How to Boost Engineering Support Via Web 2.0 (Seeds for the Ares Project … and/or Yours?)

David W. Scott
National Aeronautics and Space Administration
Marshall Space Flight Center, EO20
Huntsville, AL 35812
256-544-3226
Scotty@nasa.gov

.

Abstract—The Mission Operations Laboratory (MOL) at Marshall Space Flight Center (MSFC) is responsible for Engineering Support capability for NASA's Ares launch system development. In pursuit of this, MOL is building the Ares Engineering and Operations Network (AEON), a web-based portal intended to provide a seamless interface to support and simplify two critical activities:

• Access and analyze Ares manufacturing, test, and flight performance data, with access to Shuttle data for comparison

• Provide archive storage for engineering instrumentation data to support engineering design, development, and test.

A mix of NASA-written and COTS software provides engineering analysis tools. A by-product of using a data portal to access and display data is access to collaborative tools inherent in a Web 2.0 environment. This paper discusses how Web 2.0 techniques, particularly social media, might be applied to the traditionally conservative and formal engineering support arena. A related paper by the author [1] considers use of Web 2.0 in real time operations control environments.[1][2]

TABLE OF CONTENTS

INTRODUCTION

Developmental engineering support for NASA's Ares I launch system provides underpinning across design, development, and test phases. Less visible and in certain respects mellower than its cousin, Flight Control Operations, it deals with vast quantities of data across a broad range of times and events, frequently requiring comparison and analysis of multiple instances of events, e.g., rocket engine firings, stress tests, etc. Having collaborative tools on the same system that's used for data review and analysis will be valuable for tasks such as building iterative post-flight evaluation reports that feed into official post-flight evaluation records. Figures 1 and 2 illustrate the fundamental concepts and scope of AEON.
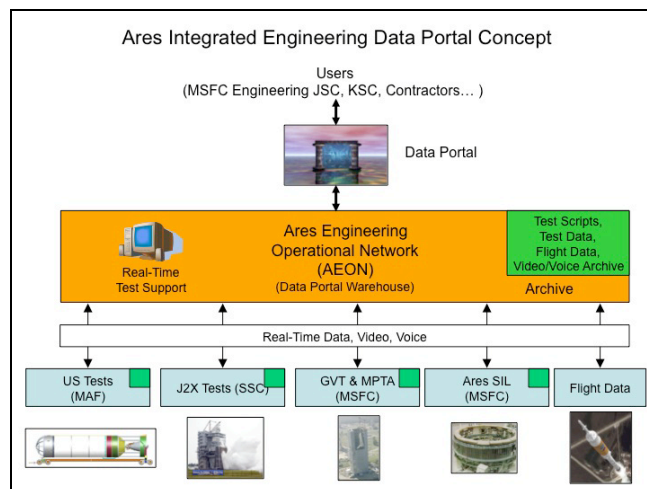

Figure 1 – AEON Concept

Figure 2 – AEON Data Perspective

[2] IEEEAC paper#1560, Version 2, Updated 2010:01:04

The data plotting and analysis software is mature, and the current version of AEON emphasizes consistent access among such applications. AEON's COTS collaboration environment has a strong set of document management tools, which will be used to store test data and related procedures, results, etc. (The Constellation Program's Integrated Collaborative Environment (ICE) is the official repository for archiving and tracking formal requirements, deliverables, and meeting minutes.)

AEON uses Web 2.0's dynamic content capabilities so that AEON web pages look and feel as if applications were running on a local PC. Due to Ares I-X data analysis needs, collaborative services of the COTS engine had not been exploited in depth at the time of this writing, but could be used to implement ideas discussed here.

While NASA uses Web 2.0 collaborative tools quite a bit for public affairs, the tools are new to MSFC as a whole, as well as to local Engineering Support activities, technically and especially culturally. Discussions with individuals at several NASA centers has identified 3 significant NASA engineering web sites that use such tools to some extent.

Discussions with about 50 colleagues indicate that fewer than 10% can readily define the core mechanisms, strengths, and contexts of the tools in a work environment, though most have had contact with some tools, often at home.

