[Un]breaking News: Design Opportunities for Enhancing Collaboration in Scientific Media Production

C. Estelle Smith, Xinyi Wang, Raghav Pavan Karumur, Haiyi Zhu
GroupLens Research,
University of Minnesota,
Minneapolis, MN, USA
{smit3694, wang4831, raghav, zhux0449}@umn.edu

ABSTRACT

Contemporary scientific media production requires a complex socio-technical infrastructure we call the "Media Production Pipeline" (MPP). Media professionals engage with researchers along the MPP to disseminate science news to the lay public. However, differing incentive structures and professional contexts frequently set researchers' values and needs at odds with those of media professionals, resulting in problematic or failed interactions. We ask the research question: what pain points in scientific media production afford opportunities for future HCI innovation? We then present a grounded theory analysis of 24 interviews with researchers and media professionals, yielding several key contributions. First, we describe two collaborative domains in scientific media production between research advocates and media outlets. Second, we characterize discrete technological gaps and pain points in both domains. Finally, we discuss implications for design and propose solutions from HCI areas like peer production, online communities, recommender systems, and online collaboration.

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

Author Keywords

Mass Media; Journalism; Misinformation; News Production; Science Communications; Online Collaboration

INTRODUCTION

Original scientific proceedings are largely incomprehensible to the general public, who rely primarily on mass media to access lay-accessible translations of scientific knowledge [8]. However, set against international deficits in scientific literacy [16, 19, 37, 50, 53], science news has historically comprised only around 5% or less of newspaper coverage in the US and UK [38]. In response to declining audiences and evolving information environments, Western mainstream media have been forced to cut staff and reformulate profit models [8]. Furthermore, lay-accessible media sometimes contain serious mistranslations of science in general [6, 30, 45], and of HCI specifically [58], which may aggravate literacy problems.

Scientific media production is a complex system involving myriads of stakeholders and multiple tiers of translation. Improving this system is necessary to increase scientific literacy, but extremely difficult due to its complexity. Numerous prior works in HCI have explored individual solutions for problems related to media production, but a holistic understanding of the design space is lacking. Therefore, this paper aims to provide an overview of scientific media production and highlight how different components within this system interact with each other. To that end, we present a grounded theory analysis of 24 interviews with HCI researchers and media professionals, seeking to answer the research question: **What pain points experienced by stakeholders in science media production afford opportunities for research and innovation in HCI?**

Based on participants' descriptions of their professional values, roles, and challenges, we define the "Media Production Pipeline" (MPP) as the socio-technical infrastructure that supports the comprehensible dissemination of scientific results and rationale to the lay public. Our results describe two collaborative domains between: (1) researchers and Public Information Officers, who together function as "research advocates," and (2) research advocates and media outlets. In both domains, we characterize pain points that result from challenging interactions with people or technology. Taking this higher level view of the MPP generates a powerful perspective with new insights for future work that could enable systematic change.

RELATED LITERATURE

The study of scientific literacy is a discipline unto itself, with multiple definitions and measures of literacy. A 2016 report by the US National Academies of Science, Engineering, and Medicine states that representative samples of adults from Western and Eastern countries perform similarly on simple knowledge-based science quizzes, answering ~60% of questions correctly [53]. Yet percentages may drop when literacy definitions include the ability to reason about scientific information as it relates to purchases, public policy, or culture [50]. A 2016 NASA report states that while 52% of Amer-

CHI 2018, April 21–26, 2018, Montréal, QC, Canada.

http://dx.doi.org/10.1145/3173574.3173955

ican adults are "very interested" in STEM issues, only 28% possess adequate scientific literacy to understand and discuss scientific results [37]. A 2014 Eurobarometer indicates that more than half of Europeans have studied and have a positive affect towards science, although it reported no measures of knowledge or reasoning abilities [16]. A 2010 Chinese survey indicates that 14.67% of citizens possess "the necessary scientific knowledge" and that only 3.27% have "basic scientific literacy" [19]. Yet communications scholars have also argued that peoples' explanations of phenomena result from conceptual, psychological, and linguistic factors derived from their own experiences in the world rather than critical reasoning [5].

While factors like education level [37, 53] and psychology [5] clearly affect scientific literacy, mass media (defined as "all means of mass communication to reach a national and international audience" including broadcast, print, and digital media [58]) represent the public's primary ongoing access point to contemporary scientific knowledge [8]. Furthermore, Web 2.0 (a term used to denote the "interactive use of the Internet" [8]) has dramatically impacted how lay consumers access and contribute to scientific media. For instance, "ambient journalism" on Twitter creates continual awareness systems [27] that may be fraught with cascading misinformation [21] and which form "alternative" information ecosystems [55]. Anyone (including researchers) can post or share blogs, comments, tweets, or updates about science that may or may not be credible. However, even in ~20-35% of real science stories by legitimate mainstream media, reporting errors may occur [6, 30, 45]. We begin by drawing from prior work to situate these misrepresentations as translational errors, which could potentially be reduced.

Science Communication as Translation

Diffuse literature in HCI suggests that an act of translation is required in participatory design or communication of design implications to industry practitioners [12, 43, 62]. It is difficult for scientific HCI expertise to be transmitted to (and used by) practitioners if there is not an effective translation between both parties and a situated mutual understanding of the translational act. Prior works from translation and journalism studies also suggest an analogous relationship between scientific experts and the general public.

Journalists have traditionally acted as gatekeepers [52] and translators who gather, reinterpret, contextualize, and edit scientific knowledge [57]. Yet journalists act within a broader systematic context. Ultimately, news story artifacts may result from interactions between media production roles, audience reception, and socio-historical context [13, 15]. Although error rates in representations of science appear to be justified, most journalists are not making errors out of laziness, though they may be motivated by political or ideological agendas [38]. We therefore refer to these errors as "mistranslations" which might be improved through systematic or contextual change. Just as HCI researchers stand to improve translation of their work to technology designers, they also stand to improve translation of their work to the general public. By aiming to improve the quality of science translation in real news, this paper complements the growing body of work on fake news.

Misinformation and Fake News

Misinformation is a critical topic in contemporary political discourse. A serious breach of fake news across social media accompanied the 2016 US presidential election, with just over half of fake news viewers believing the misinformation [1]. Web 2.0 mechanisms easily obviate journalistic gatekeeping by allowing non-experts to disseminate misleading information, e.g. in blogs or tweets, that can be deemed more credible than traditional media [31, 32, 35], while many consumers may not even be able to differentiate factual news stories from opinion blogs on news sites [8].

In order to automatically detect fake news (i.e. fabricated or manipulated stories, or hoaxes and satire [47, 60]), some studies use machine learning and natural language processing techniques (e.g. [41, 44]). Others seek to automatically identify problems like arguments lacking adequate evidence [54] or headlines that don't match article contents [11]. Some analyses explore problems like information credibility [9, 39, 40, 55] and tracking or correcting errant information in social networks [2, 21]. Recent work suggests that understanding news production processes decreases endorsement of conspiracy theories [14]. Whereas prior work examines rumors or illegitimate media, the present work seeks instead to identify solution opportunities for enhancing collaborative mechanisms that produce legitimate news. Yet a sizable body of HCI works also examine individual components of news production.

HCI for Media Production

An emerging trend indicates that technology and data both play significant roles in the production and distribution of news [24]. For example, Twitter is an important marketing and research tool for journalists and news websites [27, 59]. Likewise, various tools have been invented to improve the efficiency of media production. Some works have explored how to help journalists gather information about specific news events [7], generate headlines using Natural Language Processing [56], or use recommender systems to find stories to cover [42]. Others help journalists find appropriate people to comment on news stories, such as experts or people within particular social networks [3, 4, 18, 20, 25, 26, 36], or what journalists refer to as 'real people' (lay citizen stakeholders in news stories) [22].

