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Museum Conservation Institute

Imaging Studio Technical Note: QuadriFlash Mantis for Reflectance Transformation Imaging (RTI)

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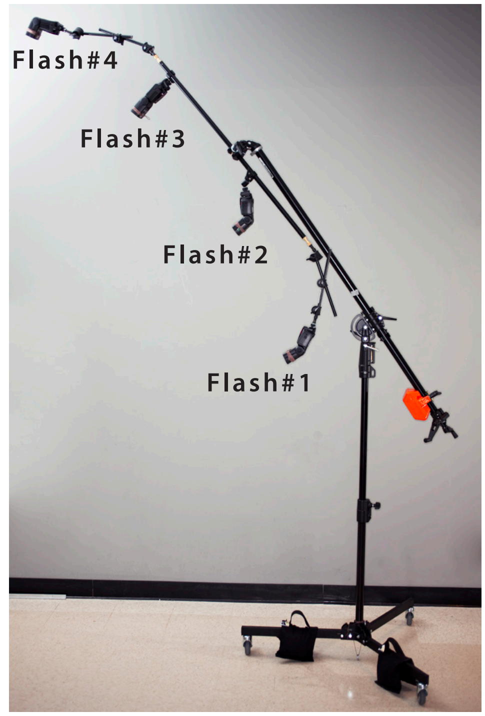


Figure 1 The QuadriFlash Mantis with the numbering of the flashes for setup and acquisition purposes.

In 2010 the Imaging Studio of the Museum Conservation Institute (MCI) and the Freer Sackler Archives (FSA) collaborated under a Collections Care and Preservation Fund (CCPF) grant to image nearly 400 paper molds using Reflectance Transformation Imaging (RTI). Senior Conservator Melvin Wachowiak and imaging specialist E. Keats Webb created a lighting setup that one person could manage for a majority of the collection, making the image acquisition more efficient and labor-saving. The testing, designing, and modifying led to a 4-flash rolling boom arm, now known as the QuadriFlash Mantis (*see* Figure 1).

The collection of paper molds (*see* Figure 2) made 90 to 100 years ago from archaeological sites in Ancient Persia includes Arabic, Cuneiform and Middle Persian languages that have not been fully translated and studied. The goal of this project was to create digital surrogates of these fragile paper objects with the technique of RTI, thus increasing the legibility of the characters on the varying surfaces of the molds. The molds will also be physically preserved by digitization and will be accessible for translation and research from anywhere in the world. This collection includes items ranging from about the size of a postage stamp up to 6' long with all variations of dimensions in between. Using the previously established workflow for RTI, two photographers/technicians would have been needed for the image acquisition of a majority of the collection, one person holding the light source and the other measuring the distance from the light to the object and triggering the shutter. By using the methods and materials described below, a single photographer can capture the RTI source images for any object less than four feet wide.


Figure 2 A paper mold from the Freer | Sackler collection.

The QuadriFlash Mantis

The QuadriFlash Mantis is essentially an arch with four off-camera flashes attached to a small boom arm that is mounted on a larger rolling boom assembly. By design, we wanted to use off-the shelf photo studio parts so that anyone can easily

Figure 3 (above) The parts for the two inner flashes (Flash#2 and Flash#3) of the Mantis.
Figure 4 (right) A breakdown of parts for the two outer flashes (Flash#1 and Flash#4) using the articulating arms.

purchase them. In fact, it is hard to imagine that a complete custom set up would have worked better. The two inner flashes are attached to the boom arm using a small clamp, fastener, a mini ball head, and a cold shoe (*see* Figure 3). The freedom of movement of the flash head on the ball head aids in positioning of the innermost flashes. The two outer flashes on the small boom arm are attached using articulating arms, a cold shoe and the appropriate fasteners (*see* Figure 4). The articulating arm allows for a range of movement and flexibility in calibrating the setup. The end of the main boom arm is counterweighted with a 10 pound steel weight to prevent tipping. When assembling the QuadriFlash Mantis, we found it beneficial to line up the direction of the flashes with one of the three legs of the mini super boom. This helps with the positioning of the setup (aiming) during image acquisition, making the process faster.

An infrared flash transmitter with at least four channels is connected to the hot shoe of the DSLR used for image acquisition. To increase accessibility to the transmitter while also eliminating movement of the camera, we used an off-camera shoe cord and mounted the transmitter on a tripod with a ball head. This is also important since the flashes are being moved through a near hemisphere of positions, and the transmitter only covers about 40°. The four flashes mounted on the boom arm are each set to a different channel (one through four) allowing each flash to fire separately in accordance with the transmitter when the shutter is triggered.

