How Twitter is being used by Australian engineering academic units

Stuart Palmer
Faculty of Science, Engineering and Built Environment, Deakin University
Corresponding Author Email: spalm@deakin.edu.au

Structured abstract

BACKGROUND
For organisations, social media provide new avenues for communication and collaboration with their stakeholders; however, any value created for an organisation through social media comes not from any particular platforms, but from how they are used. The potential value of social media tools to assist in the successful communication inside and outside of engineering organisations has been identified in the literature. While social media may be widely used by individuals and many organisations, their use in higher education is still relatively new. Applications of social media in engineering education can also be found in the literature, including in work integrated learning. One of the most widely-used social media tools employed by organisations is Twitter. Research on the use of social media by higher education institutions is still limited and evaluation of the impact of social media activities is not straightforward. One approach to evaluation is network analysis.

PURPOSE
The work presented here is an investigation into the use of the Twitter social media platform by Australian engineering academic units (AEAUs). It uses publicly available Twitter data for analyses and visualisation to characterise the engagement by AEAUs with one popular social media tool. Specifically, it seeks to:

- identify the different levels and forms of Twitter use by AEAUs; and
- to identify the networked connections between those AEAUs using Twitter as a social media platform.

DESIGN/METHOD
All AEAUs with a publicly advertised Twitter account were identified and all publicly available data originating from their Twitter account was captured with the NCapture program. Following processing, the Twitter data were used to compile basic account usage statistics, and to visualise the data in the form of a network using the Gephi program. Together, the usage statistics and network visualisation provide a characterisation of the use of Twitter by those AEAUs.

RESULTS
Eight AEAUs were discovered with a Twitter account at the time of the investigation. Use of the Twitter accounts varied widely. The network visualisations of Twitter interactions showed qualitatively different forms communication by the accounts. A novel outcome was the pooling of all the data to reveal in a single network visualisation the links between the AEAUs present on Twitter.

CONCLUSIONS
A relatively limited range of uses of social media in engineering education can be found in the literature. The network visualisations produced provide insights into the differing ways AEAUs are active on Twitter. In one case, essentially undirected 'Megaphone' Tweeting was observed. In another case, high levels of Tweeting, Retweeting and complex interactions with multiple external accounts were observed. The work documented provides useful insights into the different ways that AEAUs are using Twitter, how they might more effectively use the platform to achieve their individual objectives for institutional social media communications, and offers a methodology that can be used for future research.

KEYWORDS
Social media; Engineering education; Twitter

Introduction

Online social media systems have created new ways for organisations to communicate and collaborate with their stakeholders. However, any value created for an organisation through social media comes not from any particular platforms, but from how they are used (Culnan, McHugh, & Zubillaga, 2010). The potential value of social media tools to assist in the successful communication inside and outside of engineering organisations has been identified (Mawhinney, 2010), and documented case studies of such use exist in the literature (Murphy & Salomone, 2013). A useful model for conceptualising the management of stakeholder communication is provided by the 3-M model from the field of marketing, which identifies three components of social media communications with 'customers', all of which need to be effectively managed for best results: i) the Megaphone representing firm-to-customer communication; ii) the Magnet representing customer-to-firm communication; and iii) the Monitor representing customer-to-customer interaction (Gallaugher & Ransbotham, 2010).

While social media may be widely used by individuals and many organisations, their use in higher education is still relatively new (Forkosh-Baruch & Hershkovitz, 2012). In the context of engineering education, the potential of social media to open new modes of communication, interaction and experimentation between students and teachers has been identified (Kamthan, 2010). Examples documented in the literature include: social media tools being used to link software engineering students with practicing industry professionals (Morgado et al., 2012); the use of Twitter to engage a large group of engineering students during an information literacy class (Morrow, 2010); the use of Twitter by engineering students on work integrated learning placements (Paku & Lay, 2011) (relevant to the theme of this conference); the use of Twitter by students to send commands to a hosted installation of the numerical computing environment Matlab (Judd & Graves, 2012), and software engineering students collaborating at two universities autonomously adopting Facebook for group communications when the provided communication system proved unwieldy (Charlton, Devlin, Marshall, & Drummond, 2010). There is evidence that social media channels can play a more general role in the support and dissemination of engineering education activities. In one example, a capstone student engineering design experience employed social media channels to link students, academic staff and industry practitioners to collaborate on the theme of sustainability, and to promote the project and its outcomes more generally (Wolcott et al., 2011).

