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Understanding online firestorms: Negative word-of-mouth dynamics in social media networks

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Social media are, on the one hand, a highly beneficial environment for word-of-mouth (WOM) propagation of new ideas and products, and this has increasingly made them a focus of marketing communications. On the other hand, companies and their brands as well as politicians, governmental institutions, and celebrities have increasingly been facing the impact of negative online WOM and complaint behavior. In reaction to any questionable statement or activity, social media users can create huge waves of outrage within just a few hours. These so-called *online firestorms* pose new challenges for marketing communications. In this article, we group observations from recent online firestorms, identify related social and economic science theories, and derive generalized factors that form the basis for the proliferation of these dynamics. Furthermore, we discuss the consequences of online firestorms for marketing communications, and offer courses of action for marketers to navigate through crises of negative online WOM.

Keywords: online word-of-mouth; complaint behavior; social media networks; opinion diffusion; online firestorms

Introduction

In January 2012, McDonald's asked its customers to share their positive stories about the company on Twitter, making use of the hashtag #McDStories. After only 2 h, McDonald's had to withdraw the promotion because the company had suddenly been exposed to a massive amount of negative word-of-mouth (WOM). People had used the #McDStories hashtag to share negative customer experiences and to insult McDonald's. The sudden discharge of large quantities of negative WOM, as McDonald's has experienced, is a phenomenon that companies have to face since the interconnectivity among customers through Web 2.0 technologies has reached critical mass. As early as 2004, a biker created one of the first examples for massive customer outrage. He found out that the Kryptonite Evolution 2000 lock that was supposed to be one of the safest on the market could be opened easily with a pen. A video that showed the whole effort was posted on a biker online forum and soon became very popular on the Web. The clip attracted more than two million views in only 1 week. Although people tending to vocalize criticism and complaints about a company's products and actions through interactive online channels is nothing new (Zorbach 2011), the speed at which negative WOM diffuses through social media, as well as the sheer extent of the negativity, was not just shocking for McDonald's and Kryptonite. It has recently been reaching new levels, and marks a significant new challenge for marketing communications to cope with. Before the proliferation of mobile

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phones and the Internet, the diffusion of innovations as well as the propagation of opinions could have taken years (Ryan and Gross 1950). In social media, negative opinions about products or companies are formed by and propagated via thousands or millions of people within hours. Furthermore, massive negative online dynamics are not only limited to the business domain, but they also affect organizations and individuals in politics, e.g., ‘Weinergate’ (Petri 2011), or popular culture, e.g., Ashton Kutcher (Barker 2011).

We define an *online firestorm* as the sudden discharge of large quantities of messages containing negative WOM and complaint behavior against a person, company, or group in social media networks. In these messages, intense indignation is often expressed, without pointing to an actual specific criticism. Even though online firestorms are a new phenomenon, their dynamics are similar to the way in which rumors are circulated. A rumor is defined by Allport and Postman (1947, ix) as a ‘proposition for belief, passed along from person to person, usually by WOM, without secure standards of evidence being presented’. Online firestorms are conceptually not only close to the definition of rumors, but also differ in certain ways. The most important difference, as well as the essential characteristic which led to the nomenclature, is the level of aggression involved. Online firestorm, although based on the actual customer criticism in an early stage, denotes a phenomenon where the negative WOM in later stages is intended to be offensive and is almost free from content or arguments. Although rumors are unconfirmed, firestorms can be rumor based (unconfirmed) or event based (confirmed). The essential feature is that the messages in a firestorm are predominantly opinion, not fact, thus having a high affective nature.

