

Can aggregating existing digital activity be used to increase performance in goal-oriented groups?

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Introduction

Everyone leaves a digital 'exhaust trail' behind them as they use online services: on Twitter, Facebook, Blogs and Forums. If we chose, we can also publish give permission for someone to view more private activity: using dropbox, a mailing list or saving a paper to Mendeley for example.

Sometimes we accidentally publish information that we didn't want to. But the opposite also happens: information that could usefully reach a wider audience doesn't.

My project looks at taking data that people already generate online and extracting value from it. Maximising the value of this 'latent data' will require three steps:

1. Aggregation
2. Filtering
3. Representing the data

This final point, presentation back to the community, is an area where I'm particularly keen to investigate novel approaches. In particular, my hypothesis is that information that is presented simply as a web page will not have sufficient visibility to influence to community behavior.

Motivation

This work positions engages with new attitudes towards the workplace and urban space. These frontiers offer exciting new opportunities for exploration and experimentation. Is it possible to bring the vibrancy of purely digital collaboration to these physical spaces?

Spontaneous collaboration in digital space

Purely digital collaboration, in certain contexts, has had phenomenal successes. For example, the community that built and maintains the Linux operating system has been described as achieving the "impossible public good" (Kollock & Smith, 1999). Thousands of people, most of whom have never met each other, have produced something of exceeding complexity and usefulness. Many key web technologies have been built this way, for example: httpd.apache.org (the most prevalent web server), php.net and linuxfoundation.org. As Linus Torvalds has said, "without net access, the project would never have even gotten off the ground" (Torvalds, 1993).

An important feature of these projects is the digital nature of the underlying artefact. It's impossible that such a large number of people could work directly on a physical artefact - building a house for example.

Another factor that surely helps is that the participants in this community are by definition highly computer literate - the collaboration tools are sufficiently technically complex that users need

domain knowledge.

For these reasons collaborative software development represents a useful example of the highly effective digitally mediated communities.

While open source software projects of this kind have a long history, sites such as github.com have given the phenomena new cultural importance and lead to the adoption of the philosophy more widely.

New approaches to physical space

Companies such as GitHub and Valve (Varoufakis, 2013) are taking radical new approaches to work, using hierarchy free internal structures and highly flexible internal spaces for workers. At the same time coworking spaces are allowing new forms of collaboration and work arrangements outside of large companies (Jones et al, 2009).

The increasingly prevalent Smart Cities agenda adds momentum to the movement for new ways of thinking about physical space.

Combining physical and digital space

If open source collaboration has illustrated the potential for digital collaboration, and the coworking movement gestures towards a less structured approach to the physical workplace, how do these forces interact with one another? My research will experiment with harvesting “digital exhaust” and using it to provide a sense of cohesion to diffuse communities.

Methodology

This research will address a set of questions through a series of projects. The results of the projects will provide an empirical basis for evaluating the answers to the questions.

Over the series of projects a user centered design approach (Norman & Draper, 1986) will be applied. This entails a cycle of requirement gathering, prototyping, evaluation and feedback. Approaches to prototyping and evaluation are discussed in *Exiting the cleanroom: On ecological validity and ubiquitous computing* (Carter et al, 2008).

Prototyping

Various approaches to prototyping are detailed in the literature. The advantages of prototyping in the user centered design cycle are:

- Helping the designer understand the product
- Stimulating conversation in the design team
- Presenting to users for feedback

Various techniques for prototyping are also discussed:

- Paper drawings as mock ups (Hartmann et al, 2008)
- Non functional “looks like” mockups
- Functional “works like” mock ups
- Wizard of Oz software mockups, where although the computer looks as though it's working in a particular way, but there is an unseen person controlling it's behaviour to simulate functionality
- Paratypes, which go beyond prototypes to include a real context (Abowd, 2005)

Evaluation

There are a number of techniques that are particularly suited to evaluating prototypes so they can be further improved. A particular concern is when evaluating ambient or ubiquitous computer interfaces is that evaluation can only be done in context. Carter (Carter et al, 2008) offers some techniques that can be used to overcome this.

