Citizen Sensing: From an Ontology to a Cosmology of Digital Practices

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Citizen sensing describes an emerging range of practices for monitoring environments through low-cost and DIY digital technologies. From air pollution to the migrations of animals, sensors generate data on any number of environmental phenomena. At the same time, these practices often bear the promise of making citizens more empowered to act on environmental matters of concern through sensor data. What ontologies--digital or otherwise--might be specific to these citizen-sensing technologies and practices? Or does citizen sensing throw up a different set of considerations in relation to the ontological "turn?"[1] And how does citizen sensing as an emerging set of practices raise questions about the status of practice-based ontologies when those practices are still in formation?

Citizen sensing might on one level be considered to be what Annemarie Mol has termed an "ontology-in-practice."[2] In her discussion of the ways in which practices enact objects, Mol emphasizes how realities also multiply along with these ontologies on the move. In her account of medical practices, ontologies form through and with practices, which generate and sustain particular socio-material conditions. Within the wider realm of digital technology, there are potentially a proliferation of these ontologies-in-practice, from traces of social media activity, to algorithms that match data flows with indicative behaviors, as well as electronic meters that modulate energy use, apps that track sleep and fitness, wearables that monitor heart rate, and citizen-sensing monitoring devices that document how much pollution might be in

[1] Sismondo 2015; Walford and Knox.
[2] Mol 2002.

any patch of air. These are practices that might be seen to be enacted through digital technologies that would organize, manage, inform, and otherwise mitigate activities. If ontologies in practice are constructive of objects and worlds, then what objects and worlds might citizen sensing construct?

Yet on another level, citizen sensing then presents a problem for ontologies-in-practice since it is a practice still in formation and yet to be stabilized. How is it possible to assume the contours of this practice as already established, rather than attend to the ways in which citizen-sensing-as-practice might be formed in and through relations of subjects, objects, environments, technologies, organisms, pollutants, concretizing as an "individual-milieu dyad"[3] that come to be recognized as citizen sensing? Simondon has suggested that "ontological privilege" is typically afforded to *individuals* as already constituted, rather than attending to ontogenetic processes of individuation and all that happens along with individuation.[4] Similarly, it might be possible to note that citizen sensing as a *practice* might be afforded "ontological privilege" not just in relation to the entities that would sense and be sensed, but also in relation to the citizen-sensing practices (and by extension, relations) that would join up sensors and the sensed. One could call this a digital ontology, where the diagram of citizen sensing as a practice is largely assumed in advance as drawing together citizens, entities to be monitored, environments, data and politics in particular ways.

However, through research on the Citizen Sense project it has become evident that the stabilized digital ontologies and practices of citizen sensing rupture once put to work in particular situations.[5] What might begin as a relatively clearly delineated practice of citizen sensing begins to unfold in unexpected ways, overlapping with

[3] Simondon 1992.
[4] Ibid.
[5] http://www.citizensense.net.

multiple other "practices" to blur the boundaries of what counts as citizen sensing. The monitoring of a particular pollutant such as particular matter 2.5 (PM 2.5) with a low-cost plug-and-play digital device such as the Speck,[6] which Citizen Sense has borrowed from Create Lab at Carnegie Mellon University to use in a kit deployed to around 30 participants in northeastern Pennsylvania to monitor air pollution in relation to fracking infrastructure, quickly becomes entangled with a range of other practices--digital and otherwise--that would in-form the contours of what might typically be identified as embodied skills, relations or intra-actions.[7] Plugging in a Speck PM 2.5 monitor requires not just attending to the demands of this particular device, which would set practical actions in motion, including watching the display monitor that provides real-time counts of PM 2.5 as well as displays of data over the last 12 hours, logging environmental observations that might or might not explain particularly high readings or spikes in data at any given time, uploading data to a platform and observing data within tables and line graphs, comparing data to observations made by other participants in the area, and eventually even beginning to assemble the data in such a way that preliminary findings can be communicated to state and federal regulators, where conclusions may be drawn about whether PM 2.5 levels are higher than the recommended Air Quality Index (AQI) thresholds, for how long, and what might be done to act on this data.

But also, monitoring opens up a cascade of other "practices" that do not neatly cohere, including organizing informal and formal community meetings to discuss and compare sensor data gathered across an area, communicating about whether bugs or dust lodged in the optical sensor may be skewing readings, developing protocols to ensure the validity of data, contacting state agencies when particularly high readings

[6] http://www.specksensor.org.
[7] Gad and Jensen 2014; Suchman 2009; Barad 2003; Mol 2002.

register and arranging for site visits, preparing spreadsheets and reports to make stronger claims to state and federal agencies about the patterns in air-pollution data, debating regulators who would dismiss the legitimacy of citizen-gathered data, developing further monitoring projects that might or might not involve using digital or analogue monitoring techniques, drawing on the "expertise" of other scientists and researchers who might provide competing advice or claims, comparing monitoring data to modeled data and permitted emissions, and situating a loosely defined set of citizen-sensing practices within a larger project of negotiating a more tenable set of relationships with a continually expanding fracking industry.

What might initially be identified as the specifically "digital" modalities of monitoring, which might further be seen to circumscribe citizen sensing within a particular participant's use of a device to gather real-time data on air pollution, then opens into and entangles with a range of other practices. Any "enactment" of the "object" of air pollution is situated within a particular set of encounters and concerns that in-form how citizen sensing unfolds as a practice. Yet given the hazy contours of this practice, the enactments and objects are also thrown into question as vectors that readily unfold ontologies for study.

So while the digital modalities of monitoring that make available real-time sensor data might, because of their instantaneousness, seem to make "evidence" more readily available and hence also seem to make political action more proximate, in this case citizen-generated air-quality data raises further problems for how to engage with environmental agencies and regulators in order to document and make claims heard, and to hold industry to account. The citizen-sensing practices for gathering data, in other words, do not readily align to political engagement, and the original diagram of citizen sensing as affording this connection ruptures into a yet-to-be-defined set of

practices. Yet this set of practices might also be differently individuated, and differently activate sensors and the sensed, individuals and milieus, data and politics, whether monitoring lichens or storks, traffic flows or urban data, pollution or toxic exposure. Ontologies-in-practice then become *cosmologies-in-practice*, where the milieus of monitoring in-form the possibilities of practices to take hold.[8] Ontologies also give way to onto-genetic inquiries,[9] where stable frameworks of "being" transform into processes of becoming, and where the entities, practices and milieus that would be joined up in a digital encounter concretize in an actual occasion, rather than as an always available formula for analyzing a world or reality as a distinctly digital ontology.[10]

Figure 1: Participant image of Speck monitoring PM 2.5 in Pennsylvania

[8] Stengers 2011; Whitehead 1929.
[9] Simondon 1992.
[10] Cf. Boellstorff.