"Only say something when you have something to say" – Identifying Creatives Through Their Communication Patterns

Peter A. Gloor[1], Hauke Fuehres[2], Kai Fischbach[2]

[1]MIT Center for Collective Intelligence, Cambridge MA, pgloor@mit.edu
[2]University of Bamberg, Germany, {hauke.fuehres, kai.fischbach}@uni-bamberg.de

Abstract We study the communication patterns of particularly creative people in the R&D department of a global energy firm through their e-mail communication. We find that the most creative staff members, measured through patents, publications, and awards, are less central in the full corporate network, but more responsive and responded to, which we take as a proxy for passion and respect.

1. Introduction

In his studies and interviews with famously creative people such as Nobel Prize winners and artists, Mihaly Csikszentmihalyi (1997) found that these highly creative people share some contradictory traits. They have high physical energy, but are also frequently at rest. They are smart, but also naïve. They combine playfulness with discipline, fantasy with reality, extroversion with introversion, and show both feminine and masculine traits. They are both humble and proud at the same time, independent but also rebellious, and passionate and objective.
In this paper the creativity of employees in a research and development department of a globally active energy company is analyzed. Characteristics of patterns in communication behavior measured through e-mail is associated with creativity of teams and individuals in organizations (Kidane & Gloor 2006). The e-mail communication of the employees is studied to identify communication patterns suggesting creativity and innovational strength of the individuals. Note that while some authors distinguish between creativity and innovativeness (Martins & Terblanche, 2003) we treat the two concepts as interchangeable.

2. Background: How to Measure Creativity

Csikszentmihaly (1997) defines creativity as an act, idea, or product that changes an existing domain – which can be anything from cooking to nuclear physics – or that transforms an existing domain into a new one. Researchers have been studying individual and organizational creativity for a long time. However understanding its key ingredients has been elusive. Amabile (1983, 1996, Amabile et al. 1996) identifies creativity as a combination of expertise, creative-thinking skills, and motivation. Expertise consists of procedural, technical and intellectual knowledge. Intrinsic motivation, and inner passion to solve the problem are essential for truly creative solutions, as are creative-thinking skills that include persistence in the face of adversity.

Researchers have identified individual level-characteristics of creativity and the observable influence of these characteristics on output creativity (Helson, 1996). However the influence of the environment on the creative output of the individual has soon been recognized (Perry-Smith 2006, Perry-Smith & Shalley, 2003). It has been understood that a combination of skills, motivation, personality, and contextual factors will influence creativity (Woodman et al. 1993, Zhou 2003). Social network analysis techniques have been used to better understand the influence of collaboration on extraordinary creativity (Leenders et al., 2003, Sawyer 2007).

Gloor (2006) postulates that better communication inside an organization will lead to better collaboration, which in turn will lead to better innovation. In follow on work (Gloor et al. 2012), communication among team members has been measured by tracking interpersonal communication through e-mail archives, phone logs, and sociometric badges – body-worn sensors. These communication patterns have then been compared against individual and team creativity. In this paper an extension of this approach within a global high-tech energy firm is described. Economic growth drives energy demand. An essential global challenge is how the world can continue to grow its global economy, to increase the standard of living of billions of people while minimizing the environmental impact related to the use of energy and economic development. Technology has the highest impact, but also has highest uncertainty. This asks for unparalleled creativity in research and development. Understanding the communication patterns of particularly creative R&D members will help understand and increase our capability to take on the toughest energy challenges.

3. Method

In this paper the corporate e-mail network of the thousands of employees of the research and development department of a global energy company is analyzed. The email traffic among those thousands of employees has been collected over 13 months. Their e-mail communication with outside researchers from universities has also been included in the dataset. Only the structural data on the e-mail communication was analyzed. Neither content information nor e-mail subject lines were evaluated. The information on the senders and receiver for e-mails has been anonymized.