- Experience sampling, where prototypes are placed in the context where they will be used, and users are interrupted throughout the day to find out how they are interacting with the prototype, via phone, email, or in person. Interruptions must be kept to a minimum to avoid disrupting the context too much.
- Diary studies where users are asked to keep a record of how they interacted with the device
- Recording interaction with the device automatically, by measuring user interactions. (Eg. how often someone clicks through)

Evaluation is further discussed in the How Should Effects Be Measured section.

List of Research Questions

1. Is it possible to aggregate[make clear] the pre-existing digital activities of groups of individuals who share a common goal? Specifically, individuals who live or work in the same physical space, or people who belong to the same organisation.

Sources of data might include:

- a. Mailing Lists, Forums, Blogs, Wikis
 - b. Proprietary services: Twitter, Facebook, Dropbox, Mendeley, Readcube.
2. To what degree can this corpus of data be used to help those communities in any of the following ways:
 - a. Increase group cohesion
 - b. Directly increase performance
 - c. Automatically identify previously unknown resources within the community
 3. How should this information be represented back to a community for maximum effect?
Eg. screen, print, projection, sonification, information visualisation?
 4. How should this information be processed? What computational approaches to selecting the most salient information are there?
 5. How should the effects be measured?
 - a. Subjective reports of group cohesion
 - b. Statistical measures of cohesion
 - c. Measures of group performance
 6. What are the characteristics of communities that can benefit from this intervention the most?

In the literature review I will evaluate a theoretical underpinnings, similar work, and then look at the literature surrounding each of these research questions individually.

