Challenges in Prototyping Email in Three Dimensions

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Abstract. There are numerous arguments for the usefulness of paper prototyping. It allows the identification and prevention of design problems and usability issues before work begins on an electronic proof of concept (EPOC). It is less costly and more flexible than testing with an EPOC and then amending it after it has been built. However, this project presented challenges in relation to paper prototyping an application that represents email data three-dimensionally. Although it was possible to do some abstract prototyping on paper, there were limitations in the extent to which a 3D model could be articulated two-dimensionally. The paper details the authors' multi-methodological approach to developing an application which enables the search, display and filtering of email data beyond the standard functionalities available in conventional email software. Such methodologies included persona development, task analysis, competitor analysis, abstract (paper and electronic) prototyping. This combination demonstrates the utility of Houde and Hill's (1997) model of developing a range of prototypes within a single project to demonstrate role, look and feel and implementation of a proposed design.

Keywords:
Three dimensional (3D) visualisation, information design, interaction design, interface design, prototyping.

1 Introduction

The project is one of many that constitute the Australian Centre for Interaction Design's Virtual Communities strand. This strand is concerned with helping distributed organisations improve their processes with social software. The project emerged from the needs of an organization, Suvon, which was willing to act as a testbed environment.

The organisation is extremely distributed: all of the seven directors work from home, although all are Sydney-based and there is no physical shopfront for the company. Only one of the directors works full-time for the company, the others generally work part-time. The organisation's clients are airlines and cargo companies, and their work involves getting their systems to talk to one another by translating

between protocols. They have developed their own software to do this. While their work can include new contracts, their 'bread and butter' income is the provision of support to their clients in the use of this software. Therefore, directors are rostered to provide 'on-call' support to clients for periods of two weeks. The client company work-base is also very distributed: none, except for Qantas, are based in Australia. All correspondence is with the head offices of airlines in their home countries. Ninety percent of communication with clients is through email with support requests coming through a central email address. Clients prefer this as for some English is not a first language and they find it much easier to write emails rather than talk on the phone. It is the responsibility of the director currently 'on-call' to respond in a timely manner. Clients also have the option of telephone support, with requests channelled through a central (mobile) number to the director 'on-call' at the time. Internal communication between directors is by phone, instant messaging and email.

One of the key areas identified for improvement is knowledge sharing and management. With the geographic spread of the directors, there is no centralised system for logging email support requests and the respective responses given. Some directors have more specialised knowledge of particular protocols than others but all directors on support have extensive technical experience of many computing environments. This has led to a problem of no electronic, central repository or reference point for problems or solutions that may have previously occurred that an 'on-call' director can access. The process is dependent on the company knowledge base of the directors remaining the same. The research questions distilled from mapping organisational processes and relationships, and interviews with directors are as follows:

What are the processes by which a distributed organisation manages knowledge?

How can email be leveraged for knowledge management?

What value can be added to a standard email search function?

This project aims to investigate the sorts of tools that might be effective in extracting particular sorts of information from email archives. The hypothesis is that this archive contains information about the support activities that have taken place even though these issues have not always been deliberately logged. The project seeks to enable users to access to a centralised archive and sift through this material to find useful information about recurring issues, or for example to recover knowledge should someone leave the company. A key objective is to extend search-style tools by supporting exploration where it is not known at the start what will be uncovered.

2 Methodology

One of the directors and authors acted as an 'embedded researcher' on the project. This involved:

- interviewing directors, as methodologically speaking, ethnography or any kind of contextual enquiry as recommended by Gaffney (1999) and Kuniavsky (2003) proved to be challenging.
- participating in the iterative design and evaluation of a prototype before it was released to the other directors.

- providing important information about the organisation, such as data about the total number of hours spent providing support to clients.