WOM is important for companies (Solis 2011) and there is evidence that companies that are capable of using WOM for marketing purposes are more successful (Mason 2008). When asked about the main objectives of their social media program, 51% of marketing decision-makers declared in a survey by MarketingSherpa (<http://www.marketingsherpa.com/article.php?id=31903#>, April 20, 2012) from 2011 that ‘improving brand awareness or reputation’ was important to them. Also, it is important to point out that social media are not the equivalent of WOM, platforms, such as Facebook, Twitter, YouTube, and recently Pinterest have had a significant impact when it generated conversations about brands, and therefore play an important role with regard to a brand’s reputation (Kerpen 2011). Social media are even more appealing to marketers trying to reach their goals, and social media spending is growing more than any other marketing investment. A survey conducted by the Fuqua School of Business, Duke University, published in February 2012, shows that 7.4% of marketing budgets in the USA are currently being spent on social media (<http://www.marketingsherpa.com/article.php?id=31903#>, April 20, 2012). According to this report, the figure is due to reach 10.8% by 2013 and will rise to 19.5% over the next 5 years. This significant increase is mainly due to companies that use social media for brand building. But all these efforts can be jeopardized when an online firestorm is raised. Kimmel and Audrain-Pontevia (2010, 240) stated that rumors ‘represent an imposing competitor in the marketplace of information exchange’. The same is even truer of online firestorms. As the examples given by McDonald’s and other companies (see next section) show, these instant waves of criticism that appear without warning can have a huge impact on a company’s or a brand’s reputation. Since the complex dynamics of online firestorms are unclear, it is reasonable to assume that company leaders would fear that their presence in social media could cause maximum negative impact, with unforeseen and uncontrollable consequences for their companies and their brand’s image, all of it accompanied by a significant loss of money. In order to reclaim a level of control for companies facing a crisis due to tidal waves of

negative WOM, the dynamics of an online firestorm need to be researched and better understood. This is the goal of this article.

To begin with, we describe three examples of online firestorms to show the importance of the topic for marketing communications. The second section discusses different aspects of opinion-spreading dynamics in social media that create an environment favoring online firestorms. We extract seven factors that help to better characterize the dynamics of online firestorms. In the final two sections, we discuss the results of our work and their implications for marketing communication, and consider opportunities for future research.

Examples of online firestorms

On January 18, 2012, McDonald's launched a campaign on Twitter to make its followers aware of the heritage of the company's food. Starting at midnight, the promotion – which used the hashtag #meetthefarmers – initially received positive feedback. When the hashtag was later changed to #McDStories, however, the McDonald's social media team realized immediately that things were developing in a wrong direction. The hashtag was being used to share negative or funny stories about the company. Closely monitoring the social media activities, McDonald's decided 2 h later to switch back to #meetthefarmers. But the damage had already been done: within this short period of time, more than 1000 detractors had posted their negative experiences. Although McDonald's responded immediately and the total number of negative tweets containing the #McDStories hashtag was relatively small compared with the 25,000–30,000 daily mentions of the company, the virtual firestorm received instant coverage from the traditional media, and this resulted in broader propagation online (McNaughton 2011).

The Australian airline *Qantas* faced a comparable situation when it ran a similar Twitter promotion. On November 22, 2011, the company asked customers keen on winning a First Class gift pack, which included a pair of pajamas, to share their dreams of a 'luxury inflight experience' using the hashtag #QantasLuxury. Just 2 h later, #QantasLuxury appeared in the Twitters Trending Topics list in Australia, with about 100–150 tweets every 10 min. Within a very short space of time, thousands of people had started to hijack the hashtag to fire off relentless comments. What Qantas had failed to consider when it started the campaign was the sheer number of people at that point who had had recent memories of the company. A few weeks earlier, a labor dispute had led to situations where employees had left thousands of passengers stranded at different airports. Unlike McDonald's, the Public Relations (PR) team at Qantas decided to completely ignore the negative responses and proceeded with the promotion. Moreover, they acknowledged the large amount of reactions as positive feedback to the company. As a direct result of this, the story was propagated even further and it gained widespread negative publicity outside Australia (Beato 2011).

Although in the prior two examples the microblogging service Twitter played a critical role in the dynamics that led to cascades of negative WOM effects within a short period of time, it is not the only platform which can serve as a hotbed for online firestorms. In January 2012, *ING-DiBa*, the German direct bank that is currently leading the market suddenly saw its Facebook page under an attack initiated by vegan activists. At the height of the protest, a new message or comment was posted to the company's Facebook wall every 5 s. The reason for this wave of complaints was a commercial that had premiered on German television a few weeks beforehand. It starred the well-known basketball player Dirk Nowitzki, and showed him eating a piece of sausage in a butcher's shop. Critics accused the bank of wantonly promoting an 'unethical and terribly destructive (meat)

