Tweeting Spacecraft: Communicating Space Science in the Age of Web 2.0

Best Practices

Janet Vertesi
Princeton University
E-mail: jvertesi@princeton.edu

Key Words

Twitter
Web 2.0
Microblogging

Summary

Since 2008 NASA spacecraft have been using the microblogging service, Twitter, to communicate science topics and results to a long list of public followers. In its ability to reach hundreds of thousands of individual users, Twitter offers many benefits for the public communication of astronomy. But to use social media services responsibly requires several competing tensions outlined here to be balanced: specifically, with respect to agency[1] and intimacy, and scientific expertise.

The *Phoenix* phenomenon

In November 2008, NASA's *Phoenix* lander watched the Sun set over the arctic horizon on Mars for the last time. With the Martian winter in full swing, solar power and temperatures reached their expected low, freezing the robot's circuits. As the communications stream from Mars fell silent, a room full of the scientists and engineers who had commanded the robot for the duration of its brief mission mourned its loss at their headquarters at the University of Arizona, USA.

But once word went out to the Twitterverse on *@MarsPhoenix*, over 40 000 Twitter users around the world mourned *Phoenix's* passing, posting tributes, poems and heartfelt condolences online to commemorate the spacecraft, as if it were a dear, distant friend. When *Wired* magazine held an online competition for a suitable epitaph for the robot, they were "officially impressed" to receive almost a thousand entries. "*Either you people really love NASA swag [free gear],*" the magazine exclaimed, "*or the little lander that could captured some hearts and minds*." (Madrigal, 2008)

In this article, I will discuss how the use of microblogging services like Twitter and other Web 2.0 communities do not just communicate science ideas with the public. They also have implications for how the public sees and interacts with the spacecraft; and potentially for how science is done on the missions. First I will explore what it means to tweet from a spacecraft account, and how Twitter constructs agency and affective relationships with distant robots. Second, I will examine the tensions that Web 2.0 technologies can bring to our understanding of publishing and discovery in scientific communities. These issues must be well understood by any communications office when they engage in Twitter activities.

The findings that I present here are based not on quantitative or computational analysis, but on my qualitative studies of spacecraft organisations based at NASA's Jet Propulsion Laboratory (JPL). As a sociologist of science, I have conducted in-depth, on-site studies of the Mars Rover mission and the *Cassini* mission, as well as historical research on missions such as *Viking*, *Voyager* and *Galileo*. Lessons learned from these missions can be helpful to other organisations interested in the public communication of science to local and international audiences.

Robotic relationships

Usually, we think of single Twitter accounts as managed by a single user, who may use their profile and connections to establish their online persona or interact with other single users through the system (Boyd et al., 2010; Honeycutt & Herring, 2009). Twitter can be used by these individuals for a variety of purposes, from general chatter about everyday activities and making online connections (Java et al., 2007), to informal lightweight communications that sustain a collegial work environment (Zhao & Rosson, 2009) to rapidly distributing critical information among communities in distress (Starbird et al., 2010). But corporate microblogging is also expanding in popularity. An increasing number of companies, product lines, politicians and celebrities possess and use Twitter accounts to interact with a wider public (Böhringer & Richter, 2009; Gilpin, in press). Such Twitter accounts may masquerade as individual users with individual accounts, but in reality they are highly controlled by press offices, product managers or agents. Their

interactions with their followers are usually one-way, relying on the retweet function to spread information from a single point to a wider audience.

Tweeting spacecraft fall into this category: a single user account carefully managed by an organisation. Although *@MarsPhoenix* appeared informal and even casual, it was a carefully orchestrated presentation of "self" managed by a single member of the JPL Press Office. This staff member attended the daily *Phoenix* science meetings, and used her knowledge of NASA communication policies to craft appropriate Tweets. As the number of followers quickly grew to over 40 000 users, the NASA Press Offices, from Headquarters in Washington to individual centres across the United States, took notice. By the end of the mission, all active and forthcoming NASA spacecraft possessed active Twitter accounts, some with thousands of followers. These robots are "tweeted for" by members of various NASA Press Offices located at different NASA centres or affiliated research institutions, much in the way that other corporate entities tweet to their various publics.

What is Twitter?