Just what is "Web 2.0"? The term was popularized by Tim O'Reilly, founder of a major U.S. technology transfer firm and a promoter of the open software movement. In 2004. he and other computer industry gurus observed that companies that survived the bursting of the dot-com bubble in the early 2000's had certain things in common that were fundamentally different than before the collapse. [2]

In O'Reilly's words, "…Web 2.0 doesn't have a hard boundary, but rather, a gravitational core. You can visualize Web 2.0 as a set of principles and practices that tie together a veritable solar system of sites that demonstrate some or all of those principles, at a varying distance from that core." Figure 3 illustrates this concept. [3]

Note –Web 2.0 has an open, "free to the end user" nature that relies significantly on Web advertising to pay service providers. Of course, government and restricted user base sites typically don't have advertising, so such entities may contract with the provider for dedicated/secure servers or license the technology and host it themselves.
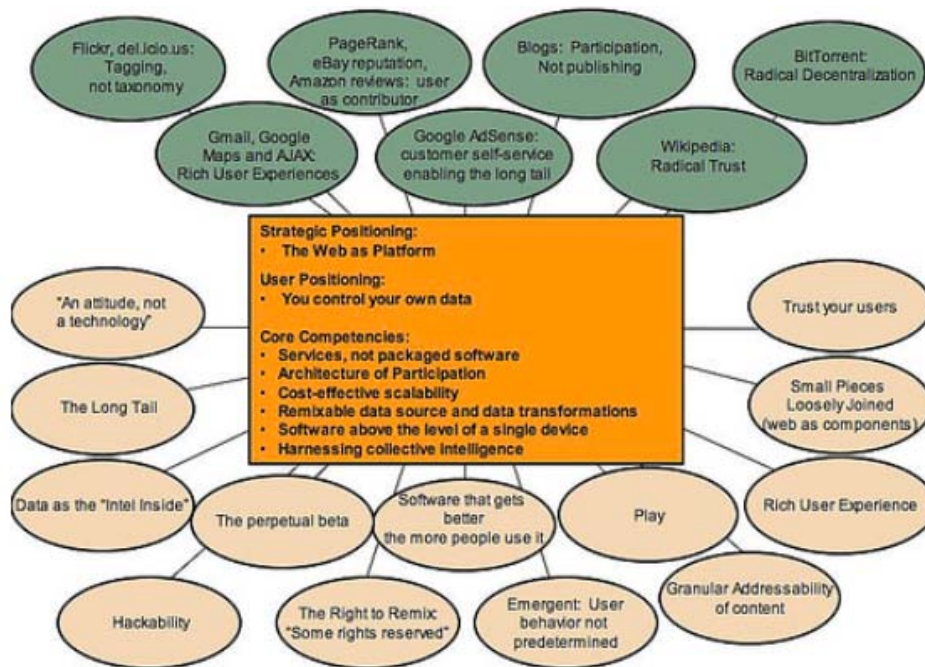

Figure 3 – Web 2.0: A Gravitational Core and its Resulting Solar System

Here's a thumbnail characterization of Web 2.0:
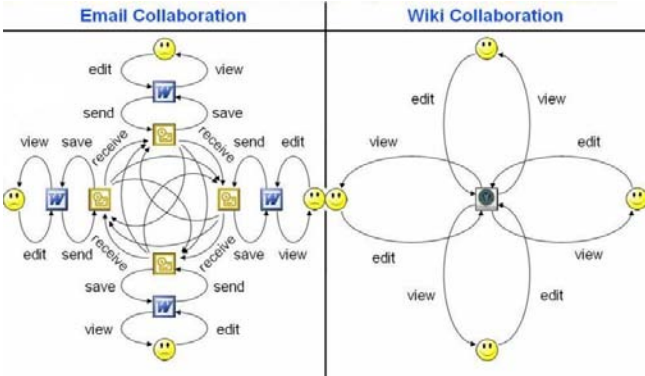
Emphasize services over content. Users manage the data and how it reaches them. Promote online collaboration and sharing among users.	Web 1.0 was commerce. Web 2.0 is people. Web 1.0 and email are one-to-many. Web 2.0 is many-to-many, with one-to-one capabilities

SIGNIFICANT TERMS

Table 1 identifies some major techniques and applications typical of Web 2.0. Subsequent discussion focuses on how most of these can benefit engineering support efforts. Many improvements pertain to endeavors in other disciplines as well. (Some terms are included just for cognizance.)