industry'. The social media team at ING-DiBa decided to give room to the heated discussion between vegans, vegetarians, and meat eaters – at least in the beginning – because the content from the critics was not perceived as a threat to the bank's core business. Indeed, the company had never had so much traffic on its Facebook page before, and those in charge saw this as an opportunity to increase the number of fans. After a few days had passed and the detractors were still posting, fans jumped into the debate and started defending the commercial and the bank. As with the previous two examples, the classical media were also involved in propagating this case: they picked up on the vegans' outrage. Two weeks after this, ING-DiBa ended the discussions on its Facebook page by announcing that from then on, the bank's Facebook page would focus on bank issues once again and that all further comments on meat would be deleted (Brinkmann 2012).

Factors of opinion spreading in social media

The examples in the last section have implicitly shown some aspects of social media dynamics in the context of online firestorms. From these examples – and many others – we have collected observations and assembled them in seven groups (see first column of Table 1). These observations are the result of technical artifacts created by social media platforms and of dynamics that are similar in offline interpersonal communication networks, but that are amplified online. To discuss the observations and to derive generalized factors, we have identified related literature in information science, decision-making and innovation research, and social network analysis. Observations, related literature, and generalized factors are discussed later.

When looking at the three examples in the previous section or at any other online firestorm, the most obvious factor that drives the dynamics is *speed*. Real-time messages in social media create a constant flow of communication in which the next piece of information displaces the former one. In case of highly attractive information, many people can be reached within a short period of time. This can result in a temporal dominance of a single topic that, consequently, leads to a large volume of communication. *Speed and volume* is the first factor that we determine as relevant for opinion spreading in social media. Although the communication/reaction cycle of traditional newspaper is a day, in social media, the affected companies and institutions need to react in hours or minutes. Recent studies show that the half-life of Twitter memes and hashtags, the time after which 50% of the overall traffic is reached (Burton and Kebler 1960), is just on the order of hours or even minutes (Fang and Huberman 2007). In terms of social media platforms, all social media networks have a high turnover of information, but Twitter stands out: it ranks as the 'fastest' social media platform. The short message length of microblogging obliges communication to be short and quick. Because of this, Twitter seems to play a critical role in the propagation of online firestorms. Indeed, the microblogging service seems to have been involved in every single recent case of negative online WOM.

The speed of communication is partly induced by technical artifacts. Sophisticated or gradualist opinions are not represented in most opinion-forming systems of social media sites; a user can 'like' or '+ 1' something or not. Even if an actual message is written, the length of that message is very limited due to technical restrictions. In Twitter, the limit is 140 characters, but messages on other social media platforms also tend to be short. Schelling (1973) described such decision-making processes as *binary choices*. Decisions on whether to pass information on (e.g., by retweeting), or to sign a petition against something, are binary because they are 'either-or situations'. The absence of discursive interactions is a second very important factor for online firestorms.

Table 1. Observations from online firestorms and ties to related literature as well as generalized factors that describe the dynamics of online firestorms.

Observation	Related literature	Generalized factor
Constant flow of information, short information half-life	Burton and Kebler (1960)	Speed and volume of communication
No gradualist opinions, absence of discursive interactions	Schelling (1973)	Binary choices
Clustering in social media networks amplifies epidemic spreading	Heider (1946)	Network clusters
Blurring weak and strong ties, hundreds of 'friends' create information	Granovetter (1973)	Unrestrained information flow
Limited information caused by homophily, friends as filter	Simon (1972), McPherson, Smith-Lovin, and Cook (2001)	Lack of diversity
Offline and online media reinforce one another	Key (1966)	Cross-media dynamics
Modified opinion adoption process, dominant network effects	Rogers (1995)	Network-triggered decision processes

