Network Visualization: The "Bush Team" in Reuters News Ticker 9/11-11/15/01

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ABSTRACT: This paper explores the use of visualization methods at two different levels of analytical detail (e.g., moving from a time-independent aggregated view to a more detailed time series analysis) of data derived from Reuters news tickers between September 11 and November 15, 2001. This data comprises a large, complex set of related words that presents an interesting analytical challenge. The relationships among words in the news articles were extracted using Centering Resonance Analysis (CRA). In this paper, we present two secondary analyses of the CRA networks. The first analysis involves a two-dimensional layered grid approach using convex hulls for examining the intersection and union of sets of words in the text in a two-dimensional projection. Additional SVG versions of these images allow exploration of the solutions interactively. The second approach involves the use of three-dimensional interactive visualizations and centrality analysis using the molecular visualization program Mage. A major guiding question of this work is the following: Can we gain knowledge about the conflicts within and dynamics of the "Bush team" from a visual exploration and analysis of the CRA data over the 66 days of the text? The analysis of the news text using these approaches suggests that Powell has played less of a role during the 66 days of the analysis then might be expected given his formal status as chief foreign policy advisor to the President.

Introduction

The primary purpose of this article is to demonstrate the power of combined visualization and analysis in the study of complex networks. This work is based on a series of analyses and visualizations of data derived from Reuters news tickers between September 11 through November 15, 2001, presented at the 2002 International Sunbelt Social Network Conference in a session on network visualization. Participants in the panel received a set of networks extracted from the Reuters articles using Centering Resonance Analysis (CRA, Corman et al. 2002). CRA analyzes the discourse behaviors of authors and speakers to form a coherent

message, and extracts from these a network of words: the position of a word in this network indicates its influence in producing a coherent message. The data comprises a large, complex set of related words that presents an interesting analytical challenge. In response to this challenge, we focus on the visualization and analysis of the portions of the CRA networks associated with the members of the White House inner circle -- the "Bush team." We show how structural network properties of Reuters stories over this two-month period may shed light on the inner workings of the team. Specifically, we address the following question: Can we understand anything about the conflicts within and dynamics of the Bush team from a visual exploration and analysis of the CRA data over the 66 days of the text as reported by Reuters?

The Problem

There are a number of recent examples in the news and other media sources reflecting possible divisions within the White House inner circle. For example, a *New York Times* article of January 28, 2002, entitled "Colin Powell Dissents" discussed disagreements between Powell and other team members in terms of the legal designation of Al Qaeda and Taliban prisoners. Even such Sunday entertainment supplements as *Parade Magazine* have alluded to the division between Secretary of State Powell and, in particular, Vice President Cheney, Secretary of Defense Rumsfeld, and National Security Advisor Rice. Disputes reported in the media between the Department of Defense and the State Department concerning Middle East policy provides further evidence of a possible rift in the Bush inner circle. Additionally, numerous humorists and cartoonists have used these inner circle dynamics as material for jokes and cartoon subject matter. The September 16, 2002, cover of *Newsweek* shows pictures of Rumsfeld and Powell with the text "Rumsfeld vs. Powell" in reference to disputes over the controversy surrounding the invasion of Iraq. In a sense this division between the two appears to represent an even deeper division in the administration itself. Rumsfeld referred to in the *Newsweek* article as "the big stud in town," who is worshipped by the White House, stands in stark contrast to the only moderate in the White House inner circle, Powell, who is one member of the team who consistently has stressed talk of diplomacy over talk of war.

The main question for this paper is: Can we understand anything about the conflicts within and dynamics of the Bush team from a visual exploration and analysis of the CRA data over the 66 days of the text? Further, are possible role conflicts evident in a visual analysis of the CRA networks? Such role conflicts are hypothesized to be reflected in comparisons of the structural characteristics of inner circle members (e.g., degree centrality) and the uniqueness and overlap in words coincidental to team member identifiers (Johnson et al. 2003a, Johnson et al. 2003b). Uniqueness of words associated with a team member are hypothesized to reflect the unique role or contributions of that actor within the administration. Conversely overlap of words among members, especially at the dyadic level, may reflect overlapping roles in the administration or may even reflect possible role conflicts.

