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Tracking Cumulative Light Exposure Using The Museum System (TMS)

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Abstract: In June 2013, the Saint Louis Art Museum opened the East Building, a new wing addition designed by David Chipperfield. The LEED Gold building features skylights and floor-to-ceiling windows and adds 21 new galleries for both temporary exhibitions and permanent collection works. The use of daylight as the primary illuminant in many of these new galleries spurred a shift from using instantaneous light level limits measured in footcandles to a cumulative exposure model using kilofootcandle-hours per year. The Conservation Department established new cumulative exposure guidelines for collections materials and worked with projections from the building's lighting designers to develop an estimate of monthly light exposure based on location. Through collaboration with the museum's database administrator, The Museum System (TMS) was adapted to create a system for tracking light exposure over time. Fields in the Conservation Module of TMS were re-purposed to accommodate new information needed to determine overall exposure, and reference documents were added as plug-ins for easy access. Additionally, a flag system was created to alert conservators, registrars, and curators of pieces that have received excess exposure. Reports for light exposure were developed to present both the exhibition history and cumulative light exposure for a specific work and the exposure status of groups of objects in the museum. The cumulative exposure model allows for increased flexibility of display parameters, including instantaneous light levels, while emphasizing the need for preventative conservation. This paper will discuss the shift to a cumulative exposure model, the challenges and benefits of working with TMS, and the progress achieved since implementation.

1. INTRODUCTION

In June 2013, the Saint Louis Art Museum opened a new wing that features daylight as the primary light source. This use of daylight in the East Building spurred a shift from establishing maximum light level limits to using cumulative exposure, which in turn required the creation of a system for tracking cumulative light exposure, the topic of this paper.

The original building was designed by renowned American architect Cass Gilbert for the 1904 Louisiana Purchase Exposition. Originally part of the Palace of Fine Arts, this building was the only structure built for the Fair designed to be permanent. The building has been home to the Saint Louis Art Museum since 1909 and resides in Forest Park, a 1300-acre park in the heart of the city.

The East Building is a LEED Gold building and was designed by architect David Chipperfield with landscape architecture by Michael Desvigne. HOK was the architect of record, and ARUP was the lighting designer. The East Building increases the Museum's public space by 30% and adds 13 new permanent collection galleries for Ancient and Modern and Contemporary art and 7

galleries for Special Exhibitions. The East Building features skylights that provide the primary illumination for the permanent collection galleries and three floor-to-ceiling windows that offer views of the surrounding park. Electric lights are only used when there is insufficient daylight, and the three light tracks are triggered by sensors in the skylight coffers. The vertical windows have two sets of shades, one slightly transparent shade that is lowered when light levels are elevated, and one opaque shade that is lowered on a timer based on seasonal conditions to prevent direct light from entering the galleries. In addition, automated opaque shades are used to cover the skylights during the museum's closed hours.

In the design phase, two options were presented for using natural light in the East Building: Daylight Feel and Daylit galleries. Daylight Feel galleries provide a sense of daylight but electric light provides the majority of the object illumination; one example of this strategy is the Kahn Building at the Kimbell Art Museum. Daylight Feel galleries can be compatible with maximum light levels, i.e. not to exceed 20 fc. In Daylit galleries, daylight is the primary source of illumination, and this was selected by the Saint Louis Art Museum. Because of the greater dependence on natural light, there is more variation in illumination and maximum light levels are not compatible. Instead, a cumulative exposure model is used to determine light exposure. In this model, illumination in footcandles is multiplied by time in hours to determine footcandle-hours of exposure – time and light levels are both factors.

This concept is based on the law of reciprocity, which is the inverse relationship between intensity and duration. The same exposure can be achieved with various combinations of light levels with time, for example, 100 footcandle-hours can be reached with exposure to 100 fc of light for one hour, or 25 fc for four hours, or 5 fc for 20 hours. As exposure time increases, the light levels must be lowered to achieve the same cumulative exposure.