However, prior research often examines discrete production problems rather than systemic structure from the perspective of a single media stakeholder group. Furthermore, prior work has not focused on science communications, in which context the lack of opposing perspectives from scientific experts is a critical research gap. Vines et al. describe problematic representations of HCI in the news, however they offer cautionary warnings rather than design implications [58]. Brossard suggests that science communications could better leverage the online revolution for greater public engagement [8], yet a holistic understanding of the design space for new tools in scientific media production is currently lacking. We aim to close this gap by providing a high-level overview of contemporary scientific media production processes, showing how different nodes interact, and suggesting design opportunities in HCI.

METHODS

This study employs a grounded theory approach [10] to understand the nuanced design space that exists in scientific media production. We conducted semi-structured interviews [49] with a professionally and internationally diverse group of stakeholders along the MPP. In this section, we describe our recruitment, interview protocol, and analysis techniques.

Recruitment and Interview Protocol

We recruited 13 HCI researchers whose work has been covered in the mass media and 11 media professionals whose work sometimes covers HCI. We began recruitment through email and in-person interactions at the 2017 CHI conference in Denver, CO, and utilized a snowball sampling technique to elicit more participants until we reached data saturation. All interviews took place in-person at the conference, or were conducted by Skype or telephone afterward, by the first and second authors. Two similar sets of prepared questions were used to guide semi-structured interviews, which lasted an average of ~48 minutes. Participants were asked to provide general descriptions of their experiences with or roles in the media, as well as of specific coverage instances of HCI research. We discussed workflows, tools, technologies, and asked about "dream" tools that could be invented, gathering data on problematic practices/interactions/outcomes from all perspectives.

Participation was voluntary and uncompensated. Participants included 14 males and 10 females based in the USA, UK, and China, with professional experience ranging from several years up to multiple decades.[1] To protect anonymity, we did not gather demographic information; see table 1 for recruitment statistics. We use the following abbreviations throughout this paper (parentheticals indicate numbers of participants):

- **HCIR:** HCI Researcher (13), including ten faculty, two graduate students, and one industry researcher
- **PIO:** Public Information Officer (5) employed by an industrial research lab or academic institution with titles like Communications Director, Media Relations Manager, or Public Relations
- **ED:** Editorial Director at a global news service (1)
- **FJ:** Freelance Journalist (2), one US- and one UK-based
- **SR:** Staff Reporter (3), full-time employees at a major US newspaper, major UK-based science magazine, and a popular science media organization that publishes to Facebook.

Anonymization

This study faces a 'small population' challenge for obscuring identity, since we report results back to the community being studied [48]. Since all participants are already publicly known, they are not "vulnerable," thus we do not require an extreme technique like "un-Googling" [51]. Using established anonymization practices, we do not present demographic information or names, referring to participants instead by roles concatenated with ID numbers [33, 34]. We sent participants portions of the pre-submission manuscript containing their quotes and allowed withdrawal of either entire quotes or specific contextual details (i.e. gendered pronouns, locations, etc.) within and surrounding quotes. We did not allow quote editing. This technique enabled participants to decide for themselves about our inclusion of details or quotes that might potentially enable readers to infer personal identities [34], without compromising the integrity of our data or analysis. No quotes or details were withdrawn as a result of this protocol.

[1] In order to avoid potential conflicts of interest, we did not recruit members from our own research group.

Participant Type		HCIRs	Other	Journalists
Recruitment Process	Contacted	23	13	21
	Completed	13	6	5
	Rate	56.5%	46.2%	23.8%
Geographical Base	USA	9	6	2
	UK	3	0	3
	China	1	0	0

Table 1. Recruitment Statistics. "Rate" indicates percent of successfully completed interviews; remainder declined or did not reply. "Other" includes 5 Public Information Officers and an Editorial Director.

Analysis through Iterative Coding

We adopted Charmaz' approach to grounded theory rather than the approach described by Corbin and Strauss, so that prior ideas and theory could be considered during analysis [10]. Thus, inductive codes extracted from interview transcripts, "sensitizing" codes from related works, and iterated codes from later-stage discussions guided analysis. According to Charmaz, members of the research team first transcribed all 24 interviews from ~19 hours of recorded audio. Next, we open coded all transcripts (generating over 1,300 individual open codes). Through a series of immersive meetings, all authors discussed and clustered codes, analyzed themes, and iteratively developed a codebook containing 48 codes, along 13 axial categories, 4 of which fell under the major category of "mistranslations," and 9 of which fell under the category of "production pain points" spanning two collaborative domains. Finally, to ensure consistent application of codes, the first author recoded all transcripts. In this paper, we present our analysis of "pain points," whereas our analysis of "mistranslations" is currently a working paper.

BACKGROUND ON MEDIA PRODUCTION

In this paper, we regard peer-reviewed science as original material and explore how it is translated *"from academese into English" (PIO5)* along the MPP (fig. 1), as defined in the Introduction. Contemporary media production is a complex combination of traditional journalistic and emergent Web 2.0-enabled production mechanisms. We present five production "nodes" through which content flows and can be modified. Our results detail numerous interactions between these nodes specifically, and with the Internet broadly. Node 1 is the research lab, where HCIRs produce original scientific research. Node 2 includes communications departments in academia or industry, where PIOs work to communicate notable milestones to internal and external audiences through websites, blogs, print publications, events, and social media. PIOs also translate scientific manuscripts into short "press releases"

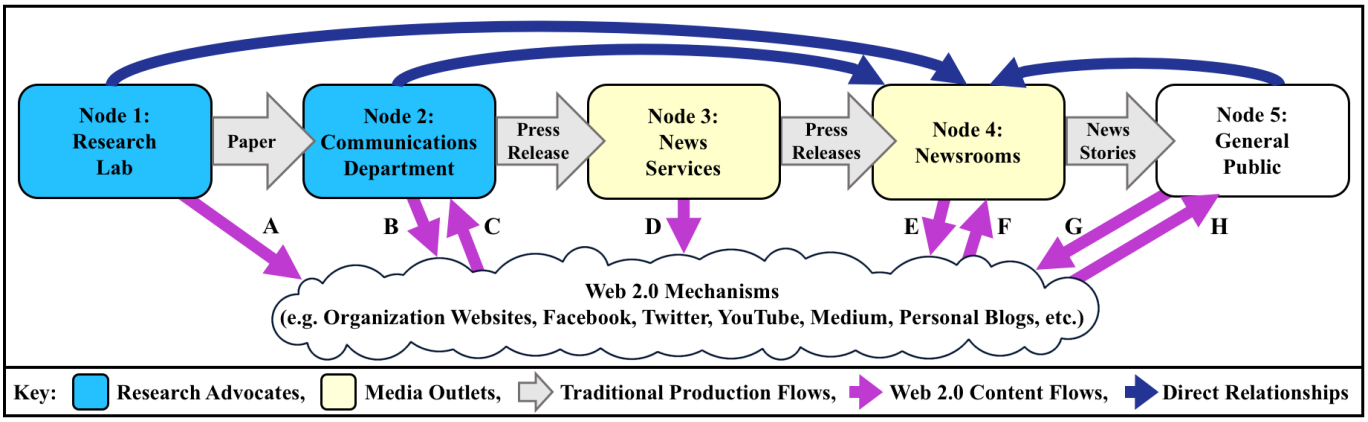

Figure 1. The Media Production Pipeline for Scientific Content. Arrows show possible routes for content flow. A: Medium/personal research blogs, tweets, Facebook posts, YouTube videos. B: Social media posts, formal press releases. C: External news, re-shared via B. D: Press releases. E: News articles/videos/photo decks, live broadcasts, podcasts. F: Content from other nodes, esp. trending news stories, replicated via E. G: Tweets, Facebook posts, comments, re-reported via F->E. H: News items algorithmically curated by feeds or aggregators via Web 2.0 metrics, e.g. likes, shares, retweets.