The *network clusters* are the third factor of online networks. Interpersonal communication networks (Pfeffer and Carley 2011) have significant local clustering. In network analysis, the term *clustering* is used to refer to transitive link creations (Heider 1946); that is, if user *a* is connected to user *b* and user *b* is connected to user *c*, then the chance is high that user *a* is also connected to user *c* (see Groeger and Buttle, this issue). Due to the high number of connected neighbors and local clustering (Watts and Strogatz 1998), the information echoes to a user from different *directions* of his or her social network – creating the impression of everybody talking about the same topics or having the same opinion (Sunstein 2001). There is also empirical evidence that locally connected clusters are very important for the start of epidemic spreading in social media (Lotan, 2012). Pfeffer and Carley (forthcoming) have also used simulation experiments to show the importance of local clusters for the spread of opinions and beliefs in social networks. The impact of clusters can be understood with the following example. Imagine an average Facebook user, Ann, has 130 friends, one of whom is Ben. Ben posts a very interesting piece of information (X). As the friends of Ben are highly likely also to be interested in X (see next paragraph), there is a good chance that a certain percentage of them also post about X or, in the case of Twitter, retweet the information. Because of the law of transitivity, many friends of Ben are also friends of Ann. Therefore, Ann receives a couple of message to the same topic within a short period of time. These so-called *echo chambers* were introduced half a century ago to describe the amplifying effects of opinion forming between politics, media, and the populace (Key 1966). Nowadays, the same concept serves as a metaphor for the effect created by a user posting information in social media, and his or her connected neighbors posting a message on the same topic.

Clustered networks are not exclusive to social media networks, however – all networks based on interpersonal communication form these patterns. The important difference is that in social media, every connection gets the same amount of attention, whereas in offline networks, the number of people interacting on a regular basis is more limited. Granovetter (1973, 1361) described the strength of a tie as a ‘combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal service’. Granovetter distinguished between strong and weak ties, and subsequent studies show that the core discussion networks of a person consist of two to three people on average (Marsden 1987). Including also people with whom a person shares activities (school, work, and leisure) results in an average network size of 12–20 people. These individuals are called *sympathy groups* by Zhou et al. (2005). In contrast, in social media, one can be a *friend* or *follower* of hundreds or even thousands of people. This large number of network neighbors creates a vast amount of communication and of transitive connections that echo and amplify information and opinions. We consider this *unrestrained information flow* the fourth factor of negative social media dynamics.

Lack of diversity represents a fifth factor. The *filter bubble* (Pariser 2011) is a concept, which refers to overemphasizing the importance of single topics or opinions. The filter bubble works in two ways. On the one hand, social connections act as a filter since connections tend to be based on homophily (McPherson, Smith-Lovin, and Cook 2001). People tend to connect with other people who are similar from the perspective of age, gender, and socioeconomic status, resulting in similar interests, topics, and opinions. On the other hand, social media communication is also subject to technology; a message is rated as being more interesting for you if your friends also seem to be interested in the information, or if you were interested in a similar message in the past. Both concepts – echo chamber and filter bubble – are interpretations of decision-making within a regime of *bounded rationality* (Simon 1972). In the case of ‘limited information gathering’, no

optimal solution is possible, and people look for *satisfying decisions*. In the context of social media, the information available to a single user is not only limited but also heavily biased. The concept of *echo chambers* (Key 1966) leads to a sixth factor for online firestorms, *cross-media dynamics*. Social media are increasingly becoming an important information source for traditional media (Diakopoulos, De Choudhury, and Naaman 2012). Twitter, for example, is frequently used as a kind of ‘radar’ by classic media, such as news publishers or television stations to pick up stories (often from eyewitnesses) at a very early stage. In the context of online firestorms and other social media activities, the following procedure can be observed. Social media users create a story. This story is broadcast by some traditional media with reference to an *online phenomenon* which results in much larger online activity – largely triggered by the social media hooks connected to the media story (for instance, buttons saying ‘Tweet this story’). Greater online activity triggers additional media coverage and the result is an echo chamber between social media and traditional media. Recently, Myers, Zhu, and Leskovec (2012, 33) analyzed this interplay of social media internal dynamics and external effects (traditional media) in the context of information diffusion. They state that about one-third of the information volume on social media is triggered by ‘external events and factors outside the network’.