Twitter (www.twitter.com) is a microblogging service. Users who sign up for accounts can post short statements of only 140 characters or less, called *Tweets*. Users may also collect *followers* with whom they share these short statements. When a user logs in to the service, the first thing they see are recent Tweets posted by the people they follow in their Home Timelines. Other Web 2.0 systems, like Facebook, have similar features in that they allow users to post status updates to their Friends list, but these often include other methods of interacting within the system than the exchange of shortened Tweets. On Twitter, users' posts are publicly available and may be traced across the system through the use of some Twitter-specific tools. For example, tagging posts with the "#" symbol can identify and then collate popular or "trending" topics; users may get their followers' attention by placing the "@" symbol in front of their follower's user name in their status message; users may also type "RT" to "retweet" or re-post someone else's message as their own.

When spacecraft tweet, what do they say?

Like celebrity Twitter feeds, spacecraft Tweets are carefully managed to give the impression of the robots speaking directly to their fans. While in actual fact, each Tweet is subject to the same regulations as NASA press releases and vetted by the Press Office, the use of colloquialisms, first person pronouns, and idiomatic expressions makes the result appear informal and direct. For example, on 23 July 2010, *@MarsCuriosity* (the Twitter account for the new Mars Science Laboratory mission) tweeted: *"Very busy in the clean room as I get ready to roll for the 1st time in about 15 mins (2pmPDT/21UTC) Join us: http://bit.ly/92t5HI."* The click-through link allowed Curiosity's followers to access an internet webcam in a backstage area of the NASA laboratory where the robot was being assembled. Note that the use of the first person makes it seem as though the robot is speaking directly to its friends in cyberspace, despite being an inanimate object on that could be on a planet millions of kilometres away. This sense of robotic personality is augmented when other JPL spacecraft like *@MarsRovers* retweeted *@MarsCuriosity's* call for webcam watchers, saying, *"Aw, they grow up too fast!"* Such a comment establishes a relationship between the two robots, using a familiar phrase often exchanged between parents or siblings. This relationship is then visible over the Twitter network to thousands of followers who feel that they are privy to this intimate relationship between their robotic friends.

Corporate accounts on Twitter are widespread, but bring up issues of online identity management and patterns of interaction in a social network setting that are still being explored by social media researchers. When commercial companies Tweet about sales or coupons, it seems that most human users do not reply, although they may retweet to pass information along to their followers. However, the fans of the spacecraft maintained their suspension of disbelief and would often address the robots as individual agents. During the Mars Phoenix mission, several users tweeted to *@MarsPhoenix*, asking questions for their science projects or to clarify news reports and received individual replies. For example, when Lucas Zallio *(@LucasZ)*, a web administrator in Argentina, tweeted, *"@MarsPhoenix Do you get oven power from the Sun or is it fuel powered?"*, the spacecraft appeared to reply directly, saying, "*@lucasZ …* I'm solar powered, saved to lithium ion batteries. At this latitude, panels are 28% efficient turning sunlight to power." The Press Officer behind the Twitter account recalls being astonished at the overwhelming volume of replies to the spacecraft's Tweets, each one of which she answered as *@MarsPhoenix*.

Only when the robot finally went silent did the users behind the account let up on the illusion. But even then, they carefully maintained the robot's identity as the source of most of the Tweets. Thus a Tweet from 1:42PM on 10 November 2008 uses brackets to designate the status of "Phoenix Ops" as interlopers on *Phoenix's* account, saying: "[*Phoenix Ops*: *We promised* Phoenix *to continue to update here its discoveries and future news. Another goodbye from Mars*…]"

Getting friendly

Because users outside NASA follow the spacecraft's Tweets, the robots' staged interactions give the impression of their acting as autonomous agents on the frontiers of space. An implication of this activity is the anthropomorphisation of the spacecraft, a transformation of the robot into something — almost someone — that can be known intimately by a diverse and dispersed group of people around the world. The spacecraft invites this sense of agency as it speaks of its experiences in colloquial terms familiar to internet users the world over, even using terms like "*yesss!*", or "*lol*". Further, because the spacecraft seems to reveal aspects of its personal experience, this invites its followers to experience a sense of intimacy with it. A spacecraft follower can expect to see regular updates from her robot on a regular basis, posted alongside Tweets from friends, co-workers or organisations. This produces a sense of the spacecraft as both singular and agential, with an evolving history. It also invokes a sense of intimacy in the constant process of revealing and following everyday events in a spacecraft's life. This affection was especially evident in the online response to *@MarsPhoenix's* death, when tributes, haikus and farewell messages were tweeted by followers around the world upon hearing of *Phoenix's* demise.