Term	Definition	Distinction From Traditional Methods
Social Media	Media designed to be disseminated through social interaction, created using highly accessible and scalable publishing techniques.	Transform broadcast media monologues (one to many) into collaborative dialogues (many to many).
Blog	A diary published on the World-Wide Web, usually written by an individual but sometimes by corporate bodies. …contributes to the easy exchange of ideas… The home page usually shows the most recent article and links to earlier articles, the owner's profile, and web logs written by the owner's friends. There is usually a facility for readers to add comments to the bottom of articles.	Information is free-flowing and discoverable, as opposed to 'stovepiped' and sanitized. Reader comments to blog entries provide valuable perspective and contrasts, plus answers to questions, problems, issues, or opportunities raised in or triggered by independent of the main post. These may be of value to the blogger and other readers.
Wiki	A collaborative website that users can easily modify via a web browser. A typical wiki allows participants to edit, delete or modify content, including the work of other authors. This has worked surprisingly well because contributors tend to be more numerous and persistent than vandals, and old versions of pages are always available. (It is possible to limit editing but allow comments.) Wikis are often used to power community websites, for personal note taking, in corporate intranets, and in knowledge management systems. "Wiki" (pronounced [ˈwiki] or [ˈviki]) is a Hawaiian word for "fast.	Eliminates proliferation of email chains with embedded content. Spend time editing, not transmitting/receiving.
RSS	A de facto, XML-based standard for automatic syndication of Web content, typically blogs, news, etc., but could syndicate a web app. Site authors create an RSS feed of their content and register it with an RSS publisher. Users configure their reader to subscribe to desired feeds. RSS readers show changes for all feeds user opts into, but original feed can be accessed for in-depth research. The acronym has many meanings - the most common is "Really Simple Syndication".	Instead of spending time searching sites of interest to find information, new information on those sites finds the user. By using a reader application or web site instead of email, the info is available and consolidated, and not an interruption. In workplace settings, conducting a project with a web tool with an RSS feed provides more incremental, timely updates to the team and the project manager than periodic emails and status meetings. This hones troubleshooting and enhancement activities.
Social Network Site or Service (SNS)	A website and/or application that builds online communities of people who share interests and/or activities, or who are interested in exploring the interests and activities of others. SNSs encourage new ways to communicate and share information. Examples: Facebook, MySpace, Plaxo, LinkedIn, Twitter, and Yammer.	Facilitates sharing of information through the social graph, the digital mapping of people's real-world social connections. Connections and development of the community can be as important as the information.
Folksonomy	Collaborative creation and management of tags to annotate and categorize content.	Bottom-up classification system means information conforms to users' preferences instead of forcing users to conform their thinking to the data's presentation.
Facebook	An extremely popular SNS with over 350 million active users. Users create and customize their own profiles with photos, videos, and information about themselves. Friends can browse the profiles of other friends and write public or private messages on their pages.	(See SNS definition)