Calibrating the Mantis

The first step in calibrating the Mantis is to mark the floor with the positions around the room for the rotation of the lighting setup (*see* Figure 5). Our studio is about 17'x34', so to maximize the space that we use for the image acquisition and to produce the best quality RTIs, our radius from the center of the acquisition position was 9'. For an ideal RTI, we would try to have 12 positions with the light at 4 different angles at each position, a total of 48 images. The number of positions and total number of images is flexible as long as the hemisphere of light is well covered and spaced, and the software's algorithms have enough information to smoothly interpolate. We try to stay close to the four-dozen images, but we have found through tests that we have some room for variability in these numbers. With limitations based on the size of the studio and the space occupied by the studio stand holding the camera, we decided to use 11 positions with the 9' radius to the center. We established the location of the camera axis just off center of the room, centering the platform used for imaging under the camera. A 9' string was taped to this center point as a measuring radius (if we needed to reestablish it) and 11 positions were marked extending over about three-quarters of a circle. The Mantis is aligned over each of these eleven marked positions for each set of four images. A washer on a string was attached to the center of the base of the main boom post, acting as a plumb bob for positioning the Mantis.

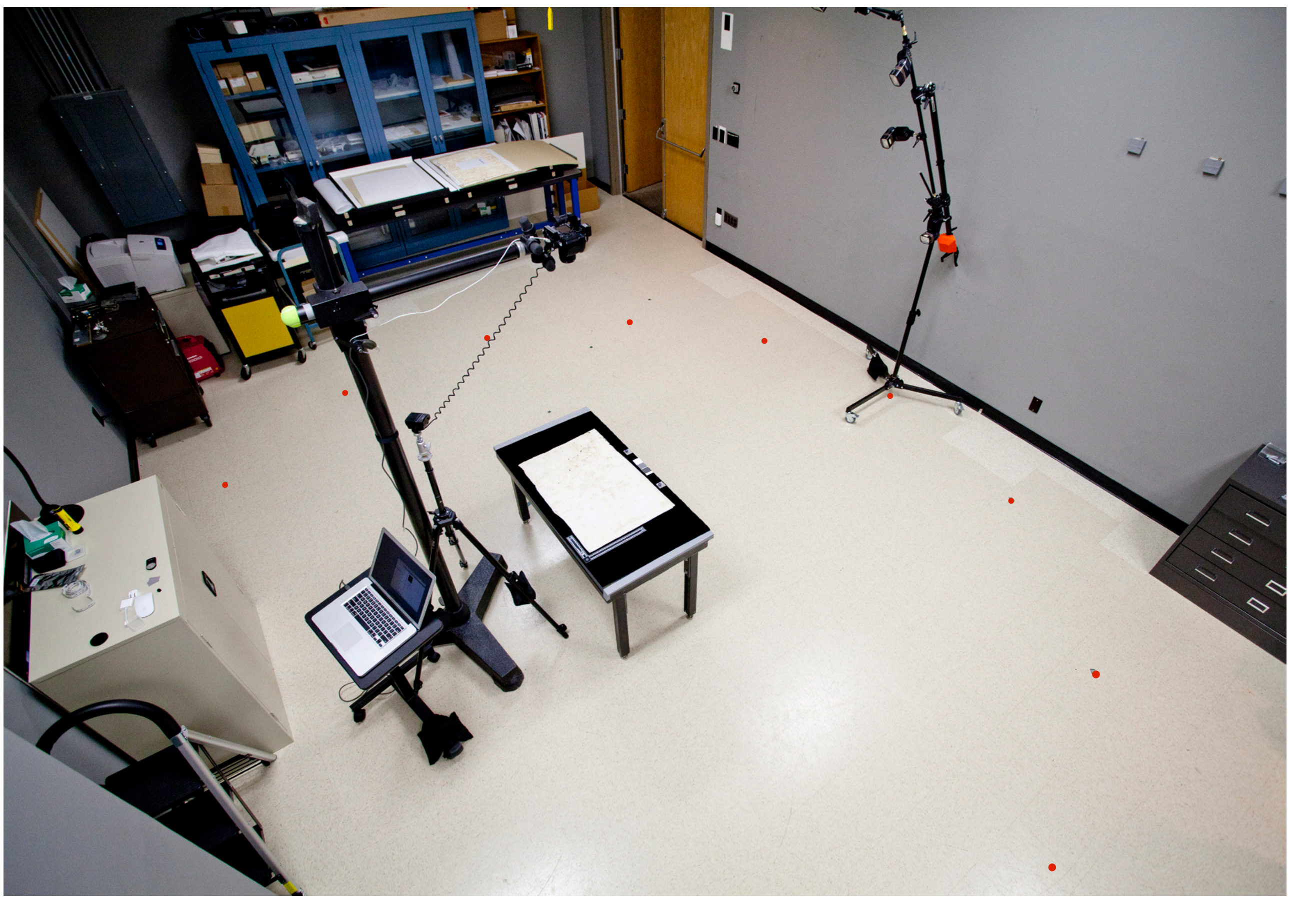


Figure 5 This image shows the setup for imaging a paper mold. The calibration markings on the floor are marked with red circles for easier viewing with nine of the eleven shown (two addtional positions fall out of the image frame).

The position of the flashes is dependent on the angles that were pre-established for the RTI method. The extreme angles are 15° and 65° with the interior angles falling proportionally in between (approximately 30° and 50° for our setup). We created a calibration tool using a sweater dryer with four short legs and a mesh cover, drawing the four angles on the mesh with permanent marker. We used an angle finder to establish the lines. Using the short legs of the sweater dryer to prop it on its side, we set the dryer on the platform that would be used for imaging with the angle lines converging at the center of the table or platform directly below the center of the lens of the camera (*see* Figure 6).

