

# Mississippi River Commodity Explorer

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## ABSTRACT

Disruption to the flow of commodities on the Mississippi River system can come in many forms: floods, droughts, shipping accidents and even earthquakes to name a few. We have created a tool, the Mississippi Commodity Explorer (MSCX) that is able to track the commodities from port to port to see the effect of disruptions on these commodity flows. MSCX allows what-if analysis through highly interactive views and drill-downs. We provide a visual story-telling capability enabling step-wise analysis of any event and its impact to the region. MSCX explores immersive game-based training through highly engaging task-based exercises embedded within each of the key functional areas. MSCX introduces novel graphical data aggregation techniques utilizing geographical hexagonal based binning.

**Keywords:** Data Aggregation, Visual Storytelling, Gamification

**Index Terms:** H.2.8 [Database Management] Database Applications – Spatial databases and GIS; H.4.2 [Information Systems Applications] Types of Systems – Decision Support; H.5.1 [Information Interfaces and Presentation] User Interfaces – Interaction Styles; H.5.3 [Information Interfaces and Presentation] Group and Organization Interfaces – Web-based interaction

## 1 INTRODUCTION

The Mississippi River system consists of thousands of miles of interconnected waterways shipping over 507 million tons of commodities in 2011. A total of 55,782 port to port trips were made from 1991 originating ports to 2414 receiving ports handling 216 commodity types. The most common disruptions to this flow are droughts, floods and barge accidents. Understanding the impact of these disruptions and the effect they have on the entire system is imperative to proactive management and information dissemination to all stakeholders.

The Mississippi Commodity Explorer (MSCX) charts new ground in creating a highly interactive visual experience for the analyst and disaster manager. MSCX visually tracks all the ports in the system allowing deep analysis for all the commodities shipped.

MSCX offers a range of views from a high level macro view covering the entire region showing an aggregation of ports and their shipped commodities down to an individual port level view showing what is shipped to and from that target port. MSCX provides visual storytelling enabling step-wise analysis of any event with robust control over the story including extensive annotation support and management of multiple story lines.

MSCX implements task driven game-based training that is integrated into each major functional area. This training approach allows the easy introduction of new task lists keeping the training fresh and up-to-date.

## 2 DISCUSSION

The Office of Cyber and Infrastructure Analysis (OCIA) under the Department of Homeland Security is charged with supporting efforts to protect the Nation's infrastructure.

*OCIA's mission is to support efforts to protect the Nation's critical infrastructure through an integrated analytical approach evaluating the potential consequences of disruption from physical or cyber threats and incidents. The results of this analysis will inform decisions to strengthen infrastructure security and resilience, as well as response and recovery efforts during natural, man-made or cyber incidents.* (Office of Cyber & Infrastructure Analysis, 2014)

Sandia National Laboratories' National Infrastructure Simulation and Analysis Center (NISAC) was tasked with creating a tool to track the commodity flows on the Mississippi River system with the expressed purpose of understanding the disruption to these flows. We have pursued a highly visual approach to understanding the dynamics of shipping on the Mississippi from the macro level of the entire center of the United States down to the level of an individual port. The Mississippi Commodity Explorer (MSCX) is multi-view web-based application. The initial view presents dual maps which can work independently or as one coordinated view with either map driving the views of the other.