Centering Resonance Analysis

CRA is a bundle of techniques which transforms the structure of natural occurring text into a semantic network (Corman et al. 2002). In a first step sentences are automatically unitized. In a second step CRA selects all noun-phrases from the

sentence units in step one. These noun-phrases consist of a noun plus zero or more nouns and adjectives. In a third step the words that make up the noun-phrases are linked. Words are linked sequentially within units; if a phrase consists of more than one word all possible pairs of the words within the phrase are also linked. Compiling these links over all sentences in the text yields a graph (discussed below) describing all words contained in the noun-phrases of text and how these are linked. To compare texts of different authors or speakers, CRA proceeds by indexing the units of the graph and also the links between the units. CRA typically uses centrality scores for these weights. Comparing identical elements in two graphs that represent different texts allows one to compute their "resonance," which is high when identical words in both texts have similar centrality.

The Data

The overall CRA data was derived from Reuters news tickers relevant to the 9/11 attacks. They were collected over 66 days starting the morning of 9/11, and participants in the Sunbelt panel received one CRA network for each day. This data was derived from data originally produced and analyzed by Dooley and Corman (2002), who describe its production more completely. We began by compiling a graph of the union of these 66 CRA networks. It contains more than 13000 words and more than 120000 links.

The first part of the paper focuses on a two-mode matrix extracted from this graph, which identifies all words that are directly connected to at least one of the nine Bush team members in the 66 days following 9/11. The resulting sub-graph describes how strongly each of the team members is connected to any of the 1444 words that are directly linked with at least one member of the team.   The players included in this analysis are President George W. Bush, Secretary of State Colin Powell, Secretary of Defense Donald Rumsfeld, Attorney General John Ashcroft, Vice President Richard B. Cheney, Chief of Staff Andrew H. Card Jr., Director of Homeland Security Tom Ridge, National Security Advisor Condoleezza Rice, and Deputy Secretary of Defense Paul Wolfowitz.

In the second part of this paper we analyze the same information but decompose the overall matrix into 66 n x m matrices, reflecting the network of relations among words and the eight team members (excluding Bush) at 66 points in time. Here the Bush connections are minimized for the sake of simplicity.

Analysis I: Global Patterns among the Bush Team Members

We want as complete a picture of the data as possible. We seek to identify unique domains to which single members are connected, and the degree to which domains in the team overlap. We see such unique domains as possible indicators of unique roles in the administration.

Layout: A Layered Grid Approach

One way to achieve a simplified drawing of the aggregated data set is to use and optimize a layered grid layout (with Pajek):

- The team members are assigned to the *top layer*, while all other nodes of the network (the words) are assigned to the *lower layer.*
- A *grid structure* is used to constrain the position of the nodes on both layers. A specific position of each layer can only be assigned to a single node.
- *Optimizing* the placements of the nodes for line length orders both layers simultaneously; the positions in each layer are exchanged until all links in and between the layers become minimal.

The result of this procedure is a three-dimensional layout. The ordering of this layout can be inspected with the help of additional graphical tools. Node sizes and color-schemes allow us to better explore the properties of network diagrams. A more systematic treatment of these problems can be found in Krempel (2002).

## Exploring Ordered Sets with Hulls and Pies

In this paper we use convex hulls (O'Rourke 1994, Sedgewick 1988) to describe the overall logic of the grid layouts by identifying the locations of uniquely linked nodes and using partitions based on degree and centrality. The convex hulls of specific node-sets allow for the inspection of how certain properties are reflected by the spatial positions in a drawing. Since convex hulls characterize the complete set of elements of a certain type, they are very robust means for detecting order in network drawings.

"The mathematical way to describe the natural boundary of a point set depends on the geometric property called convexity... A convex polygon has the property that any line connecting any two points inside the polygon must it self lie entirely inside the polygon... The convex hull of a set of points in the plane is defined to be the smallest convex polygon containing them all. Equivalently, the convex hull is the shortest path surrounding the points." [Sedgewick 1988: 359]

The size of the hulls and their exclusiveness allows for inspection of the degree to which given set classifications is represented in a given layout. In Figure 1, a number of nodes on the lower level are connected to both elements A and B at the higher level. The hulls (hatched areas) of the three sets at the bottom can now be interpreted as Venn or Euler Diagrams in terms of nodes that are exclusively connected to A, nodes exclusively connected to B, and nodes that are simultaneously connected to A and B. In this case, red identifies the intersection of A and B.