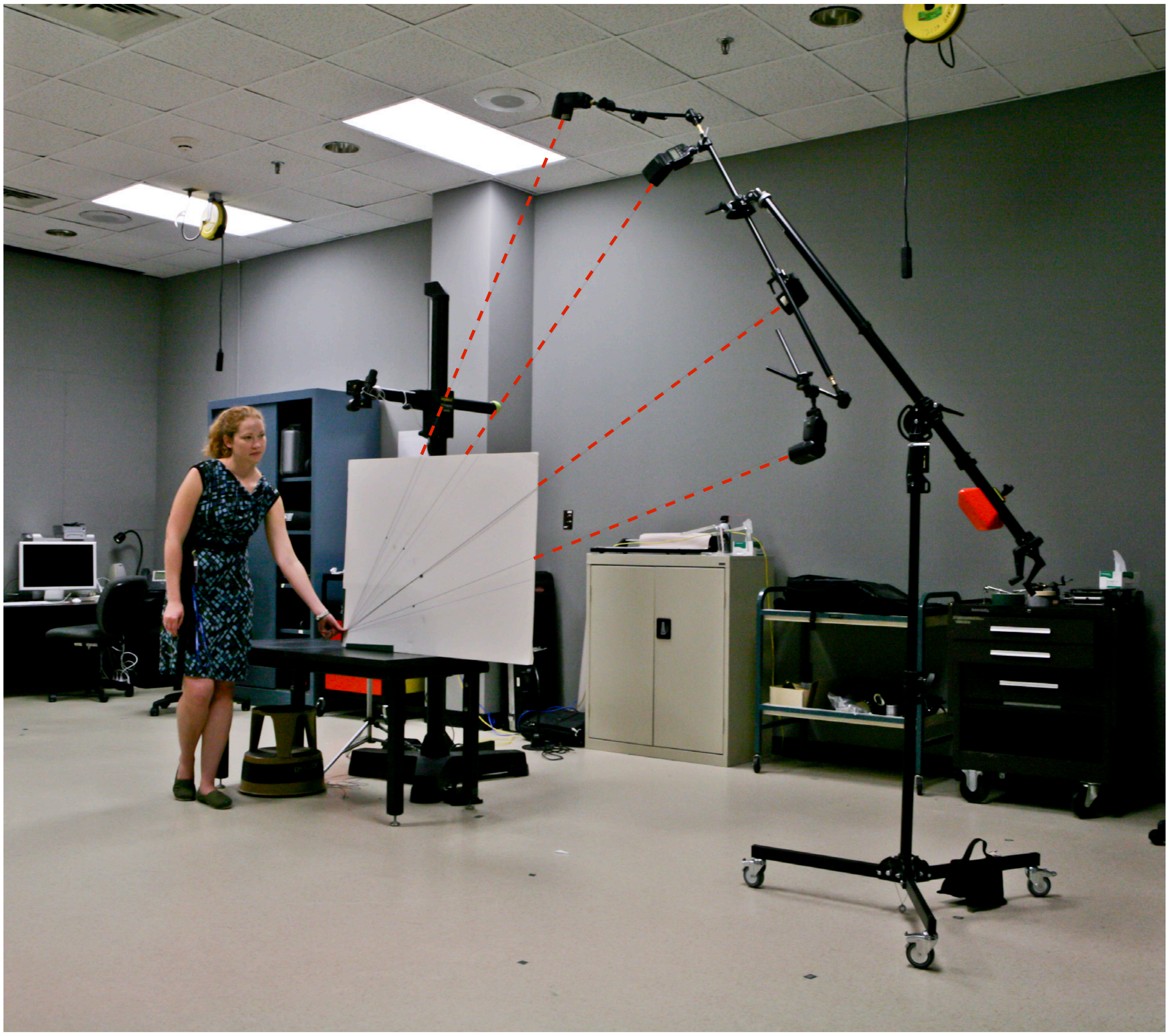


Figure 6 Webb calibrating the Mantis by pulling the four flash strings to the corner of the angle finder emphasized by the red dotted line. (The angle finder illustrated above is not the sweater dryer but is similar.)

For this particular project with the paper molds, we decided that the ideal distance between the light and the object would be 8′. The formula for finding this distance is three to four times the longest dimension of the object with some flexibility taking into account the surface area that the flash can evenly light. We established the average length of the longest side of the medium sized paper molds for this particular setup, which was around 2′ to 3′. We found that this setup would work well, if not better, even for smaller objects when the light-to-object distance was greater than four times. An 8′ string was attached to each of the four flashes to calibrate the position of the flashes on the QuadriFlash Mantis. Using one of the radius markings on the floor, we lined up the Mantis with the side of the sweater dryer in order to use the angle markings to adjust the height and position of the flashes. Pulling the four strings from the flashes together at the convergence of the four angle markings on the sweater dryer, we made the appropriate adjustments to the flash heights and positions along with the tilt and height of the boom arm until the strings lined up with the angle markings on the dryer and the strings' length established the necessary 8′ distance. This process of adjusting the flashes and boom may take some patience and "eye-balling," but once the position is correct it will not have to be adjusted again unless the setup changes dramatically. For instance, larger molds were placed on a short