Research on the use of social media by higher education institutions is still limited (Constantinides & Zinck Stagno, 2011) and evaluation of the impact of social media activities is not straightforward (Culnan et al., 2010). One approach to evaluation is network analysis (Wolcott et al., 2011). The network data inherently created by social media tools represent the connections between participants as they interact, and can be used to make visible the previously elusive social processes at play, and to identify strategically important components and participants in the social network (Smith et al., 2009).

One of the most widely-used social media tools employed by organisations is Twitter (twitter.com) (Culnan et al., 2010). Twitter is a popular and rapidly growing 'microblogging' service where users can post quick and frequent short messages (up to 140 characters) called 'Tweets', which may contain links to other online material such as photos and websites, to their 'Followers' who have subscribed to their Twitter account (Reuben, 2008). Tweets can be tagged with a searchable 'hashtag' (e.g., an event might publicise a hashtag to use so that Tweets associated with the event can be easily collected via a tag search), and a user can 'Retweet' to all of their Followers a Tweet that they receive from another user (Forkosh-Baruch & Hershkovitz, 2012; Gallaugher & Ransbotham, 2010). Tweets can be directed specifically to other named user accounts, or broadcast generally to all Followers of the sending account. Except for the content of Tweets from protected (private) accounts, all Tweets are effectively broadcast to 'the world' and are publicly discoverable via a search. A

growing number of academic units involved in engineering education internationally now advertise a link to a Twitter account on their Internet home page.

Engineering education might engage with social media for a range of purposes including: a targeted educational use that employs specific affordances provided by a particular social media platform; a more generic educational purpose that views competence in social media environments as an important element of general student digital literacy and/or a useful skill for professional engineering practice; as a catalyst for student engagement; for research collaboration and communication; for general communication with students, staff, alumni, other important stakeholders and the wider community at large; for student recruitment; and for marketing more generally. The work presented here is an investigation into the use of the Twitter social media platform by Australian engineering academic units (AEAUs). It uses publicly available Twitter data for analyses and visualisation to characterise the engagement by AEAUs with one popular social media tool. Specifically, it seeks to:

- identify the different levels and forms of Twitter use by AEAUs; and
- to identify the networked connections between those AEAUs using Twitter as a social media platform.