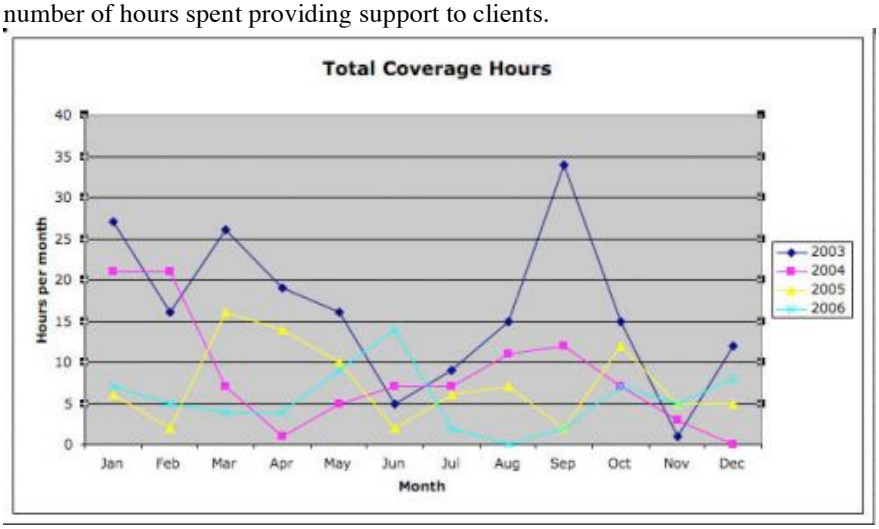

Figure 1. Suvon coverage hours by year

Figure 1 above indicates that from 2003 to 2006, there has been a gradual decline in the time taken by directors to resolve a support query. This could be interpreted as either a decrease in the number of support requests being made or that the directors are becoming increasingly efficient at solving support problems. Regardless, this suggests that the application has to be powerful in its ability to assist directors in responding to support questions by providing access to in-depth knowledge embedded in the email archive.

3 Persona Development & Task Analysis

Having a staff member as a project stakeholder meant that user needs were identified quickly and accurately, resulting in the development of two main personas and user scenarios as recommended by Brown (2006) and Kuniavsky (2003):

Persona 1: tends to rely on recollection of past experiences to solve problems 'on-the-fly'.

Persona 2: tends to defer to notes, documentation and past emails to tackle a problem.

Scenario 1: Client experiences an urgent problem and contacts Suvon by mobile.

Scenario 2: Client experiences a non-urgent problem and contacts Suvon by email.

Subsequently, a step-by-step task breakdown incorporating both personas and scenarios was developed:

1. Support request received by email or phone.
2. Email is sent to client to inform them the problem is being addressed.
3. Send email to request more information if required.

4. Perform a system check to see if there are problems in the code.

   4a. Recall past experience of similar problems.
   4b. Refer to notes taken from previous cases.
5. If problem cannot be solved, refer to past emails.
6. If problem cannot be solved, ask other directors.

4 Competitor Analysis

Before any attempt at design, other examples of software which represent large amounts of email data and relational elements within that data were explored. These included Enronic and Visual Thesaurus.

The Enronic application (see Figure 2) attempts to visualise the email communication which took place within Enron. Thus it gives a macro 'big picture' view of the organisation mapping relationships between employees (Heer 2004) by creating a visual display of categories of and connections between emails, including:

- people who were communicating with each other in Enron
- communities/clusters of people who communicated via email in Enron
- the types of emails between individuals – represented by pie charts.

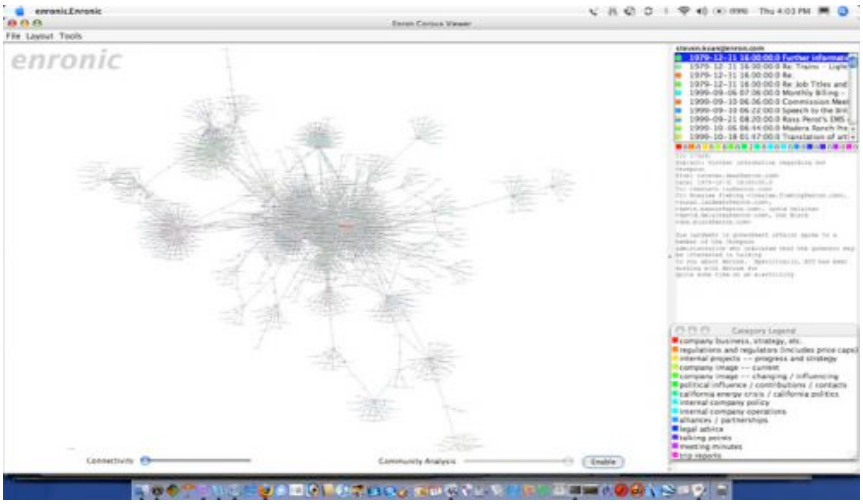

Figure 2. Enronic application screenshot

An evaluation of the software demonstrated that its visualisation of groups/emailing communities as a mass of ever moving grey lines and names was daunting and required time to interpret and become meaningful. A colour grading scale from red through to yellow and finally darker purple and blue was useful in categorising the types of sent emails. Colour-coding of emails was clearly labelled but was confusing when applied to the community analysis tool. It was also difficult to reproduce the case studies described by Heer (2004). Indeed, the constraints of the

Enronic application are acknowledged by Heer himself as he recommends improved organisation of data according to time:

'A range slider allowing users to filter data based on the dates of the messages would undoubtedly be useful. Furthermore, it would be nice to animate the evolution of the network, showing how the message traffic evolves...'

