

The Strategy and Implementation of the *Rosetta* Communication Campaign

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The communication campaign for *Rosetta* has been the biggest success in the history of European Space Agency outreach, resulting in global awareness for the agency. The mission itself is an extraordinary operational and scientific success, but communicating only the operational and scientific firsts would likely not have brought the *Rosetta* orbiter and *Philae* lander to the attention of so many people, and would not have made the mission part of people's lives across the globe.

The additional impact brought to the mission through the communication campaign was based on a strategic approach focusing on: real-time release of information with maximum transparency; direct real-time access for media and social media; adding a human dimension to the story; and communicating the risks openly in order to manage expectations.

In this article we describe our overall strategy, illustrate its implementation, and provide the framework for subsequent articles in this journal highlighting specific aspects of the campaign in more detail.

Introduction

Does a space science mission designed to accomplish a series of historical firsts need a communication strategy? Should the achievements not speak for themselves and draw everybody automatically to the news? Is content no longer king, making its way into the public domain without assistance? In today's world, with its noisy societal communication and fierce competition for attention, this is not a given. It was evident from the beginning that even *Rosetta*'s historic achievements would need a comprehensive, strategic approach to communication in order to be made as widely visible as possible.

The strategy

The formal European Space Agency (ESA) *Rosetta* communication plan states:

The purpose of the communication campaign is to raise awareness, understanding, and support by providing information and opportunities to engage.

More specifically and following Edward L. Bernays' influential 1947 essay *The Engi-*

neering of Consent (Bernays, 1947)¹ the scope of the *Rosetta* communication campaign was designed to adapt to today's societal communication reality, in order to share the mission with as many people as possible.

There is no doubt that *Rosetta* lends itself very well to communication. The adventure of comet exploration allowed people to experience an unknown world, touched with an element of risk, as this had never been attempted before. The mission's over-arching scientific themes concerning the origins of the Solar System, and potentially the origins of the water and life on Earth, along with a series of world firsts including rendezvousing with, escorting, and landing on a comet, provided ideal stepping stones to build up and nourish excitement through all of 2014.

The overall strategic approach was based on the following assumptions and key ideas:

- Given the poor signal-to-noise ratio in today's societal communication, we needed to make sure that the key events, namely the wake-up from hibernation, rendezvous, and landing, were

well above the threshold by highlighting the huge challenges and risks associated with each step.

- Although communication from Earth with the spacecraft could take anywhere between 12 and 45 minutes one way during this phase of the mission, and image processing might take more than a day, we had to stay as real time as possible in communicating. Both successes and potential failures had to be relayed near-live to provide everyone with a ring-side seat.
- Going live had the potential to foster understanding, support, trust and engagement. The aim was to treat people with the greatest transparency, so that they would know, simultaneously with us in the mission control room, what was going on hundreds of millions of kilometres away.
- Communicating the considerable risks of failure had to be properly managed, hoping for the best and being prepared for the worst.
- A global impact would only be achieved by cooperating closely with ESA's partner national space agencies, research institutes, and space industries, and only if they were in a position to implement their own targeted campaigns —



Figure 1. Rosetta communication teams, with some of the landing day programme participants, on 12 November 2014. Credit: ESA/J. Mai

in full coordination with ESA — to reach national audiences.

- Global coverage would only happen if (social) media had real-time, direct access to all information and could turn this into real-time coverage.

Additional valuable engagement could be achieved if we succeeded in making this mission part of people's daily lives, perhaps by assigning *Rosetta* and *Philae* anthropomorphic personalities, embarking on an exciting exploration mission deserving empathy.

ESA scientific missions have often been in the global spotlight before, for example with the *Huygens* landing on Titan², the discovery of Martian methane through *Mars Express*³, and *Planck*'s images of the cosmic microwave background, the left-over light from the Big Bang⁴. However, the *Rosetta* communication campaign required not only building up, but also maintaining, engagement and attention for a whole year and beyond, and on a global scale; a challenge that ESA had not had to master before.

Cooperation and coordination

While ESA's missions are designed and funded on the basis of their scientific and technological goals, as well as the application of their data, its 22 member states and partners also expect visibility through

communication, especially in their national contexts. Thus, while *Rosetta* is an ESA-led mission and ESA is a genuine global brand, it was important to ensure that *Rosetta* was present in each of the member states too. Hence it was essential to put in place an effective mechanism to coordinate and cooperate on communication and outreach.

