TRASH TRACK

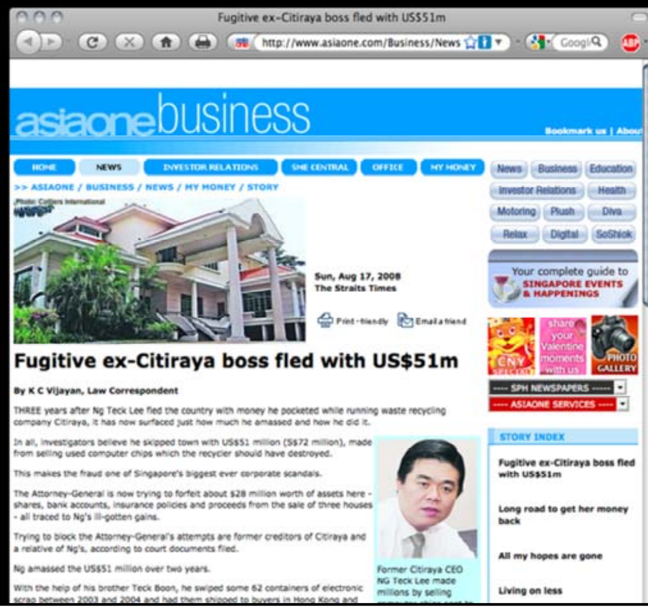
SEATTLE, WA & NEW YORK CITY, NY

We know a lot about supply chains

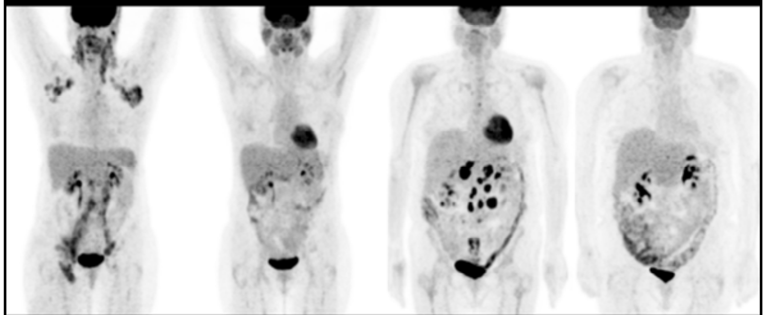
We know where everything in the supply chain comes from. But we don’t know the opposite:
REMOVAL rather than SUPPLY


China's Electronic Waste Village –
TIME Photo Essay

Waste as a Resource – Conflicting Incentives

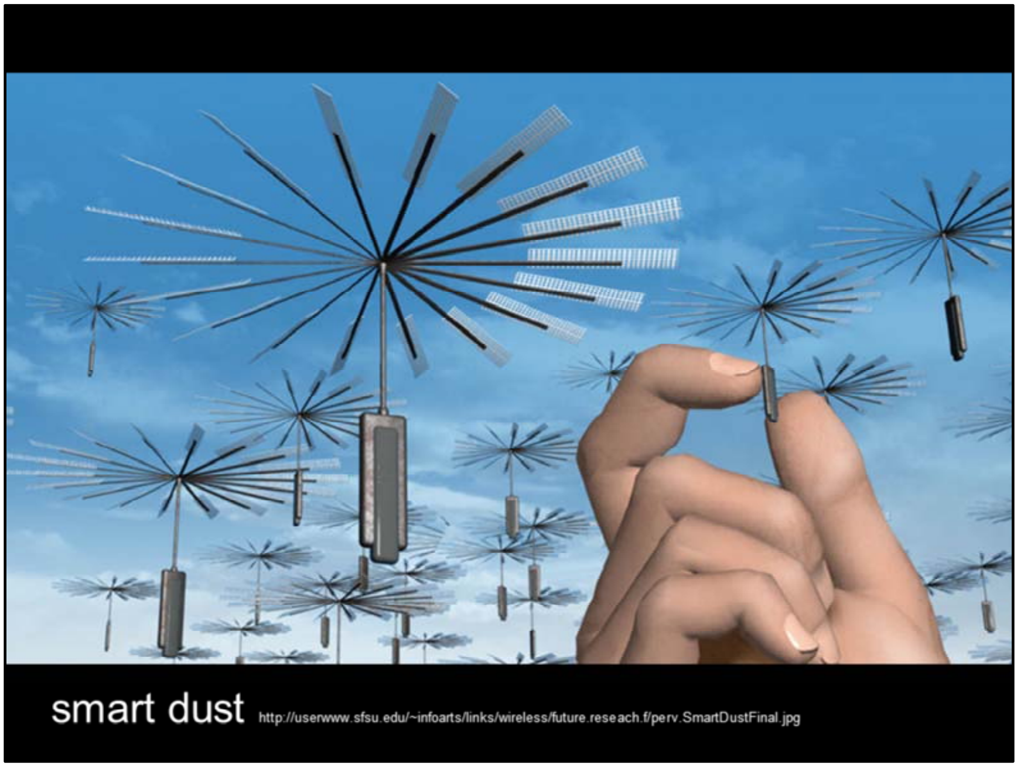


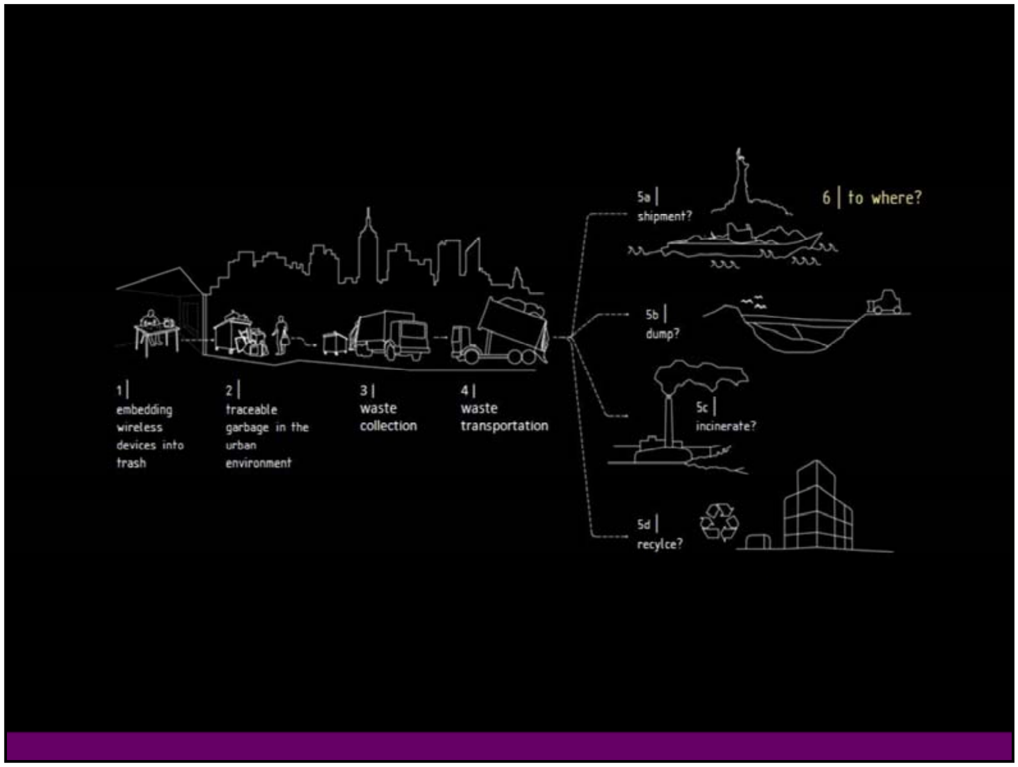
AMD commissioned Citiraya to destroy old CPUs. Citiraya realized that it could make more money by reselling the chips on the market



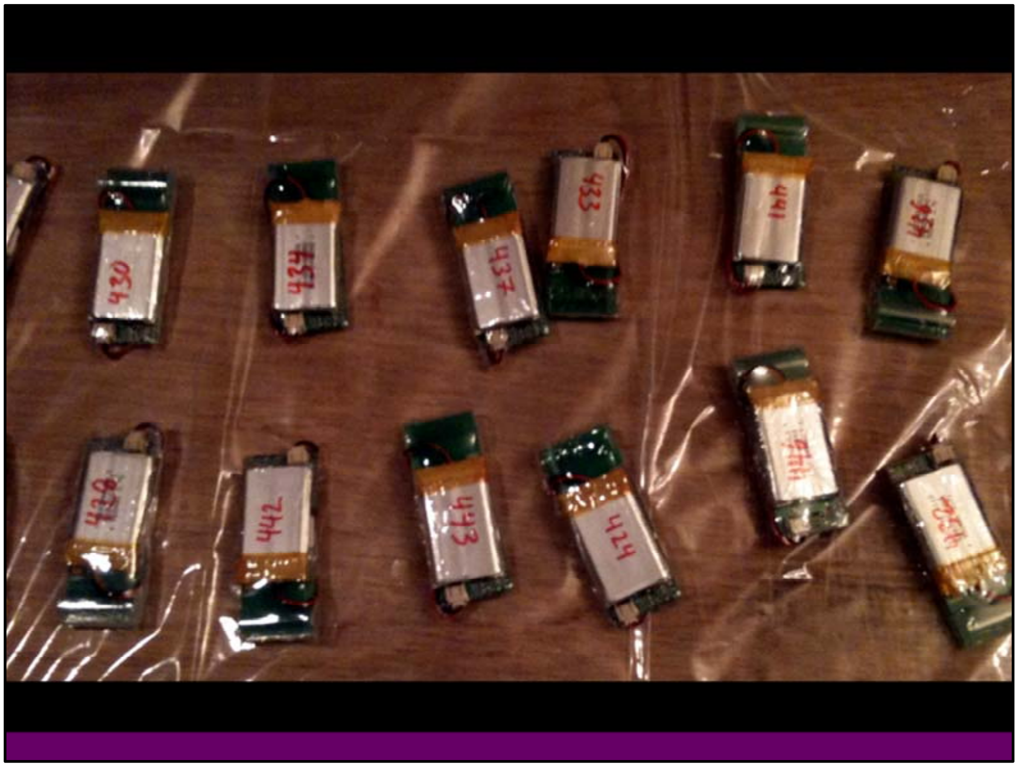
nuclear medicine

7


smart dust
http://userwww.sfsu.edu/~infoarts/links/wireless/future.reseach.f/perv.SmartDustFinal.jpg



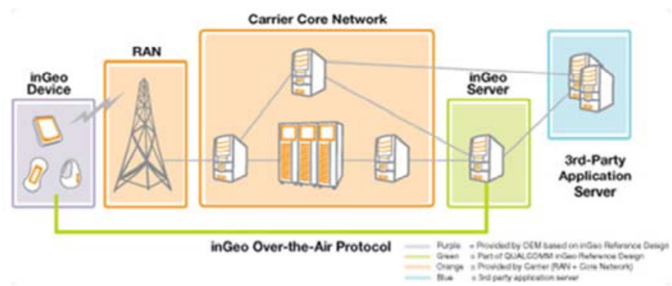
Revealing invisible processes of cities using sensors placed in trash to see where they go

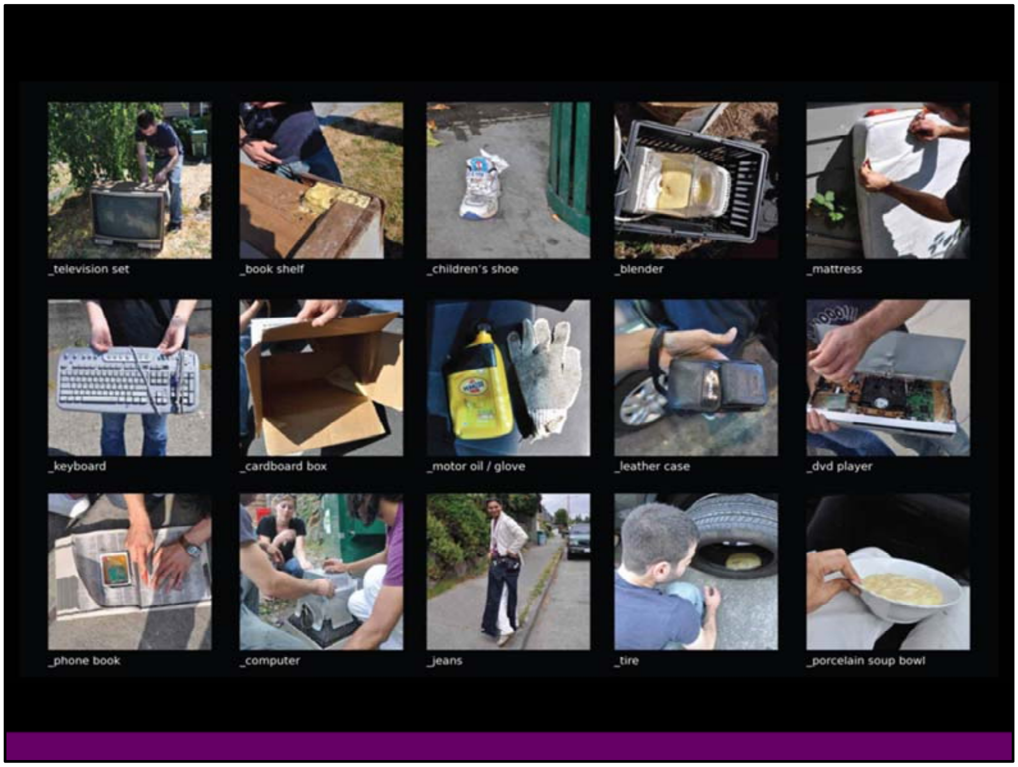


We developed sensors to report, which was a challenge in itself as we had to deal with power consumption and reporting capabilities.