Visual Thesaurus (VT – see Figure 3)) visually displays all words connected with the word typed by the user. Drawing from a database of over 145,000 words and 115,000 meanings (ThinkMap 2007) and displaying the correlations, it gives a 'visual' representation of the data (StumbleUpon 2007; Murphy, 1998). However, no images are included: the application simply arranges synonyms, antonyms and related words in a tree-like structure. Like Enronic, colour is used as a classification tool: coloured circles suggest the type of word with red, for example, denoting a noun. Both applications are similar in that they attempt to strike a balance between how much information is displayed and what is to be omitted. Too much information may be as confusing as far too little.

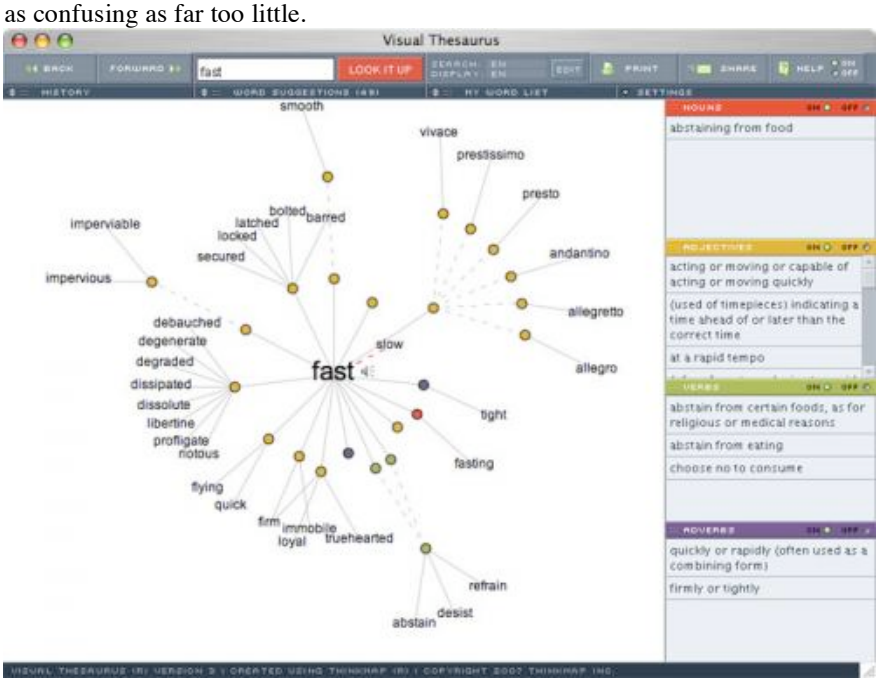

Figure 3. Visual Thesurus application screenshot

VT has a 'Free Association Mode' in which the designers have intervened in emphasising which words are deemed more important to show. However, it is harder to see many of the words. In this case it is another example of trying to provide more information aspects visually yet imparting a lot less information.

VT allows people to wander along similar words or terms which are connected to the starting word. It is an exploration of the English language that starts at one point and meanders through the database with words triggering different ideas. Reviews of the website (StumbleUpon 2007; Murphy 1998) often indicate it is not a definitive

replacement for a good thesaurus but they do add it is a great visual tool especially for users who are more often drawn to visual organisation.

Through competitive analyses of applications such as Enronic and Visual Thesaurus, the ways in which the project could improve upon these with consideration to the needs of the organisation became more evident. Such enhancements included:

- more sophisticated means of filtering emails
- greater microscopic representation of data
- better temporal depiction of the data.

5 Prototyping

During the development of this project the group used both paper and electronic prototyping to develop new aspects of this artifact. However, even at the earliest stage of paper prototyping - conceptual design - attempts to understand how 3D design concepts would work on paper were challenging. Therefore, the project utilised a combination of paper and computer-based prototypes which could be described more accurately as part of an abstract prototyping process:

'Abstract prototypes are an intermediate form that can speed the user interface design process and improve the quality of the results. Abstract prototypes help bridge the conceptual gap between a task model and a representational paper prototype for a user interface design.' (Constantine 2002: 1)

In accordance with Constantine, the project followed an abstract prototyping process by modeling the content of a large body of email data in a 'low-tech, low-fi' (paper-based) way, as well as on the computer using Cocoa and OpenSceneGraph.