(600-800 word stories) intended to engage media outlets [58]. Node 3 includes news services that aggregate and distribute press releases (e.g. AlphaGalileo, EurekAlert!, Newswise, PRnewswire) via websites and email digests. Some services offer massive databases with contact information and search tools to find journalists that cover particular beats (e.g. Cision, Meltwater). News services facilitate the "embargo system", i.e. if press releases or manuscripts are not yet publicly available, PIOs and credentialed journalists can receive early access under an embargo, but cannot post stories until the embargo is lifted [58]. Node 4 includes newsrooms, which are central locations utilized by reporters, editors, and producers to select news stories for their media outlets [61]. A huge variety of media outlets (i.e. newspapers, magazines, TV, radio, social media publishers, etc.) use hybrid offline/online newsrooms to assign stories to journalists, who then translate them for specific audiences. Node 5, the general public, is ultimately the target audience. Yet now, even lay citizens contribute content to news stories through social media posts and comments [8].

The traditional MPP traversal occurs when HCIRs (Node 1) work with PIOs (Node 2) to generate press releases; Vines et al. describe this process in detail [58]. Next, PIOs post press releases to news services (Node 3) which send them to newsrooms (Node 4). Editors/journalists can use releases to find stories. They then conduct independent reporting for their outlet and make the story available to the public (Node 5). However, many pathways wind through the MPP, as we discuss throughout this work. Most newsrooms rely on long-standing professional relationships with trusted sources at Nodes 1 or 2 more than press releases alone [38], or else they scour the Internet for intriguing stories, sometimes even gathering content from friends and family. On the other other hand, researchers frequently push scientific content online independently of journalists [8]. In addition to updating personal websites and CVs, many HCIRs utilize social media to disseminate results. These posts are primarily intended for a professional audience of colleagues, but are accessible by the public. To complicate matters, journalists may follow prominent HCIRs on social media, or else maintain professional relationships with them, hoping to scope out interesting research well in advance of peer-reviewed publication. PIOs routinely post stories to their organization's public-facing websites and publications, or bypass news services to pitch stories directly to editors or reporters. Thus, the MPP provides a defined infrastructure for media production, yet supports many non-linear pathways for scientific content flow.

RESULTS

There are two fundamental domains of collaboration in scientific media production. The first is between Nodes 1 and 2, when HCIRs interact with PIOs to share milestones, write press releases, prepare for media, engage with media, and finally track coverage. Together, we refer to HCIRs and PIOs as "research advocates" since they share a collaborative domain as employees of the same organization. However, we cumulatively refer to many different organizations at Nodes 3 and 4 as "media outlets." The second collaborative domain is between research advocates and media outlets; these interactions are often more challenging because stakeholders have different employers, resources, timelines, and biases. Nonetheless, research advocates and media outlets must overcome tensions to collaborate against rapid production timelines towards shared goals of story identification, communication of methods, provision of expertise, and multimedia production (see fig. 2).

During selective coding, we identified over 30 discrete pain points in both collaborative domains, not all of which are relevant to this paper. Throughout Results, we present **boldfaced** pain points for which we believe technological innovation could ease frustration, increase efficiency, or improve output. In the Discussion, we then present design implications.

1. Collaboration of HCIRs and PIOs (Research Advocates)

As employees of the same organization, HCIRs and PIOs collaborate as research advocates, although they have different priorities. For some HCIRs, public scholarship represents a core value, thus working with PIOs to disseminate their work to lay audiences is a promising mechanism for enacting

this value. Press coverage can also increase the visibility of HCIRs' work, leading to career growth and external collaborations. PIOs, on the other hand, primarily aim to raise their organization's profile, which can increase reputation, recruitment, and funding opportunities. Thus, PIOs communicate and promote the most "newsworthy" [58] research at their organization. PIOs can work with handfuls, dozens, or hundreds of researchers, depending on whether they manage department, college, or university level teams. Due to the sheer volume of relationships and publicity-related tasks they manage, keeping up with research milestones is a non-trivial challenge.

1.1 Sharing Milestones

PIOs described three methods for keeping up with HCIRs. First, they rely on HCIRs to conscientiously get in touch over email or in-person when they have important accomplishments. Yet this practice immediately yields to self-selection bias:

> *"Some faculty will stop in my office and tell me about stuff. I wish more would. Some faculty just don't like their accomplishments being talked about. And we have some faculty who like their accomplishments talked about a lot. We're like, yea we don't need to do another one about you guys. This isn't your personal homepage. It's the department page." (PIO3)*

Second, some journals send notifications to PIOs when researchers at their organization have accepted papers. Third, PIOs occasionally skim conference proceedings where their researchers are likely to submit. These latter options, however, occur at a late stage and are easier to miss. In some cases, PIOs never hear about important work. Alternatively, if journalists somehow find the work and do a story, a PIO might first read about it in the popular press, which bypasses their ability to help present the work effectively. For example:

> *"The disappointment is that we probably could have done more with that, and sometimes we don't have the story on our website. ... Just like the journalists want to be timely, we want to be timely, so that we can give it a push and have it on our website so that it lives, going forward, whether for future media inquiries, or just opportunities for the researcher for their work to be known more widely than the week it is released." (PIO2)*

Three PIOs discussed problems related to tracking publications by their researchers. Thus, **there exists a gap for helping HCIRs and PIOs easily share milestones.** Once PIOs *have* learned about a given newsworthy milestone, however, PIOs work with HCIRs to write press releases.

1.2 Writing the Press Release

Participants' accounts of working on press releases echoed the detailed description presented in [58]. Briefly, PIOs sometimes write stories or press releases directly from the paper and then email author(s) to request quotes. More often, PIOs complete in-depth interviews with author(s) until they understand the research well enough to describe it correctly. Yet PIOs must also distill away enough detail to make the work instantly eye-grabbing and comprehensible to the lay person. *"I feel like I'm, excuse my language, but dumbing it down one level. [Journalists] sometimes need to dumb it down two levels."*

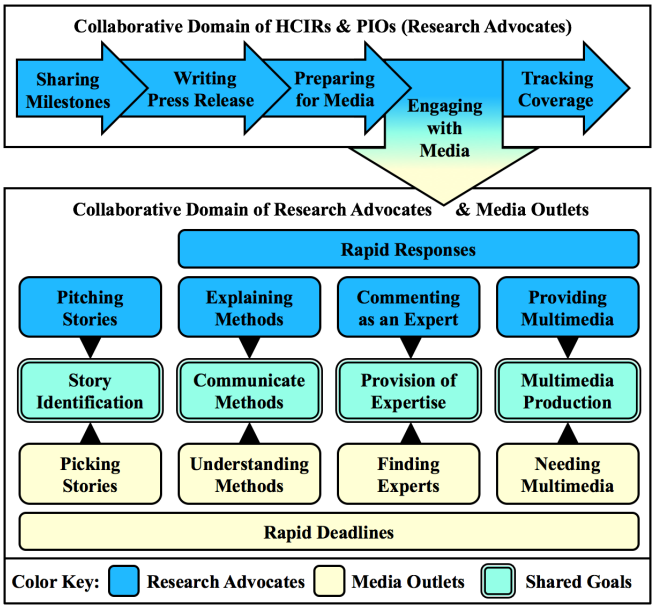

Figure 2. Interactions between Collaborative Domains in Scientific Media Production. Top: Block arrows show tasks shared by research advocates from the same organization. Bottom: Shaded boxes show objectives of research advocates and media outlets from diverse organizations. Shared goals are the abstract resolution of tensions between objectives.