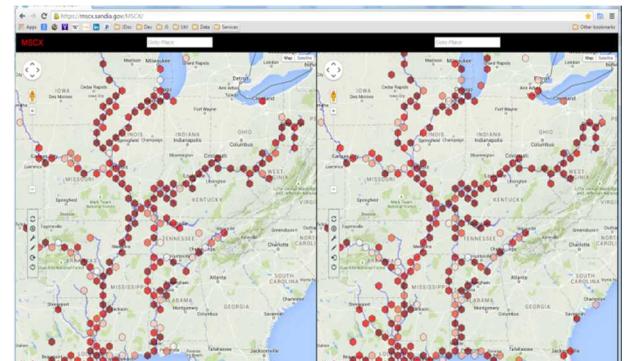


Figure 1: Initial View

### 2.1 Visual Data Aggregation

The view in Figure 1 shows a low level zoom applying hex binning with hexagonal shapes spread out on the maps. The hexagons are aggregations of ports based on whether a port falls within a defined radius for the current zoom level. If a port does fall within the defined radius then it is added to the list of ports for that hexagon. The shading of the hexagon corresponds to the total tonnage for that aggregation. A hexagon offers a more equal capture of data points than a circle or rectangle. A mouse over of any hexagon will show the list of ports, commodities and total tonnage for that region.

The hex bins are recalculated for every change in zoom giving an optimal capture for each zoom level. Once the zoom level is high enough, the hex bins are broken down into individual ports.

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Since there are 1991 send ports and 2414 receive ports, using aggregations at the lower zoom levels dramatically reduces the data noise.

## 2.2 Visual Story Telling

MSCX explores new methods for visual story telling which allow the user to create narratives based on any sequence of interactions with the application. Through view capture, the user is able to collect a series of views, annotate them, animate them, replay them and change the direction of the story as if they were interacting with the application in real time. By recording these events the user is then able to create stories that can be used for their own analysis as well as to disseminate to a larger audience.

## 2.3 Task Driven Game-based Training

MSCX implements the gamification of user training driven by defined task lists that ask the user to find points of interest such as a specific dock, total tonnage for a commodity type or where does coal get shipped to. Each task is assigned point values and the user can set a timer. The type of tasks defined can be far ranging and customizable based on what are the most valuable actions that a user should learn to do. Since MSCX is intended to allow multiple users, tracking of user performance is intended to inspire higher levels of competence with the tool.

## 3 IMPLEMENTATION

MSCX utilizes the Google Maps API for all base maps. D3.js, a JavaScript visualization library is used for layering, visual components and the management of all user interaction. All the data is stored in a PostgreSQL instance accessed by Java Rest Services. The servlet container Tomcat is used to host the application.

## 4 CONCLUSION

MSCX is in an advanced prototype stage where we are collecting usability data from the user community. By offering MSCX as a live prototype we are able to track what is working. We are able to see the functions that capture the user's interest and lead to better outcomes. We continue to receive great feedback. We strongly believe that great tools come out of a solid relationship with the customer.

D3.js offers an incredibly rich foundation from which to build virtually any kind of visualization imaginable. However, there is a significant learning curve before a developer becomes proficient. The D3.js community is strong and the underlying foundation, SVG is one of the primary web-based visualization environments. We intend to continue developing with D3.js.

What makes a useful tool is more than just whether it performs the functions it was designed to do. If the tool is not engaging, if it doesn't offer a wow factor than it will be relegated to the murky pool of "have to use software" or orphaned completely if it is of no use. In the visualization realm, we have a huge advantage over any other technique. We can create any world we want and make it truly engaging. The trick is to make it entertaining without straying from the job at hand.

There is a lot that can be done just in making functions more intuitive. But we should not underestimate how important it is to make using a tool an enjoyable experience. Especially when you consider that most tasks in most jobs are mundane and not engaging. Can we create tools that make a job more fun?

## 5 FUTURE WORK

As we move forward we intend to refine the current feature set as well as explore new visualization techniques. We are especially interesting in novel selection and filtering techniques. We have just scratched the surface with data aggregation. We would like to make data aggregation more dynamic with better drill down and data hide/expose features.

We will be integrating a number of statistical and system dynamics models which will need significant visualization components. There are a variety of new data sets that could be incorporated including everything from historical weather patterns to tracking commodity dependencies across industries.

MSCX is an excellent sandbox for trying out new visualization techniques with a live user base. We expect to offer some very exciting and novel visualization techniques in the future.

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