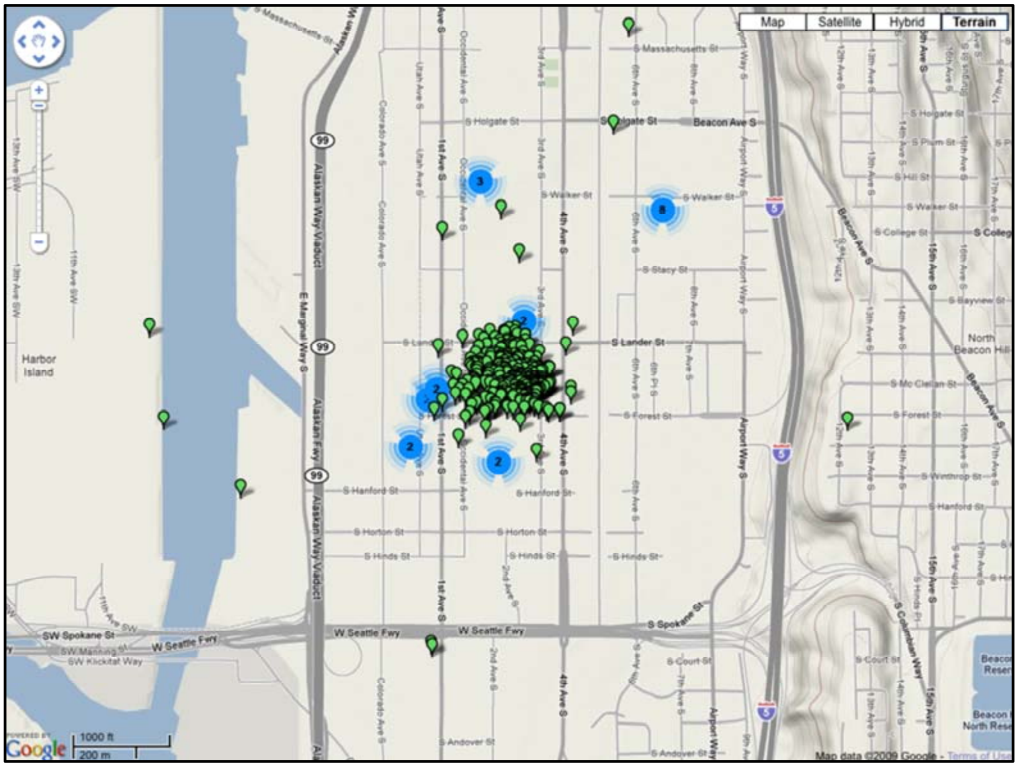
QUALCOMM

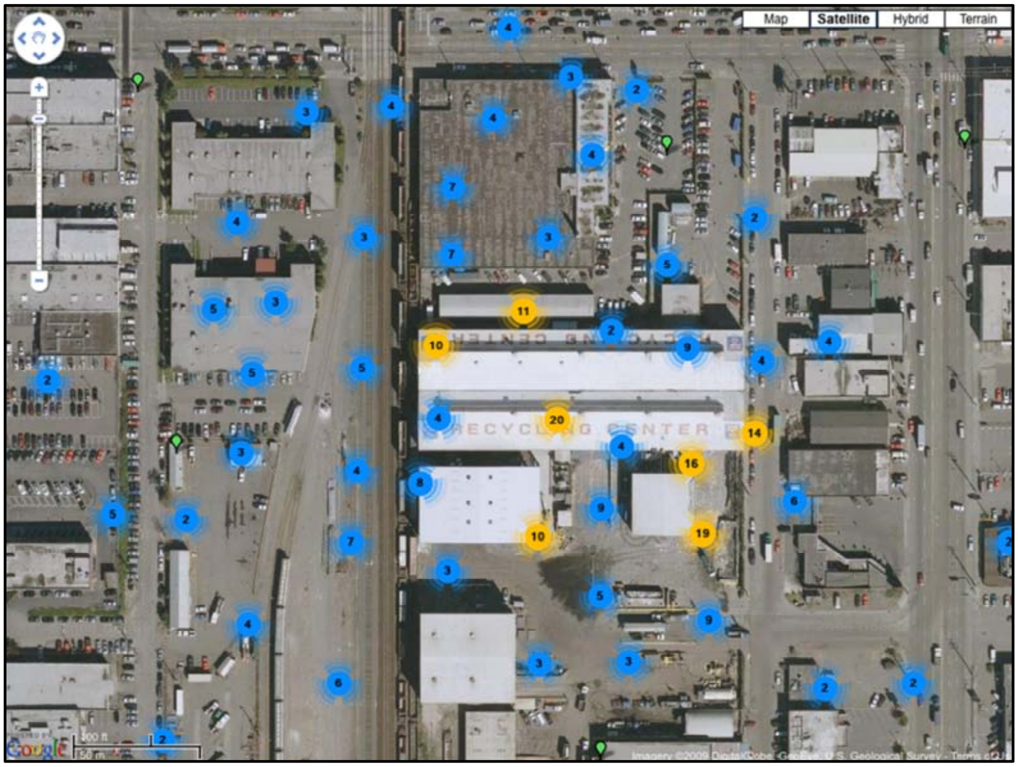
Sprint



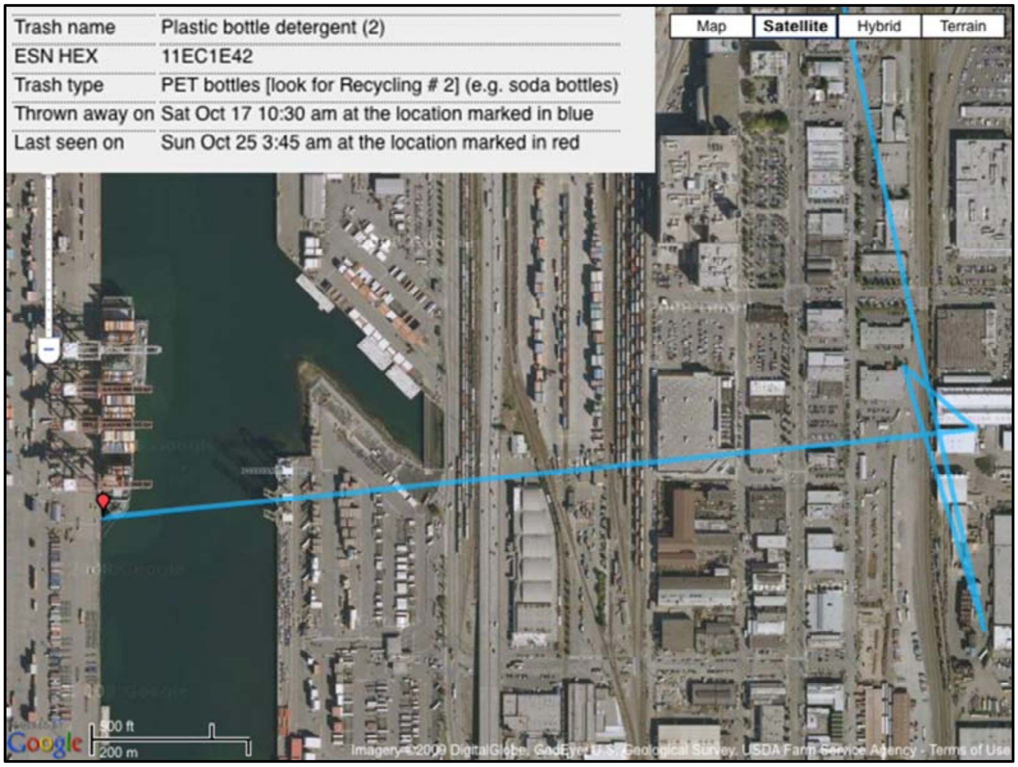


All sorts of trash from food to electronic waste


Map
Satellite
Hybrid
Terrain
Harbor Island
S Holgate St
Beacon Ave S
S Walker St
S Lander St
S Forest St
S Hanford St
S Horton St
S Hinds St
1st Ave S
4th Ave S
Alaskan Way Viaduct
E Marginal Way S
Airport Way S
W Seattle Fwy
SW Spokane St
S Spokane St
North Beacon Hill
15th Ave S
1000 ft
200 m



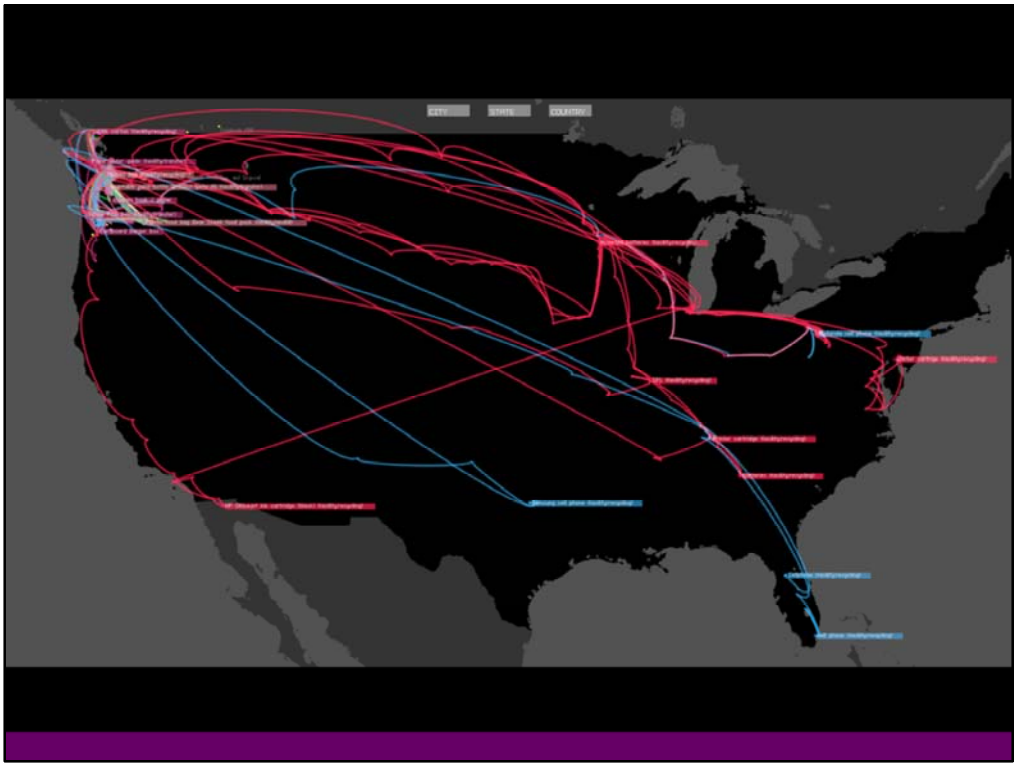
Map
Satellite
Hybrid
Terrain
RECYCLING CENTER



We even tracked items to the cedar grove composting site that Paul mentioned in his presentation

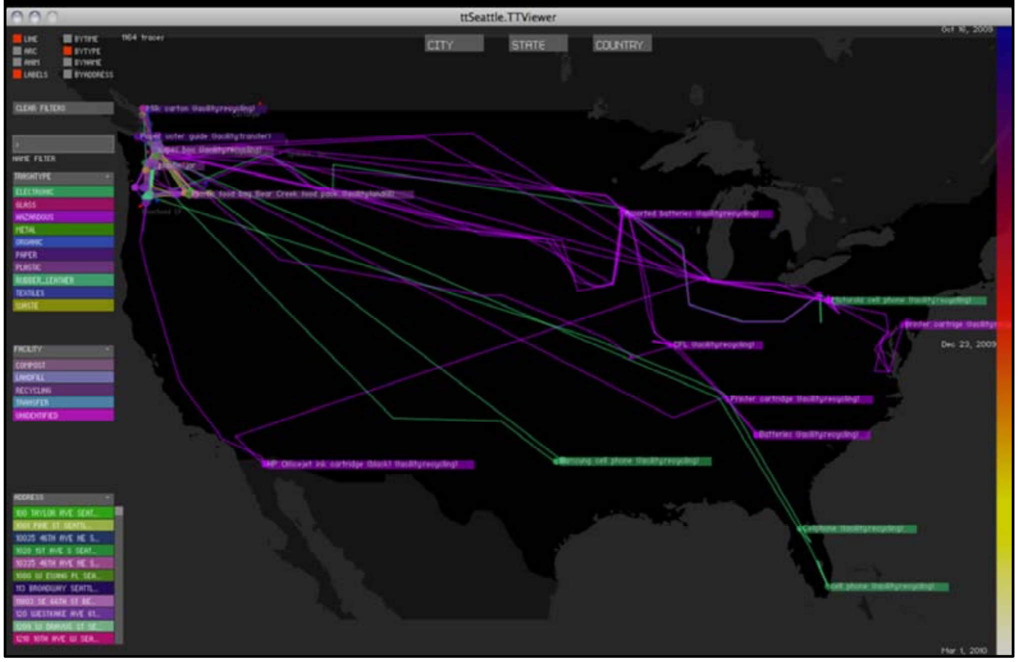
Volunteers brought trash, threw them away and we saw where they went.

Video… It’s amazing that our infrastructure in still increadibly manual because it is the most efficient way of recovering material.
- 500 volunteers in Seattle and 3000 pieces in total. Seattle public library was suffice it to say a little shocked that they were collecting trash in front of a beautiful Rem Koolhaas building

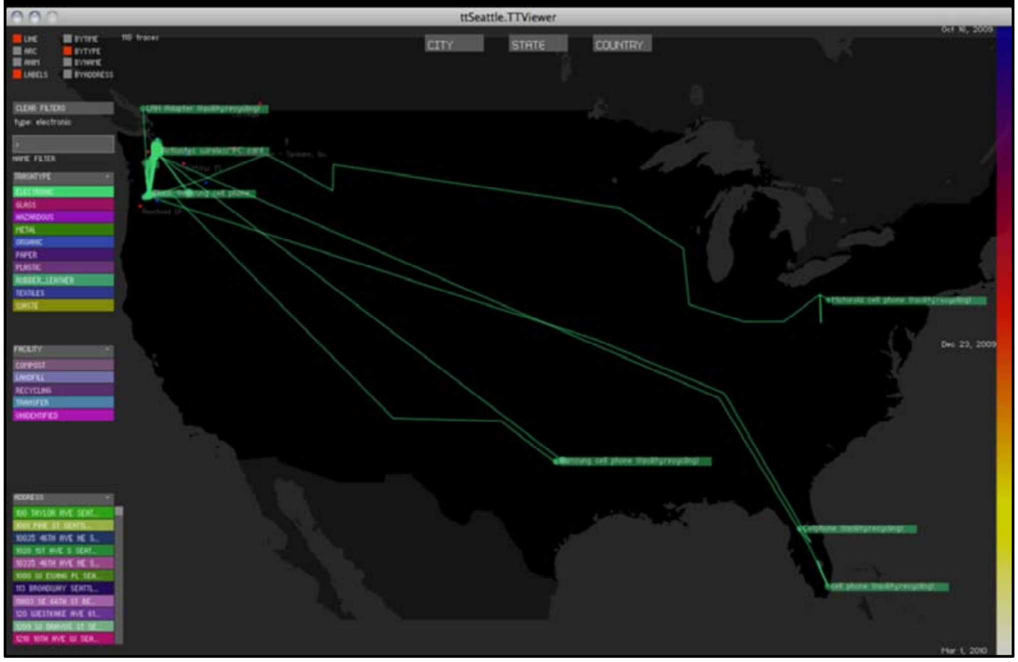


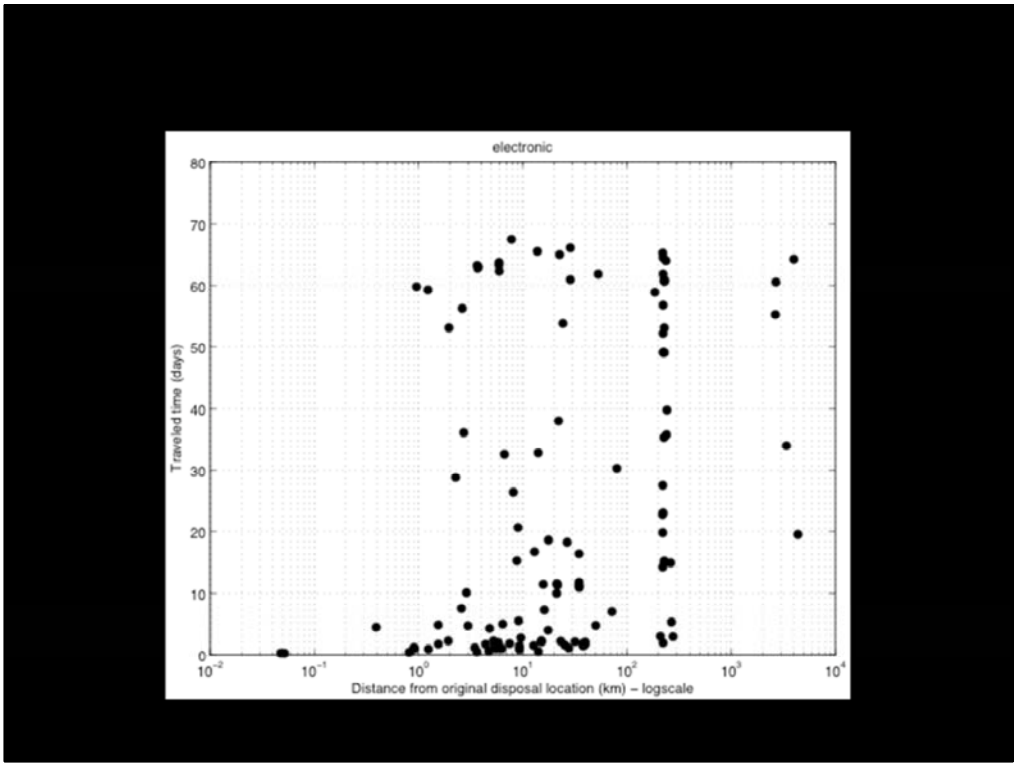
Looking at types of electronic waste (blue vs pink was just types). First time anyone had seen this map, where we actually won the National Science Foundation Visualization Award!!!

