# Digital Recovery of Water Damaged Manuscripts Using Transportable, Multispectral Imagaing Laboratory | 2011-16

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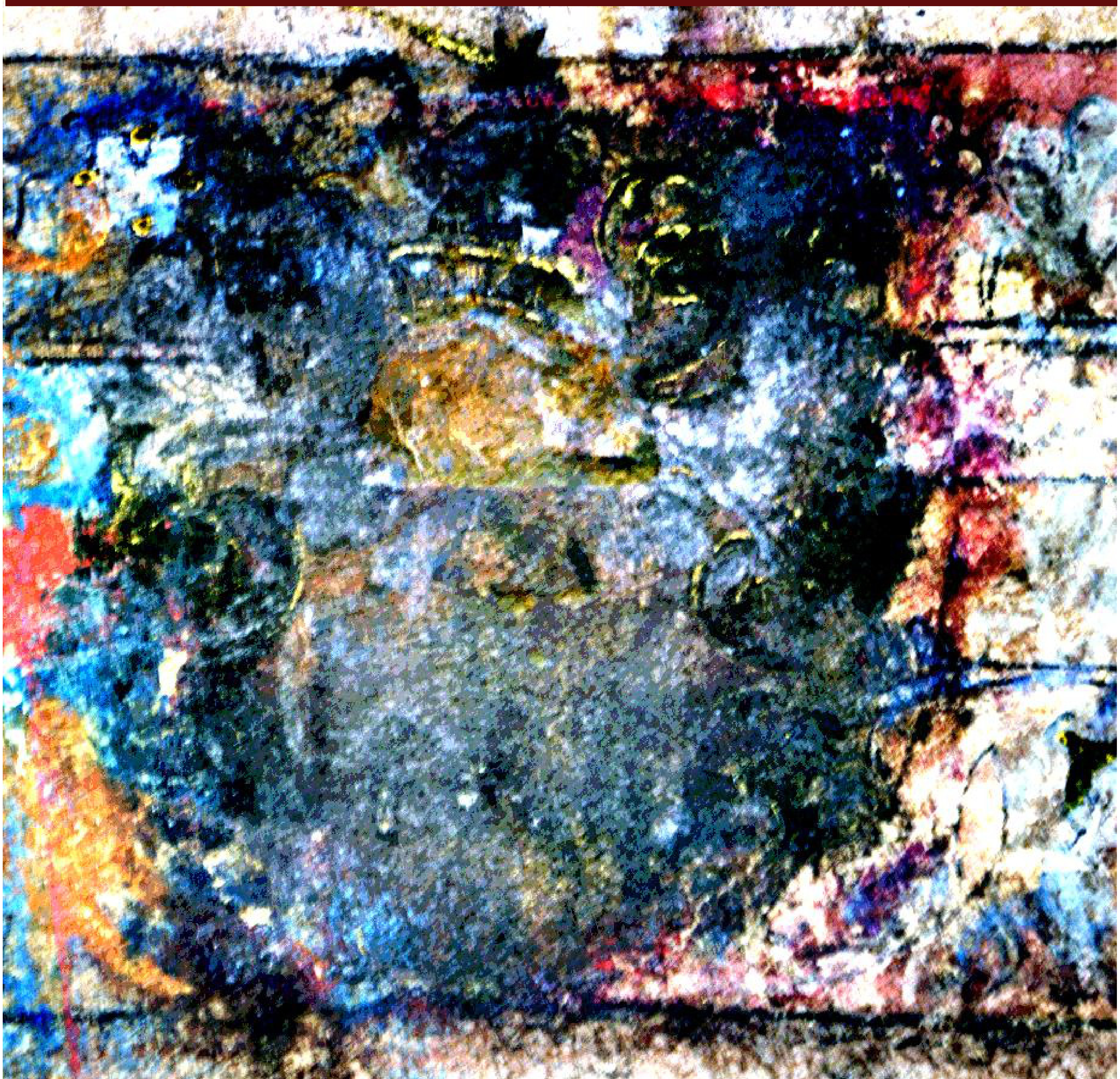

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# Final Report
# NCPTT Grant MT-2210-10-NC-04

"Digital Recovery of Water Damaged Manuscripts Using Transportable, Multispectral Imaging Laboratory"

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The challenges to preserving our cultural heritage in an age of global warming and ideologically-based political strife are many, particularly as regards manuscripts and manuscript collections. Fragile and vulnerable, manuscripts stored in collections large and small, are at risk to damage by water, fire and human intervention both here in America and abroad. And yet, until 2009, we lacked a viable strategy for responding to catastrophes that affect collections *in situ*, and remediating damage of the past before texts are irretrievably lost.

The technology of multispectral imaging pioneered by Drs. Roger Easton and William Christens-Barry on the famous Archimedes Palimpsest, when used in conjunction with specialized image rendering software, has proven to be the most effective means of recovering manuscripts damaged by water, fire and fading. Up to now, however, this technology has not been available to most libraries. As of 2009, only three multispectral systems existed worldwide; they were esoteric and expensive, proprietary to the institutions in which they are held, and were not moveable. As we have learned from Hurricane Katrina, from the construction implosion of the 1990s in Cologne, Germany that severely damaged their municipal manuscript collection, and from political strife and war that have damaged artifacts from World War II Dresden to 21st century Iraq and Afghanistan, the threats *are* moveable and require a swift, effective, flexible, and cost-effective response.

The primary goals of this grant project were several: (1) To develop, build and deploy a cost-effective, transportable, multispectral digital imaging lab; (2) To test the system in the field on a manuscript held in Dresden Germany which had sustained severe water-damage during the infamous 1945 bombing; (3) To use the lighting array to attempt Reflectance Transformation Imagery on the manuscript as a means of recovery; and (4) To develop a modality whereby the lab could be made available to future researchers and projects for little or no cost. In three of the its four objectives – the exception being RTI – the project has proven a resounding success.

