Research Report

PLATYPUS

dreamtime

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Dreamtime will **learn** how agricultural and environmental efforts can be empowered by water quality data, and **design** a system based on the needs of Platypus' users.

Platypus engineers low-cost autonomous airboats which gather water quality data information such as pH, depth, and temperature from lakes, ponds, and streams. The boats can cover territory more quickly and reliably than stationary sensors, the current industry standard. Data from the boats can help generate real-time, spatiotemporal maps of these metrics, which provide immense value to several user groups, including farmers, environmentalists, and educators. Platypus wants to develop a platform for this data that is maximally useful for its diverse user segments.

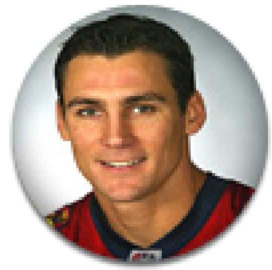
Dreamtime has spent the last 3 weeks gathering and synthesizing user needs, and surveying techniques for addressing those needs. This research report is meant to document these findings for Platypus, and aid our design process moving forward.

Interviewees

To learn about Platypus' user base, we interviewed two landowners from in Greene County, PA and an outreach coordinator from the River Alert Information Network (RAIN), a water quality monitoring group.

Blaise

Blaise lives on a 600-acre estate in Greene County, Pennsylvania. Most of his family works in non-agricultural fields, so they do not rely on their land for income. He has two man-made lakes used mainly for recreational activities like fishing and swimming. His family is concerned with the effect coal and oil drilling will have on these lakes and currently acts as a de facto community leader on environmental issues.



Greg

Greg, a former AFL star, lives on a 250-acre cattle ranch in Greene County. In addition to tending to his ranch, he runs a laundromat and general store. His estate contains both springs and ponds, which he uses for human consumption and raising cattle. Greg joined an environmental group in his township, but lacks the time or money to invest heavily in it. However, he does worry about the future of his water quality, and the impact energy companies may have on them and his family's future.

RAIN (3rain.org)

The River Alert Information Network was initiated by a voluntary collaboration of 33 water systems, PA DEP, California University of Pennsylvania and Riverside Center for Innovation. RAIN is a regional Source Water Protection program that continuously monitors public health and drinking water across the region. RAIN monitors water quality at 29 sites along the Monongahela, Allegheny, Shenango, Beaver and Ohio Rivers.

Case Study: Greene County

Greene County is among the poorest counties in Pennsylvania, but is well endowed with an abundance of natural resources. It specializes in exporting water, timber, and livestock[1]. The region sits on the Marcellus Shale Formation, which expands from West Virginia to New York. Energy companies are drawn to the region's rich shale deposits - but that can cause unintended consequences for air and water quality.

In addition to water contamination, mining has lead to the draining of private ponds due to broken rock foundations. The weathering of coal mines leads to the release of sulfuric acid, which can propagate through the rock. This may also cause a secondary reaction that produces high concentrations of aluminum, magnesium, and zinc, all of which may find their way to streams.[3] Similarly, oil companies have contributed to the poor water quality in Greene County. The fracking industry in Pennsylvania uses a technique called hydrofracturing that uses high pressure water, sand, and chemicals to break up shale to ease the flow of gas to the surface. This technique can use as much as 300,000 gallons of water a day.[2] This left over water then requires deep treatment to become nontoxic. Though frack water has designated treatment plants, it sometimes reaches water supplies, causing devastating results.

Experts believe the drinking water in Greene County has become toxic. According to the National Academy of Sciences, a lifetime of drinking Greene county water causes 1 in 100 incidence of cancer deaths, which is well above the national average. Despite these health risks, state and federal officials monitoring of pollution still comes up short. In many cases, the reports they provide are either inaccessible, or unclear, too infrequent, or downright nonexistent.

By providing spatial and temporal data, real time alerts, and more accessible reports, Platypus is well positioned to make a real difference in Greene County, and the lives of its citizens.