All by Type

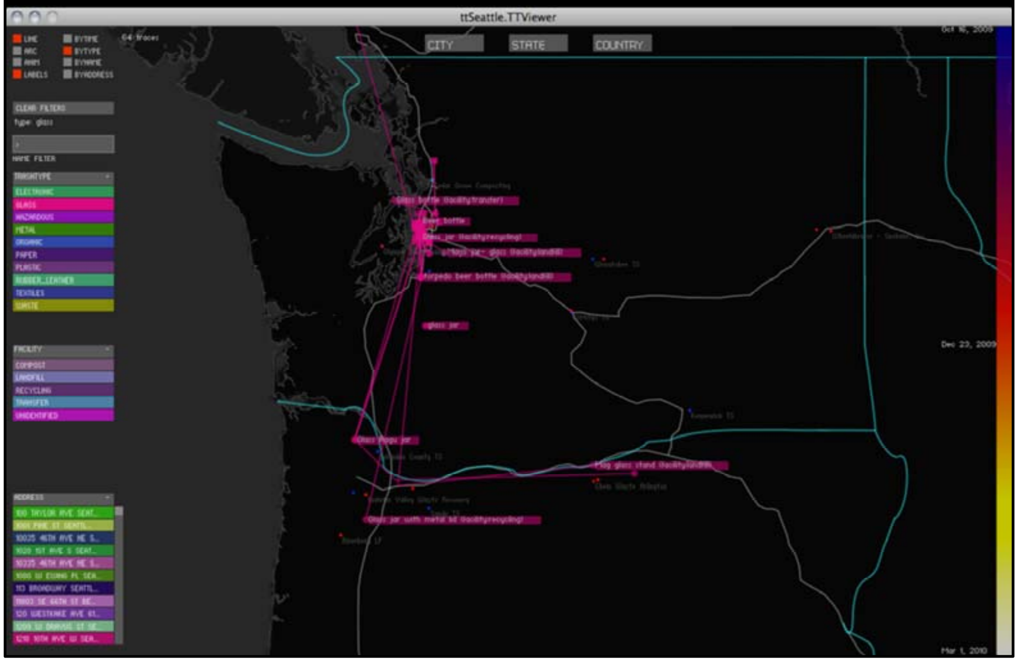


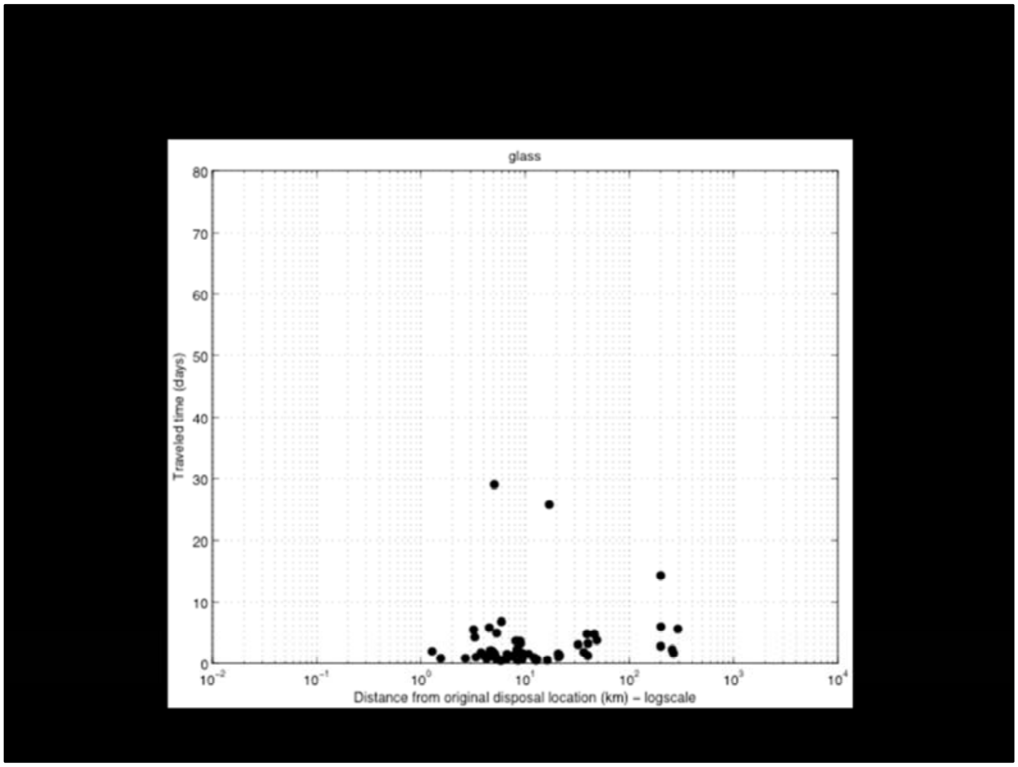
Electronic



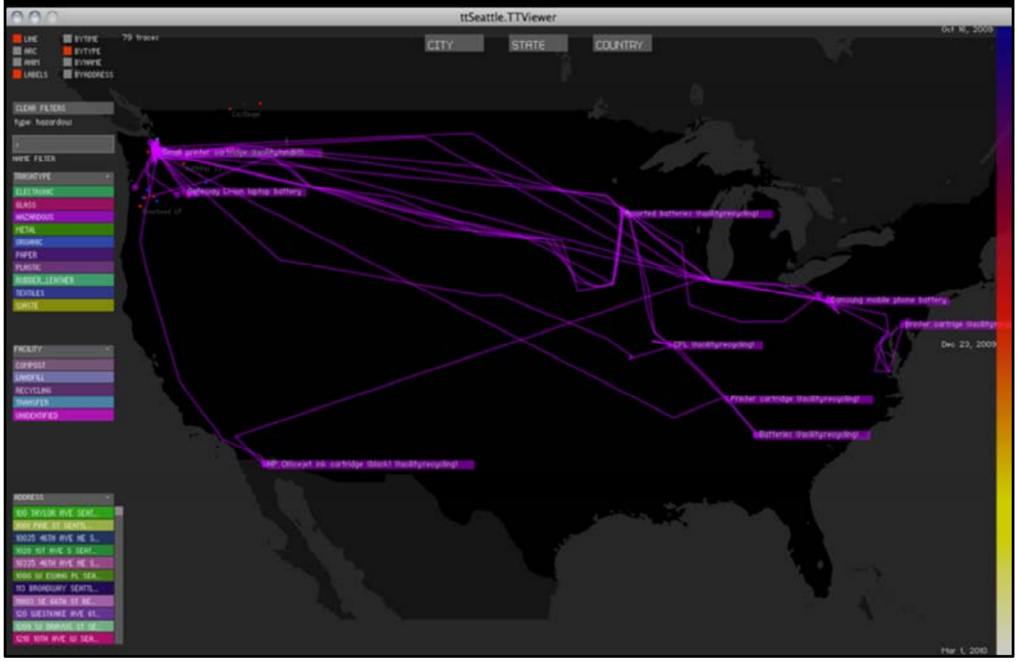

electronic
Traveled time (days)
Distance from original disposal location (km) – logscale

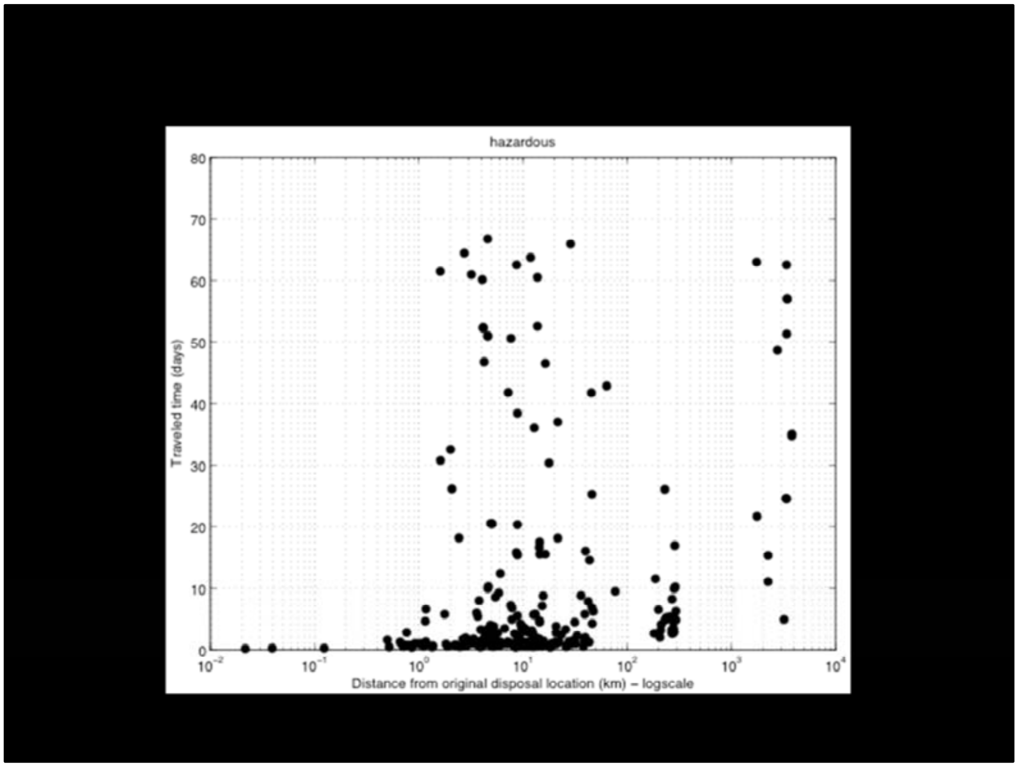
Glass



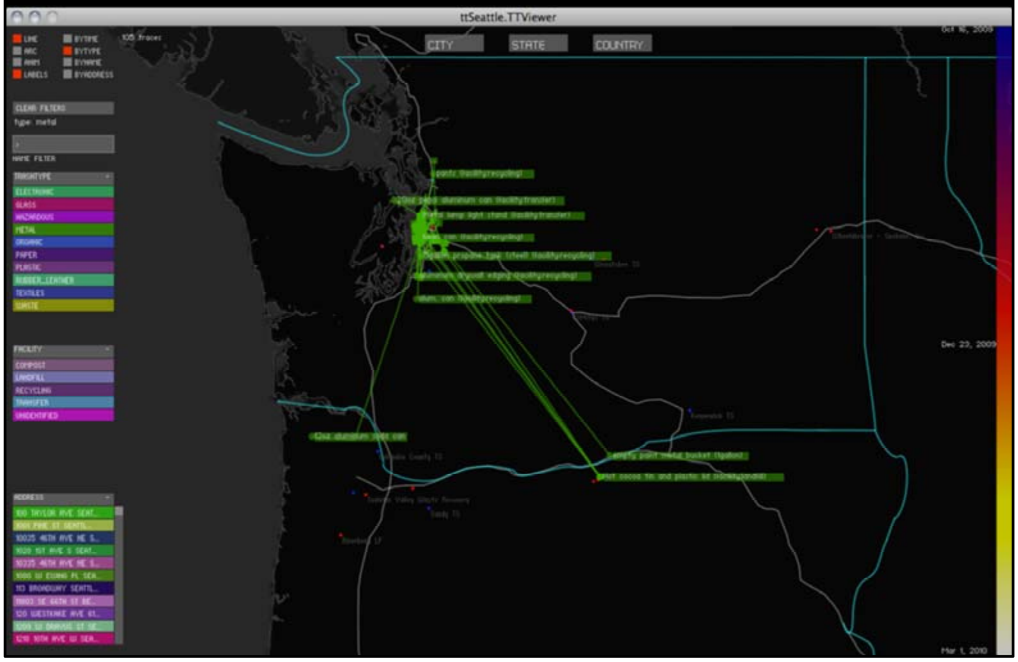

glass
Traveled time (days)
Distance from original disposal location (km) – logscale

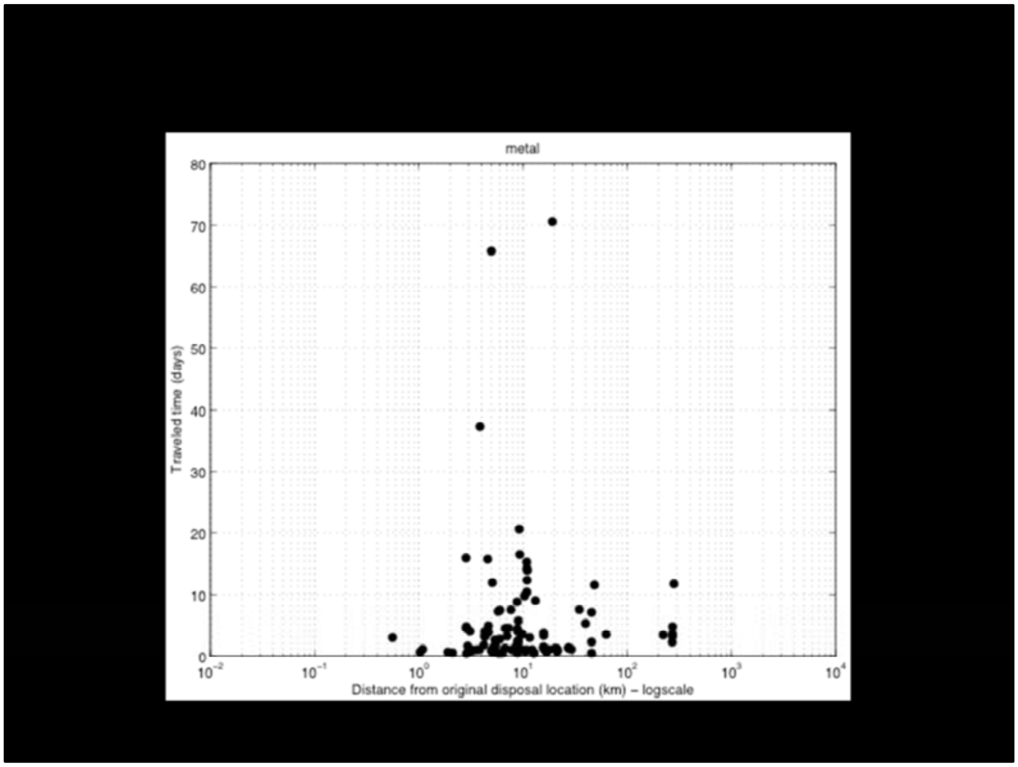
Hazardous



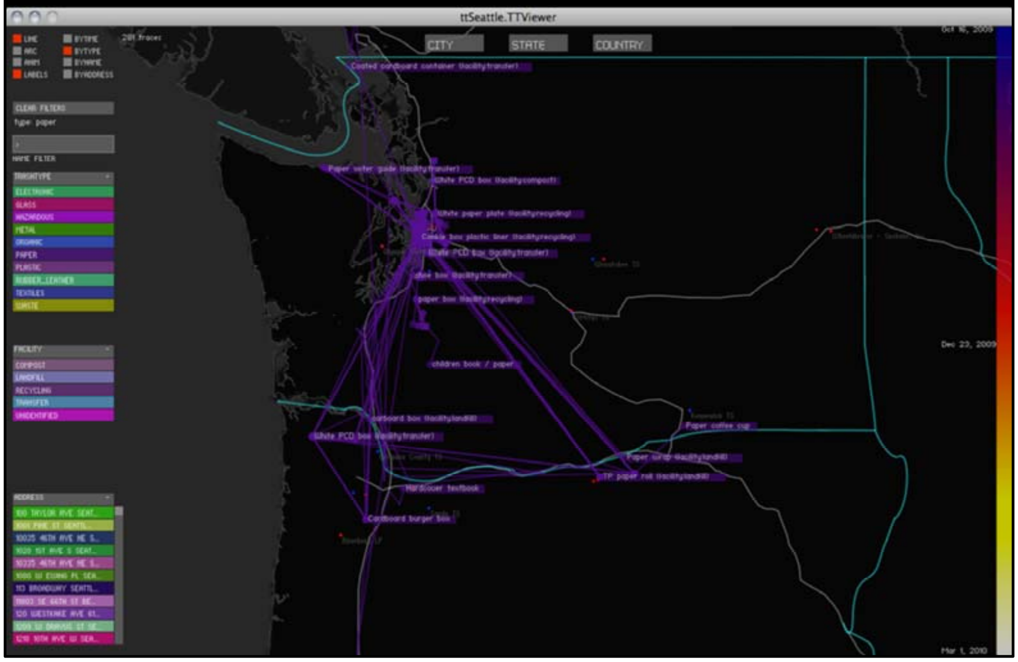

hazardous
Traveled time (days)
Distance from original disposal location (km) – logscale

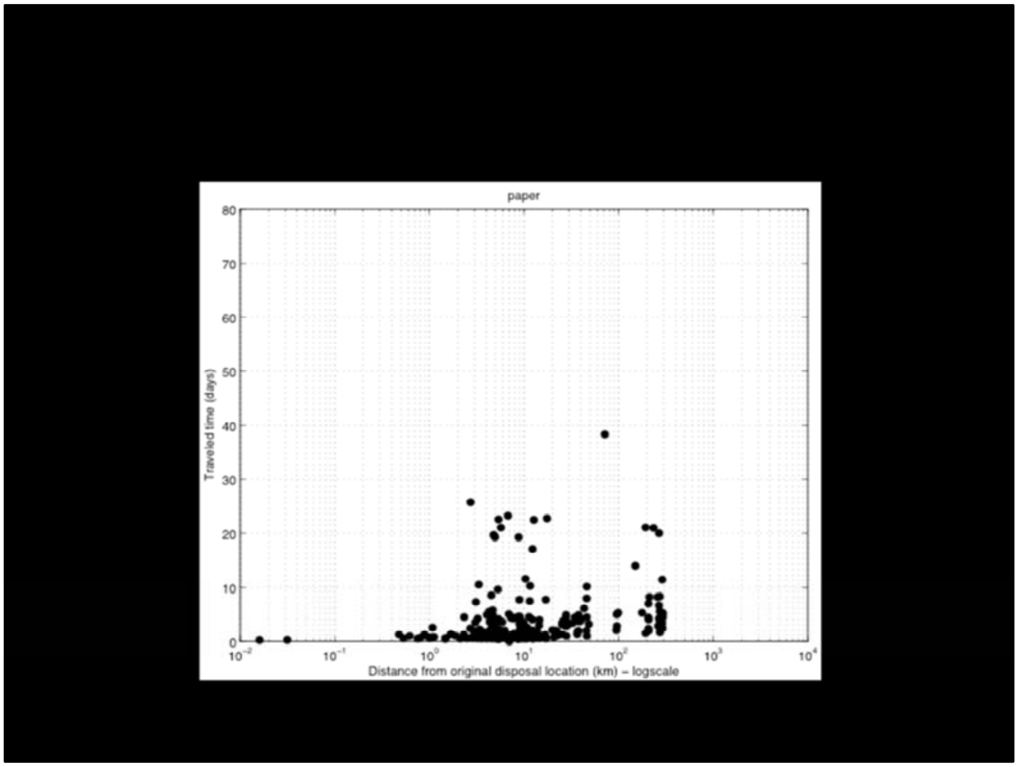
Metal



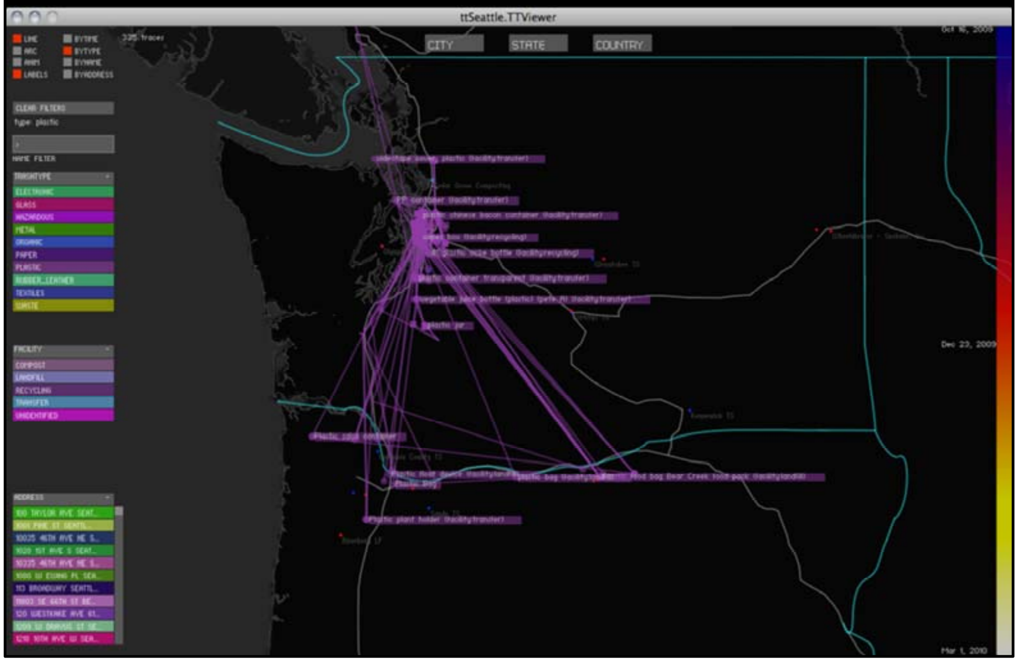

metal
Traveled time (days)
Distance from original disposal location (km) – logscale
0
10
20
30
40
50
60
70
80
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}

