INSTITUTE ON THE ENVIRONMENT
UNIVERSITY OF MINNESOTA
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MINI GRANT PROJECT SUMMARY

Please complete the project summary and return the completed form to April Snyder, Associate Administrator for the Institute on the Environment at aprilsnyder@umn.edu. Paper copies will not be accepted. Please also attach any photos, publications, brochures, event agendas or other materials that were a result of the mini grant summary.

Date of Report Submission:	June 2, 2015
Project PI & Dept/School	David Levinson, Department of Civil, Environmental, and Geo-Engineering/University of Minnesota
Project Title:	Visualizing Transportation, Land Use and the Environment in Minnesota
Grant Amount $:	$3000

Project Context & Purpose

Please include the original project purpose statement and revise for any changes that occurred in the project after the start date with a short explanation of the changes.

Original IonE Mini Grant Proposal:
Visualizing Transportation, Land Use and the Environment in Minnesota. Several UMN researchers working on transportation, land use, and environmental issues have projects that use Minnesota, and especially the Minneapolis-St. Paul region (MSP), as a casestudy location. As a result, several researchers have interesting and useful datasets related to transportation, land use, and the environmental for Minnesota and MSP; in many cases, faculty have put together simple visualizations illustrating the data. Showing off these datasets via spatial visualizations would be a way to communicate several diverse strengths of UMN that relate to a common theme. Sadly, existing visualizations, while occasionally used in presentations by faculty, do not live in a more widely accessible space. This proposal is motivated by our belief that showing off relevant data visualizations from across multiple disciplines would be a useful way to demonstrate UMN's depth of expertise around a core theme. To accomplish that goal, this project would:
(1) Hire a graduate student for a summer, to assist with the following tasks.
(2) Bring together University of Minnesota researchers, starting with those on the project team, to identify existing visualizations.
(3) If appropriate, develop a University of Minnesota website or YouTube Channel to host visualizations (working name: U-Visualize).
(4) Collect the visualizations and post them online in a common format (e.g. a movie format) that can be widely seen.
(5) If possible, develop a short ``feature movie'' from these which shows how much we can track and monitor about the Twin Cities region. (Or, more likely, after finishing tasks 1-4, we would develop a modest follow-on proposal to IonE or OVPR [Office of the Vice President for Research] to generate a short movie. See, for example, the Live Singapore movie created by the MIT Senseable City Lab: http://spatial.ly/2013/08/live-singapore .)

Benefits:

Our overall goals are to (1) bring together faculty who work on a common theme and who know each other, but have not worked as a group nor have come together to compare and combine data, and (2) develop web-based materials that provide interesting data visualization and that highlight a strength of UMN on a specific environmental research topic.

We are hopeful that these web-based materials would attract attention from potential students, funders, and faculty hires. The process of building these materials would initiate interdisciplinary discussions and potentially new partnerships.

To our knowledge, no one is packaging and promoting visualizations generated by completed and ongoing research; we see an opportunity here.

Examples of visualizations or datasets currently available in our research groups include maps of land use changes in the region, growth of transportation networks (e.g. roads, streetcars, skyways, NiceRide stations), network utilization (vehicle traffic, transit, NiceRide), network accessibility by mode by time of day, and air quality by time of day.

One longer-term aim is that this project would also inspire researchers to create additional visualizations from Big Data sources that would be added to the page; longer-term mechanism to maintain the project would be required.

Budget:
$3,000 - to hire a student RA with GIS, web design, and web movie making skills over summer 2014 for about 150 hours. In-kind contributions include a desk and computer in Civil Engineering for the RA (provided by D Levinson); data and visualizations (provided by faculty); and, potentially, graduate student time to modify existing visualizations.

Work Completed

Please provide a summary of the work that was completed for the mini grant project.

Tools:

Two open source mapping software, TileMill and QGIS, as well as the proprietary software ArcGIS were explored as potentially useful tools. TileMill allows for the use of a variable in order to select features, in this case spatially located data points in a given timeframe, which are to be displayed. In conjunction with a second open source tool ProjectMill TileMill can be used to automatically generate a series of successive maps of the data. However, this software cannot simultaneously select based on timeframe and format based on another attribute of the data. So for example, it was not possible to both display roads in the year they existed and have different symbols for roads with different functional classes using this software. In addition several essential elements of a good map including a title, text relaying important information such as author, creation date, and citation, a scale, and a north arrow could not be output along with the automatically generated mappings. It was possible to create these items within the software, but they were not included in exported graphics.