Our Findings

Dreamtime's research into user needs produced some key ideas, which we've consolidated into into four main points. In the following pages, we explain these main user needs, and provide an index of techniques to address these needs. These techniques are drawn from our survey of existing tools, both in the environmental monitoring space and in other sectors.

Enable customized reporting

What metrics do users want to see and report on, and in what detail?

Platypus' water data is used differently by various user types. For example, environmental groups and governments might track large scale trends in environmental change whereas a farmer might wish to track the pH of his lake - or even be notified when bromine levels reach a threshold. Our solution must strike a balance between providing useful warnings and not triggering false alarms.

We anticipate that users will require varied alert methods, in accordance with their familiarity with technology, knowledge of environmental data, and level of concern. This was admittedly difficult to study without a working prototype, and will require future iteration.

Blaise

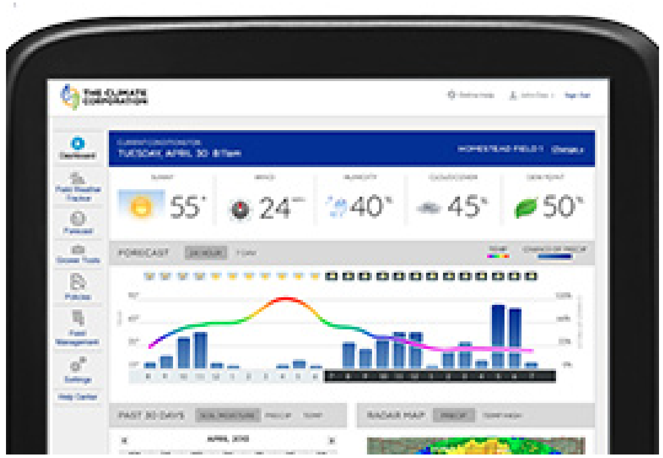
"I would prefer to know the temperature of the water, pH and presence of the minerals but some may not want specific details."

"If the information is emailed to those farmers every day or every week, that would be enough."

Customizable Dashboards

Tailor information displays to user needs for specific metrics.

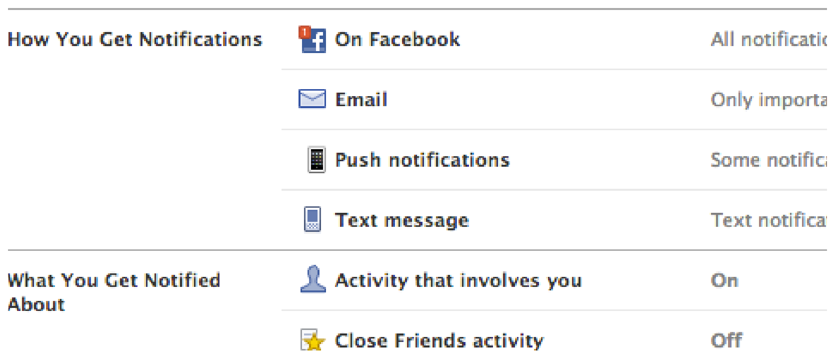
The high degree of customizability can be good for handling complex data sets, but also overwhelming to users.



The Climate Corporation's modular dashboard allows users to add and remove data "widgets" as needed

Alert Customization

Enable customization of type, medium (sms/email), and frequency of alerts.



Facebook provides extensive notification customization

Visualize Spatial & Temporal Dimensions

How can visualizing spatial and temporal dimensions empower users?

Platypus boats offer high fidelity temporal and spatial data, a major competitive advantage over existing static sensors and lab samples. Spatial data helps determine the source of an irregularity. Taking multiple samples across space and time can increase validity.