**Figure 1. Lower and higher level connections as a Venn or Euler Diagram.**
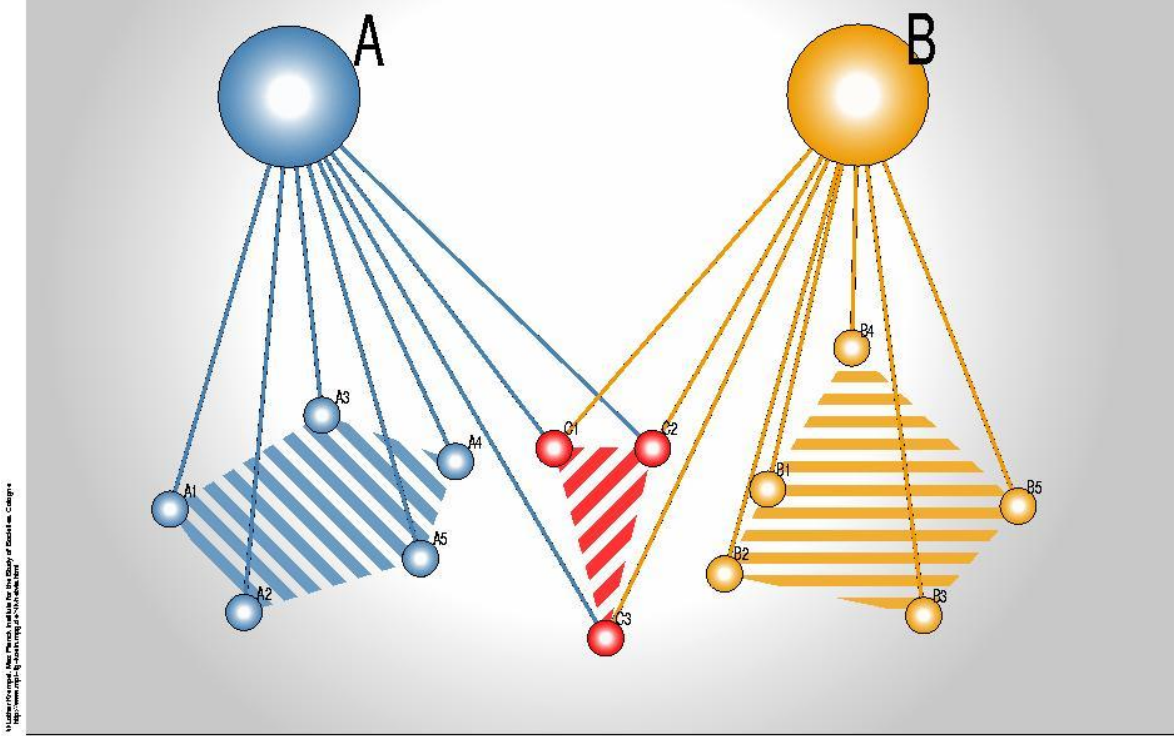
The same information can be represented with pie charts on the lower level, as shown in Figure 2. In this case, nodes that are exclusively connected to one of the members of the second set are shown in the color of the node of the top layer. The pies of the nodes that are connected to both members of the top layer contain the colors of both nodes.

Figure 2. Lower and higher level connections as a Venn or Euler Diagram with the incorporation of pie charts.