QGIS on the other hand allows for the inclusion of all of the essential elements of a good map, but a successful automation process was not found. At this point it is recommended that further exploration of the Atlas Generator within QGIS's Print Composer be explored in the future; the Atlas Generator has the potential to be used for a more automated generation process. However, neither TileMill nor QGIS can be used to create video directly. Both softwares are used only to generate the series of maps. Instead another open source software ffmpeg must be used to string together the series of images. This is a very basic function of ffmpeg, and in the future it could be useful to explore the additional functionality available in ffmpeg in order to aid in the creation of more sophisticated video.

As an alternative to the combination of two or more open source tools to create videos of the spatial change in various features through time, the Time Slider function of ArcGIS was utilized. The Time Slider allows the user to generate a single map layout, including a legend, title, scale, and north arrow as a template. Within the template desired symbology rules are also laid out. This enables features such as roads to be differentiated based on their function, so for example highways appear differently than local roadways. The Time Slider is then set to move through a series of desired timeframes and only show features based on whether or not they exist in that time. So for example, if it is desirable to see the build out of roads between 1800 and 2000, then a rule can be set within the Time Slider to generate a map based on the template for each year in that time period which shows all roads built in or before the current year, assuming that the available data on road construction is accurate. The Time Slider can automatically output either video or individual images, but at this point direct video output is unreliable and therefore ffmpeg is still warranted as a tool to combine the individual maps.

Ultimately due to the limitations of TileMill and QGIS and the availability of more thorough documentation for the features of ArcGIS, the remainder of the work completed under this grant utilized ArcGIS. However, in the future further exploration of QGIS is warranted. If the QGIS Atlas Generator can be made to step between time periods as well as the ArcGIS Time Slider, then QGIS could be more cost effective than ArcGIS. In addition exploration of further functionality in ffmpeg is warranted.

Data and Results:

Unfortunately much of the data could not be made available and properly formatted in the time allotted for this project. That being said data and the build-out of the following systems was available: the Minneapolis skyway system, the historic Twin Cities transit network, the Twin Cities highway system, the Twin Cities traffic signal system, and the Twin Cities park n'ride system. Of these only the first three had accurate enough data on build-out to be utilized in the mapping project. Both the signal system and the park n'ride system unfortunately had large numbers of data which had been given a default year because the actual year of construction was not known. Videos of the three datasets that could be used were generated and can be seen at the following links:

Minneapolis Skyways – http://nexus.umn.edu/Movies-UVisualize/SkywayMap/skyway.mp4

Twin Cities Highways – http://nexus.umn.edu/Movies-UVisualize/HighwayMap/highway.mp4

Historic Twin Cities Transit – http://nexus.umn.edu/Movies-UVisualize/HistoricTransitMap/historictransit.mp4

Partnerships & Collaborations

Please provide a summary of the project personnel, partnerships and collaborations that worked directly on the project or were started as a direct result of the mini grant project.

The proposal was submitted by Yingling Fan, Jason Cao, Carissa Schively, and Greg Lindsey from the Humphrey School, David Levinson, Julian Marshall, and John Hourdos from Civil Engineering, and Francis Harvey from Geography. David Levinson lead the group and took responsibility for successful completion of the project. Professors Schively and Marshall are IonE Resident Fellows.

Project Outcomes & Impacts

Please provide a summary of the outcomes and /or impacts of the mini grant project including future plans for the project.

Three videos were generated for future use as representatives of the potential to create useful data visualizations. These videos as well as the individual maps they are composed of have been saved to a central location, where future visualizations may also be deposited. In addition several tools for video-making have been explored and recommendations for video generation have been established as well as recommendations of tools and functions to look into for more sophisticated video generation.

Future plans for the project include the collection of more data sets and the generation of visualizations from them as well as an eventual creation of a single video combining multiple datasets which represents many facets of data available in Minnesota and the Twin Cities. In addition, ffmpeg, ArcGIS and QGIS will be explored more thoroughly to see what additional value they can bring to the project.