

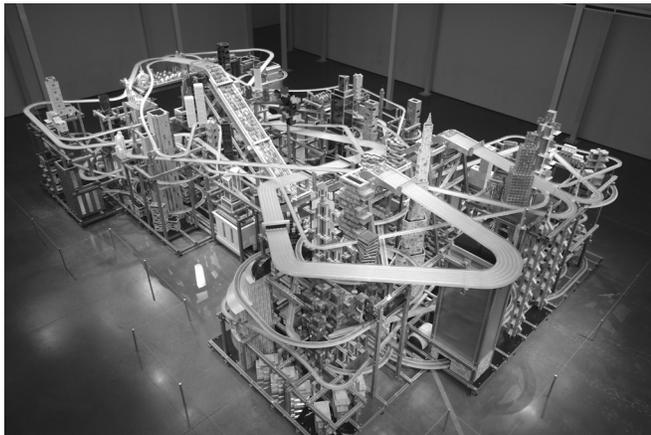
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# Fast and Furious: Operation, Maintenance, and Repair of *Metropolis II*

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## Introduction

*Metropolis II* was designed and fabricated by the late artist Chris Burden (1946-2015). Burden's *Metropolis II* is an intense kinetic sculpture, modeled after a fast paced, frenetic modern city. Steel tubing (Unistrut) forms a structural grid interwoven with an elaborate system of 18 roadways, including one six lane freeway, and HO scale train tracks.



Miniature cars speed through the city at 240 scale miles per hour; every hour, the equivalent of approximately 100,000 cars circulates through the dense network of buildings. According to Burden, “The noise, the continuous flow of the trains, and the speeding toy cars produce in the viewer the stress of living in a dynamic, active, and bustling 21st-century city.”

Burden described its fabrication as a “string and tape operation” with no computer renderings or plans. The development of the architecture was very organic with Burden in the studio every day making aesthetic decisions. Purchased by the Nicholas Berggruen Foundation, it was loaned to the Los Angeles County Museum of Art where it has been on display and in continuous operation since January 2012. It took five years to build, almost three months to take apart and four and a half month to install at LACMA.

In this paper the authors will discuss the on-going exhibition of this unique contemporary sculpture focusing on specific maintenance and repair issues - foreseen and unforeseen - that illustrate many of the problems inherent to the acquisition and operation of kinetic works of art. LACMA's overall philosophy and approach to its operation and maintenance – including the repair and replacement of damaged parts - will be discussed in light of the artist and owner's expectations and the demands of the museum's exhibition program. Particular attention will be given to the costs associated with the long term operation of the sculpture and how best to assess its condition and predict or anticipate mechanical failure.

## *Metropolis II*

The sculpture is approximately 21 feet wide and 30 feet long. When installed it is approximately 10 feet tall at its highest point. The main structure of the sculpture breaks apart into nine separate sections, or modules, which connect together via telescoping steel tubing (Unistrut). Each module is designed to fit into a shipping container for ease of transport.

The core module houses the three conveyor systems including their motors, conveyor belts, conveyor ramps, and associated control devices that operate the sculpture.



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*by Mark Gilberg, Alison Walker, and Richard Sandomeno*

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Each module has leveling feet (86 in total) that are used to calibrate the sculpture and align the tracks on adjacent modules. All car and train track bridging adjoining modules, numbering over one hundred pieces, must be removed for the deinstallation/installation process.

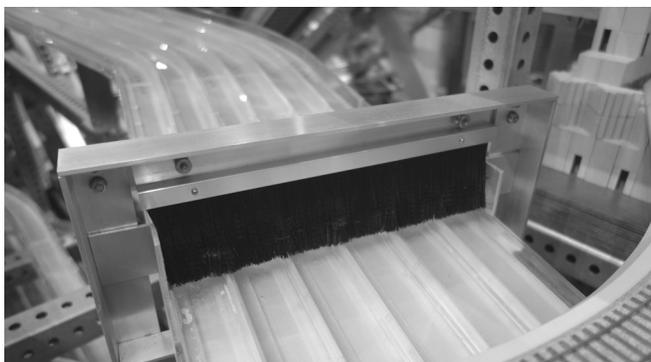
At any given time there are 1200 cars on the sculpture. The 96 custom car types were mass-produced in China after extensive prototyping at Burden's studio. There are four different body types, each with four different colors, and within each color scheme are six different combinations of detailing.