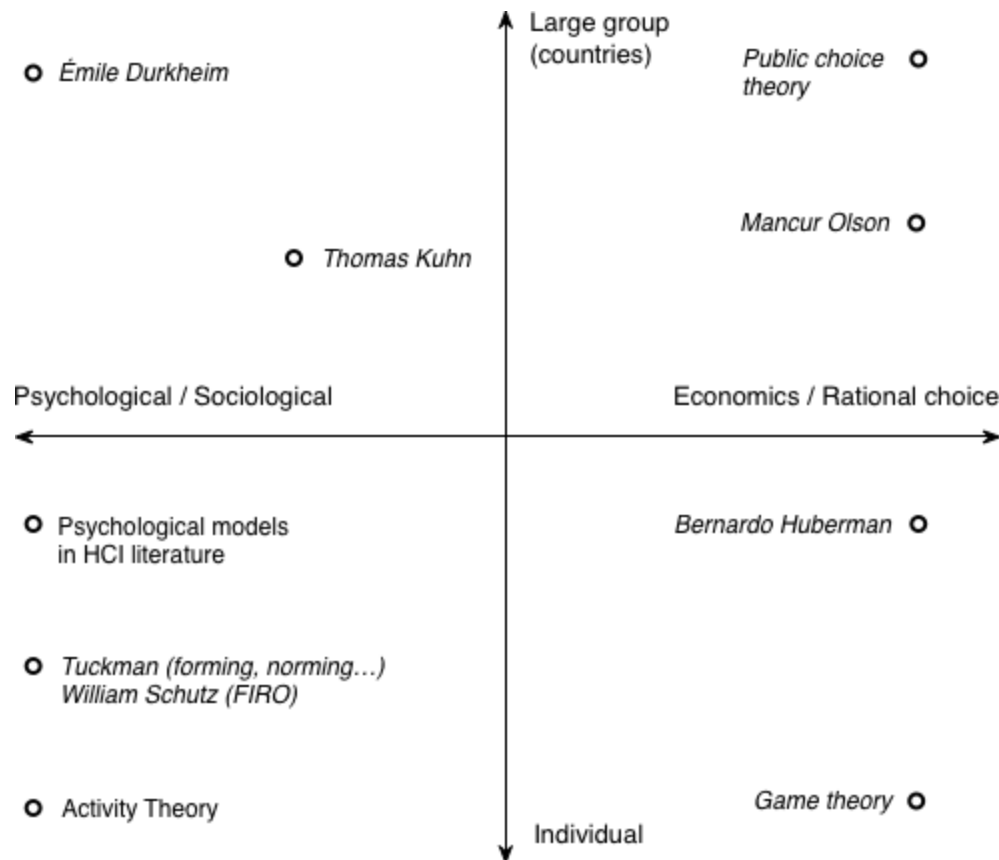
Literature Review

Theoretical Underpinnings

In this section I will investigate the various intellectual foundations that arise in the discussion of group formation and group dynamics, which I take to be the underpinning of my project.

The oldest reference I've seen regarding group formation is from Aristotle's Ethics. From there various disciplines have looked at the topic from their own perspectives.

Starting with more modern theories, I have divided up the various frameworks in two dimensions in the diagram below. On one axis I consider the theory's applicability to different sizes of group, on the other the background, ie. whether the theory originated in economics, or in psychology & sociology. This second distinction could also be regarded as the extent to which a theory models group member as rational economic agents.



Durkheim - Sociological approach to large groups

Durkheim proposes that an individual's epistemology is determined by their membership of a group, via the mechanism of categorisation. His social realism holds that our thoughts must fit

into the categories that are supplied to us by the people who surround us, so that our fundamental knowledge of what is, is conditioned by the group.

Durkheim's attempts to describe group dynamics for the benefit of a newly industrialised world seem anachronistic now - perhaps especially because of his reliance on religion and new data which tends to contradict it (Macfarlane, 2001). His work does represent an important notion that knowledge is a artifact of social context rather than ever improving representation of an underlying reality - as distinct from from say a Popperian view.

The scale at which this epistemic shaping happens is left unspecified, though it is typically either at the size of a nation or, in another example, within a field of scientific investigation (Douglas, 1986).

While a Durkheimian framework is probably not appropriate for analysis of group formation in the proposed projects, the idea of a group epistemology has had much impact in sociology, including some of the other approaches mentioned in this section.

Tuckman & Schutz - Psychological perspectives on groups

Stages of Small Group Development (Tuckman & Jensen, 1977) gave rise to the popular idea of the forming, storming, norming and performing stages in group development. This work has several drawbacks as a basis for my research. Firstly, it is exclusively concerned with small groups, while the groups I investigate might be quite large. Secondly, this construct considers a group from the time members first meet through to either failure or success. In many instances the groups I am concerned with will not be transitioning through these phases.

Finally, as Bonebright (Bonebright, 2010) highlights, this approach now represents more of "a starting point for conversations", adding that "recent theories recognize the complexity of group dynamics in today's world and are not easily represented in a simple model".

A more promising direction is Schutz's Fundamental Interpersonal Relations Orientation (Schutz, 1958) construct, which concerns the psychological needs of group members. FIRO considers that members of group require inclusion, control and affection to function as an effective team. A standard questionnaire is used establish how much inclusion, control and affection a person will bring to the team, and how much they will require for optimum performance.

The system has been validated against a number of personality metrics (Furnham, 2008), and its predictive power for selecting team members has also been tested (Ahmetoglu, 2010). This approach does not consider effects over time, as the Tuckman approach does, and is also not bound to a specific group size.

My research does not concern selecting team members, instead I will be using environmental interventions to affect group performance. However, it may well be useful to have a psychological model for group dynamics, both to inform the design of interventions and to consider when measuring outcomes.

Olson and Huberman - Economic perspectives

Olson (Olson, 1965) provides one of the first examples of using economic models to study the nature of group formation. In particular, he uses the concepts of freeriders and public goods to ask questions about how groups can form, coming to the radical conclusion that in many circumstances it is irrational for actors to carry out “collective action”.