In reality, the resulting *modus operandi* in the ESA context is usually a mixture of cooperation and competition. To ensure that cooperation prevailed over competition on this occasion, all *Rosetta* communication activities were coordinated, with the main vector being a weekly teleconference starting in late 2013, involving as many partners as possible from ESA member states and from the USA, including national space agencies and individual research institutes involved in the mission⁵.

The aim of these meetings was to exchange information; share communication material and products; agree on publication timelines, press conferences and their line-ups; balance visibility amongst partners; and above all, to ensure a coordinated release of the same information at the same time in order to maximise the impact of the *Rosetta* communications in all member states, the USA, and beyond.

By circulating draft texts, images, and animations in advance of publication, all partners were in a position to adapt this

information to fit their national and cultural environments, and to add their specific angles. Press conferences and media events were broadcast live over the internet and on satellite. This allowed partners to build local or national events around them, making those events attractive to their own communities.

The coordination teleconference also evolved into a forum to launch and develop new activities. For example, the competition to name the landing site of *Philae* was planned and executed jointly by Agenzia Spaziale Italiana (ASI), Centre national d'études spatiale (CNES), Deutsches Zentrum für Luft- und Raumfahrt (DLR) and ESA. The group also discussed shortcomings and ways to improve matters. The trust built up over the course of 2014 proved vital in resolving occasional conflicts of interest to the benefit of the common goal of communicating the mission as effectively as possible. The weekly teleconferences became a strong tool of collaboration for the *Rosetta* communication campaign and its roll out.

Trust was also key in the relationship between the ESA communication team and people directly involved in the mission itself: the science working team, the mission operations team, the science operations team, and the mission management team.

One would assume — as most of the people involved were working for the same organisation, namely ESA — that trust is a given. However, in reality, it takes time to build trust and it relies on positive common experiences while working together. For example, in the lead-up to the moment when *Rosetta* would wake from its 31-month hibernation in January 2014, the decision to kick off *Rosetta* communications with a Wake Up, Rosetta! competition was met with some scepticism. For those who had in mind mainly, or rather only, science, technology and spacecraft operations — the traditional inherent communication content of any space mission — it was not evident that a virtual shouting campaign was really suited to a Solar System exploration mission.

The ice was broken when it became clear that the daily, seemingly banal experience of waking up had indeed resonated with the general public, leading to many elaborate video contributions to the Wake Up, Rosetta! competition and even more hits and likes on ESA web pages. After *Rosetta* came out of hibernation on 20 January 2014, communication was seen as an intrinsic part of the mission.

Communicating risk

The Wake Up, Rosetta! campaign was designed to bring awareness to a critical point in the mission's timeline. On 20 January 2014, after 31 months in deep-space hibernation, *Rosetta*'s computer was supposed to start reactivating the spacecraft at 11:00 Central European Time (CET) spacecraft time, bring it out of a stabilising spin, establish its attitude, then send a signal to Earth with an arrival time during a window starting at 18:30 CET. If all went well, contact would be signalled via a spike in an otherwise flat line on control monitors at the European Space Operations Centre (ESOC) in Darmstadt, Germany.

Deliberately hibernating a spacecraft and having it wake itself autonomously more than two and half years later was unprecedented in the history of spaceflight and not without risk, even if the chances of a micrometeoroid impact or onboard system failure during that time were deemed to be low. In the absence of any contact with *Rosetta* for so long, the tension was high.

Mission managers were initially opposed to the plan to broadcast the wake-up event live, preferring to do it behind closed doors, then issue a press release the next day announcing either success or failure. From the communication perspective, however, it was clear that a live event could bring a great deal of engagement if successful, and avoid any accusations of concealing problems if not. Either way, it provided the perfect opportunity to open ESA up to the world.

At 18:30 CET, the clock started to tick and the conversations began to get quieter throughout ESOC. Mission operations personnel were watching the screens in the main control room, while senior management from ESA and partner agencies sat in the front row of the conference room, hoping, like everybody else watching around the world, to see the imminent wake-up signal. Everything was broadcast live via satellite and the internet while the minutes passed without any news from *Rosetta*.