Venn Diagram and Pies
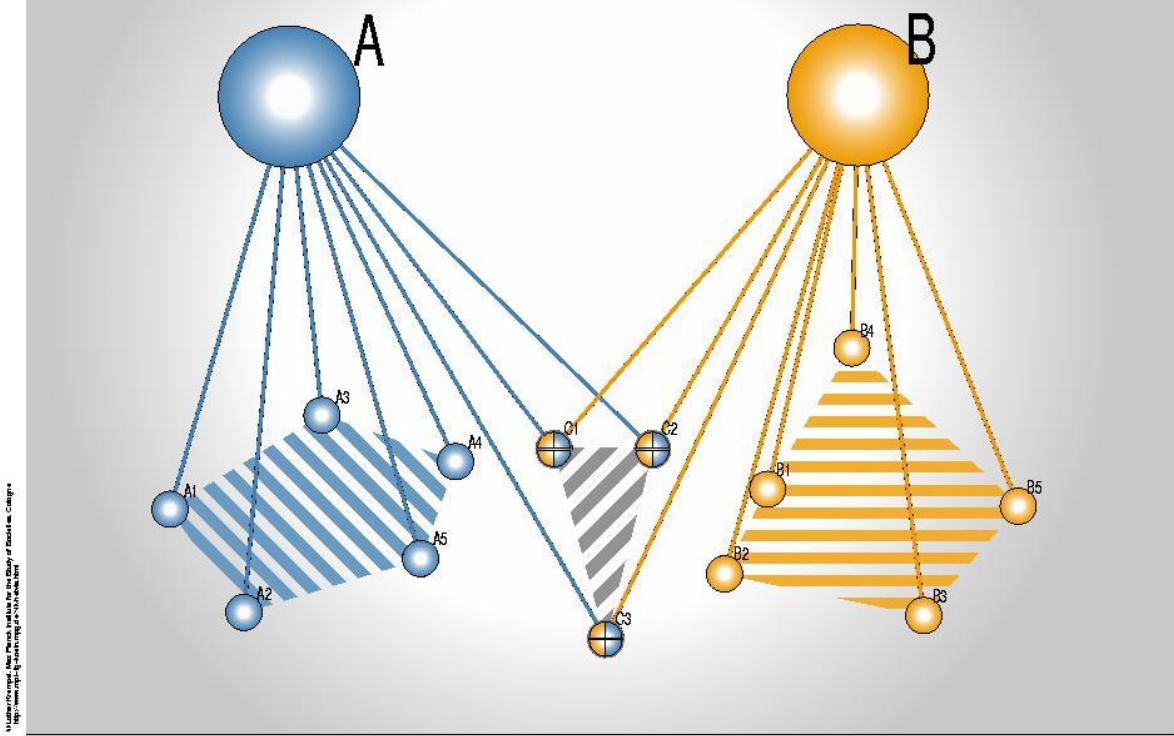
Exploring the Layered Solution of the Bush Team

The two-mode graph for the Bush team contains nine members placed at the top layer and 1444 words connected to at least one of the nine team members at the bottom layer (thus reducing considerably the number of words). We use a top view on both layers, so that the solution can be inspected with a single 2D image; the team members are represented by their names, while the words are shown with pie symbols.

To explore the layout at the lower level we use nine different *hues*, each of which stands for one of the team members. The symbols that represent the different words of the news tickers are shown with the hues of those team members to which they are linked. Counting the number of hues of a given word symbol thus informs us of its (binary) degree.

Degree Sets

For a first orientation we classify all words by their degree. This facilitates the differentiation of the nine degree-sets; nodes that are exclusively linked to only one of the team members have *degree one*, whereas words that are linked to several team members have a higher degree. The underlying logic of the node layout that results from optimizing the layered grids, becomes clear if we use convex hulls to mark the outer boundaries of the nine degree sets; the more intense the color of these hulls, the higher the degree. As can be seen in Figure 3, the hulls are nested where words

with higher degree are concentrated in the center of the drawing. This information can in principle also be read by counting the number of hues of the symbols or by looking at the relative size of the symbols which corresponds to their nodal degree. This figure identifies the *convex hulls* of the *nine degree sets*. The hulls of the sets with higher degrees are shown in more saturated colors and hulls are nested by degree.