The final factor that we have observed and categorized is a combination of previous factors; nevertheless, it is worthwhile discussing *network-triggered decision processes* as a separate aspect. Rogers (1995) described the process of adopting an innovation. Pfeffer and Carley (forthcoming) adapted this process to the way in which opinions and beliefs are adopted. *Knowledge* describes the moment when a person receives their first information about an opinion. During the *persuasion* step, people take up a positive or negative stance on an opinion. Having made a positive or negative *decision* about accepting or declining an opinion, people talk about that decision and therefore influence other people in their decision-making process (*propagation*). Meeting other people with the same opinion stabilizes a person in his opinion (*affirmation*), whereas negative feedback destabilizes. In the context of social media, we see a different process of opinion adoption resulting from the aspects described earlier. The filter bubble dominates the *knowledge* step by limiting information that reaches a user, whereas the echo chamber guarantees efficient *persuasion* and *affirmation*. Social media dynamics as well as technological artifacts all create the impression that the vast majority of other people already have the same opinion. The implications for the opinion adoption process are dramatic: cognitive processes can be replaced by network effects in social media opinion spreading.

Implications for marketing communications

In this section, we discuss the implications for marketing communications, and consider how online firestorms can be handled better. We use the enumerated factors to elaborate on courses of action.

Initially, companies facing an upcoming online firestorm have to retain their composure, and continue to communicate and interact. Earlier, we mentioned the case of ING-Diba and the onslaught on the company’s Facebook site by vegans. ING-Diba kept calm and got the situation under control. Most commentators and social media experts point out that the company’s reaction to the crisis showed composure and confidence, and could even have strengthened the brand’s position in social media as well as its credibility and image. Closer analysis of McDonald’s and its social media activities after the *#McDStories* incident reveals that, despite the wave of negative WOM, McDonald’s actually gained more followers in that particular period of time. Furthermore, as similar

Twitter promotions in the meantime have shown, the incident did not prompt McDonald's to change its social media strategy on a medium or long-term basis. By contrast, Kryptonite (see Section Introduction') and many other companies that faced online firestorms since then and decided not to respond at all had to pay a high price for the inability to deal with the situation. Due to the loss of reputation and credibility, the images of companies have been damaged severely. Based on the results of a survey, Kimmel and Audrain-Pontevia (2010) present similar hints for responding to rumors; 'state no comment' and 'ignore the rumor' are perceived as very negative.

Another argument in favor of keeping calm comes from the high inter-arrival rate of messages on social media platforms, which results in rapid devaluation of information. As stated earlier, the attention that people devote to a story decreases over time because of competition from other (newer) stories (Falkinger 2007). The persistence of a 'really big story' in social media is often much briefer, as it could be expected at the peak of, say, an online firestorm.

To overcome the lack of diversity in online as well as in offline networks, serious interventions are required. A single user can increase his or her network diversity by intentionally connecting to people who possess very different socioeconomic characteristics and opinions. The reception of different opinions intercepts network-triggered decision-making processes. From a company perspective, diversity offers an interesting approach for community-building efforts. Often, customers are clustered to target groups based on their characteristics (age and interests) that lead to groups of highly similar people. We claim that diverse communities are more stable in the context of shocks created by questionable statement or activity by the company, because higher diversity mitigates the power of several factors for online firestorms. Of course, this hypothesis needs to be tested in further research.

Another implication for marketing communications arises from the empirical observation that online firestorms are often the combined result of social media and traditional media coverage. This is why social media marketing communication has to include journalists from traditional media who cover social media stories. However, we expect a habituation process by journalists from traditional media over the course of the next 2 or 3 years, so that disproportionate social media stories will attract less media attention. We see some evidence that this is the case. First, most mainstream traditional media organizations now have a social media presence and they train personnel on how to monitor and respond to said media. Second, verifiable news stories are beginning to be carried first by social media versions of traditional media groups and then followed by in-depth reporting in the traditional media. Third, these social media versions of traditional media are now frequently among the most followed and most retweeted of social media sources. These factors all decrease overall volatility. For now, breaking cross-media echo chambers needs proactive communication with journalists from traditional media.