5.1 Paper Prototyping

There are numerous arguments for the usefulness of paper prototyping. It allows the identification and prevention of design problems and usability issues before work begins on an electronic proof of concept (EPOC). It is less costly and more flexible than testing with an EPOC and then amending it after it has been built (UsabilityNet 2003; Snyder 2003):

'With a paper prototype, you can user test early design ideas at an extremely low cost. Doing so lets you fix usability problems before you waste money implementing something that doesn't work.' (Nielson, 2003)

During weekly meetings, sketches were made in notebooks, on whiteboards, and uploaded to the project blog for comment. The key functionalities of the application were identified as:

Data needs to be organised by time (chronologically showing the pathways of email interactions)

Data needs to be organised by people (who gets and sends the most email within any one company)

Information needs to depict word/phrase patterns or repetitions across emails which are linked.

Initial sketches were concerned with a macroscopic view of the data which showed relationships between people by email activity over time. In this sense, paper prototyping was beneficial in workshopping ideas for interface design.

Beginning two-dimensionally, all emails received from one client organisation were depicted proportionally in terms of individual senders, giving a visual snapshot of key staff members who have sent or received the most email correspondence in relation to support requests (see Figure 4).

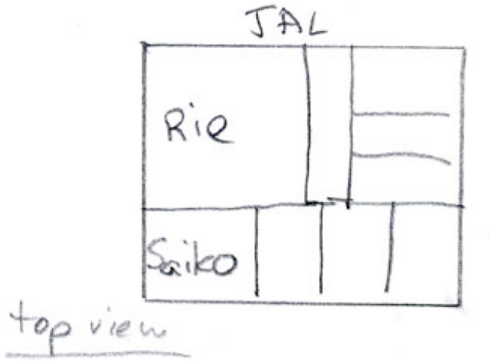

Figure 4. 2D view of all emails received organized proportionally according to sender

In considering how each organisation and their employees sent and received support-related emails *over time*, it was necessary to think three-dimensionally (see Figure 5). Therefore, the organisation was visualised as a column constituted by smaller columns represented by staff members, with the height of each column depicting time. Although individual email messages would not be seen in this view, the conceptual design suggests that emails would be ordered within each column from the most recent (at the top of the column) to the oldest (at the bottom of the column).

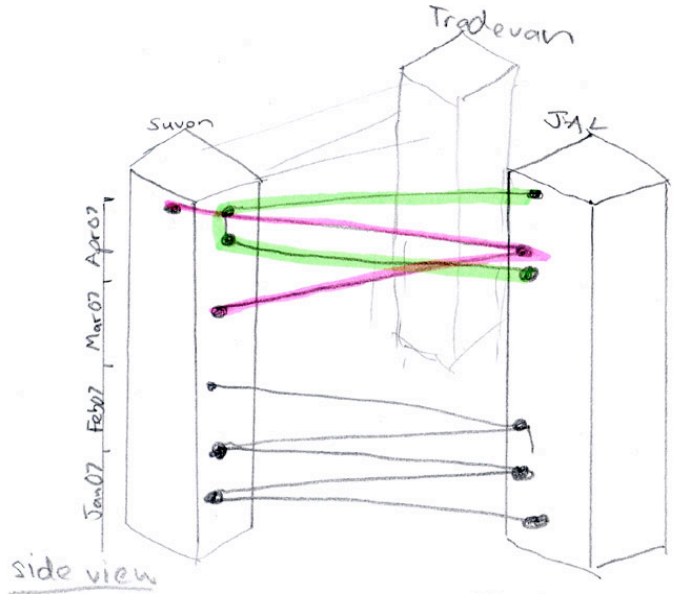

Figure 5. 3D view of emails sent and received over time between organizations

Furthermore, within this 3D view, the relationships between organisations could be shown by a plotting of chains of emails sent and received. Users would be able to move between the 2D and 3D view, as well as specify the date parameters with a range slider as recommended by Heer (2004). User interaction with the range slider would visually change the relationships between columns: in 2D view, this would translate as a change in the thickness of the lines joining each column (see Figure 6).