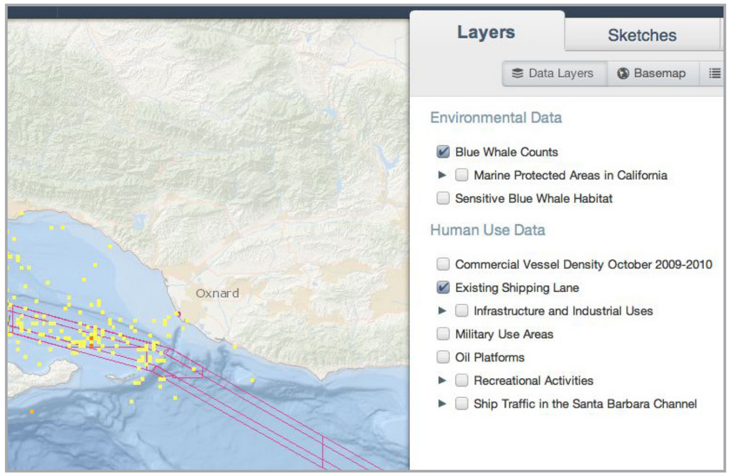
Recognizing that this is one of Platypus' main competitive advantages, we seek to emphasize this value in our design in a way that empowers users.

"With our website's current visualization, it is impossible to make sense of which sensors are where to see if there is a pattern to the readings."

RAIN

Data Layers

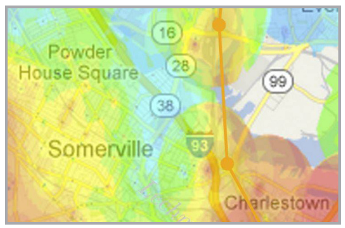
Allow toggling of multiple data layers on a single map interface. This allows users to customize their map display, and discern how one metric might affect another.

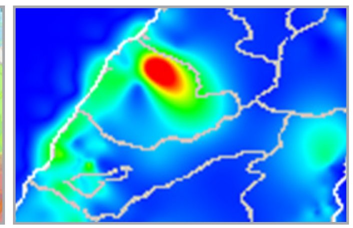


SeaSketch's data layers show interaction between "whale strikes" and "shipping lanes".

Heatmaps

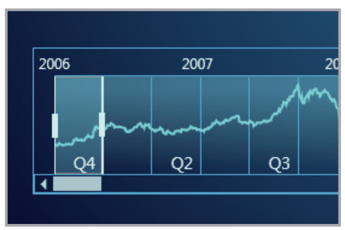
Provide a graphical representation of the distribution and magnitude of a metric using color. We found this to be a very popular visualization technique in environmental dashboards. Can be used in conjunction with the "data layer" pattern.





Timelines

Allow users to select a period of time with a slider. They were a popular way of visualizing change over time in the interfaces we reviewed. Some included a play button, which automatically scrolls through a time series.



Contextualize Metrics

How can we provide numerical, historical and causal context to metrics?

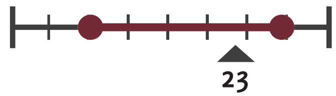
Water quality data is neither easy nor simple. Simply reporting a metric is not as helpful as properly contextualizing it. It needs background information to understand what each component of the data means and how those data is related to one's interest. A data visualization interface should help answer questions like: How likely is this value to occur? Is it within an acceptable range of values? Is it trending upward or downward? What other metrics can help explain this data?

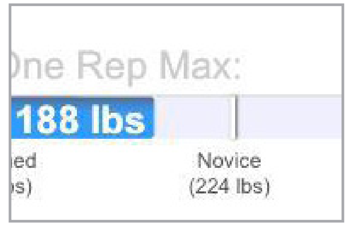
Blaise

"A lot of these people don't understand what the numbers mean. It'd be nice to just have something that says 'Hey your water is good' or 'Hey your water is bad!' would be good."

Ranges

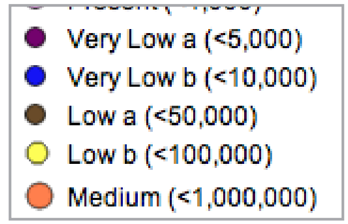
Place a point statistic in a range of values, perhaps based on historical data or EPA standards

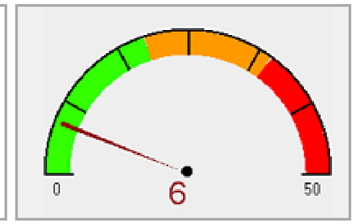




Color codes

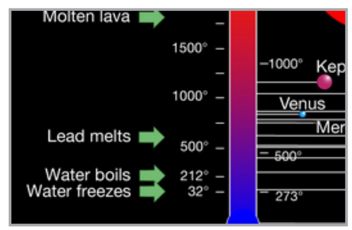
Provide a quick visual cue for displaying when something is at an acceptable or dangerous level. These generally use a common color spectrum from cold to warm colors.