In order to test the assumptions made in this paper the creativity and innovative strength of the employees is measured. Two classes of additional characteristics on the employees have thus been collected: Whether an employee filed for patents or published scientific papers shows output-oriented behavior. As internal, outcome-oriented behavior two internal awards have been taken into account. The first award rewards the most exceptional patent filed by an employee, the second award is granted to the most innovative employee.

For this study creativity and innovational strength of an employee is identified by four measures:

Output metrics:
- Number of $\text{Patents}_{\text{Emp}}$ = Number of patents filed by employees
- Number of $\text{Best Papers}_{\text{Emp}}$ = Number of "publications of the year" by employee

Outcome metrics:
- Number of $\text{Edison Awards}_{\text{Emp}}$ = Number of Thomas Alva Edison Patent Award (honoring the most exceptional efforts of scientists and inventors)
- Number of $\text{Most Innovative Employee}_{\text{Emp}}$ = Number of annual awards for the most innovative employee rewarded to employee

We call employees who hold at least one of those four criteria innovators. In addition, innovators have been categorized into *output* innovators – filing for patents and writing best papers, and *outcome* innovators – getting an award. In an additional analysis, the difference in communication patterns between *repeat* innovators – who fulfill more than one criteria or one criteria several times – and innovators who fulfill a criteria once – we call them *'one-shot* innovators' has been studied.

4. Results

We constructed the full network of the thousands of members of the R&D department. For each member of the department we calculated their six honest signals of e-mail collaboration, as defined in (Gloor 2015). They are shown in table

1. Figure 1 shows the ingroup network of the thousands of members of the department for 2015, colored by divisions. Each dot is an actor, each connecting line means that at least one e-mail has been exchanged between the two actors.

Figure 1. social network of the R&D department, colored by divisions.

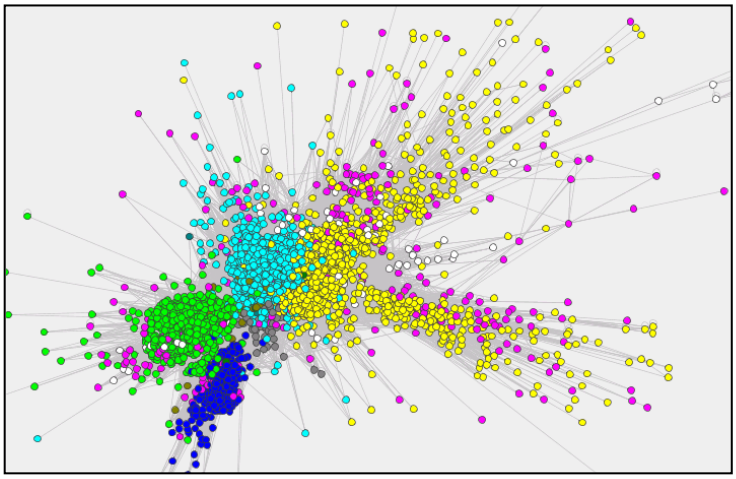

Table 1. Six honest signals of collaboration

Indicator	SNA term	Definition	How the variables are calculated in condor
Central Leadership	Degree Centrality	Number of actors each person is directly connected with in a network.	Is the number of nearest neighbors from an actor both as senders or receivers in the network
	Betweenness Centrality	It is a measure of the extent to which each actor acts as an information hub and controls the information flow	It is defined as the likelihood to be on the shortest path between any two actors in the network
Rotating Leadership	Betweeeness Centrality Oscillation	It is a measure of how frequently actors change their network position in the team, from central to peripheral, and back	number of local maxima and minima in the betweeness curve of an actor or a group
Balanced Contribution	Contribution Index	Indicates how balanced a communication is in terms of msg sent and msg received	msg sent-msg rcvd/(msg sent+msg rcvd)
Rapid Response	Ego ART	Average number of hours sender takes to respond to emails	time until a frame is closed for the receiver after he has sent an email
	Ego Nudges	Average number of follow-ups that the sender needs to send in order to receive a response from the receiver	number of pings until sender responds
	Alter ART	Average number of hours receiver takes to respond to emails	time until a frame is closed for the sender, after he has sent an email
	Alter Nudges	Average number of follow-ups that the receiver needs to send in order to receive a response from the sender	number of pings until receiver responds
Honest Language	Avg. Sentiment	Indicates positivity and negativity of communication	uses automatically generated bag of word, based on a dictionary trained for language/subject area
	Avg. Emotionality	Represents the deviation from neutral sentiment	standard deviation of sentiment
Shared Context	Avg. Complexity	It is a measure of complexity of word usage. It is defined as the information distribution, i.e. the more diverse words, which are all used evenly, a sender uses, the higher his complexity	information distribution using TF/IDF, independent of single words