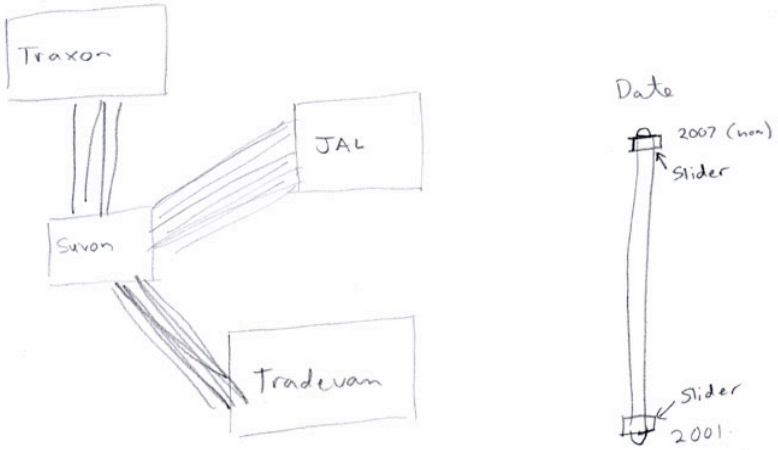

Figure 6. 2D 'top down' view of email relationships between organisations

In 3D view, the number of lines connecting people/columns would vary according to the date range selected (see Figure 7).

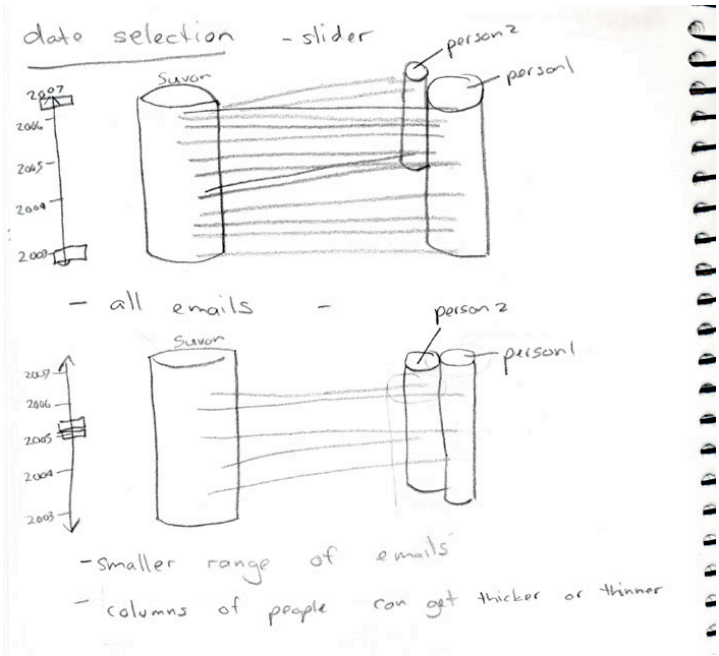

Figure 7. Variation in number of email 'lines' shown according to date range

Columns would lengthen if a short date range had been selected, allowing a better close up of emails.

In terms of the relationships between people/columns, it would be necessary to show the directional movement of emails. The use of arrows was preferred over and above the use of colour to indicate emails sent and received (see Figure 8). Indeed, the size of the arrows could be proportionate to the number of emails being sent in any given direction. For example, an even number of emails sent and received between two correspondents would have similarly sized arrows. However, where a person is doing most of the sending to another person who is doing most of the receiving, a larger arrow would depict the stronger flow of emails in one direction.

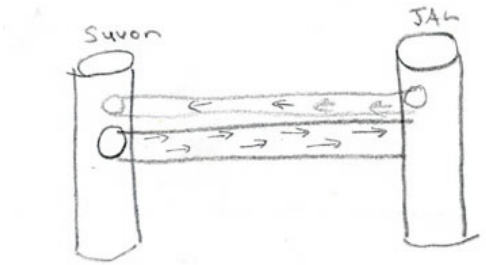

Figure 8. Indicative representation of directional movement of emails

Paper prototyping also explored design concepts for more microscopic representations of data, that is, how users could investigate the contents of email communications.

How could users move from 2D and 3D macroscopic views to see email correspondence at a more granular level? The possibility of examining the lines between people/columns was discussed.

Each line would also be a column showing an email sent or received by a person (see Figure 9). The user could zoom into the column see the contents of the email.

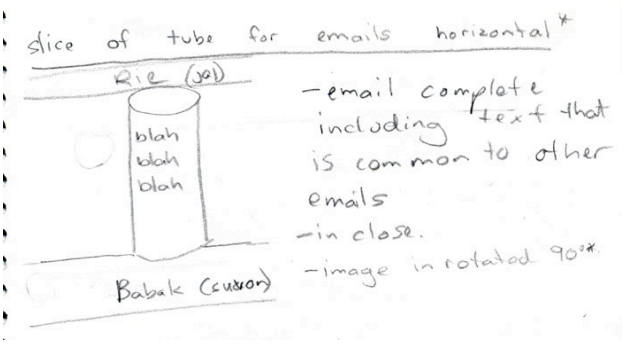

Figure 9. Microscopic representation of an email 'line'

Alternatively, the user could zoom out to view the relationship between a series of emails. In short, the user can choose a focal point and the level of detail they require. Repetitious content across email messages would be coloured in and could be eliminated to show only new additions or unique elements (see Figure 10). The application would go a step beyond the way AppleMail highlights linked emails to show overlapping content in chains of emails.