To tackle network effects, long-term strategies are needed. If we assume that network effects in decision processes are based on limited information and on the subjective impression that *everybody* has the same opinion, we can then derive one possible counterstrategy. To 'burst' a person's filter bubble, a certain amount of information that can counteract the negative WOM has to be injected into that person's social media world. By analyzing attitude-forming processes, we know that the *early* and the *trusted* sources have the highest impact on these processes (Fishbein and Ajzen 1975; Ajzen and Fishbein 1980). Being *early* is the easier task, and can also be done by means of standard marketing communication instruments. Of course, in the context of social media diffusion of information and opinions, marketing communications also have to face new challenges

resulting from the speed of the technologies involved, but this is not the focus of this article. The goal of the counterinformation diffusion must be to individually *destabilize* as many people as possible in their negative attitude forming. Imagine that a friend who tells you a very negative story about company X, and a short while later another friend tells you the exact opposite. The chances that you will begin to actively propagate the negative information are low because the situation cannot be decided on, so no opinion – which is a precondition for an efficient diffusion – can be formed (Pezzo and Beckstead 2006). The important thing here is that the trustworthiness of both sources has to be at roughly the same level and the presentation of information from both sources needs to occur almost simultaneously. Inoculation theory (McGuire 1961, see also Pfau 1997) similarly suggests that weak negative information that causes the individual to act defensively can actually strengthen defenses and prevent destabilization of attitudes. Whether through inoculation or paired messaging opinions can be stabilized, and even small failures to do so can increase the chance of opinion change and resultant information diffusion. Because of tipping points in diffusion processes (Gladwell 2000), reducing the chance of propagation by just a slight amount can have a major influence on the propagation of a topic.

Being a *trusted* source of information is, by definition, impossible for any company, politician, or other person or institution targeted by an upcoming online firestorm. This is why intermediaries needed to be in place between marketing communications and the recipients. In order to get information through to thousands of people in a trusted way, many ‘normal’ people have to be encouraged to pass on that information. These people have to be *fans* of the target of the online firestorms, and they have to be fans a long time before the first dark clouds move in. Consequently, a company needs to be proactive and create fan networks, identify trusted information brokers to spread news about their company, and develop contingency plans for organizing a collective social information response before they are needed in order to control the overall information picture.

With regard to the fears of marketing decision-makers that their company or brand might become the target of an online firestorm, we recommend that they increase rather than decrease their social media activities as a counter strategy. A company that is well connected in the social media sphere and that has established a diverse array of fan groups and channels for direct dialog with its customers is far more crisis-proof. In the case of an attack on its reputation, the company can remain calm and can instantly reach and activate its loyal customers and fans to defend its image before further damage is done.

Outlook

As budget spending suggests, social media have become an integral part of marketing communications. Although positive implications of social media, such as engaging customers and building strong brand relations, are widely accepted, the increasing frequency of online firestorms is causing great irritation among many marketing decision makers. In this article, we discussed online firestorms, a term that describes a new phenomenon involving waves of negative indignation on social media platforms, confronting an increasing number of companies, politicians, and celebrities. We argued that opinion-forming dynamics on social media sites are dominated by seven factors: speed and volume of communication, binary choices, network clusters, unrestrained information flow, lack of diversity, cross-media dynamics, and network-triggered decision processes. These factors are highly interrelated; however, discussing them separately can gain better insights to social media dynamics. In our argumentation, we focused on Twitter and Facebook, but the dynamics of online firestorms are not limited to those platforms. As

other empirical studies show, any other kind of social media technology – e.g., blogs and media-sharing sites such as YouTube and forums – can create similar dynamics as well. Our future work will focus not only on different social media technologies but also on their specific interplay.

In order to analyze the structure and the dynamics of social media more in detail, we recommend the use of methods and applications of Social Network Analysis (Wasserman and Faust 1995; Newman, Barabási, and Watts 2006). Social media platforms can be regarded as communication networks (Rogers and Kincaid 1981), in which nodes (users) are connected with each other through *friendships* or *follower* ties. The structure of these networks is analyzed with regard to identifying important users and locating communities and subgroups. In future, researchers should look more closely at the ‘preincident’ structure of users involved in the early stages of online firestorms. Our initial empirical observations seem to suggest that online firestorms result from the activation of members of preexistent networks (e.g., vegetarians) rather than from the spontaneous formation of new networks. This hypothesis leads to other dynamics that are triggered – at least in part – by social media activities. The emergence of online firestorms seems to bear a striking similarity to the online dynamics connected with uprisings (e.g., the ‘Arab Spring’) or social movements (e.g., ‘Occupy Wall Street’) as in all cases, mass concern, the cult of the negative (anti-incumbents), and information propagation can create massive echo chambers.