Figure 3. Degree hulls. Click here [binary1.html] to explore the image interactively.
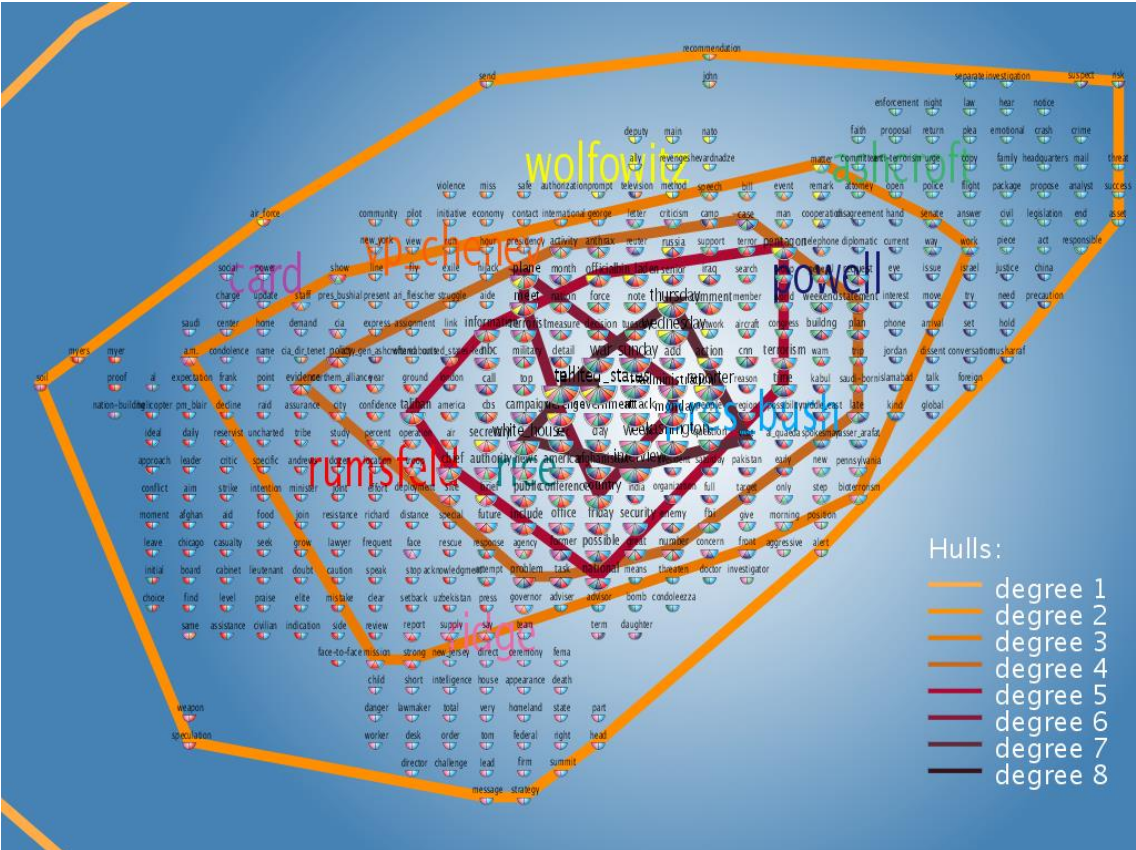
Word Sets Connected with the Team Members

A second inspection of the positions in the aggregated data again uses *convex hulls* but unlike the first approach it is used to identify which words are connected to each of the team members. This facilitates our ability to explore whether the placement of the nodes has any systematic relationship to the positions at the top layer.

Pie charts allow further exploration of the intersections of the convex hulls since they allow one to read which of the words each of the nine members is connected. Additionally we can characterize the size of the word symbols by their *binary degree*; words linked to one of the team members have the smallest size and have a degree of one while words linked to all of the team members are bigger and have degree nine.

In Figure 4 we use pies and hulls to identify all word items that are connected to both *Rumsfeld* or *Powell*. All items in the lower left of the red hull identify words which are

exclusively associated with Rumsfeld. Similarly, all items in the upper right of the dark blue hull are words which are exclusively associated with Powell. All words of higher degree that are simultaneously connected to both Rumsfeld and Powell can be found in the center (the intersection) of the hulls. All nodes that have more hues than red and blue are simultaneously connected to other members of the Bush team. The number of nodal hues informs us that these words are not exclusively connected to these two team members, but are connected to additional members as well.