4.1 Innovators among their peers

When looking at the network structure and the six honest signals of communication, innovators stand out in several ways from their peers in the analyzed department. The innovators were more respected, as their peers within the department answered them on average in 20 hours instead of the 22 hours it took for everybody else to get at response.

Table 2. Social network metrics comparing innovators with their peers (** significant on the 0.01 level, * significant on the 0.05 level)

		N	Mean	Std. Deviation
Messages sent	peers	1718	6760.55	7969.23
	innovators	194	6265.12	5669.05
Alter ART [h]**	**peers**	**1718**	**21.93**	**7.80**
	innovators	**194**	**20.37**	**6.47**
Messages received	peers	1718	6270.62	3773.43
	innovators	194	6756.89	3956.28
Messages total	peers	1718	13031.17	10702.61
	innovators	194	13022.01	9156.42
Contribution index**	**peers**	**1718**	**-0.09**	**0.27**
	innovators	**194**	**-0.14**	**0.24**
Ego ART [h]	peers	1718	19.85	5.60
	innovators	194	19.29	4.32
Ego Nudges**	**peers**	**1718**	**2.01**	**0.44**
	innovators	**194**	**1.83**	**0.31**
Betweenness centrality	**peers**	**1718**	**166.26**	**27.85**
oscillation*	**innovators**	**194**	**170.04**	**21.60**
Alter Nudges**	**peers**	**1718**	**2.09**	**0.40**
	innovators	**194**	**2.00**	**0.29**
Betweenness	**peers**	**1718**	**5302.00**	**43651.09**
centrality**	**innovators**	**194**	**1707.57**	**3568.16**
Degree centrality	peers	1718	260.68	196.02
	innovators	194	274.86	163.69
Contribution index	peers	1718	164.81	29.87
oscillation	innovators	194	167.35	22.10

Innovators were also more attentive when it comes to answering e-mails. On average, it took dialog partners less than two e-mails to elicit an answer from an innovator. Their peers from the research and development department needed over two inquiries to answer e-mails. The innovators needed 5 percent less reminders than their peers.

The network position of innovators differs from those of their peers. Betweenness centrality measuring the control over the information flows in the e-mail network has been utilized to show the influence of the single employees. Innovators changed their network position more often than their peers. Over the entire observation period of 13 months, they changed their network position 170 times from high centrality to low centrality, compared to their peers who showed the rotating

leadership behavior on average 166 times. The innovators were thus showing a higher amount of rotating leadership.
It turns out that innovators are 3.1 times less central than their peers, measured in betweenness centrality. They are also more passive senders of e-mail in terms of their contribution of new messages. When restricting the communication to the local lab of the innovators, however, they switch roles, and become more central within their local lab network than their peers. The innovators are then 2.2 times more central than their direct peers.

4.2 Communication with external researchers

The communication behavior with people outside of the organization also differed between innovators and their peers. Communication of employees with researchers from universities has been analyzed. The innovators got 1.7 times more e-mails from senders with university e-mail addresses, and they were sending 1.4 times more e-mail to university researchers compared to their peers within the R&D department. Their rotating leadership behavior became even more pronounced in communication with universities, they changed their position from being the leader to the listeners 65 times in the 13 months observation period, compared to 41 rotational changes in leadership for their peers within the company. Innovators also talked with more different people at the university over these 13 months, initiating an e-mail dialog with 56 outside people instead of 37.