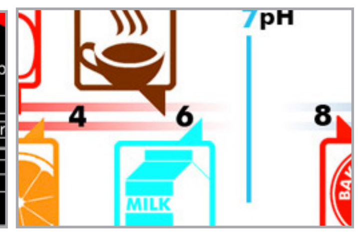




Analogies

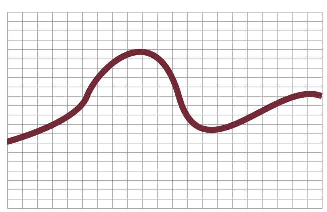
Relate numbers to familiar concepts, using analagous labels.

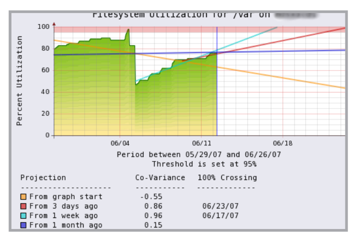




Trend Lines

show historical context for a metric, to easily determine if it is increasing or decreasing. This can be used in conjunction with the patterns above, such as ranges and color codes.

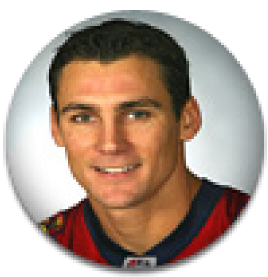




Provide actionable information

How do we bridge the gap between understanding and acting on data?

Data is often a means to an end. Users use data to stay informed, be alerted about problems, gain peace of mind, or help make a case to other people. We learned, both from interviews and background research, that the applications of water monitoring are diverse: ensuring irrigation and drinking water safety, detecting invasive species, and predicting floods. Current water quality reports and dashboards fall particularly short at providing actionable data. Our tool can go beyond providing understandable data to enable these next steps.

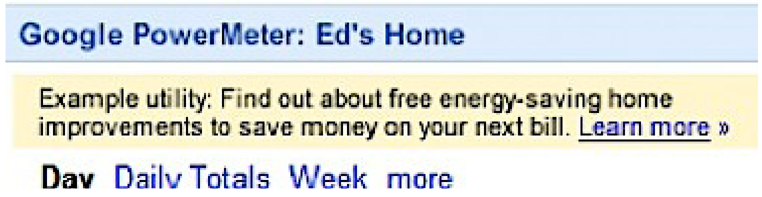


Greg

"Water quality is the #1 problem in Greene County"

Recommendations

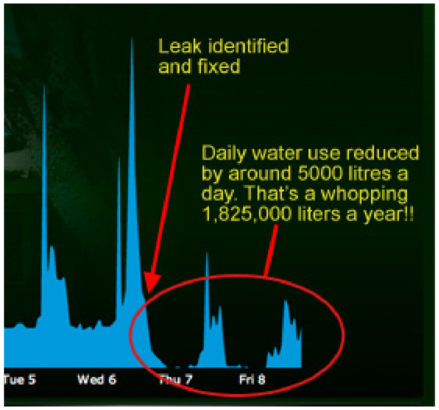
When something goes wrong, provide meaningful recommendations on how to fix a problem, who to contact for support, or what to read to learn more. However, designers must be careful to not provide misleading information here.



Google provides inline tips with its power saving tool.