Method

A search of the Internet home pages of all AEAUs (Schools, Faculties, etc.) offering an accredited professional engineering program in Australia was made to identify those advertising a link to a Twitter account. At the time of the search, seven such Twitter accounts were identified. Via inspection of the lists of Twitter accounts Followed by those seven identified accounts, another account belonging to an AEAU was identified. A ruling was obtained from the relevant institutional human research ethics committee that the use of publically accessible historical Twitter records did not require formal ethics approval for research purposes. The NCapture program (QSR International, 2012a) is able to capture all publicly available data (Tweets and Retweets) originating from a specific Twitter account, as well as data arising from a search for Tweets originating from other accounts that mention a specific Twitter account. The functioning of the Twitter system means that a significant (often multi-year) archive of Tweets from an account can be extracted. However, the results from a search for mentions of an account are typically much more limited in quantity and time period; to build a continuous record of mentions of an account requires the routine searching and compilation of Twitter search results. Over a one month period from mid-June to mid-July 2013, mentions of the eight AEAUs' Twitter accounts were systematically captured. At the end of that period, all of the publicly available Twitter data for the eight accounts were also captured. The NVIVO program (QSR International, 2012b) was used to convert the captured Twitter data into Microsoft Excel (Microsoft, 2010) spread sheets. For each AEAU, basic Twitter account descriptive statistics as at the time of final data collection were tabulated and visually presented on a timeline. These data were examined for significant statistical associations with the number of Followers, and with the number of mentions. For each AEAU, the spread sheet Twitter data were also exported in comma separated values (CSV) format, and then imported into the Gephi program (The Gephi Consortium, 2012) to visualise the communication network embodied in the data. Finally, all of the collected Twitter data were merged to visualise the connections and interactions between all eight AEAUs. As outlined in Figure 1, Gephi can be used to represent Twitter user accounts as 'nodes', and the communication path (representing one or more Tweets) between two nodes as an 'edge'. In the network diagrams presented in this paper, edges are presented as curved lines, the direction of Tweets is clockwise around the edge, and the width of an edge is proportional to the total number of Tweets recorded between the two nodes in that direction. The network diagrams produced with the Gephi program used a force-directed layout algorithm. Generically, force-directed algorithms assign attractive forces (analogous to Hooke's law) between the endpoints of each edge, and repulsive forces (analogous to Coulomb's law) between all nodes in the network. The structure of the network is then iteratively simulated until it reaches an equilibrium state.

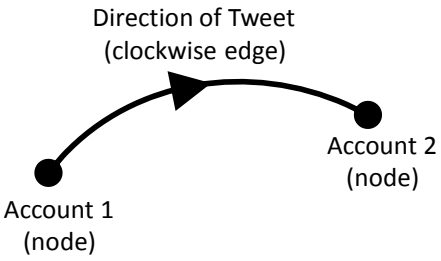

Figure 1: Twitter network visualisation schema used in this paper

Results and Discussion

Varying Twitter data archive periods were obtained from each account, with one AEAU having Tweets recorded back to November 2009. While collection of direct mentions of the eight accounts was limited to a single month, some additional mentions were able to be inferred from Retweets made by particular AEAUs that included Tweet content from other accounts mentioning that AEAU. Where such inferences were possible, those mentions have been included in the data here. Table 1 shows a range of basic Twitter account statistics for the eight AEAUs (labelled U1 to U8) at the time of final data collection.

Table 1: Basic Twitter account statistics for the eight Australian engineering academic units

Academic unit	Tweets						
	Undirected	Directed	Retweets	Total	Mentions	Following	Followers
U1	161	5	7	173	16	22	306
U2	237	306	140	683	58	189	405
U3	12	1	0	13	0	9	7
U4	219	269	73	561	59	536	695
U5	171	0	0	171	0	6	14
U6	91	106	51	248	19	76	288
U7	62	0	1	63	0	12	28
U8	32	10	49	91	40	114	211

The absolute values in Table 1 are not directly comparable, as they are drawn from varying time periods. Figure 2 presents to total Twitter activity (the sum of undirected and directed Tweets, and Retweets) originating from each AEAU, each month, over the time period for which Twitter data were available. U1 has been active on Twitter since prior to 2010; U4, U6 and U7 commenced around 2011; U2 commenced in 2012; U3 and U5 commenced in mid-2012; and U8 commenced around 2013. U3 had a single burst of activity in June 2012, but did not persist; U1 has had a relatively constant low level of activity over nearly four years; and U2 with the maximum total activity exhibits widely varying levels of activity.