By 19:00 CET, the number of TV and still cameras focused on the front row had increased dramatically. It had been decided that if no signal was received by 19:30 CET, an announcement would be made, calling off the media activities for the night, while still giving *Rosetta* more time to make contact. At 19:18 CET, just as Paolo Ferri, head of ESA's mission operations department, was about to leave the main control room to go and make that announcement, the wake-up spike appeared on the monitors and was broadcast around the world, followed by great relief and joy.

The full 48 minutes of hope and nail-biting worries had been carried live on TV and the internet, and the reward was enormous. Half a million people had watched ESA's online feed and they immediately appreciated their ringside seat and direct real-time link to the mission, even in a moment when things were not going quite as expected. Transparency is key when it comes to communicating risk: this is known from the textbooks, but proved to be true throughout the delayed wake-up.

Wake-up day also set the scene for the rest of 2014, with a number of major documentary companies including Discovery Channel, Arte and National Geographic beginning their filming ahead of releases around the landing in November.

There were also risks associated with the next key step after wake-up, the series of ten thruster burns to bring the spacecraft to its rendezvous point 100 kilometres from Comet 67P/Churyumov–Gerasimenko on 6 August 2014⁶. Although different, as there could have been chances to try again if the rendezvous was missed first time, the key to communicating the risk — even if difficult to quantify — was to be as transparent as possible and to stress the fact that when exploring new avenues one needs to expect the unexpected⁷. All ten manoeuvres were announced beforehand, illustrated in animations, and the associated risks highlighted. As with the wake-up, the day of final rendezvous was broadcast live from the ESOC main control room to share the moment in real time. Despite this being the crossing of a more or less arbitrary line in space, the event was widely followed.

For the landing of *Philae* on 12 November 2014, much more was at stake. Even though substantial effort had been put into emphasising that *Rosetta* itself was already successfully operating at the comet and would deliver the great majority of the scientific results, it was clear that the general public and media were nevertheless going to identify *Philae*'s landing as the crux of the mission. A failure of the landing could have jeopardised the public's perception of the mission and damaged the ESA brand⁸. Thus, even more intense advance communication efforts were needed to highlight and explain the risks associated with the landing, and how *Philae* fit into the wider mission. Two major communication activities were implemented to prepare for landing in this regard.

During the press conference held at ESA Headquarters in Paris on 15 September 2014 to announce the selected landing site, all mission and scientific experts



Figure 2. This is the signal that brought a nerve-racking 48-minute wait for *Rosetta* to wake up to an end. Credit: ESA

stressed the risks associated with landing. *Philae* would descend to the surface on a ballistic trajectory, with no manoeuvring capabilities to avoid dangerous terrain, and given the unexpectedly rough nature of the comet — covered with craters, cliffs, slopes and boulder fields — even the best possible landing site would be hazardous.

A more innovative approach to communicating this risk involved the short science fiction film *Ambition* (McCaughrean, 2016). Initially conceived as a way to communicate the key scientific aims of *Rosetta* to non-traditional audiences including film lovers, gamers and internet surfers, it also played a key role in framing the risk. A core message of the film was that we humans are ambitious, we explore, we take risks, and we learn from our mistakes. Released two weeks prior to the landing of *Philae*, it added a human dimension, setting expectations, and emphasising that the risks of the landing and its inherent potential to fail had the positive connotation that one has to be daring to explore and achieve ambitious goals.

The message that attempting a landing would be bold and risky was clearly received, and no doubt contributed to the intense worldwide interest on landing day: would *Philae* make it? Although the landing did indeed not go according to plan, with

Philae failing to secure itself to the surface, bouncing and flying across the comet for a further two hours, it was perceived very positively by the public. *Philae* was able to deliver images of its final landing site and perform a first run of scientific experiments before shutting down due to lack of sunlight, and was ultimately seen as a great success by the majority of commentators and viewers. Correspondingly, no harm was done to the image of *Rosetta* or ESA; quite the opposite, in fact⁹.

(Social) media relations

Since the landing of ESA's *Huygens* probe on Titan in 2005, there has been a massive shift in news consumption away from print and towards video, mobile and social media. This clearly had to be taken into account when preparing and rolling out the *Rosetta* communication campaign.

While print is in decline, television is still of major importance and remains at a high and stable level. But even established newscasters such as the BBC, CNN and Al Jazeera are competing for a global English-speaking audience alongside the websites of newspapers such as *The Guardian* and *The New York Times*, and newer, purely online players such as Huffington Post, Slate, and BuzzFeed.