As such it is a reductionist theory, in contrast with Durkheim, who under many readings, takes a group to be more than the sum of its members. Instead he treats a group as separate ontological entity (Douglas, 1986).

Huberman (Huberman, 2008) provides a more recent example of economic modeling - this time applied to information flows. This approach is useful since I will be focusing on the ways in which groups are affected by information flows. They use an economic model to discern information should be displayed on a web page, where each click on an item indicates someone allocating their scarce attention - just as paying for something in a shop signals the allocation of a scarce resource.

They are able to place their approach on a firm mathematical footing - at least as far as the model is valid. Further investigation is needed to see how widely this method has been applied.

Models in HCI literature

A number of different models are used in the HCI literature. This section presents a variety of models and a set of criteria that has been proposed to decide among them.

Criteria

Five roles for theory are suggested by Shneiderman (Shneiderman, 2002). They represent a useful comparative system for suitable models. At this stage in my investigation my intention is to remain agnostic about theoretical underpinnings until such time as specific projects have been identified. Shneiderman's five roles:

1. Descriptive theories identify key concepts or variables and make basic conceptual distinctions
2. Explanatory theories reveal relationships and processes

3. Predictive theories such as Fitts' Law, make it possible to make predictions about performance in a range of potential contexts
4. Prescriptive theories provide guidelines based on best practice; and
5. Generative theories facilitate creativity, invention, and discovery.

Activity Theory

The seminal work on activity theory is Aleksey Leontiev's *Activity, Consciousness, and Personality* (Leontiev, 1978). The application of this theory to Human Computer Interaction has been discussed at length in *Acting with Technology* (Kaptelinin & Nardi, 2006).

According to this book, psychological investigation should proceed by considering interactions between three parts:

- The subject ("Subjects live in the world; they have needs that can be met only by being and acting in the world.")
- The object, which is what the subject acts upon
- The activity (a "purposeful interaction between the subject and the world")

The activity takes primacy, and becomes the 'unit of analysis'. The reason for taking this approach is that it forces one to take account of context. One might imagine that maths ability is an intrinsic property of a subject, however, Kaptelinin and Nardi cite evidence that a person's arithmetic abilities also depend on whether they are counting familiar objects or working with unfamiliar abstractions.

In *Acting with Technology* it is asserted that at least some theoretical structure is necessary because "theories are exactly testable, dynamic, contingent things, designed to be subjected to critique, revision ... To eschew theory is to endorse a unitary point of view in which a single activity becomes a closed endgame." Finally the authors suggest activity theory can meet three of Shneiderman's criteria, and therefore is well suited to the roll in which they use it.

Actor Network Theory / Phenomenology / Distributed Cognition

In *Acting with Technology* the authors make a comparison between Activity Theory, Actor Network Theory, Phenomenology and Distributed Cognition. Their review provides a useful structure for the considering which of these approaches is most appropriate. However, without any projects specifically selected, it is currently too early to discriminate between these options.

A Pragmatic approach to ecologically valid design

Guidance on best practice for "ecologically valid design" - design which can function in real world contexts - is available in the literature (Carter, 2008). This survey of 28 practitioners gives

access to heuristics about the approaches and common pitfalls, as well as the methodological approaches discussed in the Methodology section. As such it can be used as a stand in before enough information becomes available for a more throughgoing theoretical approaches.

Similar Previous work

While there has not been a great deal of research specifically on representing social media back to communities, there has been a great deal of work in representing general community information.

Hyperlocal / geographical community

The use of screens in community focal points - shops, cafes, squares - is extremely prevalent in the literature.

A useful example of this work is a joint project between Newcastle and Lancaster Universities: the Wray Photo Display (Taylor & Cheverst, 2012). The project underwent 4 years of iteration between 2006 - 2010. In this project a touch screen was placed in the village of Wray, at first in the village hall, and then in the community shop. It allowed residents to upload photos of local events. Over its 4 year life 1500 photos were uploaded, many of historical events. Their paper provides an interesting insight into the difficulties they faced and the level on community engagement required to make the project work.

