Spatiotemporal Visualization of Local Sensor Networks for Action on Campus

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The number of technologies that provide extremely detailed information about the operation and activities on a college campus are burgeoning. From environmental monitoring of indoor air quality to energy use to traffic flow to building access, the volume of spatio-temporal data that is being captured is overwhelming. Given the complex, multi-dimensional and granular nature of this data, it is often difficult for campus managers to make sense of it. Taking this voluminous data stream and extracting the signal from the noise and then presenting that pattern in a way that is actionable on the part of the manager are critical steps in advancing the spatially enabled smart campus.

Spatiotemporal visualization as a research and commercial activity has existed since the invention of computer cartography. Many techniques including map sequences, map animation, exploratory spatial data analysis, multi-dimensional mapping, and scientific visualization have been explored by geographers, cartographers, computer scientists, artists, and technicians at leading software companies. Best practices, industry standards, and entire computer graphics libraries have been developed for the display of spatiotemporal information, some more compelling than others.

In the last decade or so, the rise of a particular type of visualization bears closer—the dashboard. Dashboards, or sometimes expanded to business intelligence (BI) dashboards, is “a data visualization tool that displays the current status of metrics and key performance indicators for an enterprise (Rouse, 2010).” Just as the dials and indicators on a car dashboard give the driver information about performance of the vehicle’s components, so too does a BI dashboard give information about the performance of a business unit, often complete with red, yellow, or green indicators tied to a predetermined performance goals. While the visualization techniques used in these BI dashboards are not new (and often not particularly sophisticated), they are worthy of examination because of their focus on a) actionable intelligence, b) the ability to drill down into the data patterns in an active way, and c) the near-exclusion of the geographic dimension of the data.

Salisbury University in Salisbury, Maryland recently completed the installation and testing of a GIS-based indoor air quality and energy use monitoring system for our newest building on campus (Esri, 2013). This system, named SpatialMMS and created by Spatial Systems Associates of Columbia, Maryland, pulls data streams related to temperature, humidity, CO₂ levels, and energy consumption directly from the building automation system and displays them on maps of the building space as well as time-series graphs. These visualizations are available to both campus facilities managers and visitors to the building through a kiosk system. While the
visualizations that are built into the system are functional, they are not particularly compelling or sophisticated, nor are they actionable. However, my team at the Eastern Shore Regional GIS Cooperative at Salisbury University have been developing and refining “spatial intelligence dashboards” that could be used to reanimate the data from our campus building sensor network and achieve a higher degree of understanding and insight. Examples of our open-source, cross-platform data visualization tools are:

- MD Dept of Labor, Licensing and Regulation Workforce Dashboard  
  http://www.dllr.state.md.us/workforcedashboard/
- MD BayStat, Causes of the Problems and Solutions  
  http://baystat.maryland.gov/sources2.html
- Caroline County (Maryland) Department of Emergency Services  
  http://www.esrgc.org/dashboards/carolinedes/

I believe that we have just scratched the surface with regard to the extraction of local sensor network data for compelling and actionable visualizations. Harnessing open-source mapping and graphing libraries for enabling a spatially-aware smart campus is likely to be an area of exploration for some time to come.

Works Cited
http://searchbusinessanalytics.techtarget.com/definition/business-intelligence-dashboard