This sense of intimacy developed through online interactions has implications for Twitter users and followers alike. First, cases like these prove that the robot can develop and maintain a sense of agency and personality despite being millions of miles away (Suchman, 2007; Vertesi, 2009). That is, we do not have to be face-to-face with a robot, nor does the robot have to appear anthropomorphic, in order for us to develop a meaningful relationship with it. Second, studies of communication and psychology have shown that revealing

details about one's private life builds a perceived sense of intimacy between two individuals, often as strongly felt on the revealer's side as that of the confidant (Collins & Miller, 1994; Levinger & Huesmann, 1980). Such perceived intimacy may contribute to the sense of success on behalf of NASA outreach personnel. That a low-budget, short-term, and largely immobile mission such as *Phoenix* could be seen to touch the lives (and Twitter Timelines) of thousands presented a public relations breakthrough. It also suggested that public outreach was being successfully accomplished on an unprecedented scale.

But because the press offices were controlling the information that the public received directly, Twitter seemed to eliminate the need for longstanding media practices. In the past, press offices had to rely on press releases sent to news media outlets, and could not necessarily control which stories were printed. As the press officer in charge of the Twitter feeds explained, "*Mainstream media are more likely to cover a bad news story than a good story. Twice we had bad days on* Phoenix*… and that would have been all [the information] they [i.e. the public] were getting. Being able to put out information daily changed the way people thought about the mission.*" Increasing control over the mission story as a whole, instead of being subject only to intermittent negative reports, can be a tremendous success for mission press offices, but the new approach also changes the relationship between these offices, the public and science reporters.

Web 2.0 and expertise

Over the course of *Phoenix's* short life, microblogging became increasingly central to the daily work of the mission. Twitter and other Web 2.0 technologies such as Facebook and blogs have since then been harnessed across NASA's offices to release their spacecraft's images in near-real time to the public. To date, *@CassiniSaturn* has 75 000 followers; *@MarsRovers* has 80 000. Their Tweets often include single-line descriptions about a discovery, and may include short links to blog posts, images or published papers. As Tweets are retweeted, URLs clicked and blog RSS feeds generated, word of a spacecraft's activities spreads quickly. But while this may seem like a dream come true for press offices, it is important to note that Web 2.0 technologies such as wikis and blogs have in the past exacerbated a tension between the mission press office and the participating scientists. In the drive to generate context for Twitter feeds, these tensions should be considered very carefully so that a strong working relationship can be established between those who operate the spacecraft and those who tweet on its behalf.

Where does data come from?

Taking a picture on *Cassini*, *Phoenix* or the Mars Rovers takes considerable social and scientific work. First, a scientist must be selected to join the mission via a lengthy application and review process. Then they must come up with a hypothesis, and observations that might prove or disprove that hypothesis. Next, they must make a case for that observation such that their team members support it, which means negotiating with other instruments for spacecraft time, bytes and power to take the observation. Finally, they may work with technical assistants to craft and code the observation request for upload to the spacecraft. The images, spectral readings and other measurements that return from the spacecraft are embedded within this delicate process. But when the spacecraft speaks with a single voice and appears to have an agency all its own, the people who make the spacecraft work seem to disappear and become invisible.

This invisibility masks three related issues with respect to spacecraft data. First, the data that spacecraft collect are neither neutral nor always inherently shared. Because scientists must compete against each other for the privilege of building an instrument, the data that their instrument returns belongs to them and to their team, and often cannot be easily or intuitively understood by outsiders. Second, scientists are cautious about stating anything about their data publicly until it has been sufficiently confirmed, calibrated and subject to peer review. They therefore negotiate for proprietary or validation periods with their data so that they can be sure to fully understand it and stand behind it when their findings are released to the public and to their colleagues. Third, many scientists on missions are anxious that when their data is released, others will see for themselves what the scientists had hoped to see in the first place: that which inspired them to convince their colleagues that it was worth dedicating spacecraft time, bytes, and power to take the observation. Scientists who express reservations about releasing their data too early are usually not being obstinate or selfish, but acting in the best interest of their own and their team's scientific process.