platform close to the floor, since the camera stand can only go so high. This required only a small angular adjustment of the boom arm when previously using a higher table for objects. Calibrating the Mantis is faster with more than one person, but once calibrated it can be operated independently.

The Mantis Workflow

Once the QuadriFlash Mantis is calibrated, we run tests to find the ideal manual settings for both the camera and the flashes. Having the QuadriFlash Mantis placed over one of the floor markings using the plumb bob, we can test the focus, white balance and exposure of the camera with the camera tethered to a computer. We always test at least the lowest and highest angles of the lighting to find settings for the flash and camera that will allow for enough detail at both of these extremes. With cultural heritage objects, we take great care in understanding the effect of light on the object and so reduce the power of the flash if possible, then make the appropriate changes in camera exposure and aperture. Once the best settings are found and the camera and flash are manually set, the QuadriFlash Mantis is positioned to start the "orbit" of the room using the floor markings. We use a remote trigger for the camera and image straight to a memory card instead of tethered capture: both choices cut down on the image acquisition time. The channel is set on the flash transmitter (starting at one), the shutter triggered by remote, an image acquired, and then the channel is changed (channel 2), the shutter triggered, an image acquired (*see* Figure 7)…this process is completed four times and then the Mantis is moved to the next floor marking and this cycle repeated until the Mantis has made a full rotation around the room, taking about 10 to 15 minutes.