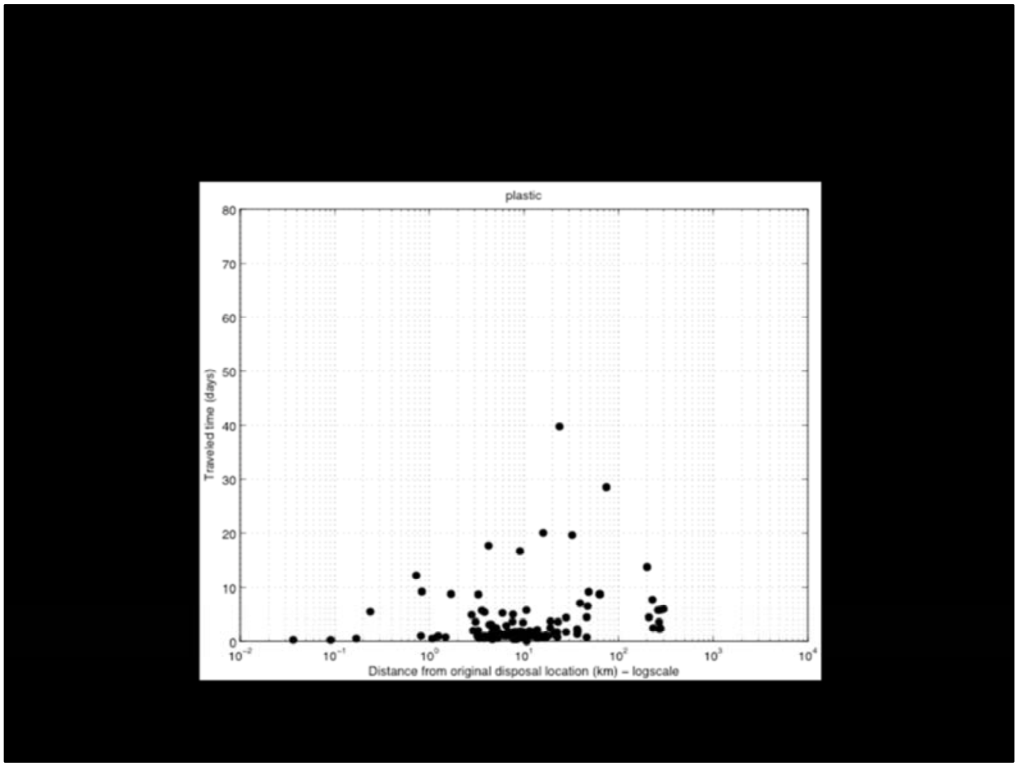
Paper




paper
Traveled time (days)
Distance from original disposal location (km) – logscale

Plastic


ttSeattle.TTViewer
CITY
STATE
COUNTRY
Dec 23, 2009
Mar 1, 2010


plastic
Traveled time (days)
0
10
20
30
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70
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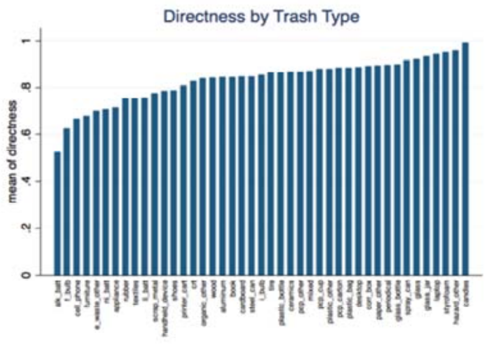
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
Distance from original disposal location (km) – logscale

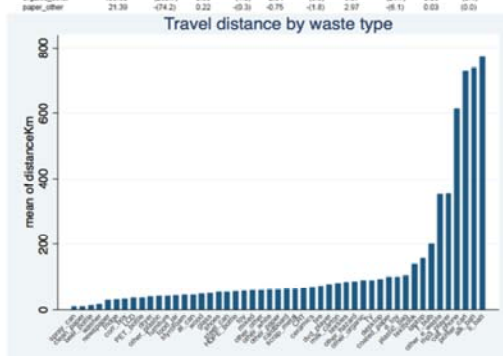
[redacted]

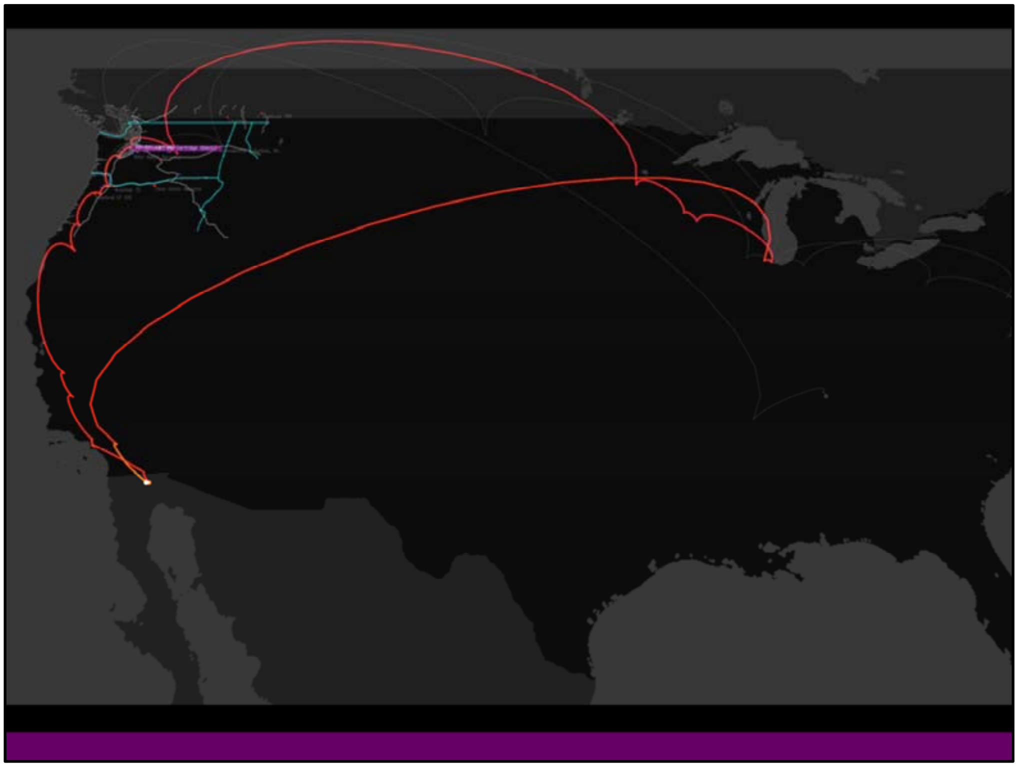
Linear Regression Models

based on Trash Types and Disposal Places

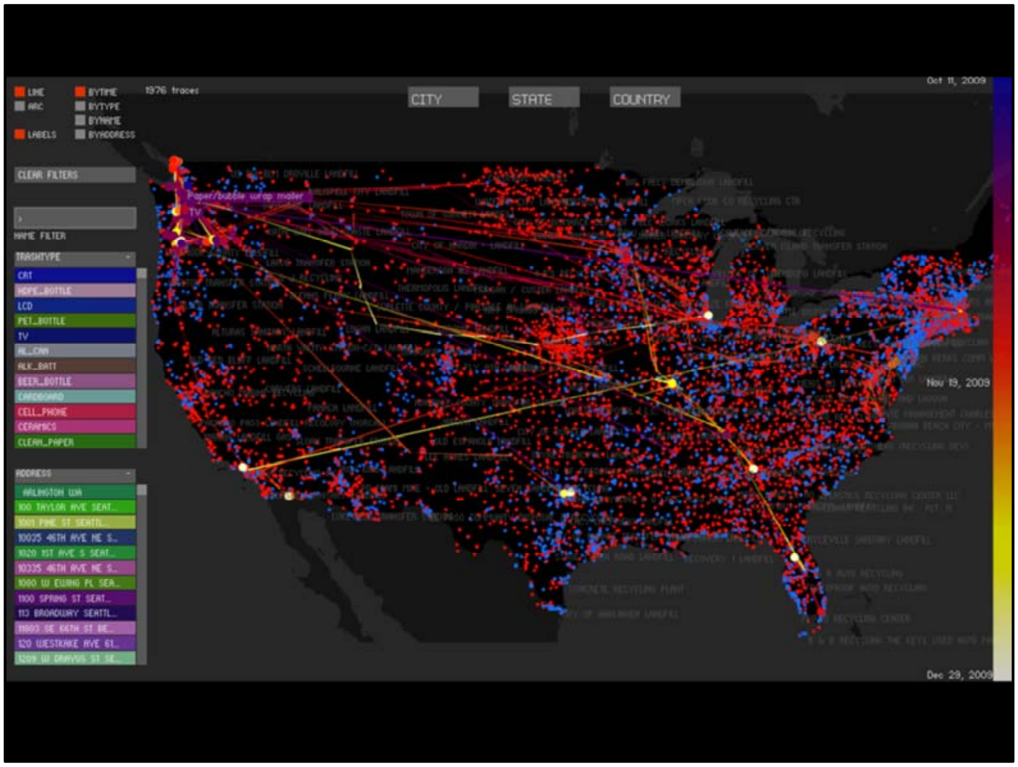
	Distance Model distance (km)		ln Dist. Model ln distance		Duration Model duration (days)		Speed Model km per day		Directness Model euclid dist. / total dist
Trash Type (Reference plastic_other)										
alk_batt	783.50 ***	-(107.8)	1.46 ***	-(0.4)	35.37 ***	-(2.7)	12.58	-(8.9)	-0.12 *	-(0.1)
aluminum	-22.78	-(87.2)	0.00	-(0.3)	1.95	-(2.1)	-1.00	-(7.2)	-0.02	(0.0)
appliance	-10.93	-(113.9)	0.04	-(0.4)	3.35	-(2.8)	4.75	-(9.4)	-0.15 **	-(0.1)
book	-6.10	-(128.9)	0.17	-(0.5)	2.40	-(3.2)	-3.16	-(10.6)	-0.02	-(0.1)
candles	19.97	-(450.0)	-1.08	-(1.6)	-3.77	-(11.1)	-10.63	-(37.1)	0.11	-(0.2)
cardboard	-3.66	-(56.9)	0.07	-(0.2)	-2.11	-(1.4)	6.78	-(4.7)	-0.04	(0.0)
cell_phone	869.90 ***	-(97.2)	2.56 ***	-(0.4)	38.65 ***	-(2.4)	12.15	-(8.0)	0.05	-(0.1)
ceramics	25.57	-(120.4)	-0.14	-(0.4)	-0.68	-(3.0)	0.52	-(9.9)	-0.02	-(0.1)
corr_box	-29.05	-(81.2)	-0.12	-(0.3)	-0.56	-(2.0)	-1.29	-(6.7)	0.02	(0.0)
crt	-27.48	-(130.6)	0.74	-(0.5)	26.35 ***	-(3.2)	-8.94	-(10.8)	0.09	-(0.1)
desktop	7.94	-(260.8)	0.64	-(0.9)	12.46	-(6.4)	-8.64	-(21.5)	0.05	-(0.1)
e_waste_other	72.36	-(75.4)	1.08 ***	-(0.3)	16.08 ***	-(1.9)	-4.71	-(6.2)	-0.07	(0.0)
f_bulb	288.10 *	-(127.9)	1.06 *	-(0.5)	30.13 ***	-(3.2)	-4.09	-(10.5)	-0.08	-(0.1)
furniture	48.74	-(206.4)	1.26	-(0.7)	3.47	-(5.1)	24.24	-(17.0)	-0.21 *	-(0.1)
glass	87.51	-(186.1)	1.49 *	-(0.7)	-2.70	-(4.6)	37.51 *	-(15.3)	0.04	-(0.1)
glass_bottle	41.28	-(121.1)	-0.10	-(0.4)	-0.97	-(3.0)	-3.39	-(10.0)	0.02	-(0.1)
glass_jar	-14.98	-(77.6)	-0.18	-(0.3)	-1.55	-(1.9)	1.83	-(6.4)	0.04	(0.0)
handheld_device	66.69	-(163.4)	0.51	-(0.6)	20.91 ***	-(4.0)	-3.66	-(13.5)	0.01	-(0.1)
hazard_other	69.55	-(147.0)	1.01	-(0.5)	0.57	-(3.6)	13.42	-(12.1)	0.07	-(0.1)
i_bulb	50.69	-(324.6)	0.11	-(1.2)	32.63 ***	-(8.0)	-8.29	-(26.7)	0.10	-(0.2)
laptop	54.06	-(203.5)	0.59	-(0.7)	0.90	-(5.0)	7.80	-(16.8)	0.10	-(0.1)
li_batt	1174.70 ***	-(131.1)	2.21 ***	-(0.5)	21.90 ***	-(3.2)	37.43 ***	-(10.8)	0.03	-(0.1)
mixed	43.83	-(98.6)	0.41	-(0.4)	1.31	-(2.4)	8.09	-(8.1)	-0.02	(0.0)
ni_batt	116.20	-(320.8)	1.64	-(1.2)	14.44	-(7.9)	0.32	-(26.4)	-0.17	-(0.2)
organic_other	155.60	-(263.7)	0.65	-(1.0)	2.54	-(6.5)	6.37	-(21.7)	-0.06	-(0.1)
paper_other	21.39	-(74.2)	0.22	-(0.3)	-0.75	-(1.8)	2.97	-(6.1)	0.03	(0.0)

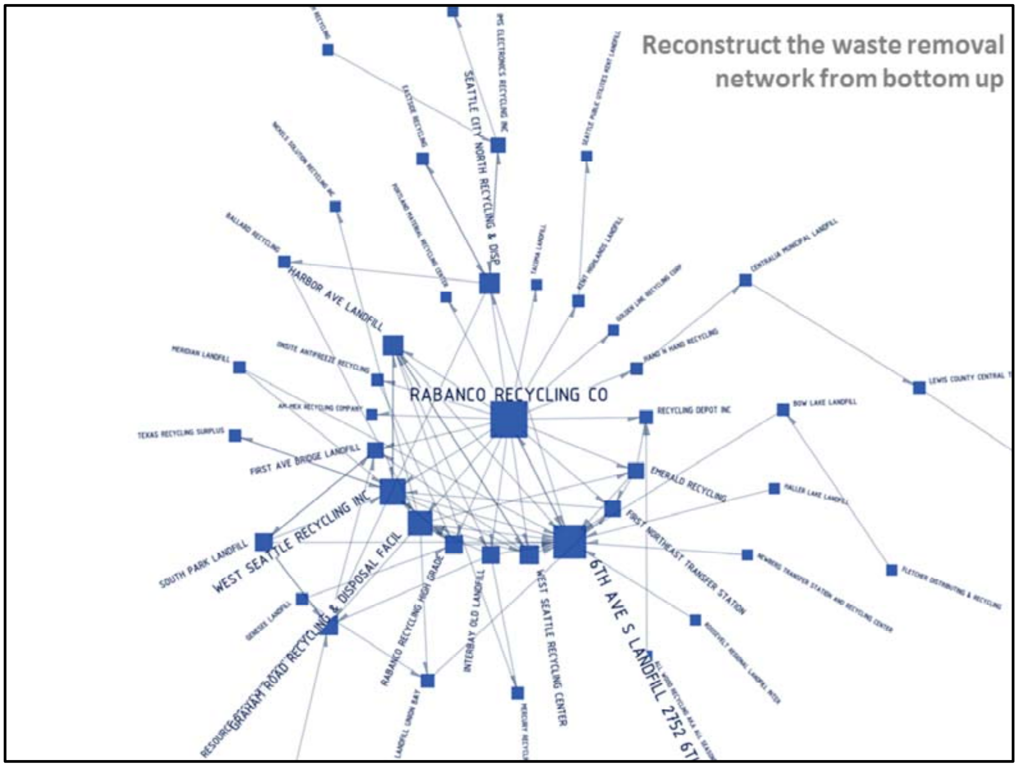






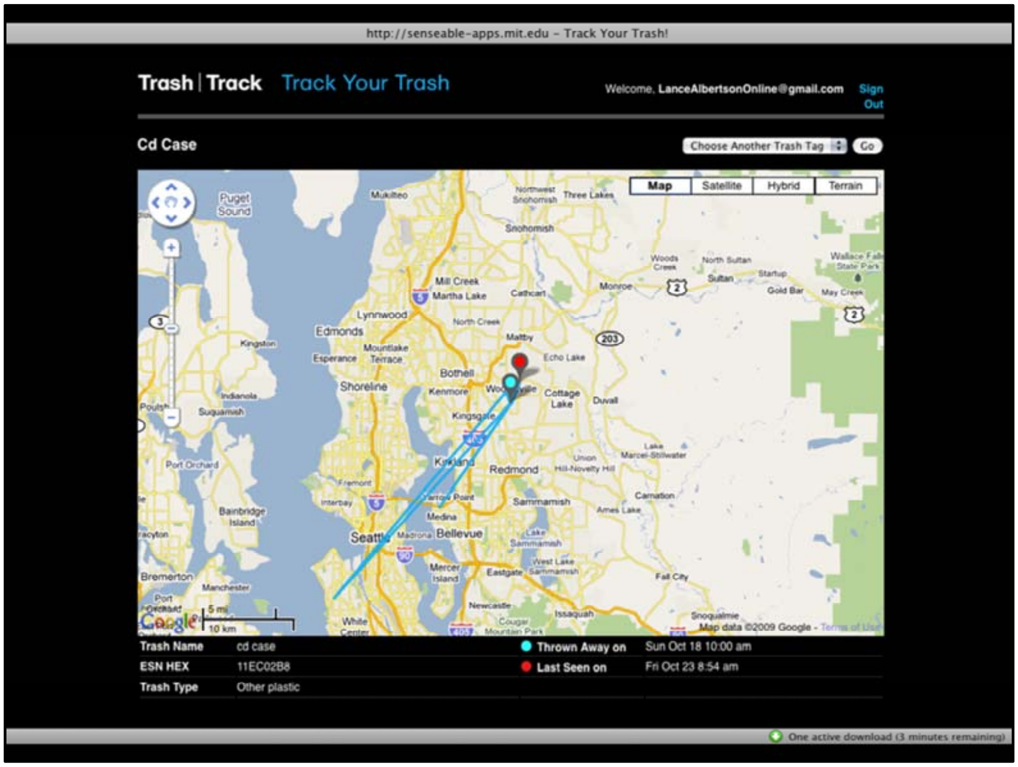
We see two printer cartridges taking two different routes to Baja California for disposal. The first flew to the Midwest, then by ground to Chicago then back to Cali. The other took a coastal route by ground… Clear implications on CO2 emissions, resource consumption. Amazing part is that it has promoted behavior change. We heard from one woman that her seeing her water bottle staying in Seattle until the end of time has changed her behavior to swear off bottles.