They have also published a paper about the legacy of the project, and the difficulties of allowing a community to take over an IT project such as this (Taylor et al., 2013).

Corporate context

In the corporate context, literature regarding group effectiveness has several strands, which will be discussed separately here.

Knowledge Management Systems

Peter Drucker coined the term 'knowledge worker' in 1959. This shifted the discourse about business management towards giving primary importance not to physical assets or factory floor processes, but instead the knowledge that precedes tangible output (Davenport, 2005).

This laid the groundwork for Knowledge Management to become a subject of academic investigation, and for discussion and analysis of Knowledge Management Systems. An early example such a system is Buckman Laboratories, a chemical manufacturer. Zack describes a system they implemented in 1998 (Zack, 1999), The Buckman Knowledge Network. This software, which ran on the still nascent web, included a chat room and a database of technical reports which had been manually edited to make them more accessible.

Corporate Intranets and similar programmes designed to spread information and increase teamwork are still the subject of much discussion.

Alavi & Leidner in their survey paper (Alavi & Leidner, 1999) highlight three key objectives:

- Corporate directories of employees
- Documentation of best practise
- Knowledge networks, where employees with similar expertise having meetings to swap experiences

While there is some overlap with my research, Knowledge Management Systems and their discussion also include much which beyond the scope of my work. In particular there is an emphasis on long term archiving of large bodies of static knowledge. Also, the enterprise-scale corporate context is at odds with my goal of asses small, lightweight projects, not all of which will be in the work place.

Software development tools

Perhaps because software development is the problem that software developers are most familiar with, many software solutions for teamwork in this context (Jakobsen, 2009; Biehl, 2007). The existence of such a large body of research, and the number of highly functional products in this area suggests that further work may not be as productive in this area as others.

For this reason I will be focusing away from the specific context of software development.

Yammer

One particular area of interest in the corporate sphere is Yammer. This software offers a service very similar to Twitter, however each Yammer instance is partitioned for all the others so that information is shared only within a single company. It offers privacy from the outside world so that employees can have frank internal discussions without fear of causing embarrassment. None the less it sticks to the format of informal short messages.

The data produced by these conversations provides a rich seam of information for studying the social interactions of employees. For example it is possible to mine Yammer conversations to reveal topics of particular concern to employees (Hoong, 2012) or to discriminate various modes of usage: question asking, crowdsourcing inspiration, broadcasting information and social bonding (Riemer, 2012). While the context is different from my work, the techniques for mining could be redeployed in new areas.

How should this information be presented back to a community for maximum effect?

Ambient Interfaces

The ambientROOM project at MIT's Media Lab used a variety of interfaces to take "advantage of background processing capabilities" and move away from interfaces that require "foreground visual attention".

The experimental setup included a variable water ripple pattern projected on the ceiling, ambient lighting, soundscapes, and fan that generated variable air flow. All of these were used to give subtle clues about the user's digital environment. It also had "graspable controls" which allowed the user to interact with a computer.

While this setup has a number of interesting features, it might be the case that the projects under discussion in this document will require at least some ability to convey direct textual content. For this reason the ambient interface may not be appropriate. However it might be possible to use sound or lighting cues to work in conjunction with displays that allow textual communication.

Displays

The use of screens in public spaces to convey information is well documented, one relevant example is presented in the similar work section. Another particularly interesting discussion of the use of screens in a cafe carried out by PARC (Churchill, 2007) gives a feel for some of the logistical issues that can arise. This paper is particularly insightful regarding the way crowding and the display interact: no crowd means no one to view it, but too much crowding provides cover for posting offensive messages. Unsurprisingly, the rate and nature of message posting changes when alcohol is added to the context.