Simultaneously, social media — especially Facebook and Twitter, but also WhatsApp, SnapChat, Instagram, Tumblr, and so on — have been experiencing a rapid rise in audience and reach, and with this a new dynamic in the ways that audiences share news and interact directly with newsmakers has been born.

These changes have been accompanied by some degree of demographic division: younger people up to 35 years of age prefer to get their news online and via social media, while those older than 45 prefer TV and online (Reuters, 2015). In terms of delivery, there is a clear trend towards the use of smartphones and tablets, albeit without yet renouncing the desktop or the TV set. Using several platforms to follow news seems to be the norm.

This sets the scene for anyone who would like to be heard and to participate in societal communication today. It is essential to produce news oneself in formats suitable for social media and mobile devices, preferably in video form, and to provide journalists and social media multipliers with direct access to the events as they unfold and the facilities to dispatch their broadcasts or stories rapidly to their audiences.

Although social media have been used throughout the mission, these wider



Figure 3. François Hollande, President of France, views 3D images during the comet landing event. Credit: CNES/PIRAUD Hervé

lessons were particularly important during the implementation of communication for the main mission events of wake-up, rendezvous and landing.

At each event, we witnessed a growing interest and participation by conventional and social media outlets. Recognising that the landing was going to be the most publicly significant event, we set up a permanent press centre at ESOC. Operations started two days in advance of landing, with journalists and social media producers informed about the status of the mission and preparations for the big day, along with interview opportunities with key participants.

Landing day itself saw a fully-fledged stage programme at ESOC featuring scientists and engineers explaining the challenges of the landing, progress and the status quo. The programme started early in the morning, as *Philae* was deployed from *Rosetta*, and continued through the day, as the first touchdown took place, and into night, when the world was informed of *Philae*'s final landing.

The programme also included live links to the Lander Control Center at DLR in Cologne, and the Lander Science Operations and Navigation Center at CNES in Toulouse. Media were present at both sites.

The programme was streamed live by ESA¹⁰ to the internet, where it was watched by ten million people, and made available via satellite to the world's broadcasters and their much larger audiences. The live broadcast was used by many European institutes and space agencies as a core part of their own events: one significant example was the CNES-organised event held at the Cité des Sciences in Paris in the presence of François Hollande, the French President.

At ESOC, there was a huge media presence, including a large number of satellite broadcast trucks. Approximately 360 media representatives were present and 1400 interviews were conducted onsite or remotely via TV, radio, or online channels on landing day alone. Both numbers are unprecedented in the history of ESA.

With regards to social media, a special emphasis was put on Twitter. According

to the Reuters Institute *Digital New Report* for 2015, Twitter is seen much more as an active destination for news by an audience that is deeply interested in the latest developments, compared with Facebook, for example (Reuters, 2015). Accordingly, ESA's various Twitter accounts, not least the account representing the *Rosetta* spacecraft, which was tweeting in the first person (Baldwin et al., 2016), became the primary lead in for real-time social media news engagement.

During landing day, a special cooperation agreement was established between ESA and Twitter Germany, with a Twitter curator onsite at ESOC to help ensure that the news of the landing was quickly picked up across their audience. As a result, the landing became the top trending topic globally on the day, as heads of state, representatives of global brands, and a very wide section of the public engaged heavily with ESA via Twitter, leading to a jump in follower growth for the @ESA_Rosetta account during the week of landing from 90 000 to 284 000¹¹.

This also extended to a crossover media campaign, with selected tweets appearing embedded in the ESA TV live broadcast, and combined with ESA's channels on Flickr, Instagram, Facebook, Google+ Hangouts, and YouTube, the mission's social media activities played a very significant role in spreading the landing day news around the world.

Making the mission personally relevant

While content is still king, in the modern era of social, video, and mobile channels, it also needs to be of personal relevance. The big philosophical questions posed by *Rosetta* can seem less pressing and rather remote compared to the problems of daily life, and yet the connection can be made, as they can be linked to the human condition.

Thematically, the search for an understanding of the formation of the Solar System and for the origins of water and life are among the big scientific questions that *Rosetta* is engaged in. The challenge for communications is to find ways for people to connect to those main themes, and for people to identify and sympathise with



Figure 4. Promotional poster for the film *Ambition*. Credit: ESA/Platige Image

them. A key way of achieving this was to place the human dimension of the mission in the foreground.