Who are the experts?

With the coming of Web 2.0 technologies like blogs, wikis and amateur web forums, a new expectation of visibility to the public has inspired some changes in how scientists plan and craft their scientific observations, discoveries and announcements. Behind the scenes, I have often observed planetary scientists exchanging concerns about what the public will think of the Tweets and blog posts about their data. There is much anxiety that images from another planet will be misinterpreted, leading to public misunderstandings, or that amateur interpretations of these images will be misinterpreted as professional ones. Twitter also brings up complex questions about the process of science. Can significant science content really be conveyed in 140 characters or less? Does a Tweet count as a "publication" when it comes to a discovery priority dispute? What is the role of the expert in this new environment? How can scientists preserve and support the public's respect for scientific expertise, work and the status of peer-reviewed publications in the era of Tweeting and retweeting?

These anxieties are not unfounded. In January 2008, there were reports of an image of a woman or a Sasquatch on Mars, which many people claimed to see in an image taken by the Mars Rover, *Spirit*. Although quickly discredited by scientists on the mission, the story was already out of their control. It gathered considerable speed on the internet as it was blogged and shared by users the world over, and was even reported by traditional media outlets such as national television networks and newspapers (CNN.com, 2008). Similarly, in April 2010, a popular blogger in the planetary science community used Photoshop to put together her own composite of images taken by the *Cassini* spacecraft, and posted the result with a discussion on her blog. This image was picked up and posted as the Astronomy Image of the Day on a website hosted on a NASA server, no doubt to the blogger's excitement. But conspiracy theorists on the internet jumped on the image, claiming that it was doctored to the point of being unbelievable, proving that NASA was manipulating the public. Both the image site and the blogger were independent of NASA, but the space agency was held accountable for this interpretation. (see Lakdawalla, 2010).

Such examples do not come from Twitter, but do speak to some tensions that Web 2.0 technologies have generated with respect to scientific work. Releases of data used to be reserved for scientific publications and major press conferences, wherein a discovery would be appropriately announced — and credited. With Web 2.0, however, the expectation of immediacy and visibility means that more

space agencies are asking scientists to release their data to the public sooner: sometimes even before their colleagues on the same mission have seen the data. To some scientists, such requests violate their scientific process, bypassing requirements such as peer review, analysis and even calibration. To be fair, not all scientists work this way: some missions believe it is important to release all their image data to the public as soon as it is acquired. However, in my research on the subject, missions launched before 2000 and the majority of European space projects are more likely to include independent teams that shepherd their results. And while one team member on an interplanetary mission may delight in the opportunity to have their data instantly streamed to thousands of people over morning coffee, another may express serious reservations about releasing such information to the public. Whether one believes that open data is the way forward or not, both perspectives need to be treated with respect and understanding when generating content for Twitter feeds.

Why, where and when to tweet?

There are clearly many benefits to starting a Twitter stream for one's spacecraft or scientific experiment. With a few short keystrokes, a single message can be relayed directly to followers around the world, by passing media relations, and allowing the public to build an intimate relationship with their spacecraft. For some, this is a dream come true, ensuring their mission's success and continued public support; for others, it suggests a public relations nightmare. But as for any new technology, reaping a cascade of benefits from Web 2.0 mission communications requires careful, local consideration of how press offices will work with scientists to release mission information responsibly and thoughtfully. This requires thinking about why, when, and where to tweet, and doing so in collaboration with each unique mission to hear scientists' concerns and excitement about the new process. Science Press Offices would be wise to meet with the scientists they represent to come up with internal policies for the use of Web 2.0 technologies or "new media." Such policies should aim to balance the enthusiasm of Tweeting spacecraft on the one hand, with a respect for local scientific and operational processes on the other. Without such initial communication, a rush to embrace Twitter runs the risk of generating more bad press than positive public experiences. As with any technology, Twitter cannot *change* the process of science, and would be unwise to try to do so. Instead, to be truly valuable both to the scientists and to the public, we must bring it mindfully into existing relationships, restrictions and ways of working within the scientific community. After all, these are crucial to getting the work of science done in the first place.