Use of social media channels by organisational stakeholders is voluntary, so it is important for an organisation to attract a critical mass of members (Followers) and facilitate their active participation in an online community (Culnan et al., 2010) – the number of mentions is one measure of an organisation engaging its stakeholders in two-way interactions. All pairs of data categories in Table 1 were tested for association using Pearson's correlation coefficient (r). The following significant associations were observed:

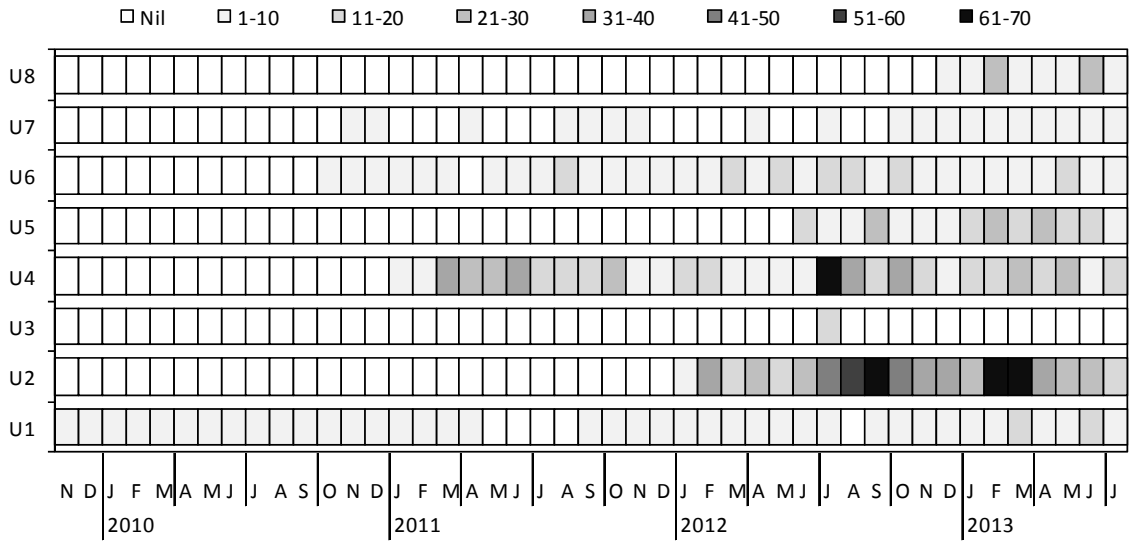

Figure 2: Map of monthly total Tweets for the eight Australian engineering academic units

- mentions and directed Tweets (r=0.851 p<0.008);
- mentions and Retweets (r=0.89 p<0.004);
- mentions and number of Followers (r=0.871 p<0.005); and
- number of Followers and number Following (r=0.896 p<0.003).

Both directed Tweets and Retweets are purposeful interactions with another user; the former is a direct communication, and the latter is the re-distribution of the content from another user. Both of these actions are flagged to the other user, and hence may stimulate a mention in response. All undirected Tweets from an account appear in the Twitter timeline of all Followers of that account, and may prompt a mention (directed Tweet or Retweet) in response. The number of Followers of an account seems to be associated with the number of other users that an account Follows. While the wider Twitter population has been found to have a relatively low rate of reciprocity between Follower/Following pairs (Kwak, Lee, Park, & Moon, 2010), the rate of reciprocity is much higher between users with similar interests (Smith et al., 2009). It is reasonable to expect that the network of Twitter users associated with AEAUs is based on common interests of engineering and education, and hence the reciprocity between Follower and Following is likely to be higher than the general Twitter population. The observed associations are based on eight observation cases only, so these results are treated as indicative rather than definitive.

Examination of Table 1 shows two principal patterns of Twitter posts. U1, U5 and U7 send mostly undirected Tweets. U3 follows a similar pattern, though with a very low number of total Tweets. In contrast, U2, U4, U6 and U8 exhibit a more diverse model of posts with a spread of Tweet types, and typically more Tweets overall. The ratio of directed to undirected Tweets clearly separates the two groups without reference to the total number of Tweets. Using the schema presented in Figure 1, Figure 3 and Figure 4 present a network visualisation of Tweets and mentions collected for U2 and U1 respectively. These two AEAUs are chosen as representative of the two principal patterns of Twitter posts. All nodes (Twitter accounts) have been de-identified, with the node for the AEAU positioned in the centre of the network diagram, and the large edge directed toward the left of the network diagram representing undirected Tweets from the AEAU sent to their Followers, and 'the world' at large. The scale of Figure 3 and Figure 4 is equal.