An obvious method for humanising the story was to emphasise the people who were making the mission happen whenever possible, ensuring that they were seen presenting *Rosetta* on video and during the live events. Mission scientists, operators, engineers, and managers were featured intensively in ESA TV broadcasts and videos, external TV interviews, documentaries, and online channels such as Google hangouts. They were briefed not only to talk about the facts, but also to describe what their work on the mission meant to them personally.

During the live events, this approach gave people a connection behind the scenes. They were able to witness scientists and engineers nervously sitting through the nail-biting minutes when *Rosetta* woke up late from 31 months of hibernation, and the flight director's tears of relief once the touchdown had successfully taken place after decades of work.

Several key individuals involved in the mission, including the flight director and the project scientist, became well known in their own right in the media and across social networks. They became the faces of

Rosetta, real people who the public could relate to because they showed their emotions and the human aspect of their work.

Beyond this direct link to people working on the mission, we also developed two competitions designed to highlight specific emotions and provide opportunities for the public to empathise with the mission and the spacecraft (O’Flaherty et al., 2016). Both focused on common experiences, linking the adventures of *Rosetta* and *Philae* to routines of daily life (Berger, 2013), in the hope that while going through them, people would also think about *Rosetta*.

The first competition had the goal of getting the public to (virtually) help wake the spacecraft from hibernation¹². Waking up or waking up another person happen daily for almost everyone on Earth: it is a routine we all share. The competition asked people to submit videos with their wake-up message to *Rosetta*, and the resulting creativity, positive online feedback, and sharing via the #WakeUpRosetta hashtag started quite a buzz on social media. The quality of the videos submitted suggested that some people had already made *Rosetta* part of their household and maybe even their wake-up routine¹³.

The other routine experience that we tapped into was the feeling of impatience to arrive when on the last leg of a journey. The *Rosetta*, are we there yet? competition¹⁴ linked the imminent arrival of *Rosetta* at its target comet in August 2014 to the holiday season in the northern hemisphere at that time. Again the creative quality was very high and showed that certain core groups of people were well engaged¹⁵.

Our short science fiction film *Ambition* was also a very important vehicle to highlight the human dimension (McCaughrean, 2016). Starting from the title itself, the film was aimed at singling out one of human-kind’s primary drivers when it comes to accepting risk as we reach out in our exploration of the Universe. It also provided a bridge spanning from the dream that *Rosetta* was 30 years ago to the reality it achieved in 2014 and still further to a possible far future. A future where people return to the big questions of the possible origins of water and life on the Earth, gives both an intellectual and emotional rationale as to why *Rosetta* is an important mission for everyone.

Made in secret, promoted virally via a fake Hollywood-style trailer, and launched just two weeks before the comet landing, *Ambition* succeeded in grabbing public and media attention, with more than 1.5 million views by landing day, and over 3 million to date. That the film was actually about a real space mission came as a positive surprise to many, and ESA was congratulated for thinking outside the box and pushing science communication to new levels.

Another essential step in fully exploiting the human dimension within the communication of the mission was the creation of anthropomorphic personalities for the two robotic protagonists, with *Rosetta* and *Philae* embarking on an extraordinary adventure of comet exploration together (Mignone et al., 2016).

While this first-person anthropomorphic approach has been used to promote other space missions, including NASA’s Mars rover *Curiosity*¹⁶ and JAXA’s asteroid probe *Hayabusa*¹⁷, we were able to develop a wider and more engaging approach with *Rosetta* and *Philae*, not least because the two spacecraft were able to interact.

While it was decided from the beginning that they would communicate in first person via Twitter, their much-loved visual appearance as cartoons came as a by-product of the promotion of the Wake Up, Rosetta! competition.

The two representations turned out to be complementary. While Twitter allowed for immediate real-time dialogue between the two spacecraft and between the spacecraft and their followers on Earth, the cartoons made it possible to access the full palette of human emotions by showing the shared experiences of an older sister and a younger brother on an exciting, but hazardous, adventure.

The Twitter dialogue, even though largely scripted in advance, provided instantaneous engagement with the mission as it unfolded in real time, including unforeseen events, such as the unexpected landing conditions in November 2014 or the revival of *Philae* in June 2015. By comparison, the cartoons provided the bigger picture and helped to put past events into context, to manage expectations and to share the scientific findings of the mission.