Printing

As discussed in the work so far section, printing has been used in two of the pilot projects. Print outs have several advantages, for example in the pilot project at Fact gallery the tactility of the printouts generated far more interaction than the screen which was also present. Obviously, text printed on paper is a medium that has widespread familiarity.

One problem with this approach is that hyperlinks don't work on paper. QR codes are one solution to this problem, another is to present the full text of an item on paper so that links are no longer required.

How should this information be filtered?

Approaches to filtering are likely to be highly dependent on the underlying communities and the types of data they produce. As a result it is not possible to foresee exactly what literature will be most relevant.

Filtering already used in prototypes

In the existing prototypes a number of approaches to filtering have been taken.

1. **Manual.** (in line with the 'Wizzard of Oz' method described previously), where an human is 'in the loop' and selects data which will be of particular interest. This is useful for proof-of-concept phase work.
2. **Popularity within the network.** Proposed work using the Mendeley paper repository within the CX Hub will flag papers that are being read by multiple people within the team and highlight them. Similarly, workbook.io highlights tweets that are being retweeted the most. Both approaches rely on the existing network to discover what content is most interesting.
3. **Semantic filtering.** An algorithm could be deployed to classify data by topic, which could allow users to select topics that they want presented to them. This is also being used on the workbook.io site.

Systems level filtering architecture

A highly generalised model for filtering data is presented by Max Van Kleek in a paper describing a project to provide digital displays in MIT's CSAIL labs (Van Kleek, 2004). Their approach requires a network of sensor producing semantically classified data, which are then networked to displays which can make decisions about which data they choose to present. Displays can also influence one another so they do not duplicate data. This provides an interesting template for the provision of a large scale system, however it would be too complex to iterate quickly, in line with the User Centered Design methodology that is proposed.

In light of this, at least to start with projects will focus away from looking at the complexity of implementing multiple devices and instead focus of testing out the smallest possible scale of implementation.

How should the effects be measured?

Subjective reports of group cohesion

There exist a number of methods for collecting data about group cohesion that have been well validated, with John Bruhn (Bruhn, 2009) surveying instruments available for various contexts. The use of these approaches would have be determined in conjunction with the projects they are

being used on.

Statistical measures of group cohesion

If users are able to express the formation social bonds through software, eg. by friending on Facebook or following on Twitter, it is possible to generate a number - the density of the social graph - which could be taken as representative social cohesion. While the mapping between actual social relations and the social graph data websites gather is dubious (Pinboard Blog, 2011), a statistical measure like this could have some uses. In particular, it could be combined with qualitative measures to build an evidence base about the impact of an intervention.

Performance measures

Since the ultimate goal of group cohesion is often to improve the performance of a group, one way to measure outcomes is to measure group performance. Performance is highly dependent on context; clearly any attempt to measure the performance of a team in a company, which may be well defined, is going to be very different from attempts to quantify a group of neighbours who form an organisation to organise street parties.

There have been attempts to (Carless & De Paola, 2000) to correlate group cohesion with performance, however this particular paper fails to establish a strong connection.

What types of communities can benefit from this intervention the most?

At the current early stage of research only two factors for community selection have been identified.

Goal-orientation

Goal oriented communities are identified as a subject of this investigation so as to focus investigation away from all social media, which would be too broad an area. Instead, investigation will focus on the activity groups with a specific goal generate on social media. For example, the way a group whose goal is the maintenance of a local park interacts on a local forum, or members of a political organisation publicly communicating via Twitter.

Choosing to investigate only goal-oriented communities has a history in the literature. For example Mancur Olson (Olson, 1965) choosing to use the distinction and supporting it with citations as diverse as Aristotle and Labour politician Harold Laski.