The lighting designers provided the Conservation Department with estimates of light exposure for permanent collection galleries in kilofootcandle-hours per year (kfc-hrs/yr) based on this cumulative model. These estimates were used to develop monthly projections for each gallery space that took into account the daylight contribution, exhibition electric lighting, and overnight emergency lighting. While the museum's operating hours are consistent throughout the year, the balance of natural and electric light varies by month. In sunnier months with ample daylight, electric lights are used minimally, and in months with less natural light, electric light use is increased. Projections were developed for small, medium, and large permanent collection galleries with skylights, and a separate set of projections were developed for two galleries that are adjacent to galleries with vertical windows. In these "adjacent to window" galleries, projections varied based on the wall's location and proximity to the window; instead of one estimated exposure for the entire gallery, there are four to six projections which are location-dependent.

2. THE SWITCH TO CUMULATIVE EXPOSURE

To utilize the projections for the East Building, the institution needed to move away from setting instantaneous light level limits (not to exceed 10 fc, for example) to the cumulative model which uses both illumination level and time or duration of exhibition. After extensive research, the Conservation Department established new cumulative exposure guidelines for collections

materials in the new exposure model with units for kfc-hrs/year. Light limits by material were outlined in a document that also provided typical lighting equivalents to ease the transition to the new system. Categories were lettered A-H and ranged from 1kfc-hr/year to an unlimited category for outdoor sculpture. After establishing the categories, an additional category, "A/B," was added between A and B. Annual exposures are based on the exhibition year at the Saint Louis Art Museum, approximately 2700 hours per year. Table 1 lists the categories, footcandle equivalents, and some sample materials in each category. Conservators assign categories to each object individually and take into account current condition, restorations, and other factors, in addition to media.

Table 1. Cumulative Light Exposure Limits for Exhibition

Category	Annual Exposure	fc Equivalent	Example Materials
A	1 kfc-hr/year	5fc for 4.5 mo. over 5 yr	Degraded paper, watercolor, pastel, organic dyes, degraded textiles
A/B	2 kfc-hrs/year	5fc for 9 mo. over 5 yr	Cased photographs, paper
B	4 kfc-hrs/year	5fc for 18 mo. over 5 yr	Carbon-based drawing media, hide, rubber, b/w silver gelatin prints
C	13 kfc-hrs/year	5fc, long term display 10fc for 6 mo./year	Contemporary paper, plastics, good condition textiles, basketry
D	20 kfc-hrs/year	7.5fc, long term display 15fc for 6 mo./year	Amber, tortoiseshell, wood, reproduction upholstery
E	35 kfc-hrs/year	13fc for long term display 20fc for 8 mo./year	Varnished wood, bone, horn, acrylic paint
F	54 kfc-hrs/year	20fc for long term display 30fc for 8 mo./year	Oil and tempera paintings, ceramics, restorations
G	83 kfc-hrs/year	30fc for long term display	Stone, metal, glass without coatings or restorations
H	Unlimited	Unlimited	Outdoor sculpture

The concept behind the annual exposure limit is to control the dose of exposure over time to mitigate light-induced damage; once an object receives its allotted annual exposure, it should be removed from view. If a work receives more than its annual exposure, it should remain off view for the balance of time.

3. TRACKING LIGHT EXPOSURE WITH TMS

The move to a system of cumulative exposure makes time is half of the equation, so it becomes critical to keep records of how long individual works are on display and at what light levels. TMS, the collections database the museum has been using for almost 20 years, was utilized to store this new data. Conservators, curators, and registrars all have access to TMS, making it an ideal central location for storing light exposure information that is critical to all three departments. The authors of this paper, conservator Claire Walker and database administrator Ella Rothgangel, worked together to adapt TMS for tracking light exposure.

Just as cumulative exposure is not standard across institutions, TMS 2010 does not have a standardized way to track light exposure. The authors utilized four different areas of TMS for this project: the conservation data entry screen, the plug-ins utility within the conservation screen, status flags, and customized reports.

3.1 Conservation Data Entry Screen and Plug-Ins Utility

The conservation data entry screen contains fields that can be renamed. Renaming allows a museum to take an existing field and designate it for another purpose. Careful thought was put into changing field names, and long-term consequences of this modification were considered. Renaming would mean both never using a field for its original purpose and also not being able to rename the field in the future. With this in mind, the use of the conservation fields was assessed to determine which fields were in use. While a field can be renamed, its field type cannot be changed – for example, while "Cost" can be renamed, entries into this field will always be displayed as dollars.