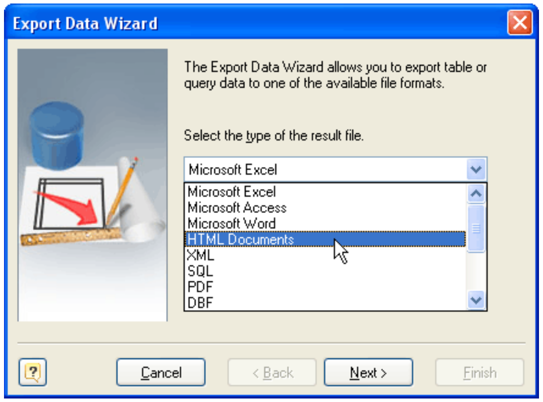
Annotation / sketching

Add human intelligence to data, where automated solutions come up short. This is specially useful in the context of map based visualizations and report generation functions. We must take care to differentiate these annotations from the original data.



Report generation

Data tools should strive for openness, allowing users to own their data. Allow users to generate reports for others (perhaps pdf, emails, or generated pages)



This “wizard” tries to tame the complexity of exporting big data sets to multiple formats.

Appendix

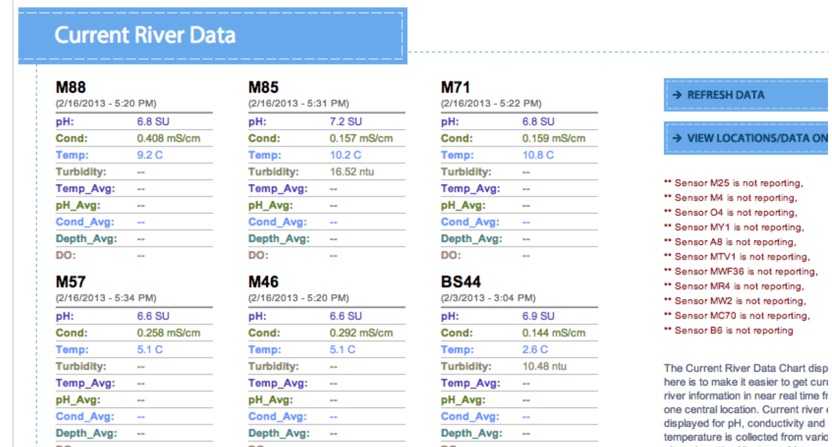
Methods Review

We began with a case study on issues related to water contamination, especially in Greene County, PA. We reviewed water pollution cases and analyzed the relationship among energy companies, water monitoring groups, and users of the water "users". This grounded our interviewing process.

We found interviewees and conducted a series of contextual interviews. We visited a Greene County farm and talked with two landowners in the area. We also talked with RAIN, an environmental group that monitors water quality at 29 continuous water monitoring sites.