LINE
ARC
LABELS
BYTIME
BYTYPE
BYNAME
BYADDRESS
1976 traces
CITY
STATE
COUNTRY
Oct 11, 2009
CLEAR FILTERS
NAME FILTER
Paper/bubble wrap mailer
TV
TRASHTYPE
CRT
HDPE_BOTTLE
LCD
PET_BOTTLE
TV
AL_CAN
ALK_BATT
BEER_BOTTLE
CARDBOARD
CELL_PHONE
CERAMICS
CLEAN_PAPER
ADDRESS
ARLINGTON WA
Nov 19, 2009
Dec 29, 2009



Further research on which trash goes where, distances, types of plastic which was very tough to distinguish. Percentage of trash items going to landfills, recycling, waste-to-energy.

Public exhibitions



Measuring impact on sustainable behavior

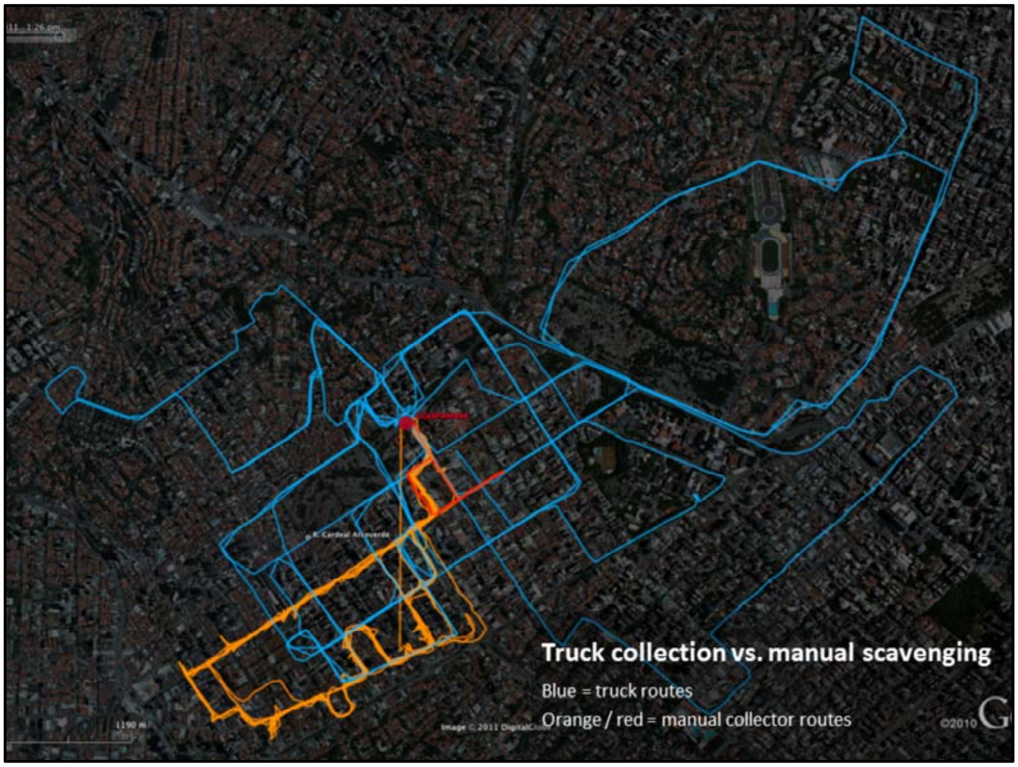
http://senseable.mit.edu/foragetracking

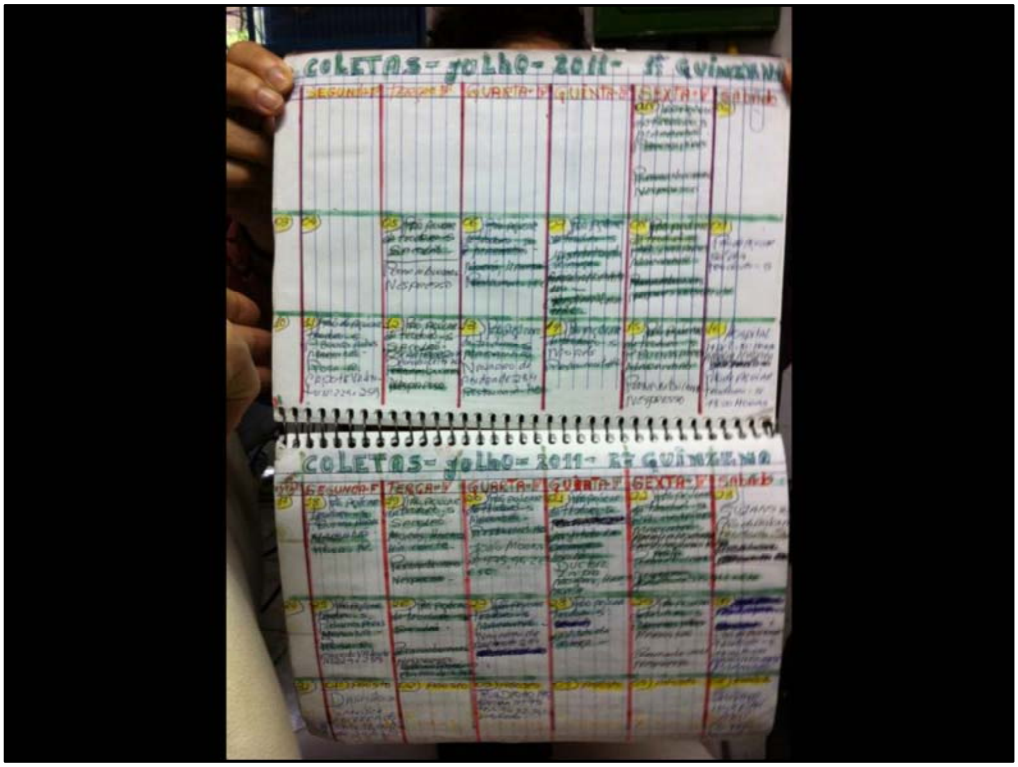
coomapamare is a former waste picker cooperative in the center of sao paulo, successful model, operation since 20 yrs. they reject assistance from the city

They combine methods: scheduled bulk pickups from many regular partners (businesses and residences)

And independent scavenging for high-value materials by hand-cart.

relationship between the individual pickers and the rest - pickers are very independent, do their own thing - no one knows what each other is doing – in our project they were sitting for the first time on a single table and discussing their organization


Truck collection vs. manual scavenging
Blue = truck routes
Orange / red = manual collector routes



The only document of the collection process – the calendar with the itineraries made by the driver - only the driver knows all the destinations - but its just a list and not even the president of the cooperative knows details

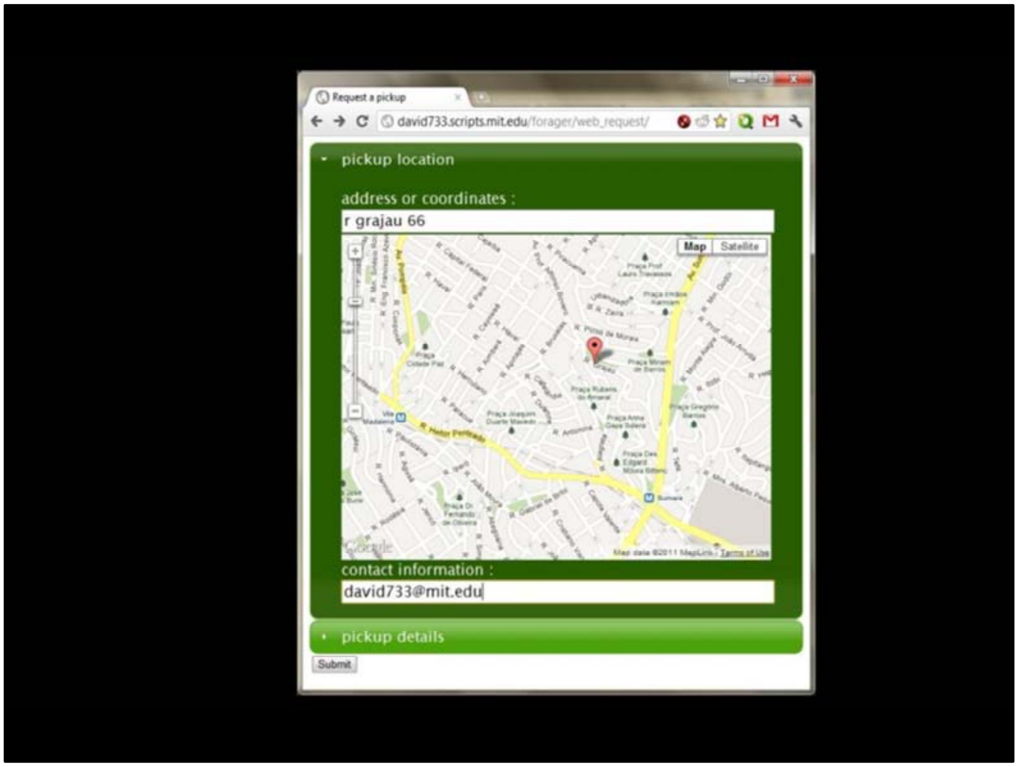
Mapping out, we found that these collection points are actually very sparsely distributed – with the main collection points very far from each other
Which is critical because of the driving restrictions in downtown sp, and the difficulty for the coop finding drivers

we did more than that - to really understand the collection, we joined for a day and worked as waste collectors

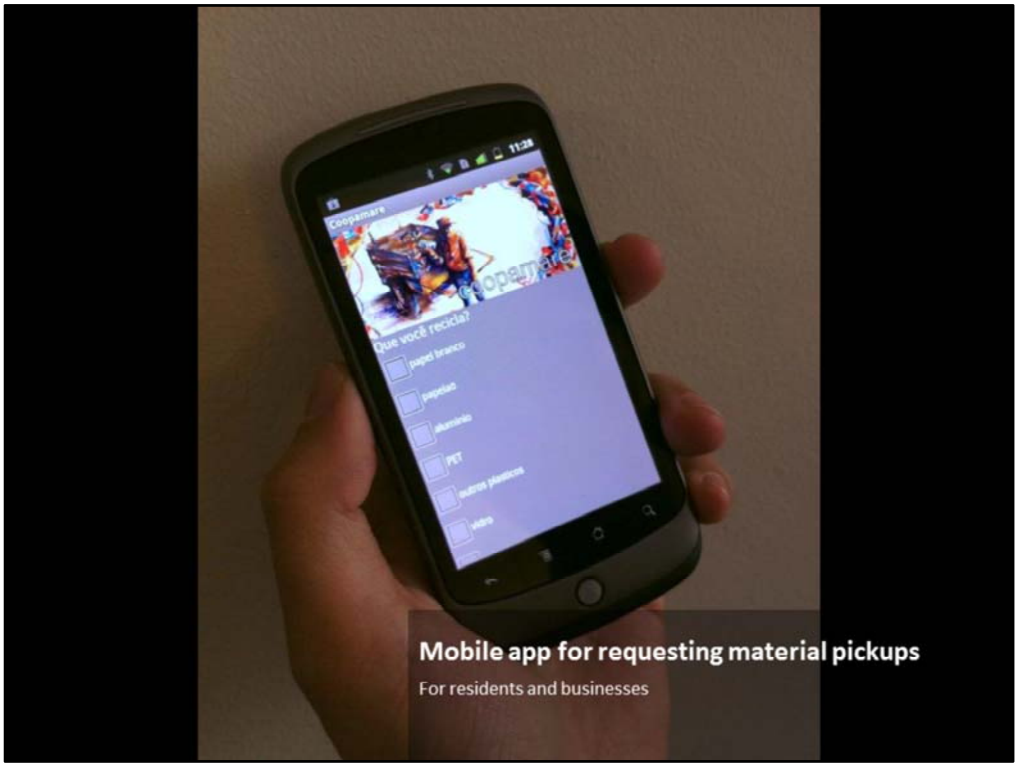
And held workshops collecting their tacit knowledge on physical and digital maps

Typical route of a hand-cart collector

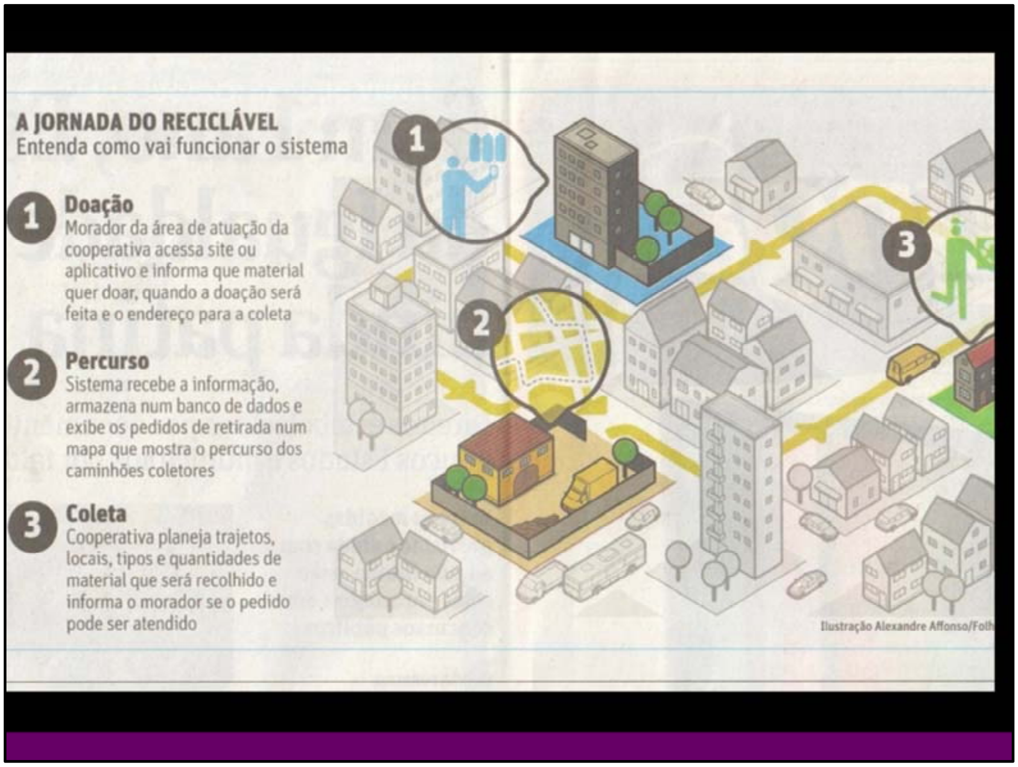
Other strategies - starting on the hill with an empty cart, working down along busy streets. Very efficient recyclable collection for one man, despite no motor vehicle.



Prototype web app for scheduling waste pickups with cooperatives



Prototype mobile app for scheduling waste pickups with cooperatives



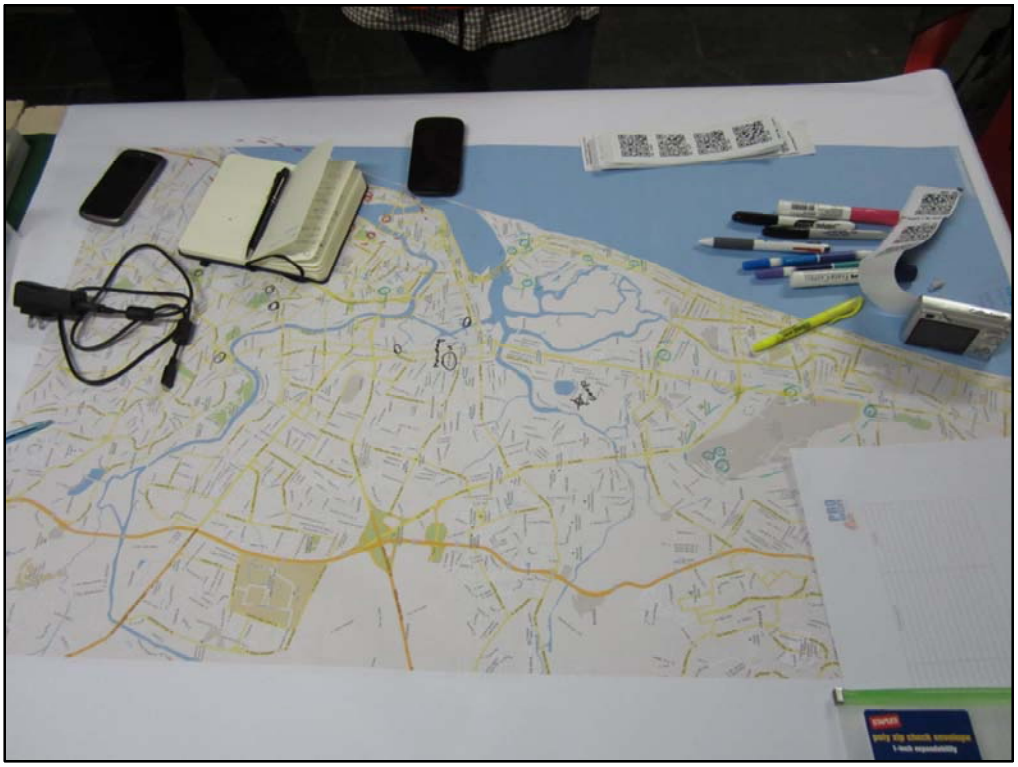
Work profiled at local, national, and international levels (Finalist for 2013 Katerva sustainability prize)