(PIO4) To ensure accuracy, PIOs routinely send press releases to HCIRs for feedback and approval prior to publishing them. All HCIRs and PIOs indicated that they exercise caution and self-constraint while writing a release. Yet several stated that they became too familiar with it and thus did not recognize how their own writing might be interpreted by outsiders, e.g.:

> *"We reflected on how we unwittingly misrepresented the research ourselves in how we created our first press release. I don't think we felt we were doing this at the time, but looking back in hindsight, we probably put quite an overly positive spin on the potential of the technology based upon some preliminary insights." (HCIR6)*

Furthermore, press releases must not only be accurate and unlikely to be misinterpreted, they must also be engaging. Several media participants described how the only way they write headlines is through intuition and casual discussion, e.g.:

> *"Some of what I do is very unscientific. I walk around with some headline possibilities and just ask some colleagues, what do you think of this one? Does this one grab ya? ... I don't have another way to do it right now other than asking fellow pros, or people who know nothing, which is sometimes the most helpful because they're not already a priori interested." (PIO5)*

While writing press releases is a well-established procedure, our data confirm prior work stating that media professionals lack a complete understanding of their audience [38], thus another gap is that **participants struggle to understand how releases might be interpreted by uninformed outsiders.** Time-permitting, PIOs might also provide media training.

1.3 Preparing for Media

At many organizations, PIOs coordinate media trainings, including everything from informal chats to structured events. These trainings provide useful and personalized mentoring.

> *"Just the process of sitting down and talking with me, and trying to explain to me, who is outside the field, is helpful. Seeing the release is helpful to the researcher. And then in turn, later talking about it with either media or others, it gives them practice in how to present it to the public in a way that is palatable or understandable." (PIO5)*

However, trainings are not always completed prior to major coverage events, especially with junior researchers. Three HCIRs discussed how their largest instance of media coverage to date occurred during their early career.

> *"I'm awful for mind blanking and stuff like that, so I don't really do very well. I definitely didn't feel prepared [as a grad student]. ... I feel like I have a little bit more authority to talk about certain things now, after I've gone through my PhD." (HCIR11)*

> *"It was, for that university, the news of the year. Obviously, working with the press officer, like, oh my god, we've got all these requests, and they put us in the radio studio for a couple of hours, and they were like, these people are going to call in, you just sit down and you do radio interviews. It's almost like, this is such a great opportunity for the university, I felt, this is what we needed to do, and I wasn't prepped for it properly." (HCIR1)*

This concept was echoed by a current grad student:

> *"[Reporters] ask questions that researchers don't ask. ... They take me a little bit off guard, and I'm hoping that as I do this more, I'll get a better handle." (HCIR4)*

Media trainings with PIOs are important educational experiences, yet **PIOs are pressed for time and do not always have an opportunity to provide trainings prior to press engagements, and there is no technological solution presently available on demand.**

1.4 Engaging with Media

If a press release successfully engages the media, HCIRs must respond rapidly, whether or not they feel adequately prepared. However, media engagement involves collaboration between research advocates and media outlets, and thus comprises the second collaborative domain which we describe in the second section of Results. Thus, we move on to a final challenge for research advocates, i.e. keeping track of press coverage.

1.5 Tracking Coverage

Press coverage can range from a single article on a local newspaper or tech blog to an international media frenzy. Regardless of breadth, PIOs and HCIRs share the challenge of tracking coverage instances and deciding when (or if) to attempt corrections. One HCIR described a strategy of not following the press coverage because, *"You become a caricature of yourself. ... You don't want [press coverage] to reflect on your feelings about yourself, because it's not real." (HCIR8)* More often, however, HCIRs described haphazardly following coverage on their own. For example, *"I suddenly remembered two months later that I'd done this [interview], and so I Googled the reporter's name and my name and was like, oh, there it was published two months ago." (HCIR2)*

Furthermore, even when explicitly requested, media outlets do not necessarily send links to the final article, video, or audio:

> *"Even though it was the [media organization], and [they] archive everything online, I think because it was just a local TV show, we couldn't actually pin down the segments we recorded. And even though we asked [them] to send us copies, they never did. So we never got access to these things, and there's always a weird uncertainty." (HCIR6)*

PIOs felt that available tools do provide a general sense of coverage. Yet they also described specific gaps:

> *"Meltwater and Google Alerts are not looking at the amount of coverage on Facebook, for example. We're finding that certain publications will just go ahead and create a video that they'll put on Facebook. ... If I'm not following [them], I never see it, unless I go back to the reporter and say, hey, did you guys ever post it?" (PIO2)*

> *"If there's not a written web component, finding the broadcast instance is hard. There are services that do that. They're extremely expensive and they're not very good. Sometimes I wish there were a better way of putting it all together." (PIO5)*

Finally, whereas understanding coverage becomes increasingly difficult the bigger a story gets, correcting problems rapidly becomes infeasible. For instance, *"[My study] was so widely covered that there were two or three thousand articles. ... I initially wanted to correct everybody that was covering my work. After a while, you recognize, you just can't, it's too much." (HCIR5)* Thus, **current technological options for tracking news coverage do not sufficiently capture all media formats and instances, nor do they afford mechanisms for dealing with errors.**

In the next section of Results, we describe how research advocates engage with media outlets. Because these interactions occur between organizations with differing goals, they are more complex. While both parties share objectives related to the production of individual stories, tensions can arise due to opposing professional values or needs.

2. Collaboration of Research Advocates & Media Outlets

A huge diversity of organizations potentially fall into the category of "media outlets." As described in Methods, our participants capture a snapshot of the diversity in the modern media landscape. We begin this section by describing critical distinctions between these roles in greater detail.

News Services (e.g. AlphaGalileo, EurekAlert!, Newswise, PRnewswire) perform an important function by collecting press releases and posting them in a central online location, yet they differ in key ways. Some employ teams to manually vet every submission against quality criteria; others automatically post any release. Some post releases in chronological order; others allow subscribers to pay fees to elevate releases

in the ranking. Some allow all types of news; others focus exclusively on science. Services also differ in national or international scope. News services quintessentially enable the embargo system, which gives credentialed journalists early access to pre-publication manuscripts, though they cannot publish stories until the embargo is lifted. An ED said,

> *"Ultimately, [the embargo system] provides reporters with time to come up with better, more accurate, and well rounded coverage of a piece of scientific research. We believe that this will ultimately lead to better coverage of scientific research and will be beneficial to the public who reads these stories." (ED)*

Press releases contain single-sided narratives from the perspective of the organization that put them out. *"[Journalists] use the press release as a starting point. They use it as a way to get an idea, and then they do their independent reporting." (ED)* Independent reporting includes gathering and synthesizing many perspectives, then translating the press release into a multi-faceted news story that will engage a specific audience. However, press releases are now only one of many possible ways journalists find stories. Our data and prior work suggest that most press releases are perceived as "junk" [38] by journalists. Instead, web technologies, e.g. social media, are influencing how journalists find stories [8, 24, 28], which may prioritize rapid replication of news stories from differing perspectives rather than cautious, time-consuming independent reporting. Alternatively, media participants and prior work [38] emphasized the importance of direct professional relationships with scientists or PIOs for access to the best stories as they are developing, often before press releases are written.

