

VIA - Visualizing Individual Actions to Develop a Sustainable Community Culture through Cycling

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Abstract. Improving the sustainability of our society requires significant change in our collective behavior. But today, individuals in our society have no regular way of seeing that collective behavior, or how their own behavior compares to it. We are creating a research network that will study how new technologies such as mobiles and visualization can encourage individuals to change their behavior to improve sustainability. In Winston-Salem NC, network members will use new technologies to engage the community about its use of transportation—especially biking—and study how that communication affects sustainability awareness and behavior.

Keywords: sustainability, biking, mobiles, visualization, persuasion, measurement.

1 Introduction

Sustainability is connectivity: actions that are beneficial in the short term regularly have unseen economic, ecological and social impacts that harm us in the long term. Sustainability is also now in crisis: we are reaching natural limits, and are no longer

able to ignore those long term impacts. Mitigating this crisis will require behavioral change at both the individual and societal levels. Unfortunately, we often find it difficult to act toward achieving long-term goals, even when we are quite familiar with the benefits of such action.

Emerging mobile and visualization technologies may offer a solution. By improving connectivity in the web of sustainability, these technologies have the potential to:

- *Enable improved sustainability measurement.* For planners and researchers, mobile technologies such as GPS can provide crowdsourced “big” data measuring human sustainability behavior at an individual, nearly minute-by-minute level. For individual community members, mobile measurement can provide feedback on any improvement in their sustainable behavior, and enable comparison of their behavior to peer groups.
- *Enable improved sustainability action.* For planners and researchers, mobile measurement and resulting visualizations will provide prompt feedback on the effect of infrastructure improvements, incentives, and outreach efforts; to enable more effective investment and more relevant research. For individual community members, mobile wayfinding tools will make acting sustainably easier: individualized persuasive visualizations will motivate that action, and well-timed sustainability reminders will trigger that motivation.
- *Build cultures of community sustainability.* Community leaders communicate more directly and promptly with their constituents, and constituents with their leadership; researchers will study the effect of different communication campaigns on both awareness and behavior; and individual community members will be more tightly bound to communities by improved awareness.

Examining these possibilities will require a regionally-focused, broad collaboration across disciplinary, organizational and social boundaries. Our emerging VIA research network is just such a collaboration, centered around transportation and the growing biking movement in North Carolina.

The network will have three primary nodes associated with the triple bottom line of sustainability: ecology, economy and society[0]. Three teams of researchers from multiple disciplines will network to improve short distance transportation decision making. The methods and tools team is creating an ecology of mobile and visualization tools, used to measure and communicate about short-distance transportation behavior, especially bicycling. The tools will be field tested and instituted with the activities of the academic team, which functions as an iterative economy. The feedback will affect the next generation of method and tool development as well as guide our community institutions team in their visualization activities. This community institutions team will feed back to the academic and methods teams and provide assessment of activities and methods development, and interface through an extensive group of community supporters (CSs) to citizens. The goals of promoting a community of citizens for sustainability will be met through these networking exercises and activities.

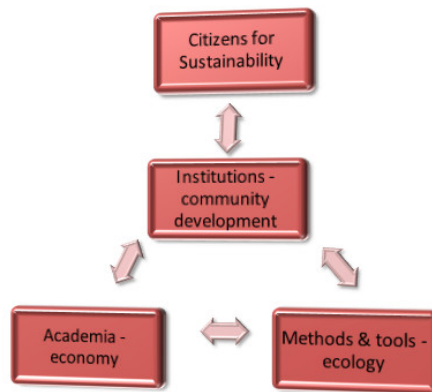


Fig. 1. The structure of the VIA research network

2 Prior Work

2.1 Community

Organizing the large number of motivations and barriers involved in short-distances transportation decision-making draws from a body of theory on effective communication of sustainability [2], taking into consideration cultural variables as well as individual responsibility. At the collective level, Pacanowsky and O'Donnell-Trujillo [3] observed more things happen in organizations than getting things done: they are not single-minded task-oriented communities; they are mini-cultures. Communication in this sense is more about creating a reality of the world consistent with strongly held beliefs and attitudes shared within the community and nurtured by the persuasive campaign. Using the metaphor of webs, also known as axiologies, organizational communication theory optimizes effect by building upon the existing panoply of beliefs and attitudes shared by a community and by tapping into these sensibilities and demonstrating significant and substantive linkage with the subject of the persuasive campaign, in this case sustainable transport decision-making, attracting and supporting individuals into a shared community by providing them with a coherent vision using concepts such as personal, effect, and cultural salience.