As a result of this combined anthropomorphic approach, both *Rosetta* and *Philae* have been adopted empathetically by many, adults and children alike, and there have been many occasions when strong emotions have been stirred up by the pair, not least at the moment when *Philae*’s battery dwindled after three days on the comet. People continue to ask for more episodes of the cartoons, probably the greatest compliment one could hope for.

Conclusion

Even a mission like *Rosetta*, which is already communication-friendly by its very nature, can gain enormously through a concerted, strategic communication campaign spanning a wide range of approaches and audiences, bringing global visibility and widespread public engagement.

By stressing the human dimension, personalising the two protagonist spacecraft, telling the comet exploration adventure in compelling visual ways, and allowing the public and media to have a real-time ring-side seat for engagement and interaction, the *Rosetta* communication campaign helped create the fertile ground out of which arose huge awareness of and interest in the mission around the world.

Notes

See also Edward L. Bernays 1965, *Biography of an Idea: Memoirs of Public Relations Counsel*, (London: Simon & Schuster)

¹ More on *Huygens* and Titan: http://www.esa.int/Our_Activities/Space_Science/Cassini-Huygens

² The discovery of Martian methane through *Mars Express*: http://www.esa.int/Our_Activities/Space_Science/Mars_Express/Mars_methane_and_mysteries

³ More on *Planck* and the images of the cosmic microwave background: http://www.esa.int/Our_Activities/Space_Science/Planck

⁴ Regular participants of the weekly coordination teleconferences were: ASI, CNES, DLR, UK Space Agency, Swedish National Space Board, Istituto Nazionale di Astrofisica, Max Planck Institute für Sonnenforschung, NASA/JPL, TU Braunschweig, Centre National de la Recherche Scientifique, University of Uppsala, Finnish Meteorological Institute, Swedish Institute of Space Physics,



Figure 5. Rosetta Flight Director, with colleagues, in the mission control room after the successful landing. Credit: ESA/J. Mai

- Observatoire de Paris, Norwegian Space Centre, Institut für Weltraumforschung.
- ⁵ The approach to the rendezvous was presented in a continuous photo stream stemming from the Navigation Camera on *Rosetta*. The fact that the higher resolution images from the OSIRIS science camera could not be used for communication purposes during this time met with some criticism on social media channels. Since December 2015, OSIRIS has provided a regular image stream of recently acquired images.
- ⁶ Another example of an unexpected discovery came when the shape of Comet 67P/Churyumov–Gerasimenko was resolved and it was anything but spherical, resembling much more a duck with a body, a neck and a head.
- ⁷ ESA had already experienced what it means to recover from negative publicity in the case of the failed landing of *Beagle-2*, a UK-led lander carried by *Mars Express*, in December 2003, where it took almost two years to demonstrate the scientific success of *Mars Express*.
- ⁸ Landing day also saw the unfolding of a significant online and broader media debate about an inappropriate shirt worn by a key member of the *Rosetta* team and seen widely on television. While clearly an important and sensitive issue, the cultural and political implications have already been discussed in detail by many commentators, and further analysis is beyond the scope of the current overview article.
- ⁹ The platform livestream.com was used to enable livestreaming of the event.

- ¹⁰ During landing day, @ESA_Rosetta gained 156 000 followers, @Philae2014 278 000 and @esa 50 000.
- ¹¹ More on the Wake Up, Rosetta! campaign can be found here: http://www.esa.int/Our_Activities/Space_Science/Rosetta/Wake_up_Rosetta
- ¹² Examples of the Wake Up, Rosetta! messages created by the public can be found here: http://www.esa.int/Our_Activities/Space_Science/Rosetta/The_competition_winners_who_helped_us_wake_up_Rosetta
- ¹³ More information on the Rosetta, are we there yet? competition can be found here: http://www.esa.int/Our_Activities/Space_Science/Rosetta/Rosetta_are_we_there_yet
- ¹⁴ The Rosetta, are we there yet? winners can be found here: <http://blogs.esa.int/rosetta/2014/08/28/rosettaarewethereyet-winners-announced/>
- ¹⁵ More on NASA's Mars rover *Curiosity*: <http://mars.nasa.gov/msl/>
- ¹⁶ More on JAXA's asteroid probe *Hayabusa*: http://global.jaxa.jp/projects/sat/muses_c/

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