SRs and FJs have significantly different roles. SRs are full-time employees with extremely routine-driven workflows. They juggle daily deadlines on breaking news, and longer deadlines of weeks or months on features. They begin workdays by catching up on news that broke overnight, skimming TweetDecks, email digests, RSS feeds, competing news sites, tech or industry blogs, or even ArXiv. Next, many newsrooms have daily morning meetings, using tools like Slack to pitch, discuss, and assign the day's stories to local and distributed staff. Finally, SRs estimated writing/producing 1-8 stories/day, while also keeping an eye out for breaking news to cover immediately. By contrast, FJs have more freedom around scheduling, workload, and story selection, generally writing features and thought pieces rather than breaking news. Although any given day is fundamentally less structured, FJs still race against strict deadlines, and they face challenges that SRs do not, e.g. competition to get assignments, uncompensated time for potentially lengthy editorial processes, and financial instability. Yet both SRs and FJs share the quintessential challenge of picking stories (although they do so in very different ways), whereas PIOs invest substantial energy pitching stories. Thus, one key shared objective is identifying news stories.

2.1 Story Identification

For PIOs, a quick and dirty way to get coverage for less exciting stories is to simply post a release to a news service and move on with their day. However, for journalists, the sheer volume of releases posted on news services creates an "information overload" problem. SRs expressed the opinion that most releases they skim on news services are boring or irrelevant to their organization. They quickly judge stories by headlines, and usually discard them. Furthermore, press releases on news services are visible to all subscribing media outlets, which creates a paradoxical frustration for PIOs. *"Even with local media, they always want exclusives, at the national level too, but yet they always want to cover what their counterparts have covered. So you're like, how do I balance all that? There's no rhyme or reason." (PIO4)*

PIOs said that when they simply post to a news service, they do get some (often mediocre) coverage, yet this act does not independently result in excellent coverage by reputed newsrooms. Thus, PIOs proactively pitch stories by: (1) collating lists of relevant reporters through memory of prior interactions, or time-consuming research on journalist databases, search engines, and past email, and (2) carefully crafting individualized emails that include direct links to the press release on a news service, or copy/pasted portions of it. Three PIOs described the substantial burden of pitching. For example,

> *"I individualize every single one of those emails because a reporter from here and a reporter from here, if they get any kind of inkling that it's a mass email, it automatically gets deleted. They want an individual pitch. That just takes so much more time." (PIO4)*

> *"The hardest part [of interacting with media] is, you write a good pitch, at least you think its a good pitch, and you send it to journalists, and the majority of them don't write back. They're busy. They get a lot of pitches and we know that they're being bombarded." (PIO2)*

Thus, journalists are inundated with possible stories by news services, pitches, and social media. All three SRs expressed difficulty with picking stories for their specific outlet:

> *"Number one, by far, [my biggest challenge] is sourcing stories, finding unique stories. I think there are so many different places to get stories from, that it can be difficult to collate everything in one place." (SR2)*

> *"There are always a lot of things I could be writing about, but figuring out, ok, so how does this news relate to our audience? That is what takes time on the front end of the story. ... And then, partially because there's such an information overload, what do they call it, 'analysis paralysis,' it's like there are 6 things I could write about, so which am I going to take the time to talk about?" (SR1)*

> *"Sometimes you're looking for stories and then, you don't feel like there is anything there. ... You don't want to have to lower the bar because you can't find anything." (SR3)*

Whereas SRs hash out assignments synchronously with colleagues, FJs (similarly to PIOs) expend considerable energy on preliminary research, email pitches, and subsequent follow-ups. In fact, the professional livelihood of FJs depends on their ability to select and sell unique stories that newsrooms cannot easily produce internally. For instance,

"For any kind of mass press releases that have obviously been very widely distributed, maybe through outlets like EurekAlert! or AlphaGalileo, that basically means everyone can see them, so the chances are, someone else has had the same idea. I have to be very particular and I have to try to be efficient with my time." (FJ2)

Thus, FJs write features and thought pieces more often than breaking news. One FJ explained that,

"Editors are stingy with assignments to freelancers. Esp. with magazines, you may think this is a great idea, but they'd say, we're doing an article on that, or it's too close to something we're doing. It's hard to know what's down the road three months from now with a magazine. To me, getting the assignment is the biggest challenge." (FJ1)

The other FJ said, *"Most of the stuff I write about is through finding something that captures my imagination," (FJ2)* and that most pitches are accepted due to longstanding relationships with editors, since *"it comes down to experience and knowing what to pitch and what not to pitch to whom." (FJ2)*

Eventually, some combination of pitching and picking stories will identify stories that make the cut, however **current technologies available to PIOs and reporters result in information overload and substantial additional communication tasks that often fail.** Once a story is identified, understanding the complexity of the science is a non-trivial challenge for media professionals, who may lack relevant scientific expertise.

2.2 Communicating Methods

Seven media professionals mentioned challenges related to understanding methods. One PIO said, *"The hardest part of my job is understanding some of the research," (PIO2)* whereas an HCIR said, *"It's very hard to talk to journalists about research methods." (HCIR10)* When PIOs and journalists cover new studies, they rely on researchers to explain their work, yet five HCIRs described difficulty explaining methods:

"I had a hard time just communicating the research in a way that science writer could digest and get out. So I remember that the conversation itself was really difficult because there were so many underlying pieces that had to be explained." (HCIR8)

Despite difficult conversations, some journalists persist and ask questions until they are certain they understand:

"I need to know as much as I can know to be able to tell an unspecialized audience. That's why I have to revisit a point again and again, because it's like trying to translate that knowledge through, to get it out in a way that makes sense to me." (SR3)

Yet not all journalists are so conscientious. For example, *"They don't give you as much space to clarify the research, because that's the part that isn't as interesting for the audience." (HCIR1)* HCIRs described four difficulties related to explaining methods: (1) their sheer complexity, (2) no time to discuss them, (3) insufficient space in popular articles, and (4) the public's inability to understand them. Thus, **with insufficient lay-accessible resources for understanding cutting-edge methods, HCIRs and media professionals both struggle to communicate them.** A related problem for journalists is figuring out who to talk to in the first place. *"If you don't understand the basics of the problem, then you can't understand who will be able to explain them to you." (SR1)*

2.3 Provision of Expertise

Four journalists mentioned that finding experts who are trustworthy, appropriate for a given subject, and willing to provide public comment, is a fundamental challenge. *"If you're on deadline, and you need some particular specialist, that can be really frustrating to figure out who to talk to."(SR1)* Experts vary in caliber and reputation, often disagreeing with each other, which makes it difficult to discern what is "correct" or how to balance perspectives. Furthermore, *"You kinda have to identify who the person is, see what kind of industrial ties he has, or what conflicts of interests that person may have."(FJ1)* And,*"You have to be careful not to go back to the same researchers too often, otherwise there's this air of fatigue."(FJ2)*

Conversely, three HCIRs described difficulty with commenting as an expert on work or timely topics which they did not have a hand in. HCIRs might experience tension because, *"Mine isn't the only voice being heard, and sometimes I disagree with those other voices." (HCIR10)* On another level:

"With a paper, I know what I'm hoping to communicate. With other things where I'm being called in as an expert, I don't always know. It can be harder to prepare. ... I get really frustrated when they don't give me enough information to actually tell them if I'm a fit, so it's annoying when I'm on the phone with them and I realize that I'm just not the right person to be commenting on this. I feel like I'm wasting their time, and I feel like, the more I talk, the more risk there is that I'll say something that's misleading or wrong." (HCIR12)

Therefore, **existing practices and technologies for finding experts are inefficient and do not necessarily ensure that possible experts are either relevant or willing to comment.** Yet to create effective stories, journalists need more than expert commentary–multimedia are key to effective stories.