2.2 Sustainability

Bike transportation provides benefits to various measures of sustainability. The Triple Bottom Line approach is one measure of sustainability that includes multiple variable analyses. In this formulation sustainability is defined as an activity or process that contributes to economic, environmental and social welfare and persistence [4]. Multiple options for transportation within a city provide more access for those who live

there and increases options for their travel. For this activity to be sustained and provide options into the future, transportation planners rely on accurate data collection and analysis to determine traffic patterns, usage and constraints. The lack of data around various transportation options limits the availability of these user groups to be accurately assessed. Many communities have undergone increased monitoring of bike transportation data in order to fill these gaps [5].

Biking contributes to environmental sustainability by decreasing fossil fuel consumption, thus generating an overall reduction of carbon in the environment. Increasing the mode share of all trips made by bicycling and walking could lead to fuel savings and reduce greenhouse gas emissions, the equivalent to replacing 19 million conventional cars with hybrids [6]. Biking also provides a great benefit for social welfare by creating more healthy transportation choices. Researchers compared the relationship between bicycling and walking travel and obesity in 14 countries, 50 U.S. states, and 47 U.S. cities, and found statistically significant negative relationships at all levels [7].

2.3 Technology

The mobile phone has become the most rapidly adopted technology in history [8]. The most recent PEW study showed that 83% of adults own a mobile phone, 42% of whom say that they own smartphones, meaning that 35% of all U.S. adults are now smartphone owners. There are now more than five-billion mobile phone subscriptions worldwide [10].

Mobile platforms are especially important to underrepresented populations. African-Americans talk on their cell phones an average of 1,300 minutes per month, more than twice the 647 minutes averaged by whites. Hispanics were next at 826 minutes per month, followed by Asians and Pacific Islanders at 692 minutes per month. Blacks and Hispanics were also the most likely to send and receive text messages, averaging 780 and 767 per month respectively [11].

Only 20 years ago, obtaining camera output required several days. Less than 15 years ago, civilians could not automatically locate themselves. Less than five years ago, speaking with a foreigner meant learning her language, or finding a human translator. Today all of that sensing functionality can be had by reaching into your pocket. Understandably, research and development in applications for these newly pervasive sensing capabilities has grown rapidly.

Fogg [12] was among the first to argue that technology should be used to persuade. Persuasive technology, he said, is any “interactive computing system designed to change people’s attitudes or behaviors.” Technology has several advantages over the traditional persuasive media, including its ability to simplify (e.g. Amazon’s one-click purchasing) and recommend (e.g. Netflix). Fogg was particularly excited by the persuasive potential of mobile devices, with their convenient pervasiveness, ability to sense context, emotional importance to their users, and social connectedness [12].

With all this excitement about pervasive persuasion, it is not surprising that there has been a very recent explosion of research development applying mobiles to the problems of sustainability [13][14]. Moreover, given the complexity of sustainability

problem, it is also no surprise that many of the same researchers have used visualization and sensing as they persuade [15][16].

3 Existing Regional Activity

3.1 Research and Education

In what follows, we provide only a sampling of current sustainability work in Winston-Salem and more broadly, North Carolina.

Scientific Visualization (SciViz)

This undergraduate Liberal Learning Seminar is situated at CDI and co-taught by WSSU faculty in art and science. Visiting contributors from other fields and nearby institutions augment their perspectives. The interdisciplinary seminar explores visual and human-computer interaction design processes through creative solutions to communicating about challenging scientific and visualization problems. Students from a variety of backgrounds learn content and techniques of visual art, the natural sciences and computer graphics by working together to design dynamic and interactive solutions for representing multimodal data. The approach is computer-intensive, experiential, and discursive. The students and their digital productions benefit from frequent display, discussion, and critique of work. Students keep track of their progress, showcase their work and reflect on their experience in the seminar using an individual, online blog. Weekly video-logs (vlogs) capture the dynamics of the class and provide another communication channel among peers and the faculty.

Data from the VIA network will become grist for visualization experiments incorporating themes of wellness, sustainability, connectedness, and comparisons of human behavior. Collaboration between SciViz and our Life on Two Wheels course (below) will give each group of students a deeper understanding of sustainability issues.

Life on Two Wheels (Lo2W)

Young people in college are creating new identities, trying different activities and expanding their minds far beyond what they learned at home. Increasingly independent, they may make both good and bad decisions. One of the most important choices concerns physical activity. A 2008 report by the National College Health Assessment team found that only 18% of college students are active most days a week and 23% of college students are not physically active on any days of the week [17]. Additional research confirms the physical and psychological benefits of physical activity and suggests that green exercise – that is, physical activity outdoors in nature – has a synergistic effect that provides mental and physical health benefits beyond exercise alone [18]. Further changes to lifestyle and awareness of how personal decisions impact one's community, environment, and the very lifespan of the planet can also be initiated during the college years.