Each car is die-cast aluminum with a rare-earth magnet embedded in its chassis along with front and back rubber bumpers. These rubber bumpers dampen the impact of the cars as they run into each other at the bottom of a conveyor ramp.

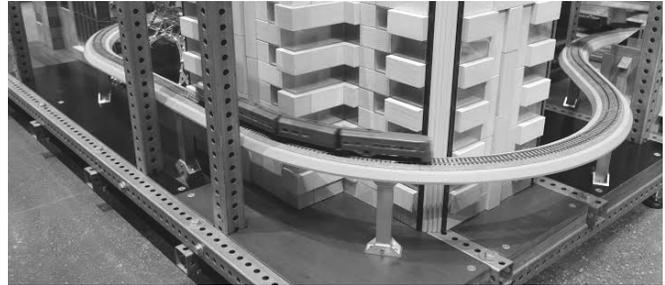
The three conveyor ramps are each a six lane highway. Each conveyor ramp has a corresponding conveyor belt with magnets imbedded in it. When the conveyor motor is on, moving the conveyor belt, it is the attraction between the conveyor belt magnet and the car magnet that draws the car to the top of the ramp. Once the car is at the top, the conveyor belt loops away allowing the car to fall by gravity down the track until it comes to an abrupt stop as it hits the line of cars at the base of the ramp. It is this push from behind that is needed to engage the conveyor belt and draw the car back to the top again.

The speed of the cars can be controlled by a series of adjustable brushes installed over the car track.



Located at various strategic points along the roadways, particularly near curves, these brushes can be lowered or raised to change the amount of friction on the car as it passes under; therefore, influencing its speed.

In addition to the cars there are thirteen electric trains on *Metropolis II*, eight loops with train sets and five end-to-end trolleys.



Each train track has its own controller allowing the operator to individually adjust the speed of the trains. Each trolley track has an optical-sensor (tiny light-sensitive photocell) at each end. When the moving trolley gets close to the optical-sensor, blocking light from hitting it, a signal is sent for the trolley to stop and reverse direction. Both the trains and trolleys were store bought at the time and are HO scale, approximately 1:87. The trains and trolleys were specifically chosen by the artist for their aesthetic qualities.

The cars, trains, and trolleys weave through a maze of architecture of varying shapes and sizes. Over 200 buildings made of HABA blocks, Lego blocks, Lincoln logs, glass tile, stone, and acrylic densely cover the landscape.

About 80% of the buildings are fixed in place with the remaining being partially or completely removable for disassembly/assembly of the sculpture. All building components taller than the conveyor belt are also removable to allow the sculpture to be placed in a cargo container as previously mentioned. While a number of buildings are reminiscent of famous architecture such as the Eiffel Tower, Taj Mahal, and Empire State Building, it was never the artist's intent to present replicas of these famous structures.

It should be noted that there is an earlier version of this kinetic sculpture, *Metropolis I*, which is owned by the 21<sup>st</sup> Century Museum of Contemporary Art in Kanazawa, Japan. It is a third the size of *Metropolis II* with four trains and 80 cars (modified Hot Wheels). Unlike *Metropolis II*, this version requires two operators and is currently not on view.

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## Fast and Furious: Operation, Maintenance, and Repair of *Metropolis II*, continued

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### Operation

LACMA is, thus far, the first and only venue where *Metropolis II* has been exhibited and operated for the public. As a consequence, there was essentially no data or information available to assist us in determining its longevity, the key component of which being its operation.

In the end we decided to operate the sculpture three days a week on Friday, Saturday, and Sunday (our busiest periods) as well as holidays and special events.

On the regularly scheduled days the sculpture is operated four times: starting 30 minutes after the museum opens, the sculpture is run every other hour, for an hour. It was necessary to adopt this schedule to allow the operator time to rest, retrieve any cars that jumped the track, answer patron's questions, and make necessary notes on the sculpture's performance. The conditions inside the sculpture are extremely cramped and noisy.



