Splash Crown

By: Nathan Lester

MCEN 4228
Flow Visualization
Professor Jean Hertzberg
1 April 2009

The intent of this image is to display the “crown” effect of the splash of a fluid after an object has been dropped into it. The crown is formed when a drop hits a film of fluid. The drop pushes the fluid away forming the ejecta which then forms the crown.

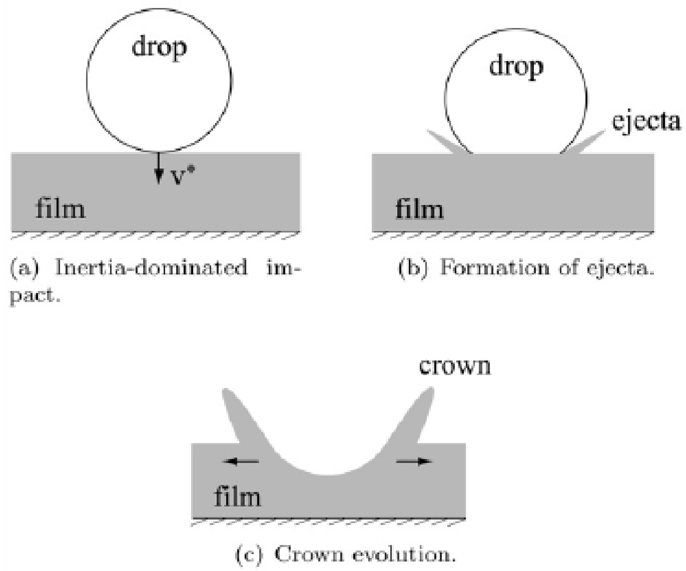

Figure 1: Formation of the Crown [1]

The phenomenon was photographed from several different angles with respect to the surface of the fluid. It was found that the optimum angle for photographing the crowning phenomena was between 15 and 45 degrees from parallel to the fluid surface. Because the “crown” of the splash occurs very quickly, timing the shutter is very important. Since there was no electronic timing apparatus in the experimental setup, the captured image of the crown was strictly luck.

The experimental set-up was very simple. A bowl filled with whole milk was placed on a flat level surface. A syringe (also filled with milk) was fixed approximately 40 cm above the surface of the milk in the bowl. The camera was on a tripod looking down at the bowl about 1 meter away. Figure 2 shows a generic depiction of the experimental set-up.

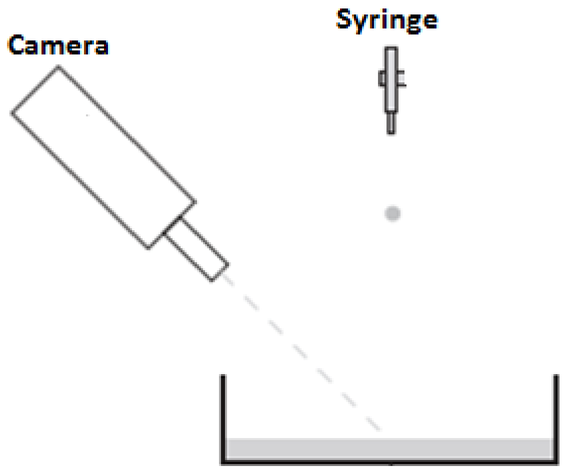

Figure 2: Experimental Set-Up (adapted from [1])

From the time when the drop of milk leaves the syringe to when it impacts the milk on the table, it has accelerated to a velocity of 0.28 m/s. The field of view for the crown photograph was approximately 15 cm wide by 10 cm high. The resolution of the original image was 3456 x 2298 pixels. With these known quantities, the shutter speed would need to be about 1/6000th of a second. With the equipment used in this set-up a shutter speed of 1/200th of a second was used. This means that the image was not fully time resolved, however, the velocity of the crown is much slower than the velocity of the initial milk droplet and as a result the effects of the image not being fully resolved in the time domain are negligible.

The lighting used to capture this image was the ambient daylight entering the room through a window and the flash on the camera. There is evidence that the flash caused the image to saturate in several locations, but the lost information is minor and does not detract from the image as a whole.

The photographic technique is summarized in Table 1.

Table 1: Photographic Technique

Field of View	15 cm wide by 10 cm high
Distance from object to lens	Approximately 1 m
Lens Focal Length	62 mm (28mm – 200mm zoom)
Type of Camera	Canon EOS Digital Rebel
Original Image Width	3456 x 2298 pixels
Final Image Width	2000 x 1360 pixels
Aperture	f/22
ISO	100
Shutter Speed	1/200

There was some Photoshop editing performed on this image. The original image was cropped and a curves filter was applied to improve the brightness and contrast. The image after these two modifications was 969 x 659 pixels. Using Photoshop the image was then "re-sampled" to 2000 x 1360 pixels using the bicubic algorithm.

This image shows an irregular crown caused by a drop of milk into a bowl of milk. The qualities of this image that I like are the irregularity of the crown as well as the depth provided by the shadows. The physics of the crown are shown quite well in this photograph; however, it would be really nice to see a time lapse of the crown forming instead of one single instant in the entire sequence. Another interesting experiment would be to dye the drop a different color and see how much of the crown comes from the droplet and how much is the standing milk.

References

[1] Krechetnikov, Rouslan, and Homsy, George M., "Crown-forming instability phenomena in the drop splash problem," *Journal of Colloid and Interface Science*, No. 331, 2009, pp. 555-559.