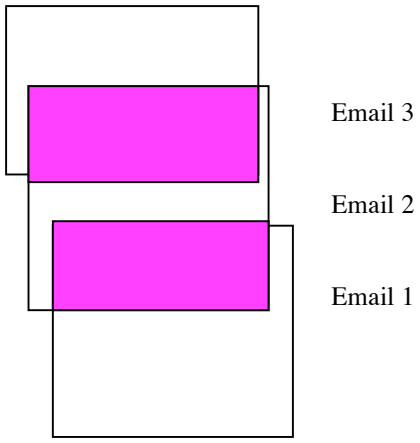

Figure 10. Indicative representation of email 'chains' and how repetitious content would be highlighted

Email 'chains' would be represented in some form of date order. The user could view emails in two possible orders: either newest first or in the order the emails were

sent. The user could literally turn the columns 180 degrees to select this (see Figure 11).

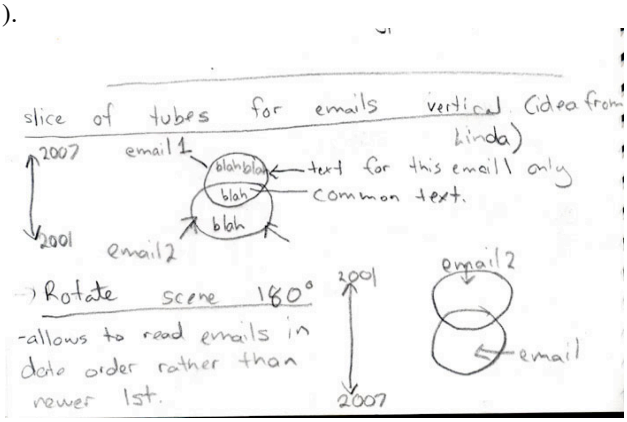

Figure 11. Indicative representation of how email chains can be viewed in preferred date orders

5.2 Electronic Prototyping

Because it was difficult to comprehend on paper how the user would navigate around the 3D view, and move between it and the 2D view, it was necessary to begin experiments in computer modeling in parallel to the paper prototyping. Development was conducted in an electronic form by creating different Cocoa applications. These applications sought to explore not only the technical validity of the rendering capability and performance of the application, but further to visualise how the application can still be understood using more raw data than was possible with the paper prototypes. However, the development of electronic prototypes lagged behind the rate at which paper prototypes were produced.

Using the publicly available email data from Enron, a computer visualisation of each person within the database as a ‘column’ was made (see Figure 12).

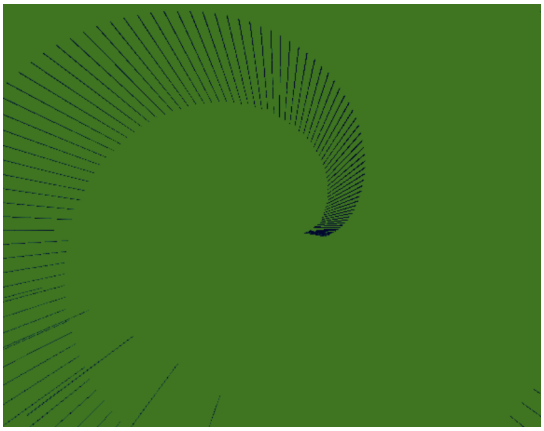

Figure 12. First implementation prototype showing each person as a column

The initial Cocoa application used the open source program Pantomime (Marcotte, 2007) to decode the Enron emails, held within an SQL database, and translate each person to a specific column within the 3D display.

This prototype was useful as it confirmed that the application was capable of producing a graphic representation of emails quick enough to be of practical use. This application would be used in an environment in which an answer may be needed fast – the stress of ordinarily waiting for an application to render an image may cause frustration for the user.

This first electronic prototype gave an indication that the initial proposed navigation though the 3D image was far from adequate and needed to be replaced. It was slow, clunky and jerky as the user moved through the 3D space.