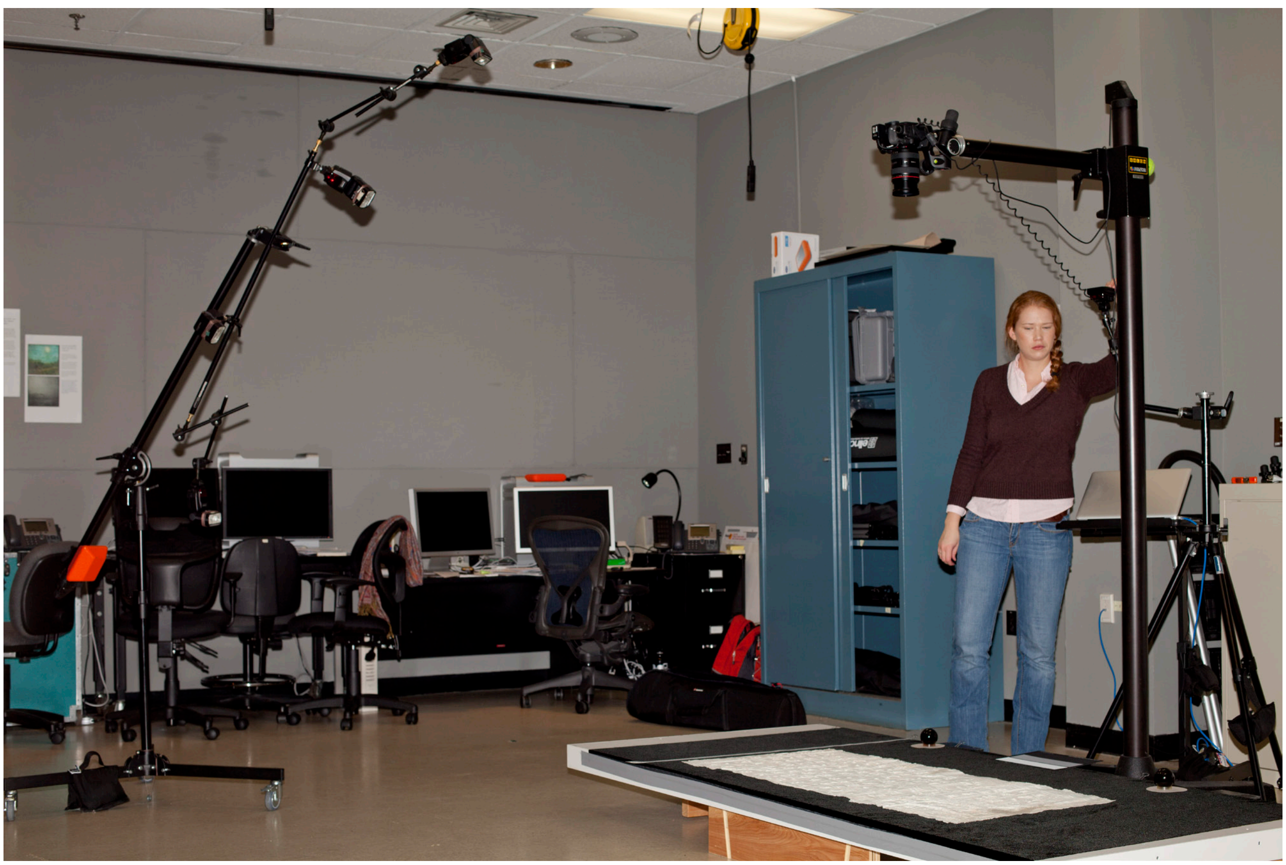


Figure 7 The Mantis in action. Webb triggering the flashes from a transmitter mounted on a tripod near the camera.

Conclusion

The QuadriFlash Mantis was created to make the image acquisition for RTI more efficient and economical by having one person able to work independently. The testing, designing, modification and developing of this setup continued throughout the imaging of the nearly 400 paper molds. The model presented in this paper is the version that we arrived at after improving certain aspects, but it is open to improvement. In addition to imaging the FSA paper molds, the Mantis has been used for a variety of large and small objects, such as silicone molds of early Mayan writing, a 19th century oil painting on canvas, and even for an infrared version of RTI of a letterpress paper document.

As there is no one imaging technique that can work for all objects, this is not the only setup for RTI. We successfully created a lighting setup that made the imaging of a specific collection vastly more efficient and economical. Even so, there were a few paper molds within the FSA collection that were too big for this setup. The light from the off-camera flash would not light such a large surface evenly. The size of our studio was a limiting factor so prevented us from moving 360° around such large objects. The working distance for an object that is 6' in the longest dimension would be closer to 24' (not 8'), so while the QuadriFlash Mantis was a great solution for the small to medium objects, it will not work on such large objects. However, since the Mantis will work for even small objects, the setup can be maintained for all but the most unusual sizes. And since it can be disassembled, it is portable enough to take in the field.