Twitter	A free social networking and micro-blogging service. Users send and read "tweets", text-based posts up to 140 characters long. Users may subscribe to – "follow" - others' tweets, and may view them via browser, dedicated app, and/or receive via email or mobile phone text message. Also permits direct messages between individual users.	Archives of an individual's tweets are readily available, even if not following them. Brevity of tweets provides opportunities for text mining and trend analysis across traffic streams. Use of tags enhances this.
Yammer	A service similar to Twitter, focused on organizations – each org's network is private, and is based on email domain. Groups within the company can be formed. Basic membership is free, with paid advanced services and configurations available. Tweets are short, but not limited to 140 characters, and may have attachments.	
Social Bookmarking	Bookmarks are saved on a website with user-assigned tags, and thus may be identified/accessed in multiple contexts. Bookmarks are available to other users (general public or established "friends") or may be kept private.	User's bookmarks are available on any networked computer using any browser. Users with common interests benefit from each other's bookmarks, simply by searching on tags.
Portals (not a Web 2.0 term, but relevant to discussion)	An extension to traditional dynamic Web applications, combines fragments provided by portlets (various applications and/or servers) into a single Web page. Portals and Web 2.0 services can cross-references each other. Portal technology is mature and widely used throughout NASA.	Promotes seamlessness from a user perspective.
Mashup	A web page or application that combines data or functionality from two or more external sources to create a new service. Integration is usually fast and easy, often using open interfaces and data sources to produce results not intended for any of the original pieces. (Example: AlertMap (hisz.rsoe.hu) mashes data from over 200 sources into a worldwide map of weather, biohazard, and seismic situations.) Term comes from the music industry technique of blending multiple songs and/or multimedia elements into a new work.	Often produces hybrid or "melting pot" display, while portal technology presents content in a non-overlapping, side-by-side "salad bar" style.
Webinar	Web-based seminar. . . A workshop or lecture delivered over the Web. . . may be a one-way Webcast, or there may be interaction between the audience and the presenters. May include audio and/or video streams.	In addition to enabling remote presentation of charts, many webinar applications include text chat, multivoting, and other interactive features that, when recorded, capture the collaborative process.

Table 1 – Some Major Web 2.0-Related Techniques and Application [4]

COLLABORATIVE NASA ENGINEERING SITES

As noted in the introduction, production uses of Web 2.0 collaborative tools at NASA seem to be primarily in public affairs. Three fairly large-scale engineering-related efforts have come to light, and there could be more:

• The Constellation program's ICE, mentioned in the Introduction, has several thousand registered users, and is being expanded to serve a variety of Exploration and other projects across the agency. It has wiki capabilities that are customized to user organization preferences, and also supports traditional applications for file management, requirements definition, etc. Blogging and other Web 2.0 applications could be added.

• The NASA Engineering Network, sponsored by the NASA Office of the Chief Engineer, also serves several thousand NASA engineers across the agency with technical communities of practice for disciplines such as

Guidance Navigation and Control, Structures, and Systems Engineering, a semantic search engine, wikis, forums, expertise location, collaborative document authoring, and sharing of NASA lessons learned.

• MSFC's Engineering Knowledge Management (ME KM) system, which is going "live" in early 2010 after 4 years of development, embeds engineering practice and workflows to capture and reuse knowledge, best practices and lessons learned, and provides access to internal/external information, knowledge content, training and subject matter expertise. It will be offered as a Center-wide professional collaboration and enterprise search platform.

Also, an internal NASA Social Network Site, appropriately named Spacebook, was begun in 2008 by Goddard Space Flight Center, and is evolving. There is also a Yammer site for the NASA email domain. MSFC is revamping an internal blog/wiki service, and has begun to introduce the Center community at large to Social Media. A resulting primer is publicly available at http://bit.ly/8rPon6.

WHY IS SOCIAL MEDIA IMPORTANT?

There are distinct differences between data, information, and knowledge:

- Data is fact without context.
- Information is data presented in context.
- Knowledge of what to do with information enables sound decision making, regardless of project phase.

The bottom line is that PEOPLE hold the knowledge, even if assisted by databases, web sites, and the like. Social media and networking link people more effectively, resulting in better knowledge sharing and better decisions. [5] It does this in at least two ways:

- Collaborative tools enable conversations among known interested parties across geographic and/or time gaps, and by capturing and/or cataloguing the results instantly.

- Search engines introduce conversations to previously unknown interested parties, multiplying collective knowledge and participation.

In addition, improved capture of the knowledge sharing process often leads to insights and opportunities that are otherwise missed. Process is often as important as product.

The author believes that adoption of Social Media as an everyday working tool has been slow for two main reasons:

• The best-known examples, e.g., Facebook and Twitter, have been experienced, and often merely observed as activities of our friends and/or families, in the sense of "social" as "friendly companionship or relations." if "social" is reframed as referring to the interactions among organisms and their collective co-existence, perhaps our means of communication will receive as much attention as we give to the interactions among aeronautical systems and their collective co-existence.

•It's common for people to avoid investing the time and risk of learning new, potentially more effective methods because "there's too much work that needs doing right now." This phenomenon might be reduced if organizations require their member to spend a certain amount of time exploring, "playing", and sharing the results.