In terms of the 3-M model of social media communications (Gallaugher & Ransbotham, 2010), both network diagrams show evidence of the 'Megaphone' – the large edge representing Tweets emanating from the AEAU account in the centre, directed toward the left

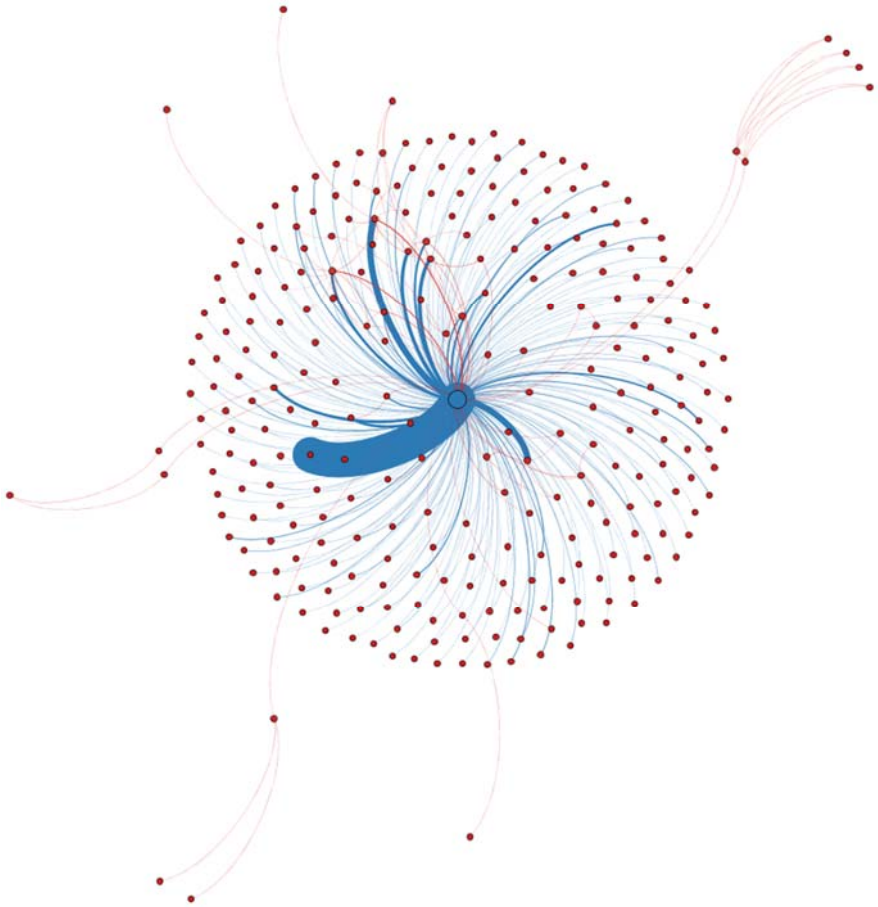

Figure 3: Twitter network diagram for Engineering Academic Unit 2

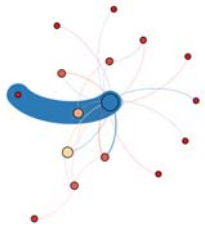

Figure 4: Twitter network diagram for Engineering Academic Unit 1

of the diagram and directed to their Followers, and the world at large. In addition, there are varying numbers of edges emanating out from the AEAU account in a clockwise direction to specific nodes, which represent Tweets directed to, and Retweets that mention, specific user accounts. Collectively, these three types of Megaphone edges emanating clockwise from the AEAU account represent the Tweets identified in Table 1 for each AEAU. To varying degrees, Figure 3 and Figure 4 show evidence of the 'Magnet'. Edges from nodes that connect into the AEAU account at the centre in a clockwise direction represent Tweets from user accounts directed to, or mentioning, the AEAU account. The most difficult element of the 3-M model to quantify is the 'Monitor'. Retweets from an AEAU represent Tweets observed by the AEAU and considered worthy of re-transmission; hence Retweets are a measure of the Monitor activity of an AEAU that can be explicitly accounted for. What other monitoring an AEAU might be doing cannot be directly assessed. The balance of edges in the network diagrams presented are those that link between nodes pairs not including the AEAU account in the centre of the diagram – these edges are part of the 'mentions' of the AEAU identified in Table 1, and are 'discussions' about the AEAU by other parties.

Some distinct differences in the forms of social media interactions can be observed. In Figure 4, U1 is largely 'Megaphoning' only, with very low numbers of directed Tweets and Retweets. Contrast this to Figure 3 where, even though U2 sent several times the total number of Tweets as U1, these are split more equally between undirected Tweets, directed Tweets and Retweets (i.e., the majority of Tweets are to, or mentioning, named accounts rather than to 'the world' at large). U1 is in a largely one-way conversation, 'shouting' at the world, while U2 is engaged in a much more complex conversation with the stakeholders in its social media environment. The Twitter networks of the eight AEAUs potentially share some nodes in common – if nothing else, all AEAUs sent undirected Tweets to 'the world'. Pooling all the Twitter data collected, and visualising it in the same way as Figure 3 and Figure 4 gives the resultant 'all-in' network diagram presented in Figure 5.