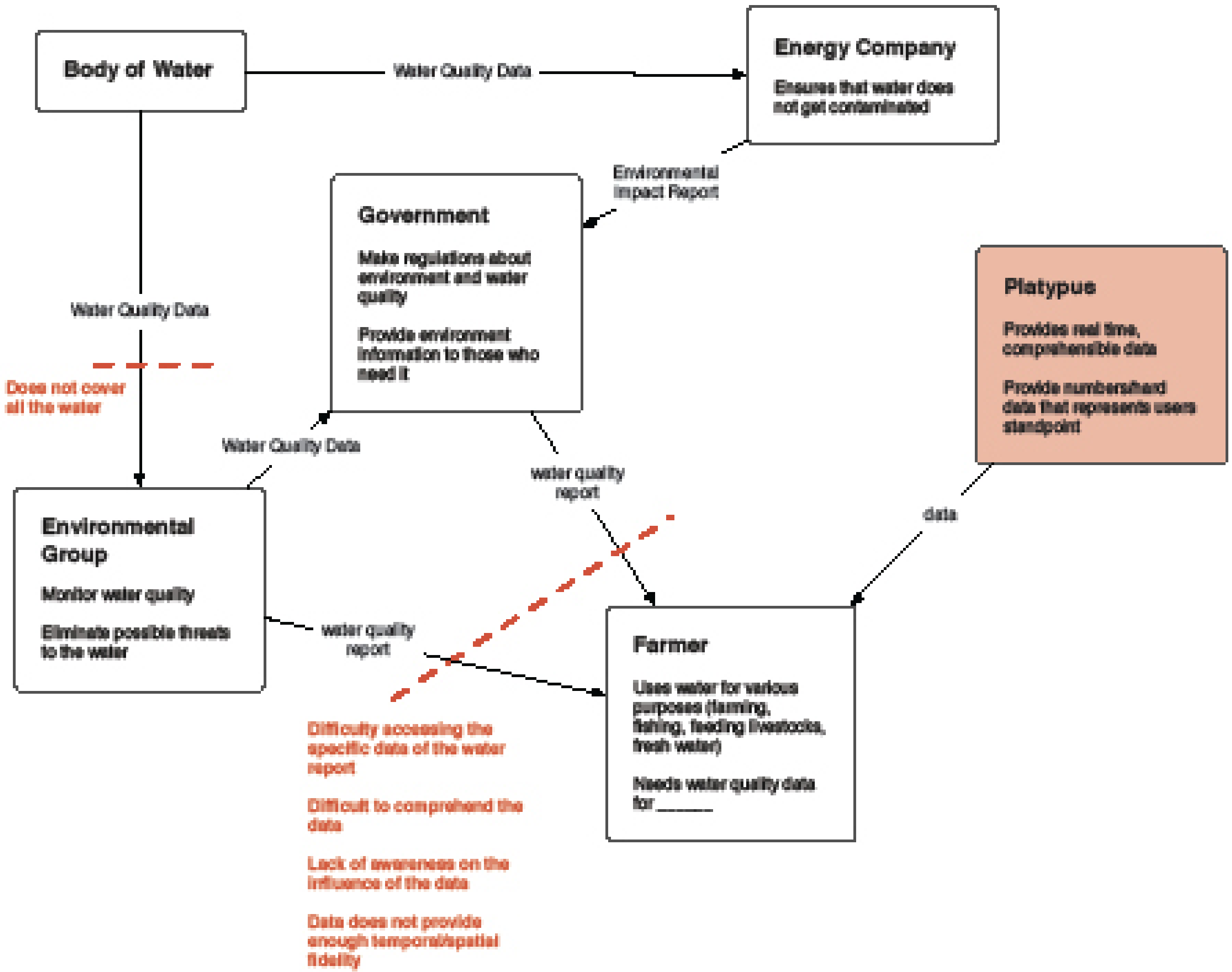
After getting a sense of how Platypus might address its user's needs, we began looking at existing environmental monitoring tools, and investigating patterns and interaction techniques that might motivate a prototype. Research domains included government supported systems (i.e National Centers for Coastal Ocean Science), a mobile-web platform for farmers (The Climate Corporation), a web platform particularly designed for crisis (Google's Crisis Response) and NASA's Earth Now.

Then, we created a flow model based on the admittedly limited interviews with involved parties. We identified breakdowns involving the accessibility, understandability, and fidelity of current water quality data. We also made an affinity diagram of key themes from the competitive analysis and contextual interviews.



RAIN's current interface.

Affinity diagramming to condense research into major themes.



Flow model summarizing the flow of information between involved parties

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2Pollution Unchecked: A Case Study of Greene County, Pennsylvania. Natural Resources Defense Council. 2004. ‹https://www.nrdc.org/water/pollution/greene/greene.pdf›.

3Effects of Coal-Mine Drainage on Stream Water Quality in the Allegheny and Monongahela River Basins—Sulfate Transport and Trends. U.S. Department of the Interior and U.S. Geological Survey. 2000. ‹http://pa.water.usgs.gov/reports/wrir_99-4208.pdf›.

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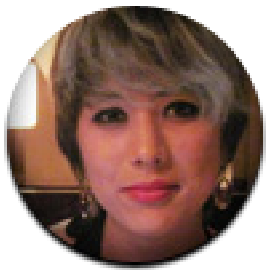

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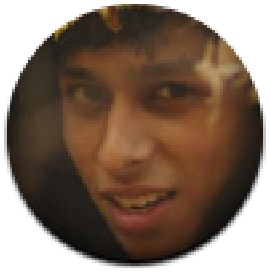

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