Table 3. Social network metrics comparing innovators with their peers when communicating with outside academics peers (** significant on the 0.01 level, * significant on the 0.05 level)

		N	Mean	Std. Deviation
Messages sent	innovators	103	268.78	361.32
	peers	165	189.79	313.92
Alter ART [h]	innovators	97	20.20	15.44
	peers	145	16.85	16.95
Messages received**	**innovators**	**103**	**129.54**	**113.85**
	peers	**165**	**77.05**	**109.17**
Messages total**	**innovators**	**103**	**398.32**	**443.33**
	peers	**165**	**266.85**	**380.09**
Contribution index*	**innovators**	**103**	**0.12**	**0.42**
	peers	**165**	**0.24**	**0.37**
Ego ART [h]	innovators	103	22.19	19.38
	peers	165	18.44	17.85
Ego Nudges	innovators	103	1.65	0.48
	peers	165	1.69	0.65
Betweenness centrality	**innovators**	**103**	**65.17**	**41.25**
	peers	**165**	**41.92**	**40.39**
Alter Nudges	innovators	97	1.19	0.26
	peers	145	1.24	0.49
Betweenness centrality*	**innovators**	**103**	**4.23E+06**	**1.07E+07**
	peers	**165**	**2.32E+06**	**3.78E+06**
Degree centrality**	**innovators**	**103**	**55.99**	**54.48**
	peers	**165**	**37.21**	**39.48**
Contribution index oscillation**	**innovators**	**103**	**54.61**	**39.22**
	peers	**165**	**38.75**	**37.51**

4.3 Output-oriented and outcome-oriented innovators

Innovators at the examined department can further be partitioned into two groups of innovators. Output-oriented innovators are those who fulfill the first two criteria of being an innovator: They publish scientific papers and file patents. The second group of innovators, the outcome-oriented innovators are employees who were rewarded with the Edison patent award or with awards for the most innovative employee. Paper and patent writing innovators show more introvert behavior than their peers, while award winning innovators show more extrovert behavior: while on average innovators send less e-mail than their peers, award winning innovators were the most active senders and receivers of e-mail in the entire R&D department. However, it seems that paper and patent writing innovators are more respected than award winning innovators, as they are responded faster than award winning innovators. However this could also be related to the higher amount of e-mail generated by outcome oriented innovators, as this puts a higher strain on others to answer them. Paper and patent writing innovators are less central – more introvert – than award winning innovators, who must be highly visible in order to be nominated for their awards. Award winning innovators also show more rotating leadership, switching between leading and listening, than the more introvert paper and patent writing innovators.

Table 4. Social network metrics comparing outcome innovators with output innovators. Bold denotes a significant difference (non-parametric Kruskal-Wallis test)

outC0outP1		Messages sent	**Alter ART [h]**	**Messages received**	**Messages total**	**Contribution index**	Ego ART [h]	**Ego Nudges**	Betweenness centrality oscillation	**Alter Nudges**	**Betweenness centrality**	**Degree centrality**	Contribution index oscillation
outcome innovators	Mean	7196.47	**20.57**	**7640.18**	**14836.65**	**-0.11**	19.04	**1.89**	171.65	**2.03**	**2253.23**	**275.92**	167.34
	N	74	**74**	**74**	**74**	**74**	74	**74**	74	**74**	**74**	**74**	74
	Std. Deviation	5924.62	**6.01**	**4322.13**	**9509.54**	**0.23**	3.45	**0.31**	23.32	**0.36**	**4366.79**	**145.59**	22.73
output innovators	Mean	5690.78	**20.25**	**6212.19**	**11902.98**	**-0.17**	19.44	**1.80**	169.04	**1.98**	**1371.08**	**274.21**	167.36
	N	120	**120**	**120**	**120**	**120**	120	**120**	120	**120**	**120**	**120**	120
	Std. Deviation	5451.47	**6.76**	**3625.10**	**8785.83**	**0.25**	4.78	**0.30**	20.50	**0.24**	**2941.43**	**174.51**	21.80
peers	Mean	6760.55	**21.93**	**6270.62**	**13031.17**	**-0.09**	19.85	**2.01**	166.26	**2.09**	**5302.00**	**260.68**	164.81
	N	1718	**1718**	**1718**	**1718**	**1718**	1718	**1718**	1718	**1718**	**1718**	**1718**	1718
	Std. Deviation	7969.23	**7.80**	**3773.43**	**10702.61**	**0.27**	5.60	**0.44**	27.85	**0.40**	**43651.09**	**196.02**	29.87
Total	Mean	6710.28	**21.77**	**6319.96**	**13030.24**	**-0.10**	19.79	**1.99**	166.65	**2.08**	**4937.29**	**262.12**	165.07
	N	1912	**1912**	**1912**	**1912**	**1912**	1912	**1912**	1912	**1912**	**1912**	**1912**	1912
	Std. Deviation	7767.21	**7.68**	**3794.16**	**10553.90**	**0.26**	5.49	**0.43**	27.30	**0.39**	**41405.90**	**192.99**	29.18