BLOGS, WIKIS, RSS

The basic value of group dialog and/or authorship provided by blogs and wikis, free of the redundancies, confusion, and clutter of email chains, is plain. Discoverability is a significant added benefit – search engines, user and author-assigned tags, and inclusion in RSS feeds allow interested parties not on distribution lists to find relevant items and join the conversation if admin permissions allow. All this, and automatic archiving, too.

For engineering support, the following uses come to mind:

• Orientation and training. While the author was developing Ares I Upper Stage training in 2007-2008, one of the most frequent concerns voiced by engineers and managers was not having a big picture of what other teams were working on and "worrying" about. A major part of this problem stemmed from a) having an ocean of information too big to sort through, especially when standing outside a particular discipline, and b) formal documentation takes too long to catch up with current reality. The "highly accessible and scalable publishing capability" of Social Media can overcome these challenges brilliantly.

• In any environment, wikis work well for encyclopedia functions – defining terms, explaining "how-to's", "gotchas", and the like. Uncontrolled wikis could be used to capture guidance, advice, and issues for escalation to other forums. A more controlled, wiki-based glossary could show established terms, identify proposed and approved additions or changes. Official revision can be decreed more frequently with little or no cost.

• Discuss major concepts, themes, and issues during

each phase of document preparation, embedding links to specific documents or, better yet, to appropriate locations within those documents. This would be especially useful in flagging and tracking cross-disciplinary items. More detailed discussions could be linked to the major ones, and vice versa.

• Support formal document reviews. At the very least, this could lubricate the interchange between Review Item Discrepancy (RID) authors and RID reviewers, and among reviewers prior to contacting authors. Ideally, RID management could move away from manual handling of "Change wording from" and "Change wording to" spreadsheets to a wiki-based system with capabilities to spawn side discussions and keep track of dependencies within or across documents. Hyperlinks and/or floating windows might let participants see proposed changes in context. It should also be possible to submit graphics integrally in a RID. The author knows of a developer who is working on precisely such an application, and there are probably others.

• Rigorous configuration management is an obvious need for engineering efforts, especially for space and human-rated systems, yet wikis produce more rapid convergence on "truth" than traditional methods of document circulation and review. Standard wiki editing adopts all changes and saves archive copies, which would be difficult to follow and could create chaos. However, a wiki/blog combination that shows a proposed change and the original text or graphic, immediately notifies interested parties (already part of Web 2.0 subscription models), accepts comments, and organizes an attached or linked discussion with moderation by the document manager, could improve both the quality and speed of modifications by orders of magnitude. To the best of the author's knowledge, this application does not exist currently, but might be built as a mashup.

• RSS provides an ideal mechanism for making information available to all who have an interest. There are ample provisions for access restriction, if needed. Mandatory reviewers can be notified via traditional email distribution lists.

SOCIAL NETWORK SITES

A major inhibitor to using SNSs at work is apprehension about being open with one's profile. This is quite understandable, given the free-for-all appearance of extemely popular sites like Facebook and Twitter and the images they conure up. Using more closed environments such as (for NASA's situation) Spacebook, NASA Yammer, or an SNS embedded in a major engineering site should provide intimacy to encourage participation. Facebook-like SNSs have great potential for engaging in

the "hall talk" that keeps us connected as people, which bolsters our capacity for technical discussion.

There could be valid uses for an applications similar to Flickr, a SNS based on photographs, especially since users can assign "tags" to dynamically re-categorize photos, saving on the overhead of shuffling and re-shuffling through traditional online photo archives. The same concept applies to video storage and retrieval.

It's generally known that the original basis of Twitter was "In 140 characters or less, answer the question, 'What are you doing now?'" If that's all one does with the service, it stands to reason that traffic can easily become boring, especially if it's just people describing their daily doings.

Of course, there have been some good twists on this. For example, progress on some Martian rover missions has been broadcast as though the rover was a "person." In addition to having public appeal, the tweets provided an excellent "big picture" of what was going on. This same method could be valuable for real time engineering support of launch or Upper Stage and/or engine test operations. Tweets could be generated manually and/or automatically, depending on what information is intended. As usual, followers can tailor reception preferences to match their needs for instant vs. when-convenient review of information.