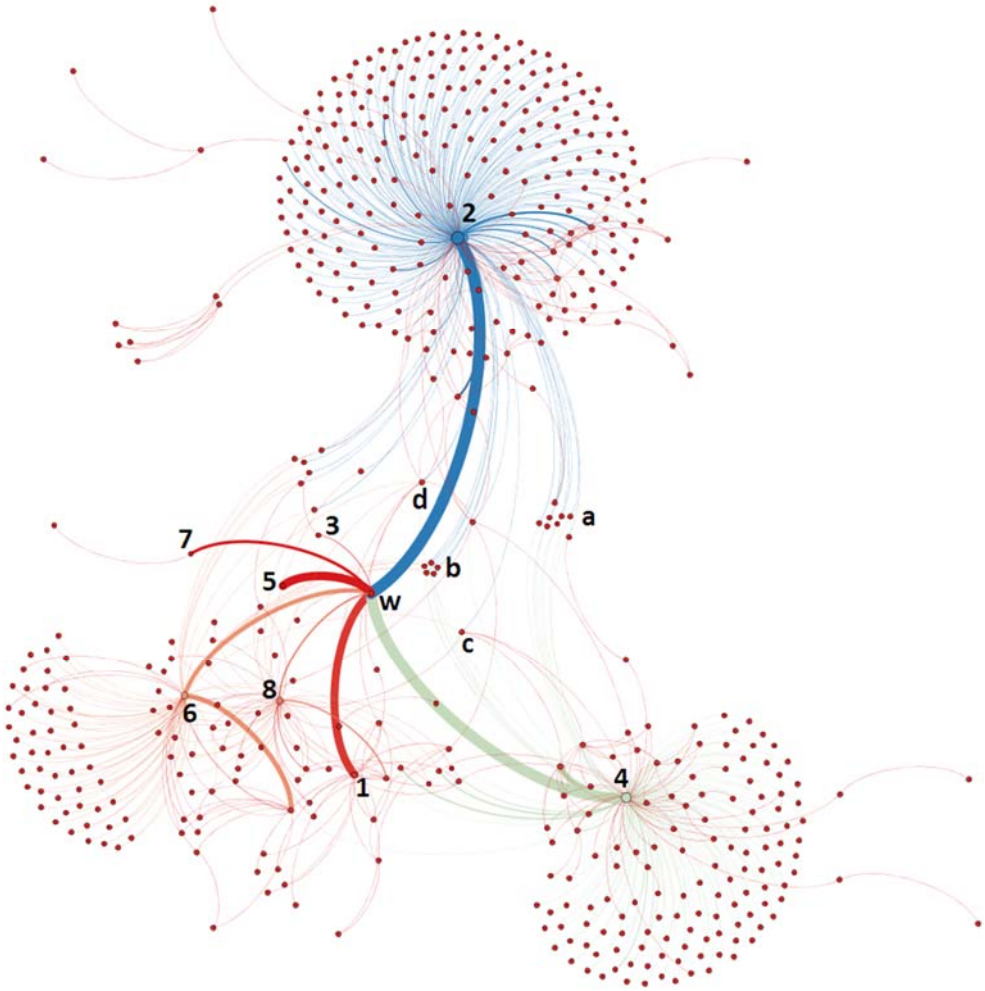

Figure 5: Twitter network diagram for all engineering academic units combined

The nodes representing the Twitter accounts for the eight AEAUs are labelled '1' to '8'. Node 'w' represents 'the world' – the recipient of undirected Tweets. Nodes in the group labelled 'a' are a group of Twitter accounts that form common links between U2 and U4. Nodes in group 'b' are Twitter accounts that form common links between U2, U4 and U5. Node 'c' has connections to unit 2, 4, 6 and 8. Node 'd' (which belongs to Engineers Australia) has connections to five of the AEAUs, as well as to other nodes in the network. While it may not be clear from Figure 5, no direct connections between any of the AEAUs were observed in the data collected. However, as Figure 5 does show, there is a significant level of indirect 'connection' between AEAUs via the wider Twitter environment.

Social media use in engineering education is still relatively new – some specific examples were given in the Introduction. In considering how Twitter might be productively used, it is useful to look at the Georgia Tech College of Engineering (Twitter handle @GaTechEngineers). As currently one of the most regular engineering academic unit Twitter users internationally, it is observed that its Tweets are typically not related to specific learning activities, instead they largely spread topical engineering news and respond to student queries – a more affective rather than cognitive use, presumably aimed at creating links and building general student engagement. Additional research into the ways in which social media are being used in engineering education and their effectiveness is needed.

Conclusions

Online social media systems have created new ways for individuals and organisations to communicate and interact with a wide audience. A comparatively limited range of uses of social media in engineering education can be found in the literature. Evaluation of the effectiveness of social media activities can take a number of forms, including network analysis that