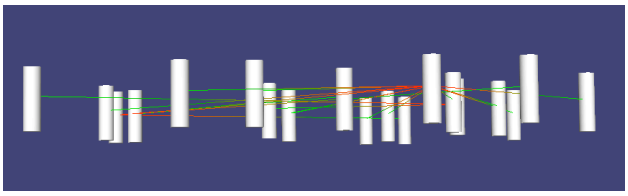

Figure 13. Second implementation prototype using OpenSceneGraph

Figure 13 above shows the next prototype included OpenSceneGraph (2007) to improve the user movement within the scene and cleared up the spread of visual graphics – this was highly important as the application depended heavily on the user's understanding and interpretation of the objects within the scene.

The database from the first prototype was removed as the sample data from Suvon would not be accessible from a database but rather an '.mbox' file type. This meant that the emails were accessed from a mailbox that could be obtained directly from an application. This step was necessary as emails in the Suvon environment were not saved in a database and data needed to be decoded on demand – that is the data is not prepared in a database.

The graphical representation meant each person/column was linked together via emails sent between each person. Colours were used to indicate that emails were sent (green) from one person and received (red) by another. Although only a small amount of new information was incorporated into this image it is easy to see how this can be used to gain insight into who is receiving and sending a high volume of emails.

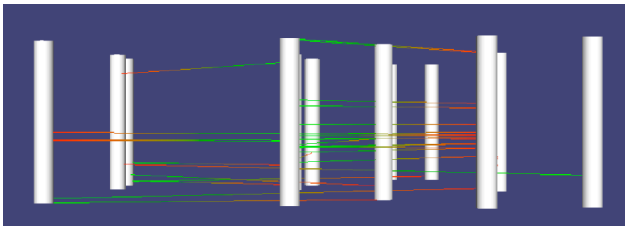

Figure 14. People/columns connected by email 'lines' – side view of columns

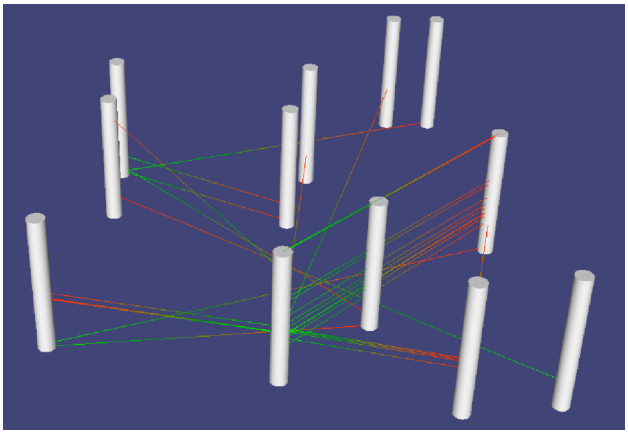

Figure 15. People/columns connected by email 'lines' – figures rotated 45 degrees

In the next version of the prototype, as shown in Figures 14 and 15, the lines that connect the white columns, which represent the emails, are initially ordered from the newest at the top to oldest at the bottom. This is the beginning of implementing the idea sketched in the paper prototype of allowing the user to see the emails in their own preferred date order, so by rotating the image 180 degrees the emails can be seen in chronological order.

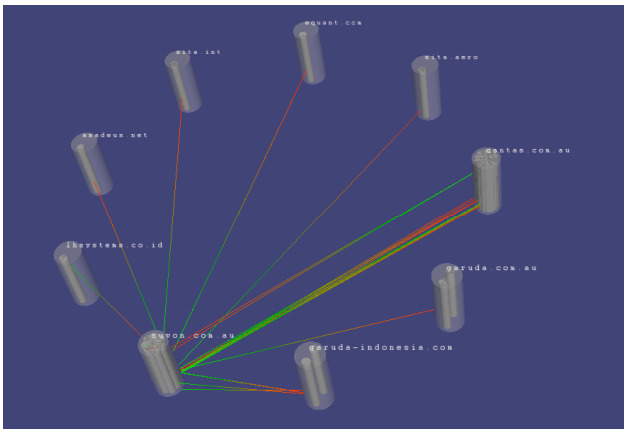

Figure 16. Third implementation prototype showing people 'clumped' into larger organizational columns

As shown in Figure 16, the next prototype grouped the columns into clusters of people from the same organisation. These clusters were then placed at even intervals around a circle. In previous prototypes, people were randomly placed within an area on the screen. This more structured layout gives a clearer indication of organisations

with high email activity but is also the first step towards identifying people within the same company who have email activity. The need to know this information was a high priority of Suvon support staff.