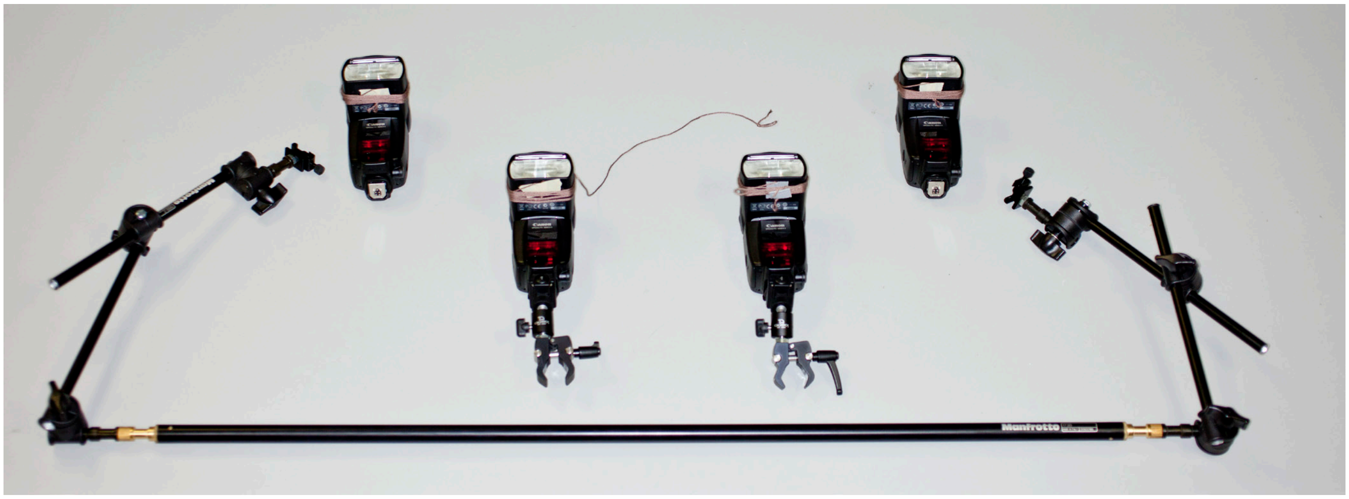
Citations

Malzbender T. Gelb d. and Wolters H., 2001. *Polynomial Texture Maps*, Hewlett-Packard Laboratories (http://www.hpl.hp.com/ptm).

Mudge M. Schroer C. et al., 2010. Principles and Practices of Robust, Photography-based Digital Imaging Techniques for Museums. *Proceedings of 11th International Symposium on Virtual Reality, Archaeology and Cultural Heritage* (VAST2010), A. Artusi, M. Joly-Parvex, G. Lucet, A. Ribes, and D. Pitzalis (Eds.), Eurographics Association, 2010.

Manfrotto 025TM Mini Super Boom on wheels with column stand and counter weight.

Equipment List



An "exploded view" of the equipment attached to the boom arm: 4 flash heads, 2 articulating arms, 2 nano clamps, 2 mini ball heads, and appropriate fasteners.

LIGHTING SYSTEM	Canon	Speedlite 580 EX II		4
	Sanyo	Eneloop AA Rechargeable Batteries with Charger	4-Pack NiMH Batteries	2
	Sanyo	Eneloop AA Rechargeable Batteries	8-Pack NiMH Batteries-no charger	1
TRANSMITTER & SET-UP	Canon	ST-E2 Speedlite Transmitter		1
	General	2CR5 6v Lithium Battery	Batteries for ST-E2 Transmitter	3
	Nissin	SC-01 coiled universal off-camera shoe cord (5'1.5m)	attach transmitter to camera to maintain access to transmitter	1
LIGHT STRUCTURE	Manfrotto	025TM Mini Super Boom with Column Stand and counter weight	wheeled base and cranked boom	1
	Manfrotto	173B Mini Boom Arm		1
	Manfrotto	196B-2 Articulating Arm- 2 sections	Arms for Flash#1 and Flash#4	2
	Manfrotto	035RL Super Clamp with Standard Stud	connect mini boom arm to boom stand	1
	Manfrotto	386B Nano Clamp	Attachment to boom arm for Flash#2 and Flash#3	2
	Manfrotto	147 3/8-1/4 inch spigot	attachment to accessory shoe to 196B-2, Flash#1 and Flash#4	2
	Giotto	MH 1004 Mini Ball Head	Attach Flash#2 and #3 to 368B Nano Clamp	2
	Ikan	Elements Cold Shoe Adapter	Attach Flashes #1 and #4 directly to 196B	2
	Hama	Accessory Shoe (1/4"-20 Bottom Thread)	Attach Flashes#2 and #3 to Giotto mini ball head	2