visualises the connections and interactions between participants. One of the most popular social media platforms is Twitter. This paper presents an investigation into the use of Twitter by Australian engineering academic units (AEAUs). It uses publicly available Twitter data for analyses and visualisation to characterise the engagement by AEAUs with one popular social media tool. Two differing patterns of activity were observed: i) sending mostly undirected Tweets; and ii) a more diverse model of posts with a spread of Tweet types, and typically more Tweets overall. Tentative associations were observed between: mentions and directed Tweets; mentions and Retweets; mentions and number of Followers; and, number of Followers and number Following. The network visualisations produced provide insights into the differing ways AEAUs are active on Twitter. In one case, essentially undirected 'Megaphone' Tweeting was observed. In another case, high levels of Tweeting, Retweeting and complex interactions with multiple external accounts were observed. A limitation of this investigation is that it includes only limited data regarding Twitter mentions of the AEAUs. Also, by focussing on the Twitter platform, this investigation only addresses one aspect of the total social media environment of the AEAUs. The numbers recorded in Table 1 and the various visualisations do not indicate the purpose and content of the Twitter communications that they summarise. The Twitter data collected here include more than 36,000 words, and content analysis of these Tweets would provide more insight into the purpose and nature of the social media conversations undertaken by AEAUs. However, the work documented provides useful understandings about the different ways that AEAUs are using Twitter, how they might more effectively use the platform to achieve their individual objectives for institutional social media communications, and offers a methodology that can be used for future research in engineering education and more generally.

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