Dunbar's number

Dunbar described a correlation between the neocortical volume of primates and their maximum social group size (Dunbar, 1992) . As Bruno Gonçalves puts it "The limit imposed by neocortical processing capacity appears to define the number of individuals with whom it is possible to

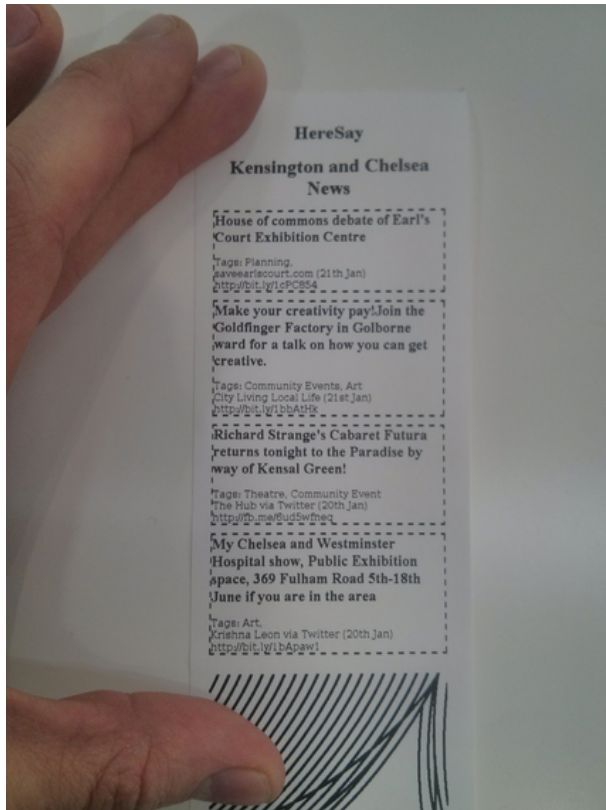
maintain stable interpersonal relationships” (Bruno et al. 2011). Dunbar took the correlation to imply that humans can maintain relationships with between 100 and 200 people, while other researchers have put the number at approximately 300.

Numbers of roughly this order have been empirically observed on Twitter (Bruno et al. 2011), Facebook (Economist, 2009) and through examination of phone records (Jukka-Pekka et al, 2007). In each case, researchers looked for the average number of people that an individual regularly engages in contact with and found numbers between 100-200.

Given the evidence for a step change in behaviour when a group exceeds approximately 200 people, any research considering an underlying group that is bigger than this number might not be applicable to smaller groups, and vice versa.