2.4 Multimedia Production

Three PIOs mentioned how, *"media need visuals," (PIO4)* yet generating high quality visual material by media deadlines is challenging due to time and resource constraints. Scientists often do not have the time or knowledge to generate lay-accessible imagery, infographics, videos, or aural syntheses of research topics. Several HCIRs described experiences when press teams came to generate clips:

"We had a full week where we had just basically blocked out a week of press stuff, and it really was actually quite intense. ... [Media organization] came and did videos and stuff, and that actually took the entire day to do like a little clip of a video." (HCIR11)

"The press is very pushy, they want everything immediately, you have to give them all your time. I have that vibe, where it's like, oh we need all these high resolution images yesterday. A film crew's coming in, you should

have had everything set up, and accommodate them, as and when they see fit." (HCIR1)

When researchers do not have visual or audio materials prepared ahead of time, the experience of working with production teams at the last minute can be time-consuming or unpleasant. However, another issue with multimedia production is that researchers do not have control over how sound bites or video clips are synthesized into a story, or else they cannot ensure that they will represent the research accurately under the pressure of live recording. *"I don't do radio or television because there is no editing after the fact, and I'm not generally articulate enough to say what I meant the first time." (HCIR10)* Thus, **multimedia are stressful to generate at the last minute, and researchers often do not often have the technical means or time to produce high quality multimedia ahead of press coverage.**

2.5 Rapid Deadlines, Rapid Responses

Journalists need quick responses. Yet, *"a lot of people are just busy or they just, I do find they don't respond timely." (FJ1)* Or, *"Especially with academics, I'll oftentimes get an email two days later that's like, oh yeah, I can speak to that next week, and I'm like, I needed it two days ago, thank you." (SR1)* With unforgiving deadlines, *"Sometimes a story just falls apart if you can't get anyone to comment on it." (FJ1)*

Some PIOs try to post press releases when HCIRs have increased availability, e.g. avoiding travel dates or conference deadlines. Nonetheless, seven HCIRs described challenges related to unpredictable demands for their time, since media requests can come in a deluge, dearth, or steady trickle. *"It's hectic. ... Once a release goes out, we're sort of reacting. Sometimes we'll get requests that come in to be interviewed, other times we'll just be waiting." (HCIR7)*

Furthermore, participants described conflicting desires related to collaborative interactions that must happen rapidly to meet deadlines. For example, some HCIRs prefer that reporters email questions rather than schedule calls. *"Usually asynchronous is easier to pull off. Plus I can copy/paste them, because a lot of people might have the same questions." (HCIR7)* But journalists want unique quotes, and from their perspective, *"People are so boring and dreary by email. You don't write the way that you talk, so I never do interviews by email. A lot of people want to do that, because then they can control exactly what's on the page. I don't let them do that." (FJ2)*

Many HCIRs also want to see drafts prior to publication, but *"most times, you don't get to see the article before they publish it." (HCIR2)* Conversely, journalists do not send drafts because researchers *"don't get how pressed for time we are, don't get what makes an interesting piece of science writing, and they will come back to you and they will make it twice as long and twice as boring. Then you get into this awkward conflict, where you don't want to upset them, but you just can't go there." (FJ2)* Thus, rapid deadlines are draining on journalists and challenging for HCIRs, who may prefer different interaction types. **Current technologies do not afford communication mechanisms that ease tensions between journalists and HCIRs during the short timeframes before deadlines.**

DISCUSSION

Results of our grounded theory analysis [10] denote two collaborative domains: the first between HCIRs and PIOs (i.e. research advocates), and the second between research advocates and media outlets. Here, we offer implications for design and future research in HCI across both domains.

1. Enhancing Collaboration with Research Advocates

In the first collaborative domain, research advocates share related goals as members of the same organization. PIOs must manage many relationships, events, and press interactions to raise their organization's profile. Most HCIRs are covered in the media infrequently, i.e. news coverage is not a primary incentive, although it may increase public awareness of research and have significant career benefits. Thus, PIOs occasionally work with HCIRs to share milestones, write press releases, prepare for media, and track coverage. PIOs have access to paid news services that provide information about journalists. However, other than email, participants did not describe existing technologies to support collaborative acts between research advocates. Results indicate that collaborative pain points can lead to missed opportunities for effective coverage, biased coverage only towards researchers who seek it, uncertainty about how press releases will be interpreted, inadequate media preparation, and incomplete knowledge of coverage breadth and quality. We suggest the following design implications for new technology to enhance collaboration; numbers correspond to subsection headers in Results:

1.1 Automated notifications for research milestones: Technology should make it easier for HCIRs to notify PIOs of milestones, and for PIOs to comprehensively assess milestones occurring across their organization. This could be achieved through simple UI prompts or features on submission platforms or organizational websites. **1.2 External feedback:** Technology should enable research advocates to understand how uninformed outsiders might interpret press releases. Models based on crowdsourcing or online communities like Reddit (which is now venturing into fact-checking) may offer promising mechanisms for discerning possible perceptions/receptions of releases before they are sent to journalists or posted publicly. **1.3 Training resources:** Technology should complement and assist PIOs with media training for researchers, possibly through online educational tools like massive online open courses or online communities that allow researchers to share experiences of press engagement and mentor each other. Automatic templating tools or bots might also be helpful for scaffolding public-facing language or practicing for press engagement (see Quartz' news bot [46] as a potential conversational model). **1.5 Tracking coverage patterns:** Technology should not only make it easier to see and understand coverage instances across many platforms and media formats (esp. on social media sites), but also to trace coverage patterns and provide corrective feedback mechanisms for emergent errors.

2. Enhancing Collaboration with Media Outlets

In the second collaborative domain, tensions between research advocates and media outlets can make it hard to collaborate against rapid deadlines on story identification, communication of methods, provision of expertise, and multimedia production.

News services facilitate the embargo system, yet they also contribute to information overload and are not heavily utilized by journalists, who rely more heavily on social media [24, 28] and take professional pride in their curated relationships with quality sources [38]. With production jobs being cut at many media outlets [8], journalists must work under increasing pressure to write, produce, optimize, and publish numerous stories to online platforms. However, HCIRs operate on different timescales and incentive structures that do not often align with journalists. Results indicate that this juxtaposition results in numerous failed or strained communication attempts, insufficient lay resources on new scientific methods and expertise, and frantic scrambles to produce multimedia. We suggest:

2.1 News service improvements: Future innovation should make it easier to gauge the relevancy of releases (possibly via recommender systems), or by reconceptualizing the system design for how, by whom, and when press releases are accessed, possibly considering mechanisms that implement matchmaking algorithms, (temporarily) exclusive access through information marketplaces, or online networking functions. **2.2 Lay resources on methods:** Technologically mediated resources should provide up-to-date and lay-accessible descriptions of contemporary scientific methods, possibly via peer production. For example, researchers could contribute to a StackOverflow-, Quora-, or Wikipedia-like community specifically for emergent scientific methods, or contribute additional information layers to online content via annotation (e.g. the model put forth by hypothes.is [29]). **2.3 Contextualizing expertise provision:** Future tools for helping journalists get in touch with relevant scientific experts should implement mechanisms that convey relevance and trustworthiness of experts, potentially by exploring technical use of citation databases and funding sources in a "sense-making" manner, so that journalists can understand who paid for research, where ideas fall along the intellectual spectrum, and whom to contact for expert comment. Importantly, new tools should also make it easier for experts to understand what type of information journalists need ahead of interviews. **2.4 Continual multimedia generation:** Technology should ease last minute production stress by offering a simpler means of collecting and synthesizing visual and audio materials throughout the research process rather than at the last minute. Crowdsourcing could be used to produce compelling multimedia to share on social media or directly with media outlets. **2.5 Accommodating deadlines via novel collaborative techniques:** Technology should provide new modes of interaction between researchers and journalists that enable journalists to rapidly get required information, and researchers to avoid repeatedly answering the same questions. This might be achieved through tools for mediating interviews with multiple attendees (e.g. virtual press conferences) or aggregating journalists' questions and allowing researchers to record/distribute audio/video files to desired journalists.