In spring of 2010, a team of researchers including myself, Roger Easton, Professor of Imaging Science at Rochester Institute of Technology, Dr. William A. Christens-Barry of Equipoise Imaging, and Mr. Ken Boydston, of Megavision (a manufacturer of bespoke, high-end digital cameras) designed and built a modular imaging laboratory consisting of a 16 megapixel camera (supplemented by a 39 megapixel lent to the project by Ken Boydston), two 12-wavelength LED lighting arrays that covered the spectrum between ultraviolet to near-infrared, a copystand with geared, adjustable camera arm, and a laptop running experimental software including Megavision's proprietary Photoshoot (a beta application that runs the multispectral camera and organizes the raw images in a database) and ENVI (a commercial multispectral imaging application heretofore used for geospatial imaging). The entire lab was then packed into three suitcases, easily transportable by commercial airplane as carry-on and stowed luggage. On June 19th 2010, the above-mentioned imaging team joined me and three students from the University of Mississippi in Dresden to image the water-damaged 14$^{th}$ century manuscript of the longest poem in French (Dresden Oc.66) that exists in one nearly-complete copy. We transported the lab by plane in three modules – the copystand, LED lighting arrays, and photographic lab equipment (camera, lens, computer) – and set up on site in six hours.

Using the lab's 16 megapixel camera and lens, supplemented by a 39 megapixel camera brought by Ken Boydston and a quartz lens for reflective imaging brought by Roger Easton, we imaged 70 folios (140 pages) and 50 lacunae at 12 different wavelengths between 350 nm and 1050 nm over the course of the following week. The last day, we used raking light and made some preliminary tests of reflectance transformation imaging (RTI). Students aided us in every aspect of the recovery as part of our larger goal to train the next generation of imaging technicians to support future projects.

By mid-July 2011, all of the 270 images had been processed and rendered, many with remarkable success. Using principal component separation, good contrast was achieved in all of the waveband images, with the exception of 1050 nm which did not capture enough information to warrant inclusion in future iterations of the system. The armorial achievement of folio 1, for example, crucial to identifying manuscript provenance and ownership, had been smudged into complete illegibility. Image processing with ENVI and Image J software (see exhibits A and B), however, revealed a crest bearing a unicorn saillante which enabled an identification with the von Waldenfels family. This use of multispectral imaging on manuscript armorials alone will prove immensely valuable in the field of sigillography and manuscript identification.

Using the multispectral images, I have been able to transcribe over ninety percent of Oc. 66. The first volume of my critical edition, whose introduction pays tribute to the role of NCPTT, is forthcoming from Brill under the title *Les Eschez d'Amours* (Exhibit C). Articles chronicling the project's work and NCPTT have appeared in the *Dresdener Neuste Nachrichten* (Dresden, Germany) and the *Oxford Enterprise* (Oxford, MS), and has been announced through the University of Mississippi main website and that of the UM English Department.

Under the auspices of the Sally McDonnell Barksdale Honors College of the University of Mississippi, I have developed and secured funding for the continued use of the lab under the title of The Lazarus Project, a scheme that would provide scholars and libraries the use of the lab complete with an imaging team of UM student technicians free of charge. I made the formal announcement of the Lazarus Project and its objectives this past April at the Medieval Academy of America annual conference in Tempe Arizona, where I gave the plenary address.

In part a consequence of this conference, the Lazarus Project, using the lab, has already recovered two, previously unknown and damaged poems by William Faulkner, and a collection of Revolutionary War letters exchanged between General Nathanael Greene and major figures, including George Washington, John Hancock, Mad Anthony Wayne and others. Students, who aided in the recovery and performed much of the image rendering as part of a project in a digital humanities course that I teach, presented their findings in April 2011 at the annual Oxford Conference on the Book in Oxford, MS. The lab will again be in use between August 11$^{th}$ and 13$^{th}$, 2011 at the John Carter Brown Library in Providence, where we will be recovering a 14$^{th}$ century map suspected of being the first to show the passage around Cape Horn to the Indian Ocean, a fact that will significantly alter and rewrite our understanding of the Age of Exploration. In the coming year, we will use the lab to image Auschwitz survivor journals in Poland, and will begin a pilot project to image the collection of the Library of Chartres in France, damaged in both World Wars I and II. Finally, in the summer of 2012, we will travel to Tblisi, Georgia to aid in the recovery of the earliest Gospels.

While our successes have been significant, our failures and difficulties have been useful in identifying important changes to the lab and its design. We encountered several technical trouble spots. First, the copystand lacked a reliable method to stabilize and manipulate the fragile manuscript bindings. Second, the current light arrays do not allow a means of performing transmissive imaging by placing lights beneath a single folio. In Dresden, we discovered the need for a coherent system for naming and organizing acquired and processed images, and transferring data from the field over Internet 2 broadband to dedicated servers at the University of Mississippi. Finally, we lacked a means of implementing and optimizing RTI by adjusting light height and 360 degree rotation, a problem that teams at Rochester Institute of Technology and Oxford University are currently addressing.

Looking forward, we hope to build on the successes of lab and the Lazarus Project by refining both the technology of multispectral imaging, and the university support structures that make time-intensive image-rendering for large projects logistically feasible. Finally, I have developed a digital humanities curriculum around the lab – a course entitled *Image Text, and Technology* – that is training the next generation of humanists in digital recovery technology. Our goal is to form a dedicated team, from multiple universities and from multiple disciplines, to address important recovery field projects within the next year.