The operator must not only monitor the movement of the trains and trolleys, but also make sure the cars do not create a jam at any brush over the roadway or at the bottom of the conveyor ramp.

The sculpture has a number of built-in safety features including over-load switches (circuit breakers) for each conveyor motor, one photo-eye sensor for each conveyor belt, and one photo-eye sensor for each lower conveyor sprocket. There is also an emergency shut off button that shuts down the entire system.

Operating *Metropolis II* on a schedule was also in keeping with the artist's desire to not run the sculpture continuously. Mimicking the stop and go of urban life in a major metropolitan city, Burden liked the juxtaposition of chaos and quiet. The frenetic pace of the cars can be exhausting to the viewer if allowed to run for even a short period of time. For this reason the artist designed a balcony in the gallery for the public to be able to step back away from the noise and excitement and observe the sculpture as a whole from a distance.

### Care and maintenance

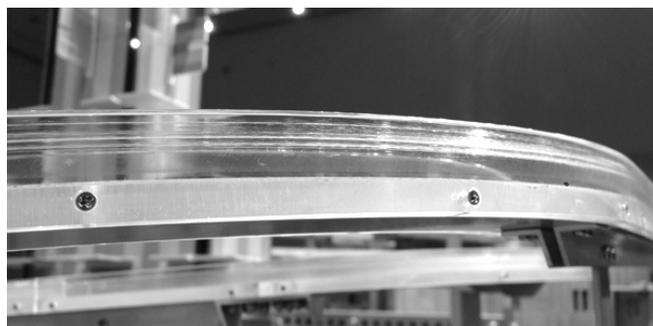
Proper maintenance of *Metropolis II* proved critical to its overall operation and function. The entire sculpture is vacuumed once a week to remove dust and debris that has accumulated from the gallery. Additionally, the car tracks are fastidiously dusted by hand with a super-soft microfiber polishing cloth. The sculpture is also inspected frequently to assess wear and identify any issues that may cause a problem in the future.



By virtue of speeding around the track, the cars degrade the plastic generating a considerable amount of fine white powder as well as grooves in the track. This wear is most pronounced along bends in the track where the cars also tend to scrape against and scratch the vertical, plastic retaining wall.



The wear is readily apparent however does not yet seem to have affected the performance of the cars. As a preventative measure we have explored how best to undertake the replacement of portions of the track that are most affected. In the absence of measured architectural drawings, individual pieces of track have been carefully measured and traced. From highly detailed templates and computer renderings, we now have the ability to cut sheet material using CNC (computerized numerical control) to the exact size and shape of any specific curve for future replacement.



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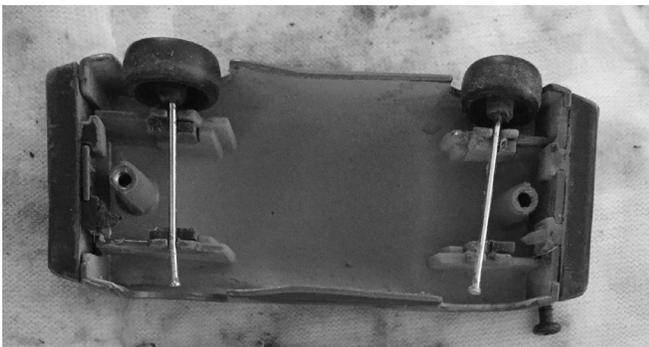
## Fast and Furious: Operation, Maintenance, and Repair of *Metropolis II*, continued

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Though the cars were intentionally designed to be robust, they take quite a beating racing down the 65 feet of roadway over and over again, six hundred hours a year. The most common failure with the cars is in their plastic wheels.

Press-fit onto a metal axle, the hole in the wheel eventually bores out from the repetitive rotation, and the wheel itself just slides right off. Spare parts are not available for these custom cars so damaged parts are replaced by trading out good parts from other used cars.