4.4 Repeat innovators

Finally, we also looked at whether there is a difference between repeat innovators – who fulfill more than one criteria or one criteria for several times – and innovators who only one once – we call them the "one-shot innovators". We found that repeat innovators sent twice as much e-mail to their peers. Repeat innovators show higher rotating leadership, changing from leading to listening 30 percent more than one-shot innovators. They also command higher respect – it takes less nudges for others to answer back to them, and they are more central in the network, although the difference in betweenness centrality is not statistically significant.

Table 5. Social network metrics comparing repeat innovators with one-shot innovators peers (** significant on the 0.01 level, * significant on the 0.05 level)

		N	Mean	Std. Deviation
Messages sent*	**one-shot innov.**	**23**	**118.74**	**131.83**
	repeat innovators	**78**	**279.03**	**376.96**
Alter ART [h]	one-shot innov.	18	20.27	12.10
	repeat innovators	70	20.25	13.97
Messages received	one-shot innov.	23	82.96	63.77
	repeat innovators	78	125.13	122.12
Messages total*	**one-shot innov.**	**23**	**201.70**	**167.16**
	repeat innovators	**78**	**404.15**	**468.13**
Contribution index	one-shot innov.	23	0.09	0.46
	repeat innovators	78	0.20	0.35
Ego ART [h]	one-shot innov.	15	18.46	17.25
	repeat innovators	68	22.30	16.82
Ego Nudges	one-shot innov.	15	1.60	0.43
	repeat innovators	68	1.72	0.49
Betweenness	**one-shot innov.**	**23**	**42.78**	**28.90**
centrality oscillation*	**repeat innovators**	**78**	**64.01**	**43.23**
Alter Nudges*	**one-shot innov.**	**18**	**1.39**	**0.54**
	repeat innovators	**70**	**1.19**	**0.27**
Betweenness centrality	one-shot innov.	23	1.96E+06	1.92E+06
	repeat innovators	78	4.51E+06	1.22E+07
Degree centrality	one-shot innov.	23	32.957	25.677
	repeat innovators	78	54.96	57.74
Contribution index	**one-shot innov.**	**23**	**35.74**	**25.85**
oscillation*	**repeat innovators**	**78**	**53.71**	**40.39**
newcontact	one-shot innov.	23	101.87	55.92
	repeat innovators	74	119.36	53.31

5. Discussion

In sum, we find that intrinsically motivated innovators can be found by looking at the "honest signals of collaboration", with signs of respect shown as faster response by others, and the innovators showing high passion by answering their e-mails faster than their peers. A second key insight is that innovators are less "political" in their e-mailing behavior by sending much less e-mail within their organization. They use their communication bandwidth to extend their external network to develop new innovative ideas. This helps them minimize organization's internal echo chambers of thought, and constantly add divergent thinking from external entities – thus increasing their 'innovation quotient' in the organization. In addition, innovators exhibit significantly higher rotating leadership through oscillations in betweenness centrality.

