or tables as follows.

		Shutter speed											
		1	**1/2**	**1/4**	**1/8**	**1/16**	**1/32**	**1/64**	**1/128**	**1/256**	**1/512**	**1/1024**	**...**
Aperture f-stop numbers	**1**	0	1	2	3	4	5	6	7	8	9	10	
	1.4	1	2	3	4	5	6	7	8	9	10	11	
	2	2	3	4	5	6	7	8	9	10	11	12	
	2.8	3	4	5	6	7	8	9	10	11	12	13	
	4	4	5	6	7	8	9	10	11	12	13	14	
	5.6	5	6	7	8	9	10	11	12	13	14	15	
	8	6	7	8	9	10	11	12	13	14	15	16	
	11	7	8	9	10	11	12	13	14	15	16	17	
	16	8	9	10	11	12	13	14	15	16	17	18	
	22	9	10	11	12	13	14	15	16	17	18	19	
	32	10	11	12	13	14	15	16	17	18	19	20	
	...												

Table 1. Exposition Values for ASA 100 in function of the aperture and shutter speed.

7 Under- and over- exposures

If the light that reach the film is not enough to print the image, (small apertures and/or little times) the photo will appear without image, dark, which means that the photo was taken underexposed. However if the amount of light that impressed the film is too much (the aperture were too wide or/and the time was enlarged) then the photo will appeared burnt overexposed. It can be seen in this figure what happens when aperture and shutter speed are not appropriated.

8 Sensibility adjustment

It is the measurement of the capability of the sensible medium (film with emulsion of silver particles or CCD digital screen) to react to the light flow. The scale is made in ASA (American Standards Association) which coincide with ISO (International Standard Organization) and are separated one *aperture-speed step*, halved or double. The bigger the number is the more sensible is the film. A film with higher sensibility needs less light flow to be exiThe principal map is made for a ASA/ISO 100 sensibility film.

9 The need of a graph

If all the concepts studied formerly were drawing in a single map, it will look as follows.