Fig. 2. A pilot of the life on two wheels course, at Winston-Salem State

This course aims to determine whether a class focused on the benefits of riding can encourage positive thoughts and behavioral changes associated with physical activity and environmental awareness, as well as the factors that may influence and potentially increase the use of self-powered transportation modalities, including biking and walking. The Lo2W course has been successfully piloted at two local schools: at Salem College it was called Grassroots Biology, and at Winston-Salem State (WSSU) it is known as Life on Two Wheels: Exploring Human and Environmental Health through Cycling. Data collection is ongoing at WSSU. The research method involves measurements taken pre- and post-class, including physiological, psychological, and environmental assessments. Additionally, throughout the class, participants write reflections about the weekly lessons and activities. Allen analyzes these online blog entries throughout the semester.

RideTheWake

Developed by a team of undergraduate computer science students at Wake Forest University, RideTheWake is a web and mobile application that shows in real time the position of shuttle busses along the six WFU routes on campus and around W-S. The application responds to the most basic need of shuttle-users: where a bus is along its route and thus how long its users need to wait for it. The app has been in service for more than two years and is credited with increasing the adoption of the shuttle system by students and faculty.

Similar efforts are underway to develop tools for indicating the positions and patterns of route use by pedestrians and cyclists around the city, with the aim of promoting increased support for existing users and greater participation by new users.

One example is a crowd-sourced tool that facilitates communication between city officials and fellow citizens, by enabling designation of problems with safety and continuity in the city's existing alternative transportation network, as well as to recognition and appreciation of solutions to previously known problems. VIA expertise and infrastructure will facilitate the further development of such tools across the consortium of schools and cooperating organizations, to create support for pedestrian, bicycle, and shuttle-users moving freely and efficiently anywhere in the city. In particular, we envision using backend VIA functionality to disambiguate the use of busses and personal cars, to identify usage patterns, inform improvements and recognize more efficient adoption strategies.

4 Research Objectives

The VIA research collaboration network will bring these research and educational efforts together around three research goals, all exploiting mobile, visualization and communication technologies and methods.

4.1 New, Mobile-Based Sustainability Measures

As the EPA's report on sustainability measurement [19] makes clear, existing sustainability measures suffer from several shortcomings. One of our primary research goals is to develop new, mobile based measures of sustainability that have the potential to overcome these shortcomings, and study their effectiveness in planning, communication and community building. Exploiting the widespread use of smartphones and the rich set of sensors on each of these devices, we will, with the aid citizens:

- *Increase the temporal resolution of measurement:* many sustainability measures are only produced every 10 years with the census. Mobiles can provide daily and even minute-by-minute measures, permitting route tracking and inference of transportation modality.
- *Increase the spatial resolution of measurement:* census data is per-tract or per-block, while video can only sense fixed locations. With mobile GPS technology, resolution is 20-meters or less, at most any location. Measurement follows commuters wherever they go, with any modality.
- *Increase the accuracy of measurement:* much of existing sustainability measurement is self-reported. Mobile measurement need not rely on fallible human memory, or on the relatively sparse sampling of human measurement.
- *Reduce measurement cost:* crowdsourced mobile measurement does not require expensive sensor installation and maintenance, nor laborious human counting.

4.2 New Techniques for Sustainability Persuasion

As devices that are nearly always present and intensely personal, mobiles have unique potential as a platform for persuasion [12]. Today's most innovative companies such

as Google, Apple and Facebook apparently believe this as well, and are in an intense battle for control of the mobile ad market. Our second research objective will examine mobiles as a medium for affecting sustainability behavior, rather than simply commercial behavior. With participant agreement, we will examine the effectiveness of persuasive messages delivered using:

- *Visualization*: emerging research shows the power of imagery as a persuasive medium [20]. We will use such imagery to deliver citizens their own data in a visually compelling form.
- *Gamification*: by introducing motivating elements from computer games, developers can affect human behavior [21]. We will introduce elements such as competition by allowing participants to compare their performance to peer groups.
- *Priming*: recent research shows that much of habitual human behavior is governed at an emotional level [22][23]. We will deliver well-timed, simple messages to citizens designed to trigger sustainable behavior.

4.3 Understand the Relationship of Community to Sustainability

For some Americans sustainability has little intrinsic meaning [24]. The public perceives sustainability in the context of the activities of those around them. They sense sustainability. Sustainability activities such as short-distances transportation decision making should privilege those activities with both a lighter carbon or consumption footprint and improved health and well-being. This demands a series of communication activities that improve understanding of benefits and represents the sustainable activities as opportunities. By exploring social capital and civic engagement through visualization [25] and developing open data sharing opportunities we can build and sustain a community culture that may be able to reinforce and perpetuate learned behaviors through supportive organizational communication [3]. This is the third research objective of the VIA network.

Acknowledgements. We send gratitude to the many community organizations in Winston-Salem and the Triad area who are providing assistance to the VIA effort.

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