Acknowledgements

Thanks to Judy Chen, Irina Shklovski, Victoria McGregor and anonymous NASA mission scientists for comments on earlier drafts. A version of this paper was accepted to the CHI 2010 workshop on Microblogging, in Atlanta, Georgia. This work was funded by the National Science Foundation's Virtual Organizations as Sociotechnical Systems Program: Office of Cyberinfrastructure, Grant #0838499.

Notes

[1] Agency: Here, specifically referring to the received impression that the robots and spacecraft are able to act autonomously.

References

- Böhringer, M. & Richter, A. 2009, *Adopting Social Software to the Intranet: A Case Study on Enterprise Microblogging*, Proceedings of the 9th Mensch & Computer Conference, Berlin, Germany, 293
- Boyd, D., Golder, S. & Lotan G. 2010, *Tweet Tweet Retweet: Conversational Aspects of Retweeting on* Twitter, Proceedings of 42nd Hawaii International Conference on System Sciences, HICSS-43, IEEE: Kauai, HI
- Collins, N. & Miller, L. 1994, *Self-disclosure and liking: A meta-analytic review*, Psychology Bulletin, 116, 3, 457
- CNN.com, 2008, *The Shot: Man on Mars?*, http://www.cnn.com/video/#/video/bestoftv/2008/01/23/cooper.shot.tuesday.cnn (Retrieved on 24 November 2010)
- Gilpin, D. R. Forthcoming, *Working the Twittersphere: How Public Relations Practitioners Use Microblogging for Professional Identity Construction*, In: *The Networked Self: Identity, Community and Culture on Social Network Sites*, ed. Z. Papacharissi, (Routledge, New York)
- Honeycutt, C. & Herring, S. 2009, *Beyond microblogging: Conversation and collaboration via* Twitter, Proceedings of 42nd Hawaii International Conference on System Sciences, IEEE Press, Los Alamitos, CA
- Java, A, Song, X., Finin, T. & Tseng, B 2007, *Why we Twitter: Understanding Microblogging Usage and Communities*, Proceedings of the 9th Joint WEBKDD Workshop, (ACM Press, New York), 56
- Lakdawalla, E. 2010, *I'm part of the conspiracy, apparently*, http://planetary.org/blog/article/00002710 (Retrieved on 24 November 2010)
- Levinger, G. & Huesmann, L. 1980, *An "incremental exchange" perspective on the pair relationship*. In: *Social Exchange*, Eds. Gergen, K et al., (Plenum Press, New York), 165
- Madrigal, A. 2008, *@MarsPhoenix's Twitter Epitaphs*, Wired Magazine, http://www.wired.com/wiredscience/2008/11/marsphoenixs-tw/ (Retrieved on 24 November 2010)
- Starbird, K., Palen, L., Hughes, A. & Vieweg, S. 2010, *Chatter on The Red: What Hazards Threat Reveals about the Social Life of Microblogged Information*, Proceedings of the 2010 ACM Conference on Computer Supported Cooperative Work, (ACM Press, New York), 241
- Suchman, L. 2007, *Human-Machine Reconfigurations*, (Cambridge University Press, Cambridge)
- Vertesi, J. 2009, *Seeing Like a Rover: Embodied Experience on the Mars Exploration Rover Mission*, Extended Abstracts of the 2008 ACM Conference on Human Factors in Computing Systems, (ACM Press, New York), 2523
- Zhao, D. & Rosson, M. B. 2009, *How and Why People Twitter: The Role that Microblogging Plays in Informal Communication at Work*, Proceedings of GROUP 2009. (ACM Press, New York), 243

Biography

Janet Vertesi is a PhD graduate from Cornell University in Science & Technology Studies. Currently she is a Cotsen Fellow at the Society of Fellows in the Liberal Arts at Princeton University, where she also holds a Lecturer appointment in the Sociology Department. Her work focuses on the complex intersections between people, science and technology such as the social organisation of robotic spacecraft teams, and the role of images in scientific practice. She is currently conducting an ethnographic study of the *Cassini* mission to Saturn. More information: http://janet.vertesi.com/