The above is still a "What are you doing now?" approach. More value can be added by tweeting "Aha!" moments or appeals for help on questions/issues. These can be followed up with more detailed discussion via other social media, email, phone, or face-to-face meetings. The power of the technique is automatic notification of those who are following the tweeter who, in a workplace setting, have a common interest. This is especially true for Yammer, since a given user logon is restricted to a common email domain.

PARTITION AND CONQUER

Email messages intrinsically clamor for one's attention, and one feels obligated to do something with them. Social media content can be kept isolated from your email, reducing the pressure in the fire hose you've been drinking from. Then, when you have the time and orientation to go fishing in social media waters, you'll find them to be relevance-infested!

VIDEOCONFERENCING AND WEBINARS

Desktop videoconferencing has been readily available for a good 15 or 20 years, as has screen sharing (passing screen draw and keyboard/mouse commands across the network, with remote workstations performing the graphics work to recreate the screen image being

observed and/or controlled). Most solutions involved dedicated software on the desktop and direct communications with participating nodes, or sometimes a server. Until fairly recently, neither function had caught on in a big way.

Today's tools are predominantly web-based and are seeing wider usage, particularly environments such as Webex and Elluminate, which often include text chat and polling tools in addition to the primary document display. Much of the innovation in conferencing is taking place in the e-training industry.

Videoconferencing technology can transmit excellent quality video at low bandwidths (e.g., 720p at 1 Mb/sec).

The challenge with video is more cultural than technical. A few years ago, a group that conferred weekly had to stop using because offline remarks, while not audible, were visible (body language)! The stress relief (in both directions) of being able to make offline comments was more important than having constant visual contact.

This is not so say that video should be avoided per se. Occasional vidcons can positively reinforce the personal relationships that make for good exchanges via phone, email, and social media. And of course, if there are products or methods to demonstrate, video is the next best thing to being there.

CONCLUSION

Web 2.0 methods are in fairly broad use at NASA for public affairs. At least three sizable systems – ICE, NEN, and ME KM – are implementing Web 2.0, particularly social media, to varying extents. NASA-centric Social Network Sites (Spacebook and NASA participation in Yammer) are evolving.

While this paper has not addressed electronic and/or information security issues related to the use of Web 2.0 tools, these should be manageable. Similar challenges related to new media have been solved in the past.

The major challenge to adoption of Web 2.0 collaboration methods in the above systems and in AEON is the same as that facing organizations in general: spawning cultural change by education and training to overcome stereotyped views and attitudes and to encourage the transition from "push" to "many-to-many" Fundamentals may be taught with modest resources, http://bit.ly/8rPon6 being a place to dip one's feet into the water.

Social media can dramatically improve a) the density and organization of relevant information exchange among engineering support personnel and b) the efficiency, capture, and tagging of collaborative activity as it occurs.

REFERENCES

[1] David W. Scott, "Using Web 2.0 (and Beyond?) in Space Flight Operations Control Centers," AIAA SpaceOps 2010 Conference Proceedings, April 25-30, 2010

[2] Tim O'Reilly, http://oreilly.com/web2/archive/what-is-web-20.html, Sep 30, 2005

[3] Ibid.

[4] Descriptions adapted from wikipeidia.com, computerlanguage.com, thefreedictionary.com, campus-firewatch.com, engagedlearning.net. Wiki diagram from engagedlearning.net

[5] Adapted from Kevin Jones, "I Finally Get It – Why Social Networking Is So Important," engagedlearning.com, Sep 29, 2009

BIOGRAPHY

David W. Scott, alias "Scotty", is currently developing innovative interfaces and applications for the Hunstville Operations Support Center (HOSC) at NASA's Marshall Space Flight Center in support of ISS payload operations. He was a Payload Communications Manager for the International Space Station from 1999-2007. He's spearheaded several console technology projects, especially in space-to-ground videoconferencing and audio archiving. He was a payload communicator for the ATLAS-1 Spacelab mission in 1992, and helped design the payload training program for Space Station. He spent 6 years as a U.S. Naval Officer, including flight duty in F-14s, and holds a B.S. in Physics and Mathematics from Principia College.*