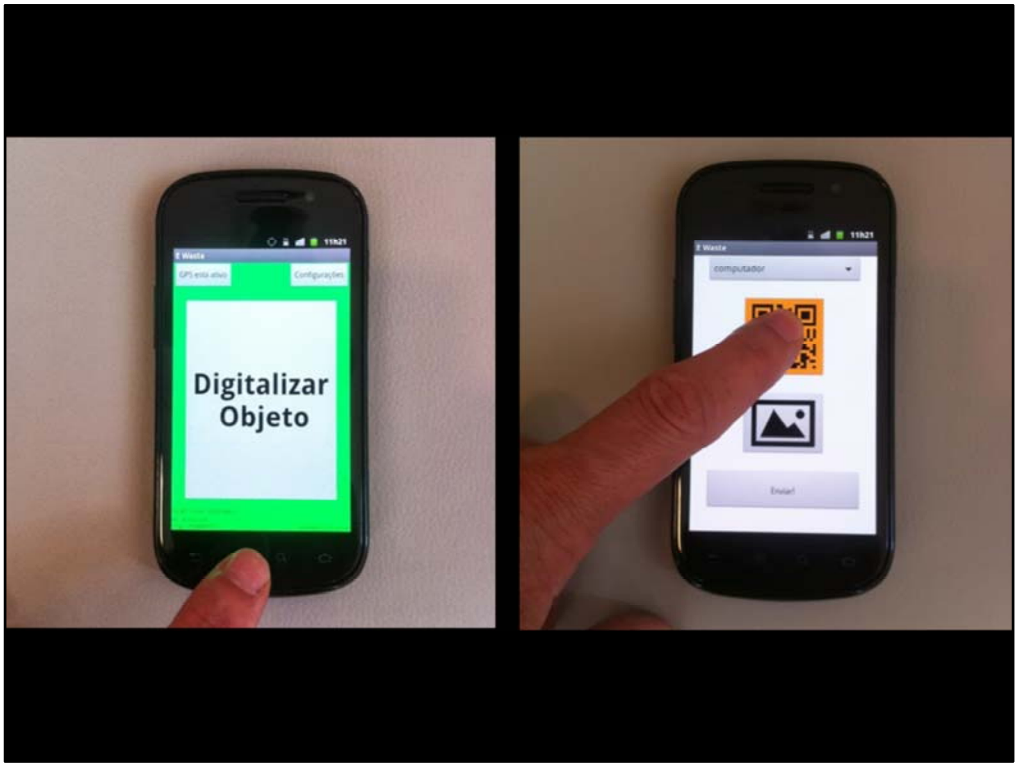
FORAGER

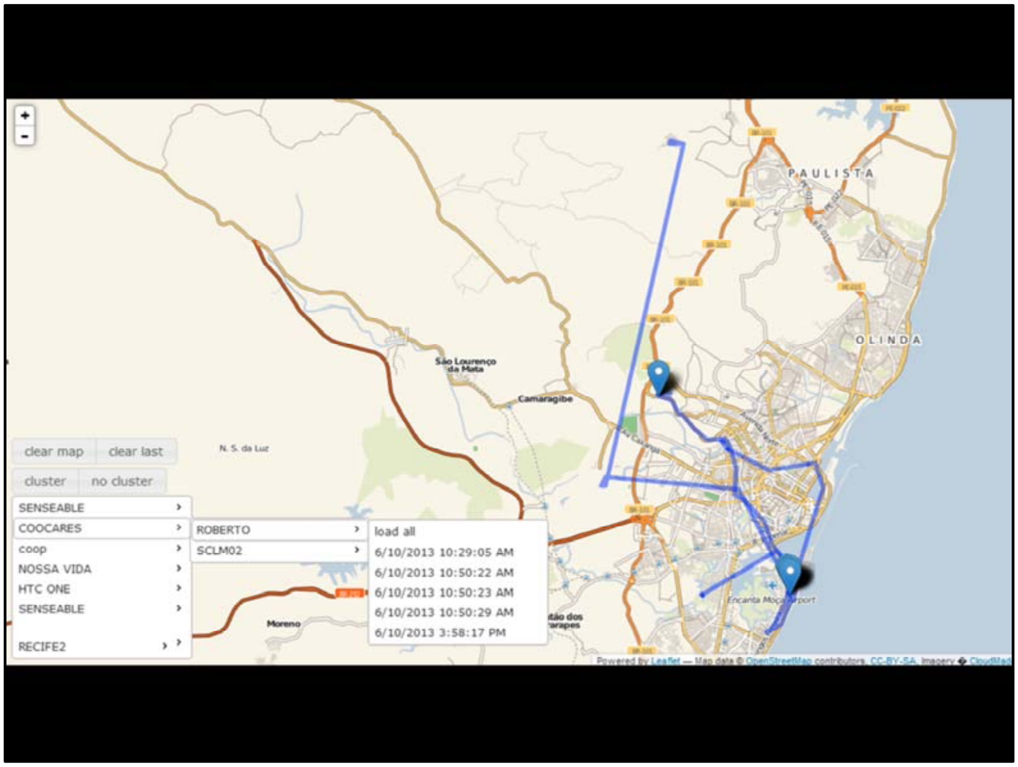
RECIFE, BRAZIL

http://senseable.mit.edu/foragetracking

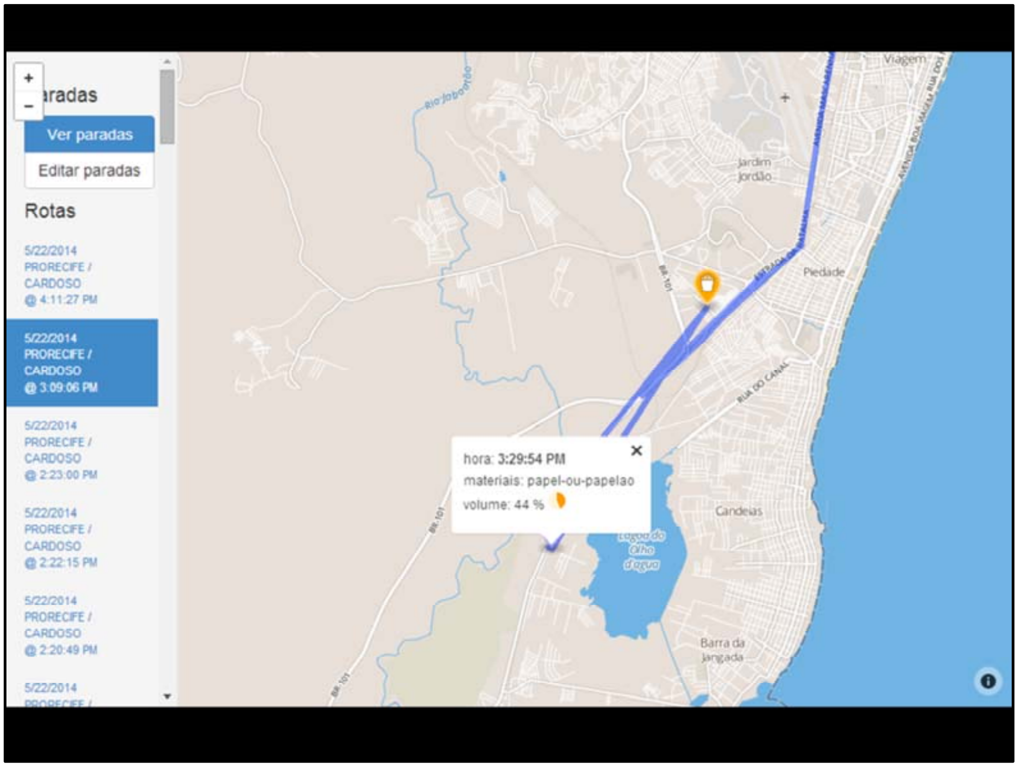

Forager v1 – QR tagging and tracking electronic waste




Digitalizar
Objeto


clear map
clear last
cluster
no cluster
SENSEABLE
COOCARES
coop
NOSSA VIDA
HTC ONE
SENSEABLE
RECIFE2
ROBERTO
SCLM02
load all
6/10/2013 10:29:05 AM
6/10/2013 10:50:22 AM
6/10/2013 10:50:23 AM
6/10/2013 10:50:29 AM
6/10/2013 3:58:17 PM
PAULISTA
OLINDA
São Lourenço da Mata
Camaragibe
N. S. da Luz
Moreno

Forager v2 – cheap, real-time waste collection tracking



aradas
Ver paradas
Editar paradas
Rotas
5/22/2014
PRORECIFE /
CARDOSO
@ 4:11:27 PM
5/22/2014
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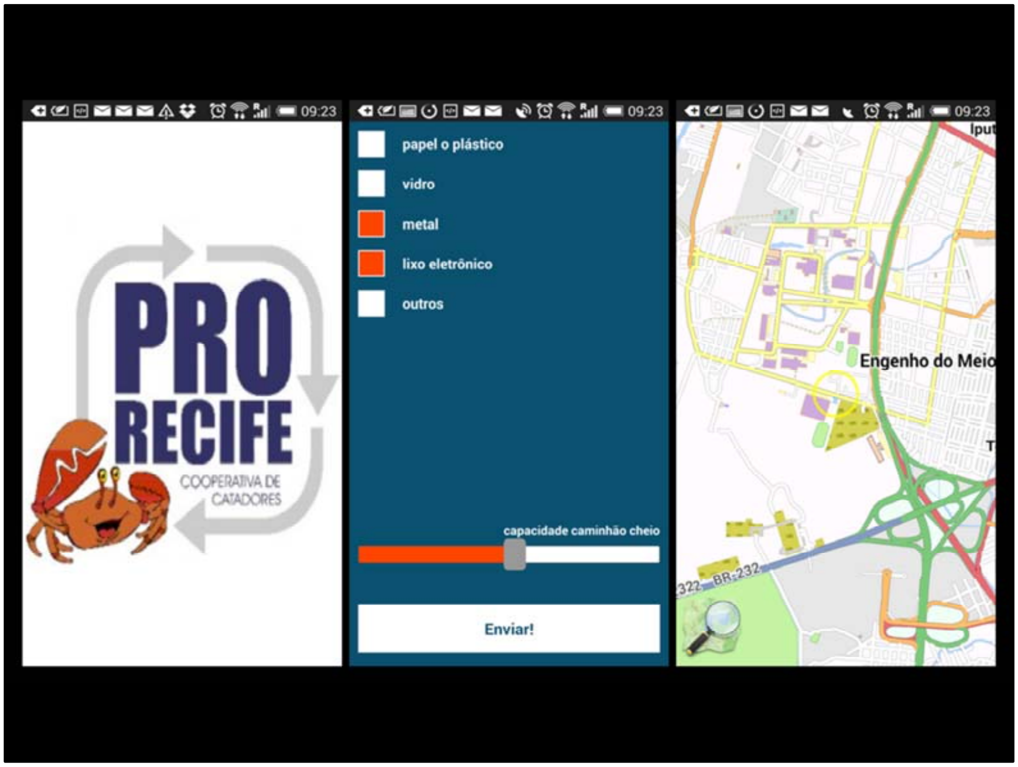
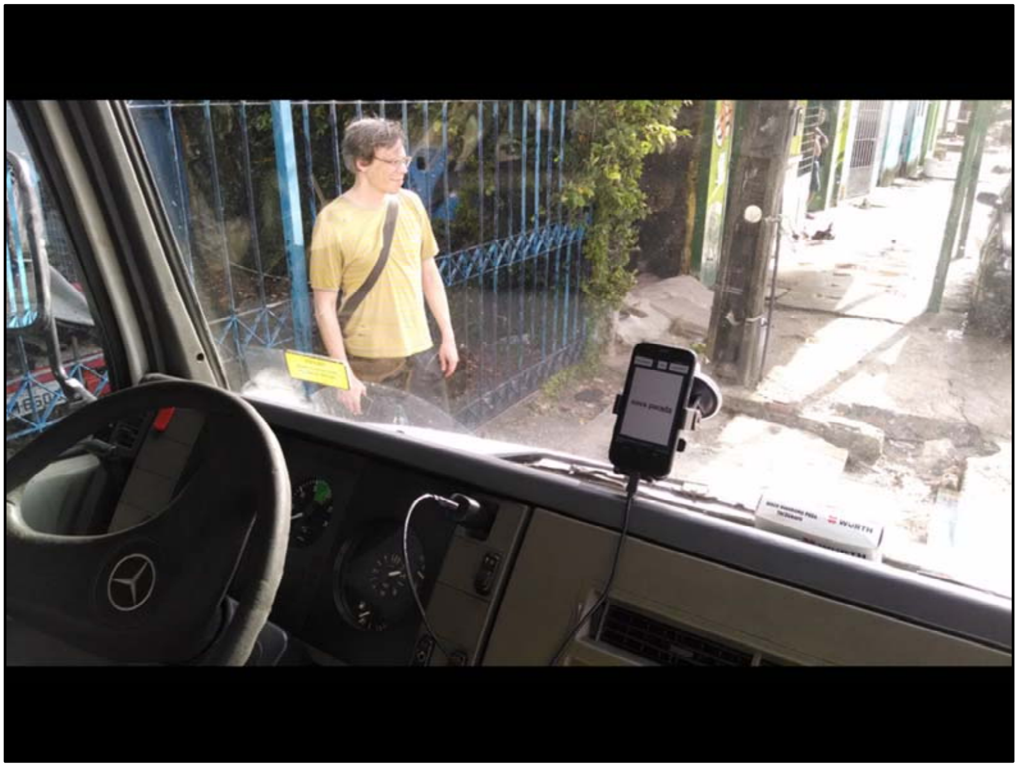
@ 3:09:06 PM
5/22/2014
PRORECIFE /
CARDOSO
@ 2:23:00 PM
5/22/2014
PRORECIFE /
CARDOSO
@ 2:22:15 PM
5/22/2014
PRORECIFE /
CARDOSO
@ 2:20:49 PM
5/22/2014
hora: 3:29:54 PM
materiais: papel-ou-papelao
volume: 44 %
Jardim
Jordão
Piedade
RUA DO CANAL
Candeias
Barra da
Jangada
Viagem
BR-101


09:23
PRO
RECIFE
COOPERATIVA DE
CATADORES
papel o plástico
vidro
metal
lixo eletrônico
outros
capacidade caminhão cheio
Enviar!
Engenho do Meio
BR-232