Limitations

Because this work is qualitative in nature, we describe results from a relatively small group of stakeholders. Thus, our participant sample is not necessarily representative of all possible stakeholders and may be affected by self-selection bias. HCIRs in our sample are primarily academic, and almost all participants are from Western cultures. Despite attempts to recruit more industry participants and participants from Eastern cultures, we did not receive many replies, possibly due respectively to internal policies (re: increased concerns about anonymity) or timezone and cultural differences. Furthermore, this work focused on production of HCI-related scientific media. Although most parts of the presented MPP infrastructure and design opportunities may be common across scientific disciplines, different disciplines may face unique challenges. Future work should investigate opportunities for other areas and geographies in science communications.

Conclusion

In the modern Web 2.0 information environment, stories can go viral in the blink of an eye regardless of their legitimacy. Their authors are not only trained journalists, but also scientists, lay citizens, and powerful political and corporate interests, often pitted against each other in a battle for credibility. With a crisis of faith in mainstream media well underway, combined with an onslaught of science-decrying public figures spreading misinformation like wildfire, the institution of science is at a critical juncture. Scientists must speak up, and they must do so effectively if their voices are to be heard through the chaotic information churn of Web 2.0.

This paper describes the MPP for producing scientific content in Western media systems. As we have shown, much can be done to enhance collaboration with media outlets, yet scientists' willingness to engage is clearly a prerequisite–and a point of opinionated contention. "Visible Scientists" [17, 23] who operate prominently in the public sphere can potentially use their influence to affect policy/public opinion. Yet researchers risk reputations as "show boaters" who egotistically pander to the media or sacrifice the quality of their work to focus on career advancement through increased popularity [17]. Academics rely intensely on citations to demonstrate scientific contributions, yet media engagement is of value to society and requires real work. We believe there exists a middleground. Technology can possibly reduce the time and effort required of scientists to share newsworthy research responsibly with the public, and perhaps even improve scientific literacy rates, though it remains critical to consider how peoples' "folk theories" [5] interact with reception of science news. We have suggested implications such as automatic tracking of research coverage in mass media, as well as expert contributions to credible and lay-accessible online resources–both of which yield quantitative metrics. In order to truly bridge the gap between science and society, the academy ought to not only study and build new media tools and systems, but also formally expand incentive structures to consider measures of public scholarship through high quality and impactful independent media production or mainstream media engagement.

Acknowledgements

We thank our participants for volunteering their time and insights, our colleagues Svetlana Yarosh, Loren Terveen, Sarah McRoberts, John Harwell, and our anonymous reviewers for their thoughtful feedback and suggestions on prior drafts. The first author undertook this work supported by the Graduate Assistance in Areas of National Need Fellowship (GAANN).

REFERENCES

1. Hunt Allcott and Matthew Gentzkow. 2017. *Social media and fake news in the 2016 election*. Technical Report. National Bureau of Economic Research.
2. Ahmer Arif, John J. Robinson, Stephanie A. Stanek, Elodie S. Fichet, Paul Townsend, Zena Worku, and Kate Starbird. 2017. A Closer Look at the Self-Correcting Crowd. *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing - CSCW '17* (2017), 155–168. DOI: http://dx.doi.org/10.1145/2998181.2998294
3. Hernan Badenes, Mateo N Bengualid, Jilin Chen, Liang Gou, Eben Haber, Jalal Mahmud, Jeffrey W Nichols, Aditya Pal, Jerald Schoudt, Barton A Smith, and others. 2014. System U: automatically deriving personality traits from social media for people recommendation. In *Proceedings of the 8th ACM Conference on Recommender systems*. ACM, 373–374.
4. Krisztian Balog, Leif Azzopardi, and Maarten De Rijke. 2006. Formal models for expert finding in enterprise corpora. In *Proceedings of the 29th annual international ACM SIGIR conference on Research and development in information retrieval*. ACM, 43–50.
5. Natalya N Bazarova and Jeffrey T Hancock. 2010. From Dispositional Attributions to Behavior Motives The Folk-Conceptual Theory and Implications for Communication. *Annals of the International Communication Association* 34, 1 (2010), 63–91.
6. Allan Bell. 1994. Media (mis)communication on the science of climate change. *Public Understanding of Science* 3 (1994), 259–275.
7. Rémi Bois, Guillaume Gravier, Eric Jamet, Maxime Robert, Morin Emmanuel, and Pascale Sébillot. 2017. Language-based Construction of Explorable News Graphs for Journalists. In *Empirical Methods in Natural Language Processing-Workshop on Natural Language Processing meets Journalism*.
8. Dominique Brossard. 2013. New media landscapes and the science information consumer. *Proceedings of the National Academy of Sciences* 110, Supplement 3 (2013), 14096–14101.
9. Carlos Castillo, Marcelo Mendoza, and Barbara Poblete. 2011. Information credibility on twitter. In *Proceedings of the 20th international conference on World wide web - WWW '11*. ACM Press, New York, New York, USA, 675. DOI:http://dx.doi.org/10.1145/1963405.1963500
10. Kathy Charmaz. 2014. *Constructing grounded theory*. Sage.
11. Sophie Chesney, Maria Liakata, Massimo Poesio, and Matthew Purver. 2017. Incongruent Headlines: Yet Another Way to Mislead Your Readers. *EMNLP 2017* (2017), 56.
12. Lucas Colusso, Cynthia L Bennett, Gary Hsieh, and Sean A Munson. 2017. Translational Resources: Reducing the Gap Between Academic Research and HCI Practice. In *Proceedings of the 2017 Conference on Designing Interactive Systems*. ACM, 957–968.
13. Kyle Conway. 2008. A cultural studies approach to semantic instability: The case of news translation. *Linguistica Antverpiensia, New Series - Themes in Translation Studies* 0, 7 (2008).
14. Stephanie Craft, Seth Ashley, and Adam Maksl. 2017. News media literacy and conspiracy theory endorsement. *Communication and the Public* (2017), 2057047317725539.
15. Julie D'acci. 2004. Cultural studies, television studies, and the crisis in the humanities. *Television after TV: Essays on a Medium in Transition* (2004), 418–42.
16. Special Eurobarometer 419. 2014. Public perceptions of science, research and innovation. *European Union ISBN* (2014), 978–92.
17. Declan Fahy. 2017. Historical moments in public understanding of science: 1977, The Visible Scientists identifies a new scientist for the mass media age. *Public Understanding of Science* 26, 8 (2017), 1019–1024. DOI: http://dx.doi.org/10.1177/0963662517732909 PMID: 29025370.
18. Declan Fahy and Matthew C Nisbet. 2011. The science journalist online: Shifting roles and emerging practices. *Journalism* 12, 7 (2011), 778–793.
19. China Research Institute for Science Popularization. 2010. *The Survey of Public Scientific Literacy, 2010: Main Findings of Public Knowledge, Approach, Interest, and Attitude regarding Science and Technology*. Technical Report. http://www.crsp.org.cn/csi.pdf
20. Jill Freyne, Michal Jacovi, Ido Guy, and Werner Geyer. 2009. Increasing engagement through early recommender intervention. In *Proceedings of the third ACM conference on Recommender systems*. ACM, 85–92.
21. Adrien Friggeri, La Adamic, Dean Eckles, and Justin Cheng. 2014. Rumor Cascades. *ICWSM* (2014), 101–110.
22. Andrew Garbett, Rob Comber, Paul Egglestone, Maxine Glancy, and Patrick Olivier. 2014. Finding "Real People": Trust and Diversity in the Interface Between Professional and Citizen Journalists. In *CHI Proceedings*. ACM.
23. Rae Goodell. 1977. *The Visible Scientists*. The Sciences, 17: 6-9. DOI: http://dx.doi.org/10.1002/j.2326-1951.1977.tb01494.x
24. Jonathan Gray, Lucy Chambers, and Liliana Bounegru. 2012. *The data journalism handbook: how journalists can use data to improve the news*. " O'Reilly Media, Inc.".
25. Ido Guy, Michal Jacovi, Elad Shahar, Noga Meshulam, Vladimir Soroka, and Stephen Farrell. 2008. Harvesting with SONAR: the value of aggregating social network information. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 1017–1026.