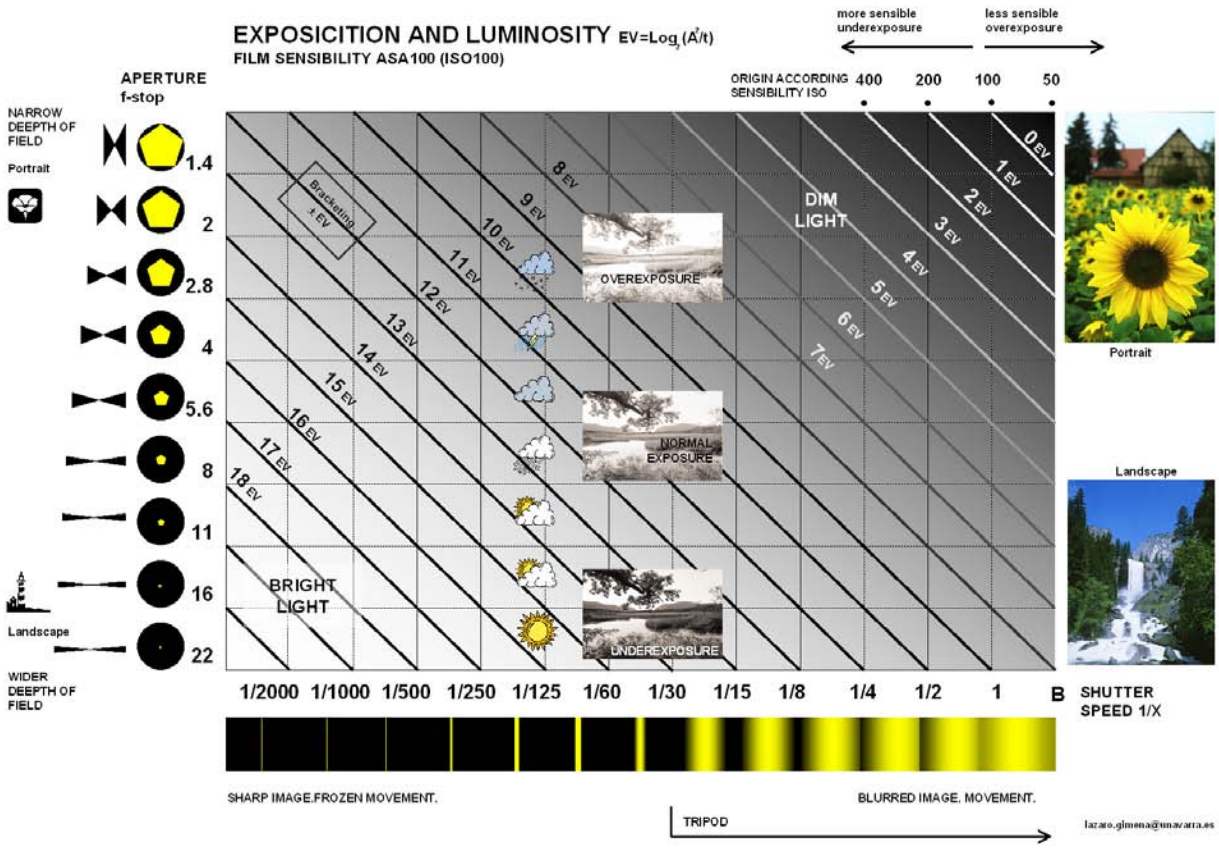

Figure 1. Exposition value graph for Photography. All concepts related.

Students have a graph that relates all basic concepts and how they influence each other. It has been proved with thirty students in classroom, that the time used to explain the basis of photography, has been reduced considerably.

Students take a short time, to understand the different numbers that appears in the camera (shutter speed, aperture, lecture of the photometer), and before, those were difficult for them and took a long time to get used to them.

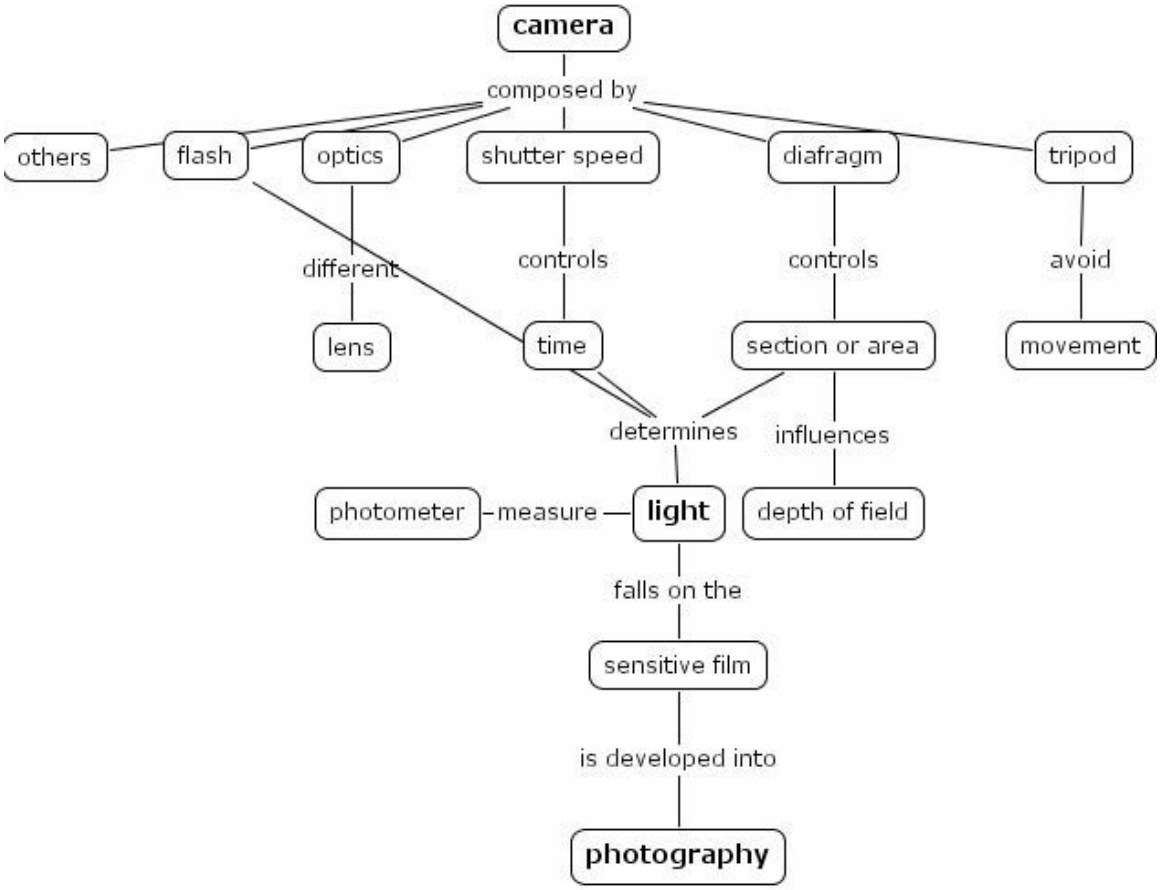

Figure 2. Concept map of the concepts related

10 Conclusions

There have been introduced the main basic concepts of photography and they were represented as a graphic map where all the concepts were connected. It has been prove how students could manage those concepts in a first sight and an important amount of time has been saved in explanation. Once again, conceptual maps have made patent its usefulness for didactics purposes.

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