Toalha de Papel
Papel Higiênico
Café
60



Smartphone tracking is operational with Pro Recife cooperative truck

And management can follow truck progress in real-time from headquarters

P&G

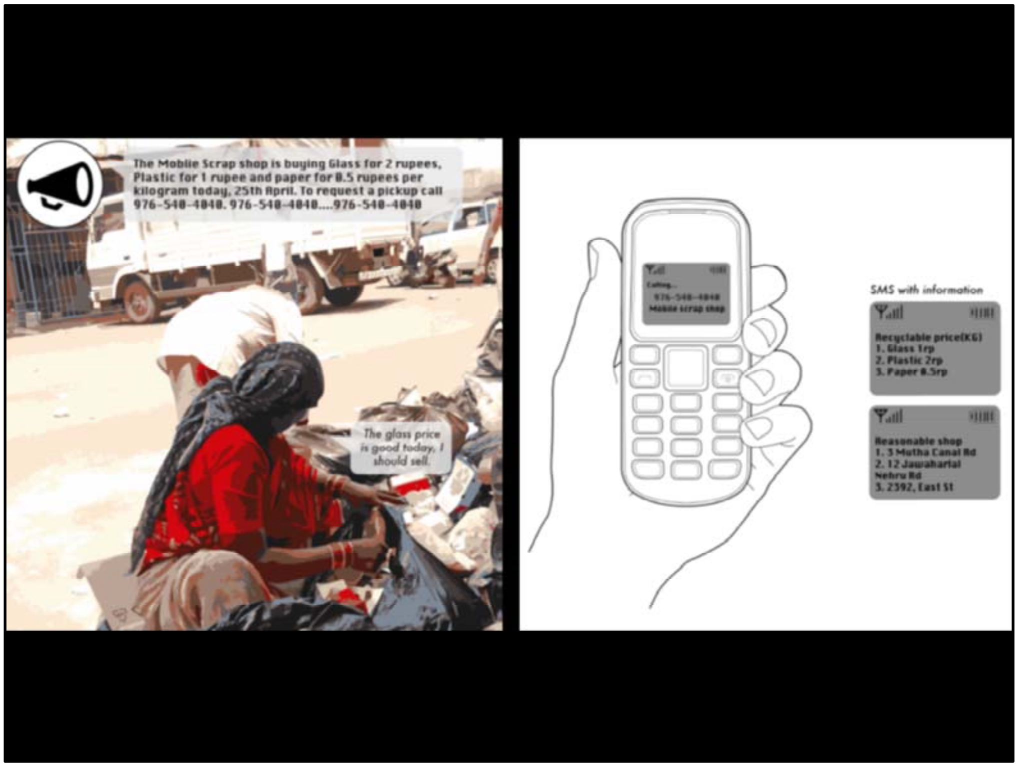
PUNE, INDIA

http://senseable.mit.edu/backtalk

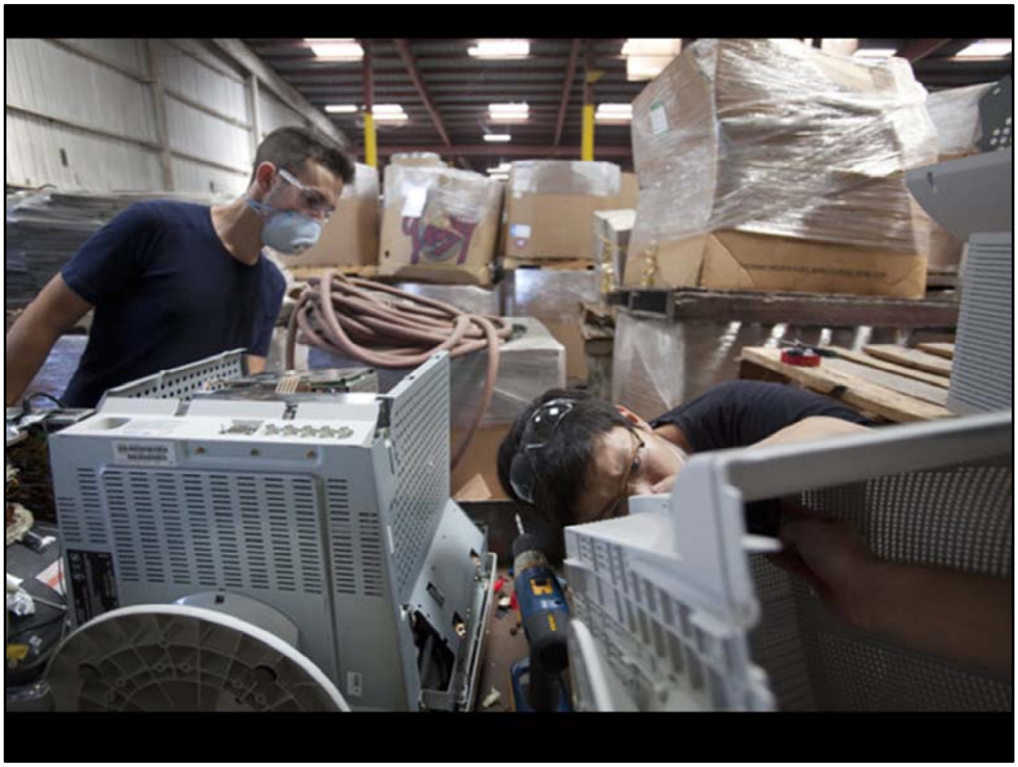

11.320 Digital City Design Workshop
Chaewon Ahn
TEMPO
SCRAP
SHOP

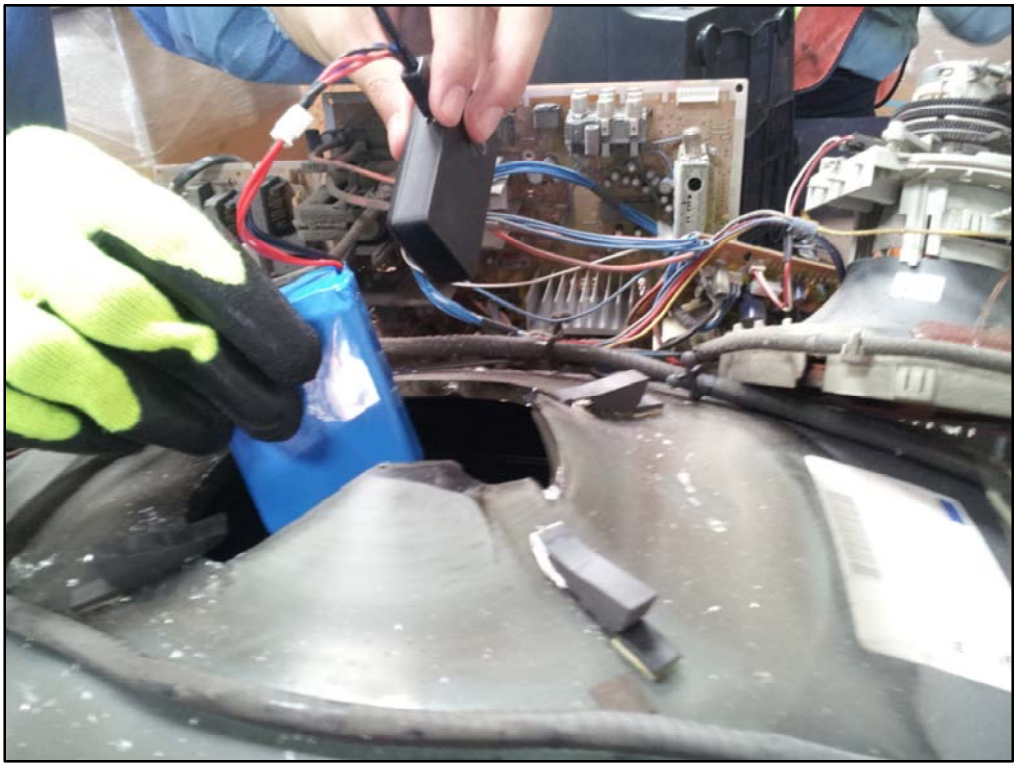

Waste picking
: 2-3 hours of waste collection
100-120 households
Daily pickup
Segregate waste - Call tempo
: 2-3 waste pickers get together
1 tempo accomodates the waste of 10 pickers
waste picking
segregation
selling to scrap shop

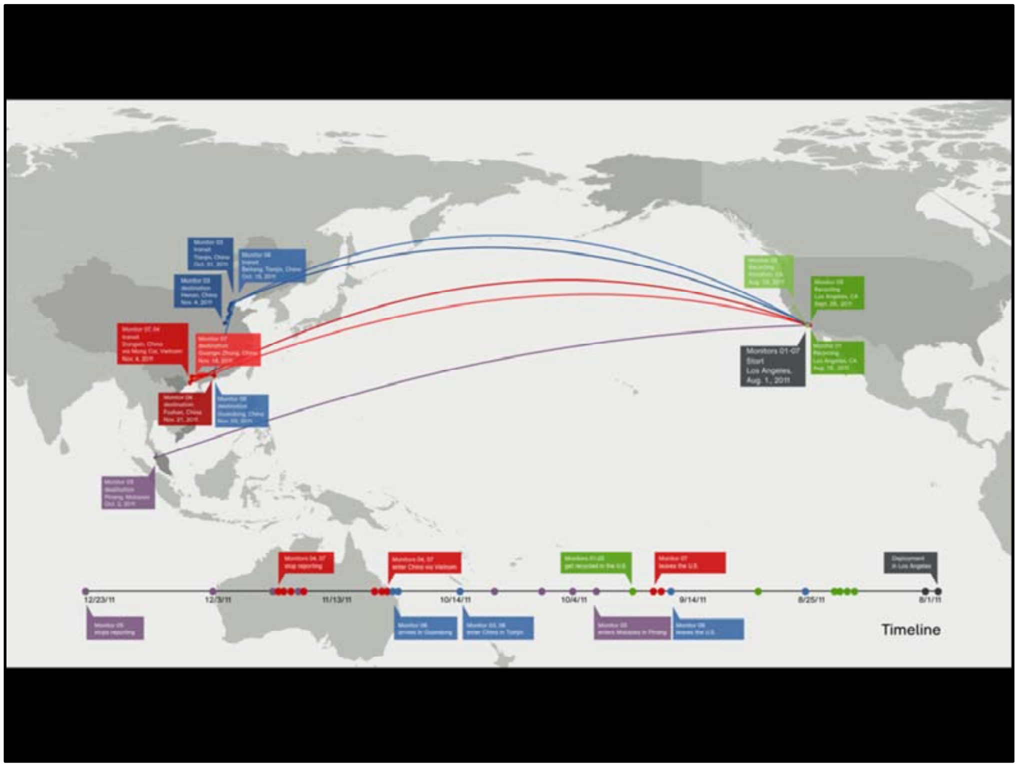

SYSTEM_ACTION
SMS
SMS
SMS
SMS
SMS
SMS
SMS
The Mobile Scrap shop is buying Glass for 2 rupees, Plastic for 1 rupee and paper for 8.5 rupees per kilogram today, 25th April. To request a pickup call 976-548-4848, 976-548-4848....976-548-4848
Announcement
Real time rout mapping
scaling & documentation
Next Destination: 3 Mutha Canal Rd
M.R.C.


The Moblie Scrap shop is buying Glass for 2 rupees, Plastic for 1 rupee and paper for 0.5 rupees per kilogram today, 25th April. To request a pickup call 976-540-4040. 976-540-4040....976-540-4040
The glass price is good today, I should sell.
Calling...
976-540-4040
Mobile scrap shop
SMS with information
Recyclable price(KG)
1. Glass 1rp
2. Plastic 2rp
3. Paper 0.5rp
Reasonable shop
1. 3 Mutha Canal Rd
2. 12 Jawaharlal Nehru Rd
3. 2392, East St

http://senseable.mit.edu/backtalk






Monitors 01-07
Start
Los Angeles,
Aug. 1, 2011
12/23/11
12/3/11
11/13/11
10/14/11
10/4/11
9/14/11
8/25/11
8/1/11
Timeline


CNN

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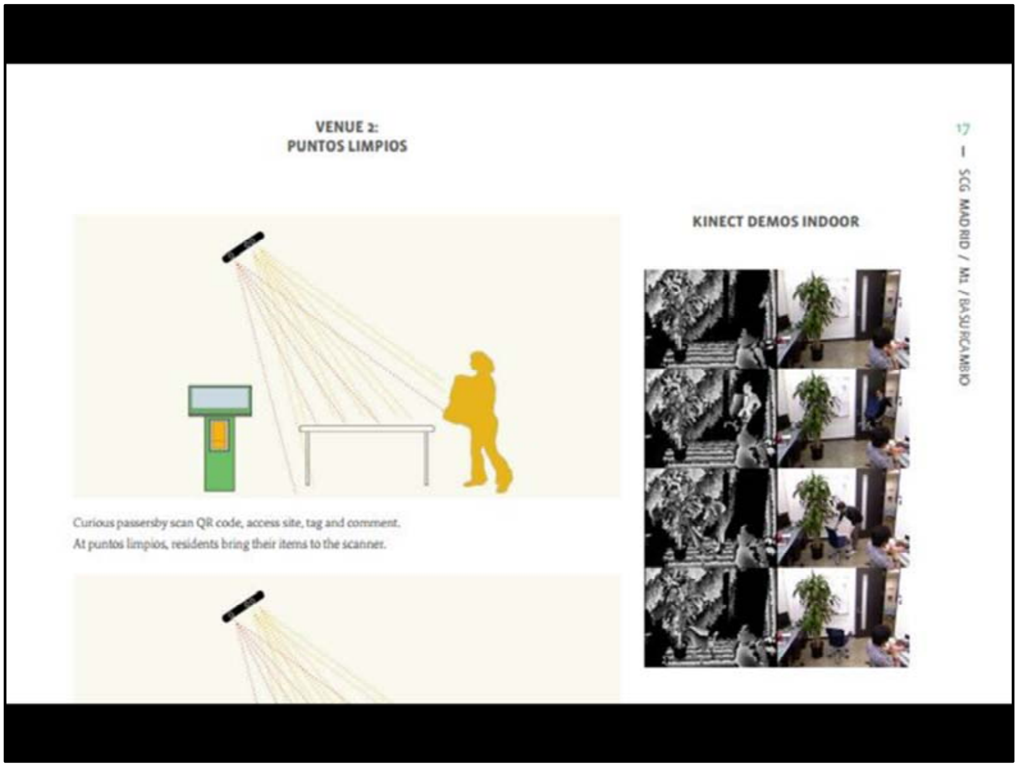
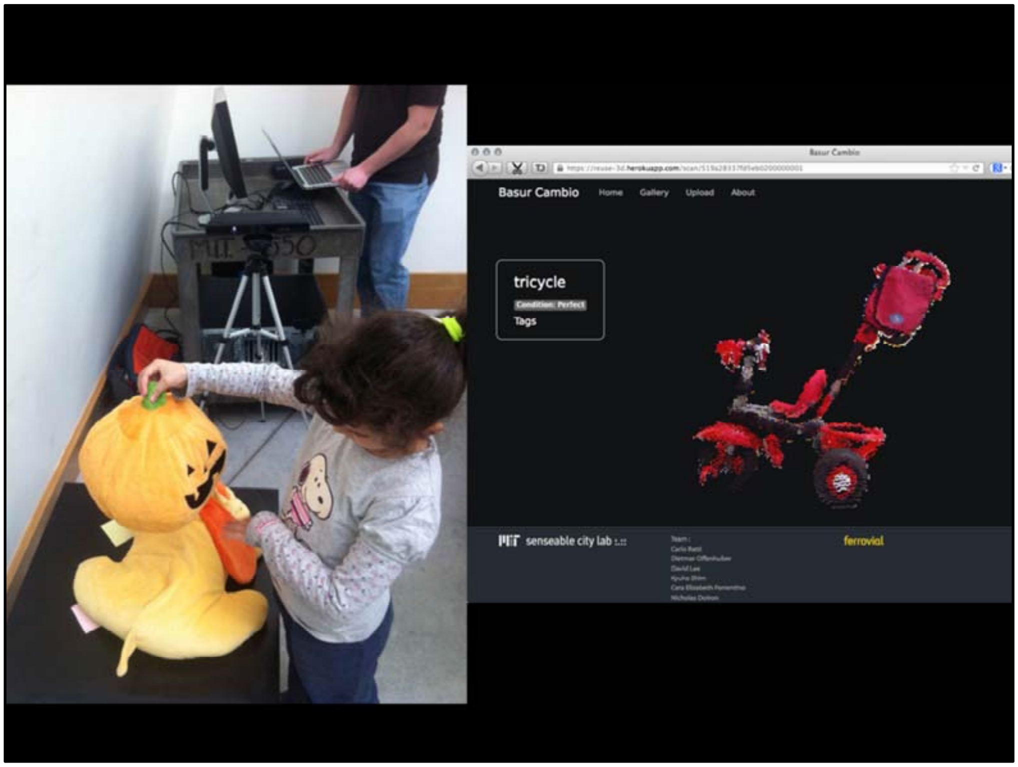

VENUE 2:
PUNTOS LIMPIOS
KINECT DEMOS INDOOR
Curious passersby scan QR code, access site, tag and comment.
At puntos limpios, residents bring their items to the scanner.
17
SCG MADRID / M1 / BASURCAMBIO


Basur Cambio
Home
Gallery
Upload
About
tricycle
Condition: Perfect
Tags
senseable city lab
ferrovial

So we’ve looked at city trash and emissions. Now lets switch gears a little and move into a different kind of waste: human waste.

Unlike the previous two projects, this one is still in an early stage.

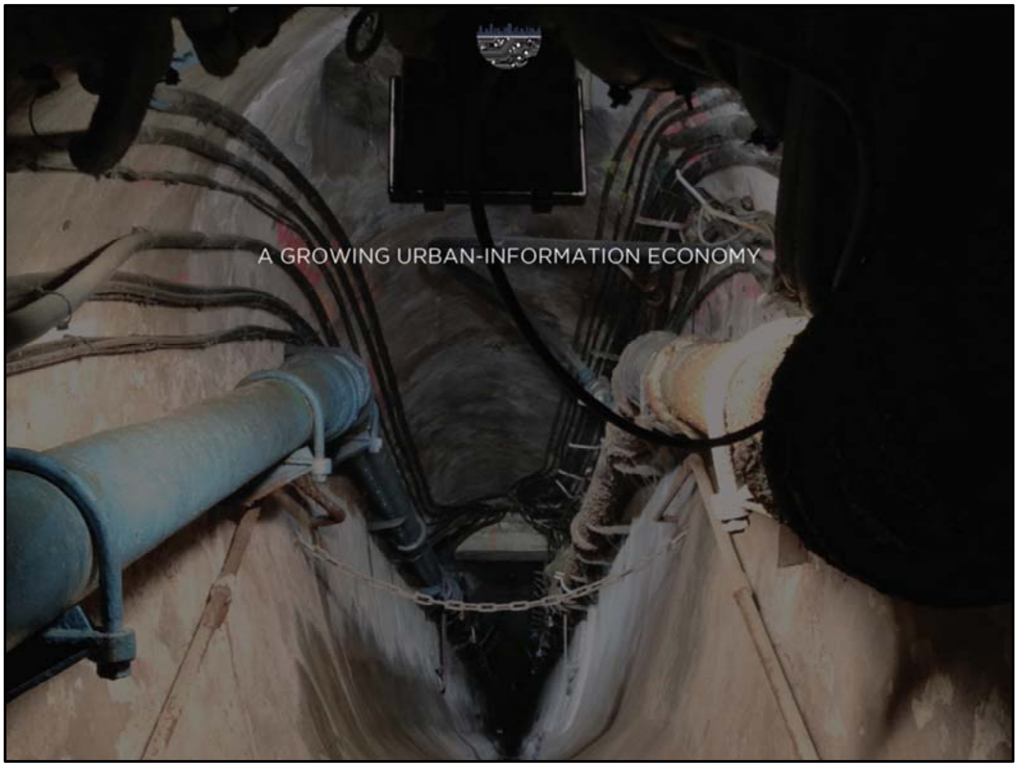
Underworlds is a smart sewage platform to mine human waste for biochemical data and the real-time monitoring of urban health patterns.

A cross-disciplinary endeavor involving labs in multiple departments at MIT, the main question that Underworlds aims to answer is “what is in our collective gut”.

A vast reservoir of information on human health and behaviour lives in our sewage, and this resource remains largely untapped.

Between 500-1000 species of bacteria live in the human gut, and we can tell a lot about a person by sampling their gut. Similarly, we can develop a human health census by sampling the “urban gut”, or a city’s sewage.

This type of sampling is traditionally only done at the Wastewater treatment plant for monitoring purposes. What is innovative about this project is that we are sampling throughout the sewage network to develop individual readings of particular neighbourhoods, as well as the aggregate readings of a city.



The combination of rapidly evolving technology and data analytics strategies provide us with an opportunity to monitor, in real-time, a population's biological signature.

We can begin to monitor how diseases and outbreaks move through cities and prepare for epidemics before they become that. There are also applications in security, health policy monitoring, and water management.