After assessing existing fields, the conservator identified the required information for recording light exposure, and those requirements were matched to under-utilized fields and to the most useful field type for each piece of information. The ultimate solution included fields that could be used without renaming, fields that were completely renamed, and fields that became a hybrid field with two definitions. Figure 1 shows the conservation data entry screen after modifications for tracking light exposure.

"Light Exposure Tracking" was added as an option from the Event type pick-list. By having its own designated event type, all light exposure tracking records appear together under the folder at left. The fields of "Report Date" and "Examiner" remained unchanged. "Light Sensitivity Category" is a renamed authority-controlled field, meaning that the examiner selects from a pre-determined list written by the TMS administrator. This field was adapted for selection of the annual exposure allowed for each object. Using an authority field simplified the process for the conservator, allowing them to select from pre-determined categories, and also influenced how the museums guidelines were established, because categories are fixed once they are entered into this TMS field. "Light Exposure Description" provides a space for the examiner to describe the light exposure event, whether it is a special exhibition or permanent collection installation, and its gallery location in the museum. Previously this field was called "Project" and was used only occasionally by conservators. This field was changed to a hybrid field, so this free-entry box can be used for either type of event. "Start Date" and "End Date" were renamed, and these date fields

are used to indicate the start and end dates of the given exposure. Light exposure is entered in the "Exposure (kfc-hours)" field, which is a renamed numerical field that allows free entry of numbers. The conservator calculates the exposure using established spreadsheet projections. Text entries provide a place for the conservator to write a prose explanation of the light exposure and how it was calculated, for example, "Painting was on view for 21 months in G257 in 2013-2014. Its annual limit is 54 kfc-hours/year. In this time it received 142.3 kfc-hours of exposure, which is equivalent to 32 months of exposure. After December 2014, it should remain in storage until December 2015." The conservator records the date until which an object must remain in storage after light exposure event in the "Storage Required Until" field. Finally, the "Current Light Exposure Record" checkbox was renamed to allow the conservator to select the most recent light exposure record if more than one event exist, which was a critical element for running reports.