6. Discussion

As with much creative work, this project set out to explore new forms of interaction (with email data), and so did not have a well-defined specification at the start. In fact, one might argue that the aim of the project was to evolve such a specification that could then be used for further system development. In this case, the team members decided that as the aim was to produce a prototype (rather than a product for commercial release), there was less risk involved in working on the computer application early rather than waiting until all aspects are finalised using paper. Thus paper-based prototyping was supplemented with working models, to contextualise thinking and provide concrete, shared concepts to discuss. As Houde and Hill (1997) maintain, the materials used for prototyping are irrelevant as long as the designers and their audiences understand the purpose of the prototype.

It is often the case in work like this, where one is attempting to create something new and unfamiliar that the communication amongst team members about how the system should be or behave is the most difficult part. When people from disparate domains come together they often communicate by means of boundary objects (Fischer et al 2005). These are concepts that have meaning to both parties. One can visualize the domain of knowledge of two people having an overlapping area of knowledge that they share, as well as areas of specialist knowledge that is possessed by just one person or the other. The boundary objects exist in the overlapping area, and can be used as analogies to describe concepts from the non-overlapping area.

As Zhang and Weakley (2007) describe, this can of course lead to misunderstandings: occasions when one person assumes that they have understood the other when in fact they have not. In such cases a prototype of one form or another can help to expose and resolve the misunderstandings. The prototype acts as a new boundary object, it is something that all parties can study, interact with and use to illustrate their discussions. However, the ways in which prototypes are defined also vary:

‘Industrial designers call a molded foam model a prototype. Interaction designers refer to a simulation of on-screen appearance and behavior as a prototype. Programmers call a test program a prototype. A user studies expert may call a storyboard, which shows a scenario of something being used, a prototype.’ (Houde and Hill 1997)

Houde and Hill’s model shows three main purposes of prototypes: firstly, to demonstrate its functionality or role in the lives of users; secondly, to indicate the look and feel of the artifact; and thirdly, to articulate how the design will be implemented. The prototyping process that has taken place as part of this project suggests that all three purposes have been fulfilled.

The persona and scenario development, together with task and competitor analysis have led to an understanding of the role and functionality required of the prototype.

This is articulated in the paper prototypes in conjunction with ideas for the look and feel.

Paper prototypes are particularly effective when they draw together elements that are already well understood. One could make a paper prototype of a Web-page complete with images of buttons and hyperlinks. This would likely be well understood by people who are familiar with hyperlinks and buttons and how these things behave in working systems. Such a paper prototype would likely not be so easy to grasp for a person who had not previously interacted with a working Web page, let alone a person who had not used a computer before. In this project, we had a vision of a system that was unlike anything with which we were already familiar. Therefore, an implementation prototype in the form of a computer model illustrated how the system would behave, look and feel in a screen-based environment.

But while the paper-based role and 'look and feel' prototypes were developed quickly and in parallel, the electronic implementation prototype was much slower to catch up. This distorts Houde and Hill's equilateral triangular model because of the lag time that exists between prototyping the functionality and experience, compared with prototyping implementation.

That the implementation prototype can also be defined as an integration prototype, according to Houde and Hill, further complicates the model. An integration prototype is described as occupying the middle of the triangle, exploring a balance of questions of role, look and feel, as well as implementation.

Nonetheless, it is interesting that each prototype is trying to demonstrate a small aspect of the final artifact rather than incorporating all ideas in one prototype. For example, in the paper prototyping each sketch encapsulates only one concept. The same idea is seen in successive versions of the electronic prototypes each of which includes a few new concepts in each prototype. This small step-by-step process may be due to the nature of the project where there is no initial clear cut specification but a rather the conception of a product that is expected to fit in with Suvon's special commercial needs and current working environment. An alternate view is that the step-by-step process is a natural development approach that assists the communication within the group as each idea is discussed, analysed and implemented. Terms are progressively defined by the group within each idea's paradigm and the group begins to build its own dictionary of definitions.

7. Conclusions

Paper prototyping, while useful, has certain limitations. Electronic abstract prototyping is necessary for 3D visualization as a result of the limitations of paper media. When the immediate aim is not to develop a product for commercial release, there is less risk involved with developing a computer prototype and such a multi-modal approach seems appropriate.

This is confirmed by Houde and Hill's three-pronged model of prototyping which suggests that irrespective of the materials used and levels of fidelity, prototypes ought to represent the parameters in which an artifact will 'look', 'behave' and 'work' (Buchenau and Suri 2000). The project discussed in this paper does this by using both

paper and computer-based role, experience, implementation and integration prototypes to design and develop a sophisticated email search and visualisation tool.

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