When repair is no longer possible, the cars are retired to storage and a brand new car is put on the sculpture in its place. Anticipating they would wear out, the artist provided the collector with 12,000 spare cars.



Like the cars, the trains require constant cleaning and repair. As dust collects on their wheels, the transfer of electricity from the track to their motor is compromised and causes them to sputter, stall, and/or derail. All dust and debris must be meticulously removed from the train wheel assemblies and gears every week. In addition, each train track itself must be carefully degreased and cleaned by hand.



With constant use, the motor components wear out. Most commonly, their plastic drive shafts are worn smooth preventing the train from being able to be run at all.

Unfortunately, the train sets are not easily replaced given the artist's preference for some older models that are no longer commercially available. Over the years, we have resorted to rebuilding the trains and making our own replacement parts.

We are experimenting with more durable materials, such as rebuilding the plastic drive shafts out of brass, which greatly increases the operating life of the trains. Even though they have been repaired multiple times some of the trains have logged over 2000 hours of operation – well beyond the average lifetime of a model train.

The trolleys have presented an additional unique problem traced back to the original fabrication of the sculpture.

Having never operated the sculpture more than 100 hours prior to its installation at LACMA, it was impossible to predict how the different components of the trolley system would hold up to constant use. As it turns out, the trolley circuit boards are not combatable for long-term use with the original controllers/transformer. With permission from the artist's studio, it was necessary to replace some of the controllers with a more robust version.

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## Fast and Furious: Operation, Maintenance, and Repair of *Metropolis II*, continued

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The architecture requires little maintenance other than minor repair of loose or fallen building elements which occurs periodically in response to vibration from the cars. The detachment of individual building blocks is largely due to adhesive failure.

The motors that drive the conveyor system also require periodic maintenance.

Installed upside down, intentionally

for aesthetic reasons, the oil seals are destined to fail. Because they are not designed to handle this type of upside down pressure, oil has leaked out of the gearboxes and contaminated the rest of the motor.

As a precautionary measure, the original motors are gradually being replaced with oil-less motors of the same kind. In addition to the above, various sensors and overload switches (motor circuit breakers) have also been replaced with more robust, industrial versions over time as problems arose to improve performance.

### Documentation

Because *Metropolis II* is on loan to LACMA documentation of the condition of the sculpture over time and an accounting of damaged cars, trains, and trolleys was required though it also proved critical to assessing the long term operation and maintenance costs of the artwork.

*Metropolis II* operates almost 650 hours per year with an average of 530 run hours before a car is retired.

The oldest car to date has run for over 915 hours.

LACMA has retired a total of 3,815 cars since it was installed: 1,758 in 2012; 390 in 2013 and 724 in 2014.

Remarkably not one single scheduled run of *Metropolis* has been missed though the sculpture has at times been operated without several trains or trolleys in operation. The artist approved operation of the sculpture under these conditions provided all the cars were operational.

### Conclusions

The installation and exhibition of kinetic sculpture presents a range of issues and challenges that are unique to every artwork. It is both costly and time-consuming, and many museums are ill prepared to meet these challenges and frequently underestimate the resources that must be devoted to ensure their proper function and operation.

The staffing of *Metropolis II* proved particularly challenging (and costly). Even though only one person is required to physically operate *Metropolis II*, additional staff is needed to maintain the artwork and to operate the sculpture for special events, tours, and donors.

LACMA initially hired two full time employees drawn from the artist's studio to maintain and operate *Metropolis II*. The staff eventually grew to five part-time employees to accommodate their individual schedules, to avoid overtime, and to ensure trained staff are "on-call" to operate *Metropolis* during non-business hours. Though none of the staff are trained art conservators, they are all artists and fabricators with an affinity for Chris Burden's artwork.

Preventative maintenance is key for this sort of work, though it is important to have a clear understanding of how the sculpture functions and operates, the artist's intent, and what changes the artist will allow and support as technology changes.

The exhibition of *Metropolis II* has proven successful primarily because the museum embraced the assistance of the artist studio and staff and was willing to take a more multi-disciplinary approach to its care and preservation, allowing professional fabricators and artists to play a far greater role under the guidance and direction of the museum's conservation staff.