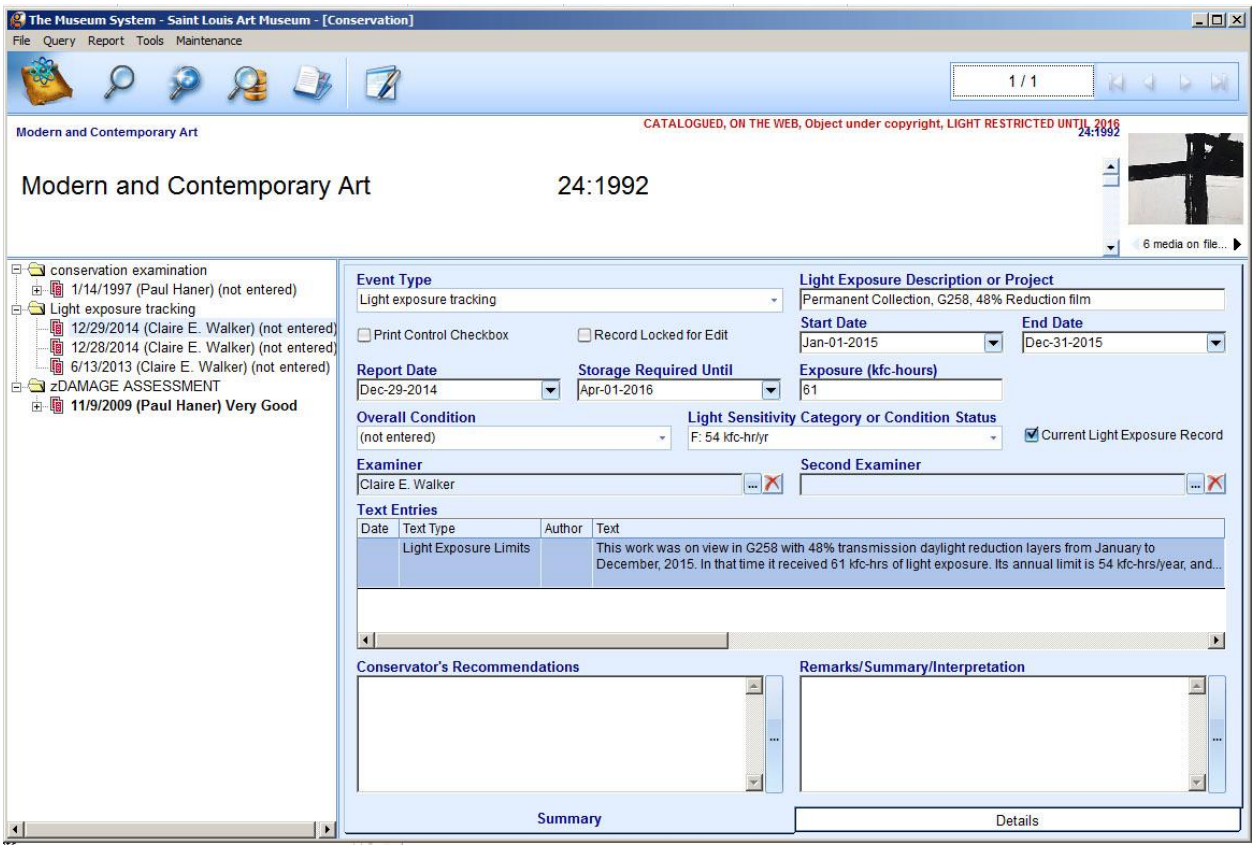

Fig. 1. Screen capture of conservation screen showing modifications made by SLAM

Plug-ins were utilized to embed reference documents within TMS for easy access. To determine the exposure for a given location and time period, the conservator opens the appropriate Excel spreadsheet of projections through TMS and selects the months of display. Excel automatically adds the values together when selected, which quickly gives the conservator the total exposure. Rather than searching on servers or keeping printed references, the Plug-ins Utility provides a convenient and central location for relevant spreadsheets and documents.

3.2 Status Flags

While the details of light exposure are tracked on the conservation screen, Status Flags provide a way to easily alert users when works have a light restriction. Status Flags are visible on the main front screen of any object record and do not require users to open the conservation screen. Flags stating "Light Restricted Until 2015" and subsequent years were created by the TMS administrator in the Registration menu and can be added or removed by conservators in TMS. The wording of this flag communicates that the work is restricted because of excessive light exposure and it is not recommended for loan or exhibition until after the given date.

3.3 Reports

Three reports were created to pull lighting information together in useful ways. The first report is Light Exposure History, which presents an object's light exposure data in addition to any other information which helps describe light exposure, including on-view location data and exhibition data. While only the most recent light exposure events are calculated in kfc-hours/year, the on-view location data and exhibition data can help inform the conservator if the work has been on view extensively or rarely. This report is now included in every outgoing loan request that is circulated in the museum, so all parties can consider an object's exhibition history and previous light exposure when deciding if works should be loaned.

The second report is Light Exposure List, which provides a snapshot of data for multiple works in a group. Users can sort based on several of the column criteria, including artist and "Storage Until Date." The "Current Light Exposure" checkbox in the conservation screen was added for this report, so the report will pull only the most recent light exposure record.

The third report is Light Restricted Status Flags. This report will group a selection of works by their status flags. This report only shows works with status flags (typically works that are overexposed), whereas the other reports will show works that do not have status flags as well.

4. RESULTS AND DISCUSSION

The light exposure tracking system has been in place for approximately two years with good results. The institution is beginning to integrate the cumulative system into loans, allowing conservators to calculate and assess the impact of exhibition, both for the works itself and for our institution's future exhibition schedule. One issue is calculating exposure for permanent installations; end-dates are required to make calculations, so exposure is recalculated on an annual basis for works on long-term display. If exhibitions are extended or rotations rescheduled, exposure tracking must be recalculated for an accurate understanding of the impact.

In addition to the object-based tracking in TMS, conservators are also assessing the lighting designers' projections and comparing them to real data gathered in the galleries. A small fleet of dataloggers collect cumulative light exposure information that is compared to the monthly estimates for a better understanding of the new building's actual performance.

Overall, the project has been both positive and effective. By using TMS, an existing museum resource, the new lighting information conveniently dovetails with other collection data in one central location. The project has been a vibrant collaboration between conservators, registrars, and curators, and has allowed all parties to work more closely together toward a common goal of collections stewardship.

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