Another aspect of future work should cover companies’ reactions to upcoming online firestorms. Based on the arguments presented in this article, we assume that if the target of an upcoming firestorm is able to activate fan networks that are already in existence, and can reach a large number of people with very different information from that contained in the negative indignation, then the impact of the online firestorm could be limited or even entirely prevented. In general, a better understanding of the factors driving online firestorms and their implications for marketing communication will assist marketing managers in making the right decisions while their brand is under attack, and should help to prevent companies and their reputations from further damage. Furthermore, our research could enable those who are in charge to ‘spin’ the stream of opinions flowing across multiple social media platforms into a new direction, which could be of benefit to their brand in the long term.

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References

- Ajzen, I., and M. Fishbein. 1980. *Understanding Attitudes and Predicting Social Behavior*. Englewood Cliffs, NJ: Prentice-Hall.
- Allport, G. W., and L. Postman. 1947. *The Psychology of Rumor*. New York: Henry Holt and Company.
- Barker, O. 2011. "Ashton Kutcher Retweets from Paterno Comment." *USA Today*, October 11. <http://www.usatoday.com/life/people/story/2011-11-10/ashton-kutcher-joe-paterno-tweet/51159424/1>
- Beato, A. 2011. "#Quantas Luxury Crashes into Ground, We Take Twitter Down to a Ride." *Intentionous*, November 23. <http://intentionous.com/2011/11/23/qantasluxury-crashes-into-ground-we-take-twitter-down-for-the-ride/>
- Brinkmann, B. 2012. "Dieser Shitstorm ist Wurst." *Süddeutsche Zeitung*, January 13. <http://www.sueddeutsche.de/digital/vegetarier-wettern-gegen-ing-diba-dieser-shitstorm-ist-wurst-1.1256820>
- Burton, R. E., and R. W. Kebler. 1960. "The 'Half-Life' of Some Scientific and Technical Literatures." *American Documentation* 11: 18–22.
- Diakopoulos, N., M. De Choudhury, and M. Naaman. 2012. "Finding and Assessing Social Media Information Sources in the Context of Journalism." In *Proceedings of the ACM CHI Conference: 2451–2460*, May 5–10, Austin, TX.
- Falkinger, J. 2007. "Attention Economies." *Journal of Economic Theory* 133: 266–294.
- Fang, W., and B. A. Huberman. 2007. "Novelty and Collective Attention." *Proceedings of the National Academy of Sciences USA* 104 (45): 17599–17601.
- Fishbein, M., and I. Ajzen. 1975. *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Reading, MA: Addison-Wesley.
- Gladwell, M. 2000. *The Tipping Point*. New York: Little, Brown and Company.
- Granovetter, M. S. 1973. "The Strength of Weak Ties." *American Journal of Sociology* 78 (6): 1360–1680.
- Heider, F. 1946. "Attitudes and Cognitive Organizations." *Journal of Psychology* 21: 107–112.
- Kerpen, D. 2011. *Likable Social Media*. New York: McGraw-Hill.
- Key, V. O. 1966. *The Responsible Electorate*. Cambridge, MA: Harvard University Press.
- Kimmel, A. J., and A. F. Audrain-Pontevia. 2010. "Analysis of Commercial Rumors from the Perspective of Marketing Managers: Rumor Prevalence, Effects, and Control Tactics." *Journal of Marketing Communications* 16: 239–253.
- Lotan, G. 2012. KONY2012: See How Invisible Networks Helped a Campaign Capture the World's Attention. March 14, 2012. [blog.socialflow.com](http://blog.socialflow.com/post/7120244932/data-viz-kony2012-see-how-invisible-networks-helped-a-campaign-capture-the-worlds-attention). <http://blog.socialflow.com/post/7120244932/data-viz-kony2012-see-how-invisible-networks-helped-a-campaign-capture-the-worlds-attention>, October 25, 2012.