26. Ido Guy, Inbal Ronen, and Eric Wilcox. 2009. Do you know?: recommending people to invite into your social network. In *Proceedings of the 14th international conference on Intelligent user interfaces*. ACM, 77–86.
27. Alfred Hermida. 2010. Twittering the news: The emergence of ambient journalism. *Journalism practice* 4, 3 (2010), 297–308.
28. Alfred Hermida, Fred Fletcher, Darryl Korell, and Donna Logan. 2012. Share, like, recommend: Decoding the social media news consumer. *Journalism Studies* 13, 5-6 (2012), 815–824.
29. The Hypothesis Project. 2011. Hypothes.is. (2011). https://web.hypothes.is/ [Online; accessed 06-January-2018].
30. Jr. James W. Tankard and Michael Ryan. 1974. News Source Perceptions of Accuracy of Science Coverage. *Journalism Quarterly* 51, 2 (1974), 219–225. DOI: http://dx.doi.org/10.1177/107769907405100204
31. Thomas J Johnson and Barbara K Kaye. 2004. Wag the blog: How reliance on traditional media and the Internet influence credibility perceptions of weblogs among blog users. *Journalism & Mass Communication Quarterly* 81, 3 (2004), 622–642.
32. Thomas J Johnson and Barbara K Kaye. 2010. Believing the blogs of war? How blog users compare on credibility and characteristics in 2003 and 2007. *Media, War & Conflict* 3, 3 (2010), 315–333.
33. Karen Kaiser. 2009. Protecting Respondent Confidentiality in Qualitative Research Karen. *Qualitative Health Research* 19, 11 (2009), 1632–1641. DOI: http://dx.doi.org/10.1177/1049732309350879.Protecting
34. Chelsea Lee and Jeff Hume-Pratuch. 2013. Let's Talk About Research Participants. (2013). http://blog.apastyle.org/apastyle/2013/08/lets-talk-about-research-participants.html.
35. Stephan Lewandowsky, Ullrich KH Ecker, Colleen M Seifert, Norbert Schwarz, and John Cook. 2012. Misinformation and its correction: Continued influence and successful debiasing. *Psychological Science in the Public Interest* 13, 3 (2012), 106–131.
36. Mark T Maybury. 2006. *Expert finding systems*. Technical Report. Technical Report MTR06B000040, MITRE Corporation.
37. Jon D Miller. 2016. *Civic Scientific Literacy in the United States in 2016: A report prepared for the National Aeronautics and Space Administration*. Technical Report. University of Michigan.
38. Steve Miller and Jane Gregory. 1998. Science in public: Communication, culture & credibility. (1998).
39. Tanushree Mitra and Eric Gilbert. 2015. CREDBANK: A Large-Scale Social Media Corpus With Associated Credibility Annotations.. In *ICWSM*. 258–267.
40. Tanushree Mitra, Graham P Wright, and Eric Gilbert. 2017. A parsimonious language model of social media credibility across disparate events. In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing*. ACM, 126–145.
41. Saif Mohammad, Svetlana Kiritchenko, Parinaz Sobhani, Xiao-Dan Zhu, and Colin Cherry. 2016. SemEval-2016 Task 6: Detecting Stance in Tweets.. In *SemEval@ NAACL-HLT*. 31–41.
42. Alejandro Montes-Garcia, Jose Maria Alvarez-rodríguez, Jose Emilio Labra-Gayo, and Marcos Martinez-Merino. 2013. Towards a journalist-based news recommendation system : The Wesomender approach. *Expert Systems with Applications* (2013). DOI: http://dx.doi.org/10.1016/j.eswa.2013.06.032
43. Michael J Muller. 1995. Ethnocritical questions for working with translations, interpretation and their stakeholders. *Commun. ACM* 38, 9 (1995), 64–65.
44. Dina Pisarevskaya. 2017. Deception Detection in News Reports in the Russian Language: Lexics and Discourse. *EMNLP 2017* (2017), 74.
45. D. Lynn Pulford. 1976. Follow-Up of Study of Science News Accuracy. *Journalism Quarterly* 53, 1 (1976), 119–121. DOI: http://dx.doi.org/10.1177/107769907605300119
46. Quartz. 2017. Quartz New App. (2017). https://itunes.apple.com/us/app/quartz-news-in-a-whole-new-way/id1076683233
47. Victoria L Rubin, Yimin Chen, and Niall J Conroy. 2015. Deception detection for news: three types of fakes. *Proceedings of the Association for Information Science and Technology* 52, 1 (2015), 1–4.
48. Benjamin Saunders and Jenny Kitzinger. 2015. Anonymising interview data: challenges and compromise in practice. *Qualitative Research* 15, 5 (2015), 616–632. DOI:http://dx.doi.org/10.1177/1468794114550439
49. Irving Seidman. 2013. *Interviewing as qualitative research: A guide for researchers in education and the social sciences*. Teachers college press.
50. Benjamin SP Shen. 1975. Science literacy and the public understanding of science. In *Communication of scientific information*. Karger Publishers, 44–52.
51. Irina Shklovski. 2013. "Un-Googling" Publications : The Ethics and Problems of Anonymization. (2013), 2169–2178.
52. P.J. Shoemaker and T.P. Vos. 2009. *Gatekeeping Theory*. Routledge.
53. Catherine E. Snow and Kenne A. Dibner. 2016. *Science Literacy: Concepts, contexts, and consequences*. National Academies Press.

54. Christian Stab and Iryna Gurevych. 2017. Recognizing insufficiently supported arguments in argumentative essays. In *Proceedings of the 15th Conference of the European Chapter of the Association for Computational Linguistics: Volume 1, Long Papers*, Vol. 1. 980–990.

55. Kate Starbird. 2017. Examining the Alternative Media Ecosystem Through the Production of Alternative Narratives of Mass Shooting Events on Twitter. In *ICWSM*.

56. Terrence Szymanski, Claudia Orellana-Rodriguez, and Mark T Keane. 2017. Helping News Editors Write Better Headlines: A Recommender to Improve the Keyword Contents & Shareability of News Headlines. *arXiv preprint arXiv:1705.09656* (2017).

57. Luc van Doorslaer. 2000. *Handbook of Translation Studies : Volume 1*. John Benjamins Publishing Company, Chapter Journalism and Translation, 180–184.

58. John Vines, Anja Thieme, Rob Comber, Mark Blythe, Peter Wright, and Patrick Olivier. 2013. HCI in the press: Online public reactions to mass media portrayals of HCI research. *Proc. CHI 2013* (2013), 1873–1882. DOI: http://dx.doi.org/10.1145/2470654.2466247

59. Farida Vis. 2013. Twitter as a reporting tool for breaking news: Journalists tweeting the 2011 UK riots. *Digital journalism* 1, 1 (2013), 27–47.

60. Claire Wardle. 2017. Fake news. It's complicated. (2017). https://firstdraftnews.com/fake-news-complicated/ [Online; accessed 13-September-2017].

61. Wikipedia. 2017. Newsroom — Wikipedia, The Free Encyclopedia. (2017). https://en.wikipedia.org/w/index.php?title=Newsroom&oldid=785447797 [Online; accessed 31-August-2017].

62. Marian G Williams. 1993. Translation in participatory design: lessons from a workshop. In *INTERACT'93 and CHI'93 Conference Companion on Human Factors in Computing Systems*. ACM, 55–56.