Work so Far

Kensington & Chelsea Council staff cafe

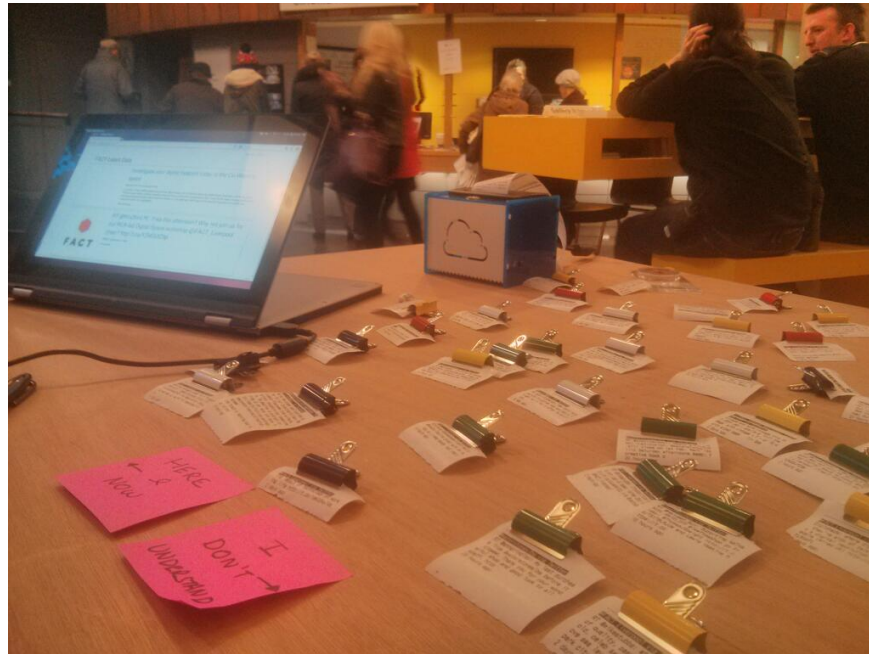


Using a Little Printer (bergcloud.com) receipt printer to print out items of news from around the borough of Kensington and Chelsea, with the news all gathered that day. Staff could pick up the print outs and read them while they had lunch.

A significant drawback of the receipt printer is that it doesn't have enough room to print out the whole news item, only the first few words. We provided a link to the complete item, however no one used it. One suggested solution was QR codes, however their effectiveness is dubious.

Another problem was the length of time that Little Printer takes to receive and print out a document.

Fact Gallery, Liverpool. Day long workshop.



We asked passers by in the gallery space (which also contains a cinema) to respond to printed out snippets of hyperlocal news from Facebook and Twitter. Using post-its, we encouraged users to sort the printouts into labeled piles.

A touch screen was also available for interaction, but most people were not inclined to use it.

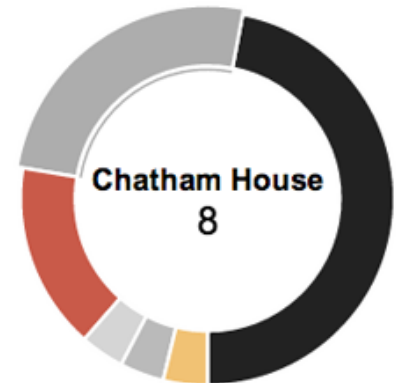
We used Raspberry Pi printer, rather than the Little Printer. It was much quicker, and radical improvement on the previous system.

WonkBook

Name	Thinktank	Retweets▼	Tweets	Total	MP Followers	Thinktank
Louisa Loveluck	Chatham House	285	64	3953	6	10
Jamie Bartlett	Demos	216	47	3128	5	64
Matthew Goodwin	Chatham House	215	40	6146	9	49
Jill Segger	Ekklesia	212	36	2922	8	9
Duncan Green	Institute of Develop	196	51	11505	5	31
Christopher Snowdon	IEA	195	59	2871	9	27
Stephen Tall	Centre Forum	183	58	3419	22	32
Andy Sawford	LGIU	173	35	6833	89	47
Patrick Dunleavy	LSE Public Policy Gr	135	59	3698	4	42
Ryan Bourne	Centre for Policy St	131	29	2760	20	42
Symon Hill	Ekklesia	100	26	2147	3	8
Chris Goulden	Joseph Rowntree Foun	89	28	4743	21	87
Jon Worth	IPPR	81	37	8659	17	35
Antony Paine	Ekklesia	74	25	4200	40	26

Louisa Loveluck

Followers



Most Retweeted

Louisa Loveluck
@leloveluck

Follow

My BBC R4 piece on the human cost of #Egypt's North Sinai military operation: bit.ly/15X9AK4?cc=d61...

7:55 AM - 12 Oct 2013

11 RETWEETS 1 FAVORITE

Louisa Loveluck

Follow

Wonkbook collects tweets from 374 MPs, 2,747 Thinktank staff, 498 Journalists. It then uses them to create a weekly league table of the users who are getting the most retweets within the policy community.

Discussion of potential projects and resources

I'm currently thinking about ways I could approach a number of companies:

- 00:/ (architecture00.net/blog)
- Readcube (readcube.com)
- westminster.impacthub.net
- <http://commonplace.is/wp>
- Internal CX project

At the moment a web platform is under development with a view to supporting work with these partners. The major resource for this work is currently time for building relationships with partners and writing software.

Buying small amounts of hardware, for example printers or Raspberry Pi's and wifi dongles might also become important.

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