One limitation our study is the focus on publication and patent productivity, which does not imply correlation with output quality. A more realistic metric would be the financial impact of the patents on the bottom line of the company.

Unfortunately, these numbers were not available to us. Another open question is causality, it might be that better connected employees at the company have an easier time to file a patent, in particular because having many patents filed is considered a major means of success for an R&D employee, so it might be that this is an instance of the "rich get richer" syndrome, and once somebody has filed a patent, it will become successively easier to file more patents.

In combination, looking at these honest signals of collaboration gives valuable insights both to individual innovators and their managers. For individuals, it tells them that it pays to focus on their work, and reach out to the outside for novel ideas. It also encourages them to "take time off for thinking" in between intensive information exchanges with their peers. For managers, the lesson is clear: do not reward "political behavior" by spamming others with too many messages, but nurture a self-organizing emergent leadership style. Employees should be encouraged to employ a more intrinsically motivated communication style (Pink 2011), to "only say something when they have something to say." Employees are encouraged to reach out and connect to outside sources of ideas and innovation. They are allowed to form small ad-hoc workgroups, Collaborative Innovation Networks (COINs) (Gloor 2006) to pursue unconventional "crazy ideas".

6. References

Amabile, T.M. (1983) The social psychology of creativity: A componential conceptualization, *Journal of Personality and Social Psychology*, Vol. 45, No.2, pp. 357–376.

Amabile, T.M. (1996) Creativity in Context: Update to the Social Psychology of Creativity, Westview Press, Boulder, CO.

Amabile T.M., Conti R., Coon H., Lazenby J., Herron M. (1996) Assessing the Work Environment for Creativity, *The Academy of Management Journal*, Vol. 39, No. 5, pp. 1154-1184.

Csikszentmihalyi, M. (1997) Creativity: Flow and the Psychology of Discovery and Invention. New York: Harper Perennial.

Gloor, P. (2006) Swarm Creativity, Competitive Advantage through Collaborative Innovation Networks. Oxford University Press.

Gloor P.A., Grippa F., Putzke J., Lassenius C., Fuehres H., Fischbach K., Schoder D. (2012) Measuring Social Capital in Creative Teams Through Sociometric Sensors, *International Journal of Organisational Design and Engineering*, Vol. 2, No. 4, pp. 380-401.

Gloor, P. A. (2015) What Email Reveals About Your Organization. Sloan Management Review, Winter

Helson, R. (1996), In search of the creative personality, *Creativity Research Journal*, Vol. 9, pp. 295–306.

Kidane, Y. H. Gloor, P. A. (2007). Correlating temporal communication patterns of the Eclipse open source community with performance and creativity. *Computational and mathematical organization theory*, *13*(1), 17-27.

Leenders, R. Th. A. J., van Engelen, J. M. L. Kratzer, J. (2003): Virtuality, communication, and new product team creativity: A social network perspective. Journal of Engineering and Technology Management, 20, 69-92.

Margins, E. C. Terblanche, F. (2003): Building organizational culture that stimulates creativity and innovation. European Journal of Innovation Management, 6(1), 64-74.

Perry-Smith J.E. (2006) Social yet creative: the role of social relationships in facilitating individual Creativity, *Academy of Management Journal*, Vol. 49, No. 1, pp. 85–101.

Perry-Smith, J. E. Shalley, C. E. (2003): The social side of creativity: A static and dynamic social network perspective. The Academy of Management Review, 28(1), 89-106.

Pink, D. H. (2011). *Drive: The surprising truth about what motivates us*. Penguin.

Sawyer, C. (2007) Group Genius: The Creative Power of Collaboration, Basic Books, New York, NY.

Woodman R.W., Sawyer J.E. Griffin R.W. (1993) Toward a Theory of Organizational Creativity, The Academy of Management Review, Vol. 18, No. 2, pp. 293-321

Zhou, J. (2003) When the presence of creative coworkers is related to creativity: Role of supervisor close monitoring, developmental feedback, and creative personality, Journal of Applied Psychology, Vol. 88, pp. 413-422.