- Marsden, P. V. 1987. "Core Discussion Networks of Americans." *American Sociological Review* 52 (1): 122–131.
- Mason, R. B. 2008. "Word of Mouth as a Promotional Tool for Turbulent Markets." *Journal of Marketing Communications* 14 (3): 207–224.
- McGuire, W. J. 1961. "The Effectiveness of Supportive and Refutational Defenses in Immunizing Defenses." *Sociometry* 24: 184–197.
- McNaughton, M. 2011. "Lessons from the #MCDonalds Promoted Trend Controversy.", *The Realtime Report*, Montauk, NY, USA. <http://therealtime.com/2012/01/24/lessons-from-the-mcdstories-promoted-trend-controversy/>
- McPherson, M., L. Smith-Lovin, and J. M. Cook. 2001. "Birds of a Feather: Homophily in Social Networks." *Annual Review of Sociology* 27: 415–444.
- Myers, S. A., C. Zhu, and J. Leskovec. 2012. "Information Diffusion and External Influence in Networks." In *Proceedings of the 18th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, KDD'12*: 33–41, August 12–16, Beijing, China.
- Newman, M. E. J., A. L. Barabási, and D. J. Watts. 2006. *The Structure and Dynamics of Networks*. Princeton, NJ: Princeton University Press.
- Pariser, E. 2011. *The Filter Bubble: What the Internet is Hiding from You*. New York: Penguin Press.
- Petri, A. 2011. "Weinergate. Anthony Weiner's Twitter Image Problem." *The Washington Post*, May 31. http://www.washingtonpost.com/blogs/compost/post/weinergate-anthony-weiners-twitter-image-problem/2011/03/03/AGjSzeFH_blog.html
- Pezzo, M. V., and J. W. Beckstead. 2006. "A Multilevel Analysis of Rumor Transmission: Effects of Anxiety and Belief in Two Field Experiments." *Basic and Applied Social Psychology* 28: 91–100.
- Pfau, M. 1997. "The Inoculation Model of Resistance to Influence." In *Progress in Communication Sciences*, edited by F. J. Boster, and G. Barnett. Vol. 13, 133–171. Norwood, NJ: Ablex.
- Pfeffer, J., and K. M. Carley. 2011. "Modeling and Calibrating Real-World Interpersonal Networks." In *Proceedings of IEEE NSW 2011*, 9–16.
- Pfeffer, J., and K. M. Carley. forthcoming. "The Importance of Local Clusters for the Diffusion of Opinions and Beliefs in Interpersonal Communication Networks." *International Journal of Innovation and Technology Management*.
- Rogers, E. M. 1995. *Diffusion of Innovations*. 4th ed. New York: Free Press.
- Rogers, E. M., and D. L. Kincaid. 1981. *Communication Networks: Toward a New Paradigm for Research*. New York: Free Press.
- Ryan, B., and N. C. Gross. 1950. "Acceptance and Diffusion of Hybrid Corn Seed in Two Iowa Communities. Iowa Agricultural Experiment Station." *Research Bulletin* 372: 661–708.
- Schelling, T. C. 1973. "Hockey Helmets, Concealed Weapons, and Daylight Saving: A Study of Binary Choices with Externalities." *Journal of Conflict Resolution* 17 (3): 381–428.
- Simon, H. 1972. "Theories of Bounded Rationality." In *Decision and Organization*, edited by C. B. McGuire, and R. Radner, 161–176. Amsterdam: North-Holland.
- Solis, B. 2011. *The End of Business as Usual: Rewire the Way You Work to Succeed in the Consumer Revolution*. Hoboken, NJ: Wiley.
- Sunstein, C. 2001. "The Daily We." In Boston Review New Democracy Forum: Is the Internet Bad for Democracy? <http://bostonreview.net/BR26.3/contents.html>
- Wasserman, S., and K. Faust. 1995. *Social Network Analysis, Methods and Applications*. Cambridge: Cambridge University Press.
- Watts, D. J., and S. Strogatz. 1998. "Collective Dynamics of Small World Networks." *Nature* 393: 440–442.
- Zhou, W. X., D. Sornette, R. A. Hill, and R. I. M. Dunbar. 2005. "Discrete Hierarchical Organization of Social Group Sizes." *Proceedings: Biological Sciences* 272 (1561): 439–444.
- Zorbach, T. 2011. "Die Kunst des Zuhörens: Customer Insights im Kontext viraler Kampagnen am Beispiel PONS." In *Customer Insights: Wissen wie der Kunde tickt*, edited by H.-C. Riekhof, 67–81. Wiesbaden: Gabler.