Working together with labs in Biological Engineering and Microbiology, we are designing untargeted assays to look for

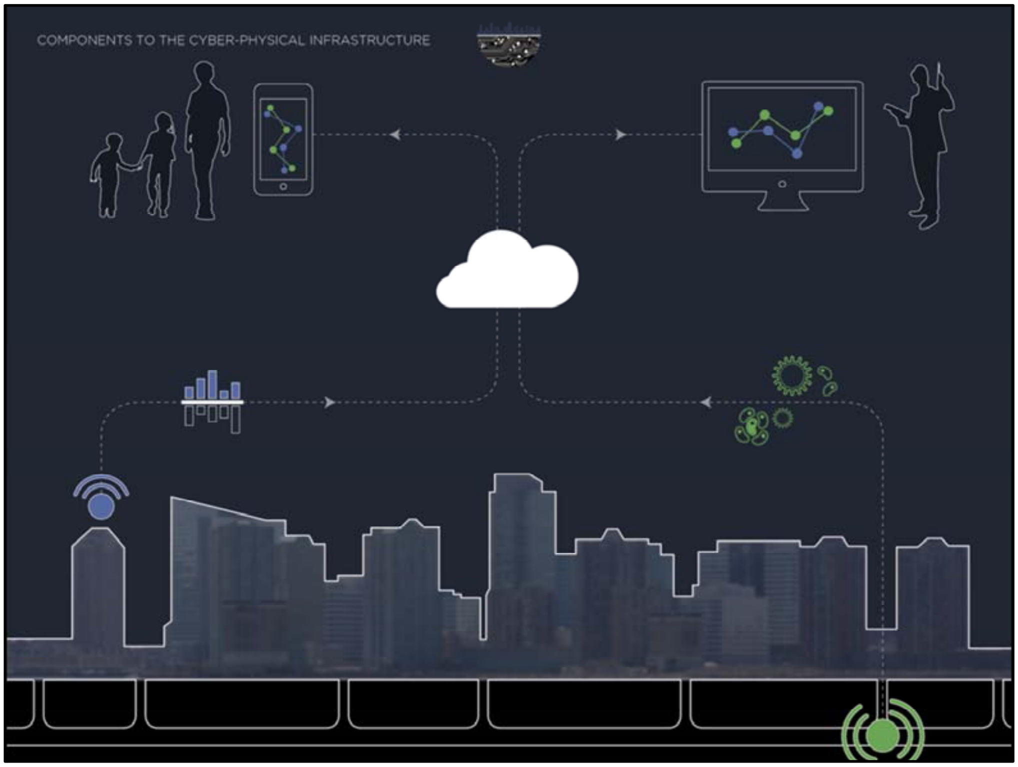
Viruses for the tracking of disease, things like influenza.

Currently disease monitoring is symptomatic, so hospitals report cases that have already gone through the incubation period. With this platform, we can identify the emergence of disease during the incubation period before people become infected so that hospitals can prepare.

We interested in bacteria

As well as Chemical Compounds to measure non-communicable diseases such as obesity and diabetes. We can also begin to measure the downstream effects of public health policy. For example, when former NY mayor Bloomberg attempted to ban soft drinks, would we have been able to measure, literally, the downstream effects of this ban?

We can also monitor the use of pharmaceutical drugs and illicit drugs. Do they correspond with particular demographics?



So the way that the project is structured is that we are developing a cyber-physical infrastructure consisting of the actual sampling device collecting information on viruses, bacteria, and chemicals that exist within the waste stream. This data is being paired with demographic data, such as age, socio-economic, to see if there are any patterns that could be useful.

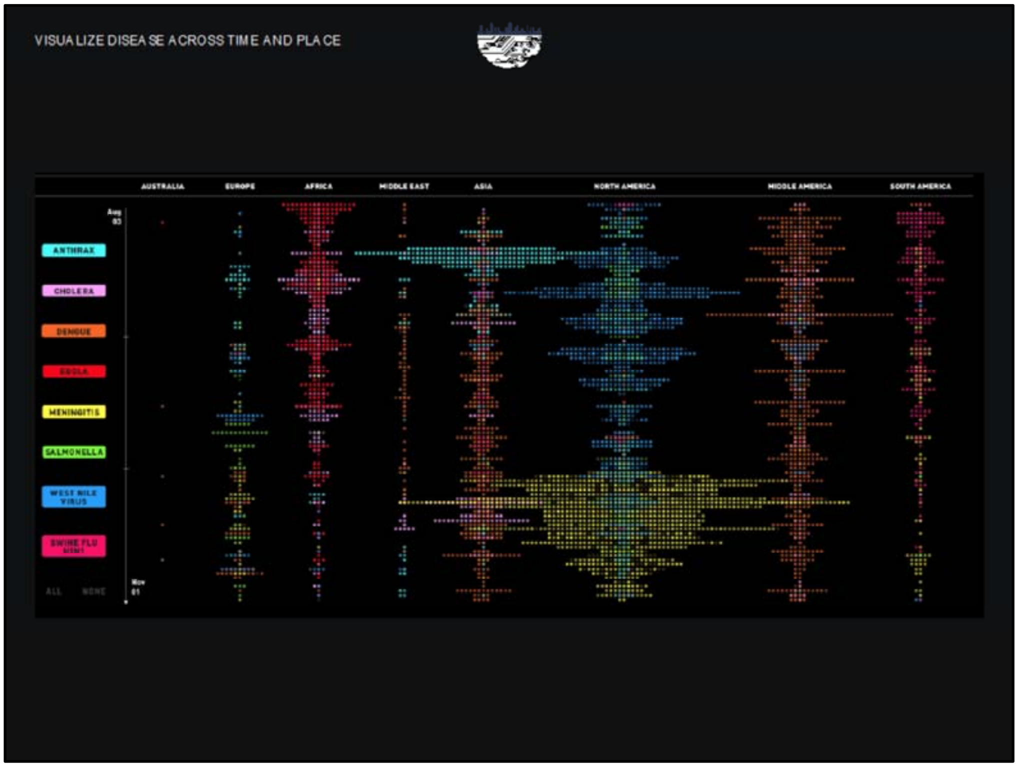
We are also building a frontend platform that will visualize and interpret the findings to inform public policy, health practitioners, designers, urban researchers, and citizens.

We are building this entire system here in Cambridge over the next year, using Cambridge as a test city. And then moving the system to Kuwait in the next couple years to be implemented at full-scale.

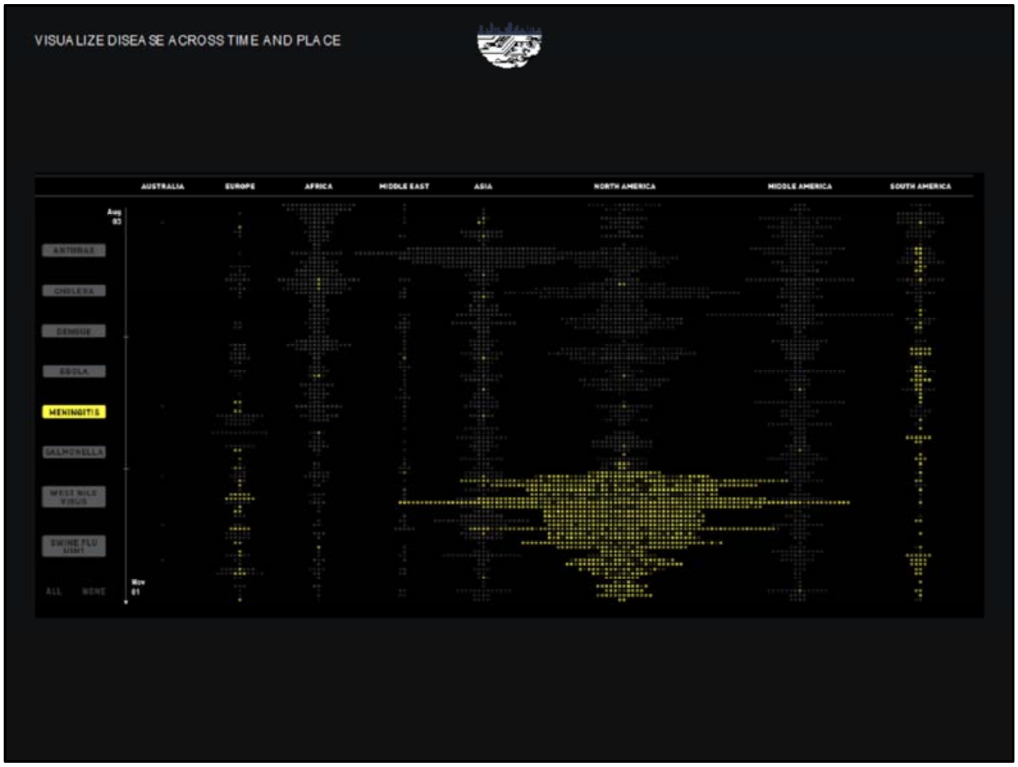
So to give you an idea about the experiments we are running in the coming months, here is a map of Cambridge.

We are sampling at 10 points throughout the sewage network, and each point has a distinct tributary area.

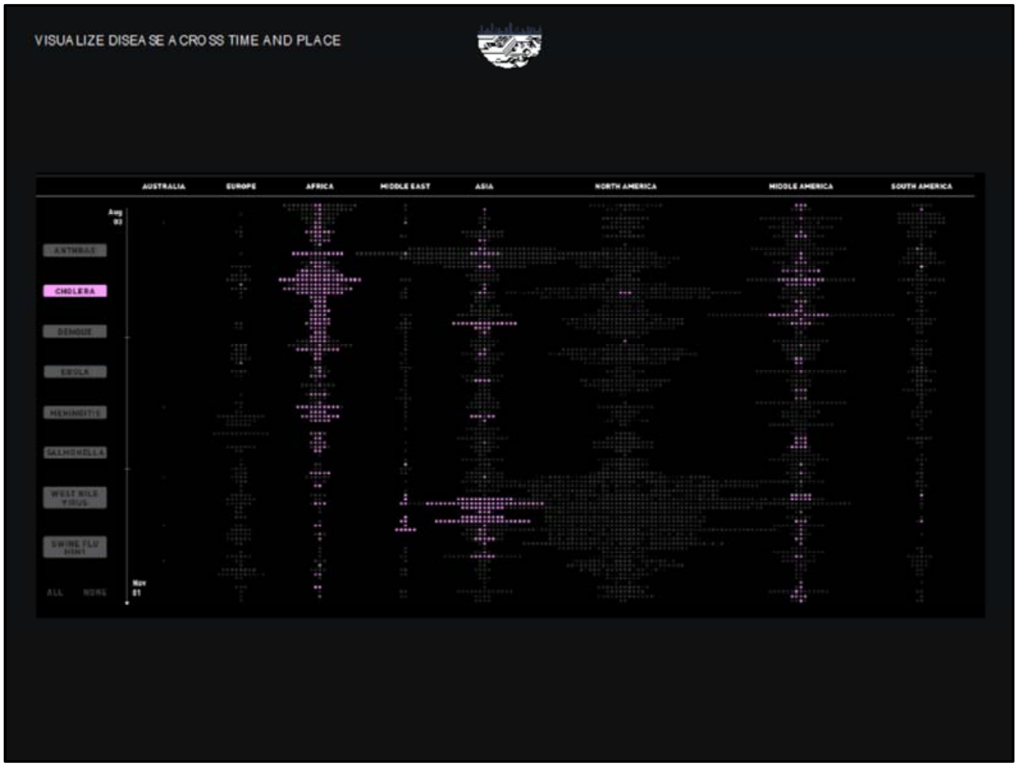
We are sampling 6 residential neighbourhoods of roughly the same population size so we can compare them, along with their demographics, to one another. Harvard and MIT, and the two biotech areas in the city.



The system offers the possibility to build rich databases that document, integrate, and analyze fluctuations in urban health parameters


VISUALIZE DISEASE ACROSS TIME AND PLACE
AUSTRALIA
EUROPE
AFRICA
MIDDLE EAST
ASIA
NORTH AMERICA
MIDDLE AMERICA
SOUTH AMERICA
CHOLERA
DENGUE
EBOLA
MENINGITIS
SALMONELLA
WEST NILE VIRUS
ALL
NONE

Over time…

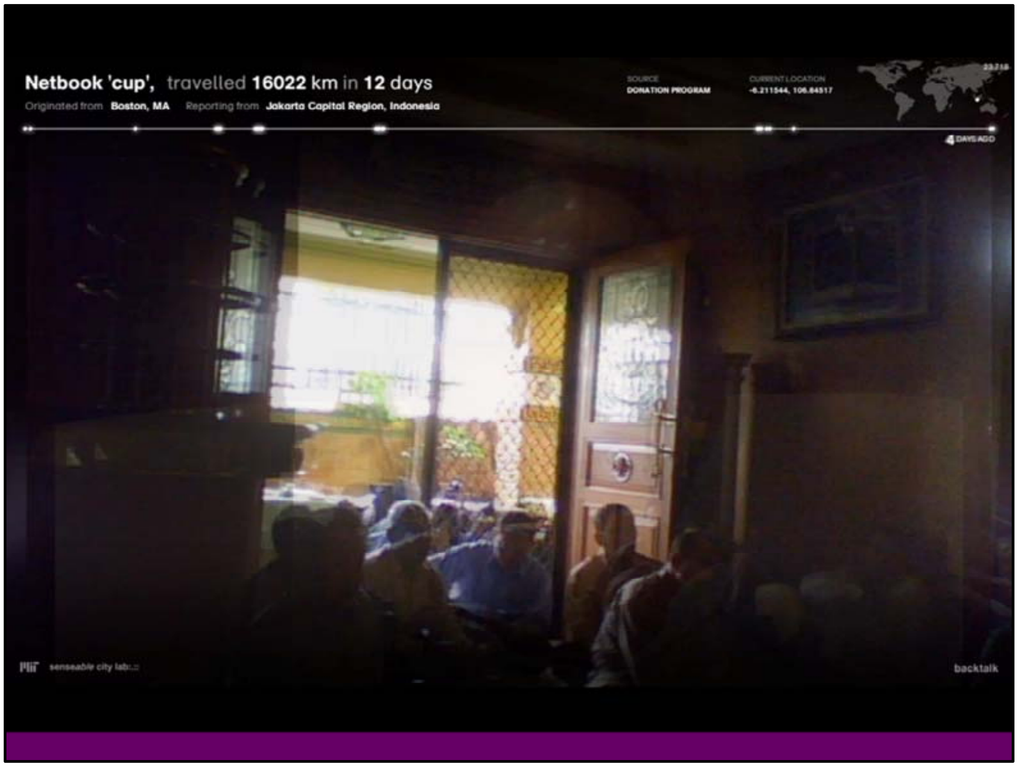


And over space.

http://senseable.mit.edu/backtalk

Chance to do a follow up for MOMA… What if all objects could talk back to you..

Talk to Me- what if objects could talk back to you.. We wanted to see where recycled electronics go, telling the human story. These computers were donated to groups around the world but for the duration of exhibit, they would take photos and report their locations.



Amazing perspecting, here into an islamic school in Jakarta.

Well, something else happened….


take out the trash
One year of Big Belly trash can alerts, with red bubbles signaling full cans and yellow as ~60% fill. The busiest cans tend to be near areas with many take-out restaurants, shown in the blue hexagons.
EAST CAMBRIDGE
BEACON HILL
YELLOW
RED
GREEN
LESS
MORE
12/04/2014

Researchers Carlo Ratti (Director), Assaf Biderman (Associate Director), Giovanni Alli, Eric Baczuk, Rex Britter, Andrea Corti, Jennifer Dunnam, Kael Greco, Kristian Kloeckl, David Lee, Claudio Martani, Nashid Nabian, Till Nagel, Otto Ng, Dietmar Offenhuber, Paolo Patelli, Prudence Robinson, Markus Schlapfer, Stefan Seer, Oliver Senn, Stephane Roche, Tony Vanky, Mark Yen

Past Researchers Clio Andris, German W Aparicio Jr., Burak Arikan, Dima Ayyash, Seckin Basturk, Luis Berríos-Negrón, Daniel Berry, Francesco Calabrese, Xiaoji Chen, Carnaven Chiu, Enrico Costanza, Dominik Dahlem, Alyx Daly, Lorenzo Davoli, Talia Dorsey, Sarah Dunbar, Luigi Farrauto, Chris Fematt, Filippo dal Fiore, Lucie Boyce Flather, Saba Ghole, Fabien Girardin, Daniel Gutierrez, Gabriel Grise, Cesar Harada, Guy Hoffman, Anyang Hou, Sonya Huang, Robert Johnson, E Roon Kang, Aaron Koblin, Jan Kokol, Gautier Krings, Sriram Krishnan, Eugene Lee, Xiongjiu Liao, Alyson Liss, Charles Liu, Liang Liu, Giusy Di Lorenzo, Jia Lou, David Lu, Mauro Martino, Andrea Mattiello, Diego Maniloff, Vincenzo Manzoni, Stephen MilesSey Min, Justin Moe, Mahsan Mohsenin, Eugenio Morello, Marina Neophytou, Walter Nicolino, Giovanni de Niederhausern, Christine Outram, James Patten, Francisco Camara Pereira, Santi Phithakkitnukoon, Fabio Pinelli, Riccardo Pulselli, Pietro Pusceddu, François Proulx, Adam Pruden, Rahul Rajagopalan, Martin Ramos, Jon Reades, Bernd Resch, Francisca Rojas, Basant Sagar, Darshan Santani, Aaron Siegel, Luca Simone, Christian Sommer, Susannes Seitinger, Andres Sevtsuk, Louis Sirota, Najeeb Marc Tarazi, Musstanser Tinauli, Vlad Trifa, Andrea Vaccari, Kenny Verbeeck, Nathan Villagaray-Carski, Malima Wolf, Angela Wang, Yao Wang, Sarah Williams, Dustin York, Caitlin Zacharias, Shao Zhou

senseable city lab:.:: | MIT

-Education- data literacy, coding, data access
-Governance- conducive to innovation, testing and experimentation
-Data- untapped reserves ‘opportunistic sensing’- combination of different types- exponential value/information
-Knowledge platforms- learning from other cities experiences.
-Rather than solution provider- technology as an enabler