Figure 4. Team hulls and words directly connected to Rumsfeld OR Powell.
Click here [RumPowOR.html] to explore the image interactively and use [RumPowAND.html] to study the set of words to which both are connected.
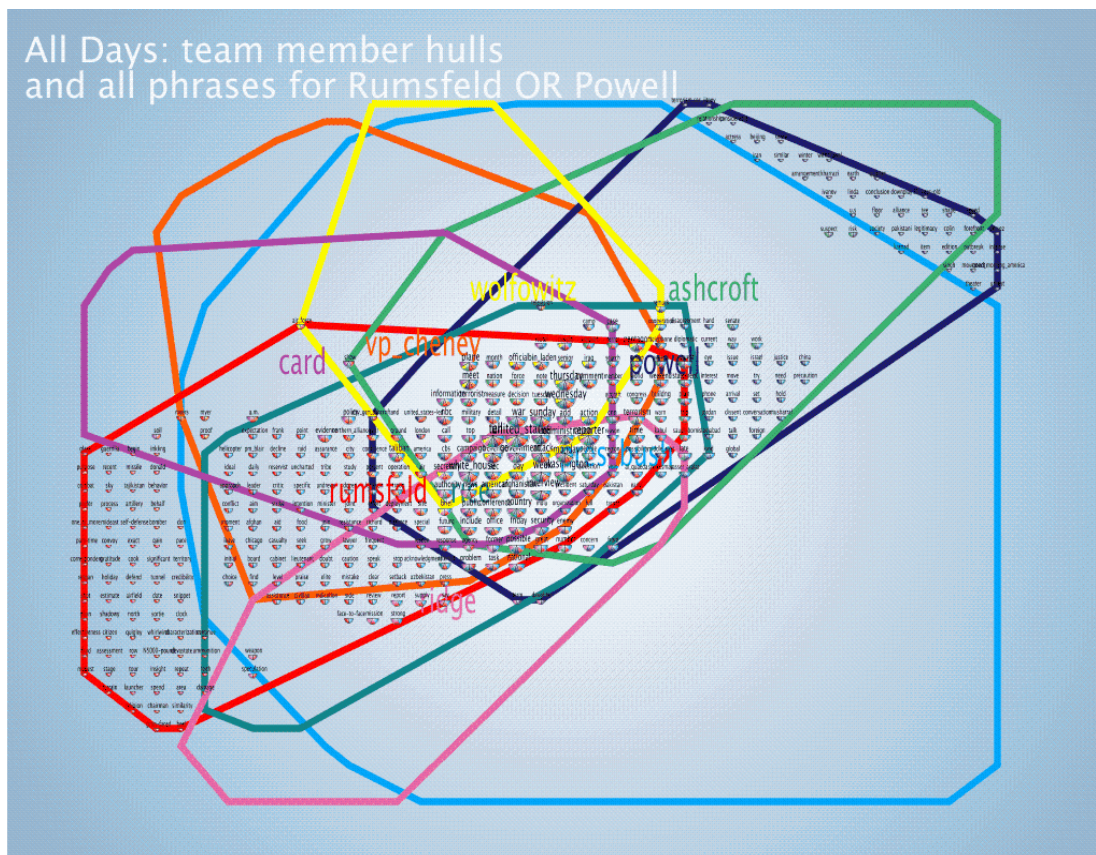

Since the placement algorithm worked on the valued version of the two-mode graph, the placement of the nodes also reflects how often a word is linked to each of the team members. This yields additional information since specific team members can be linked by more than one word. If we select the words by their weighted degree as is shown in Figure 5; we get the most central words which are not only highly connected to team members but are also more frequently connected. This leads to some interesting observations. The words *United States*, *attack*, *war*, *terrorism*, *security*, *terrorist* and *taliban* identify the meaningful core of the text-centers that connect many of the team members. For example, the words *terrorist* (card, rice, rumsfeld, vp_cheney, pres_bush), *taliban* (card, rice, rumsfeld, vp_cheney, pres_bush) are not (directly) connected to Powell but are to Rumsfeld. On the other hand, *security* and *terrorism* are two words with no connection to Rumsfeld but to Powell.

The remaining words are associated with days of the week, places (e.g., Washington) or institutions (e.g., White House) that describe nonspecific or commonly used attributes in news reports. Thus CRA finds not only meaningful centers but also identifies the common or typical settings of the reported activities. For example, most news articles refer to the day of the week in which the article was published or the day of the week in which a press conference was given.

Figure 5. All words having degree higher than 15. For interactive svg versions of this image click [weighted.html]. The image [weightednb.html] also shows the frequencies with which team members are connected.
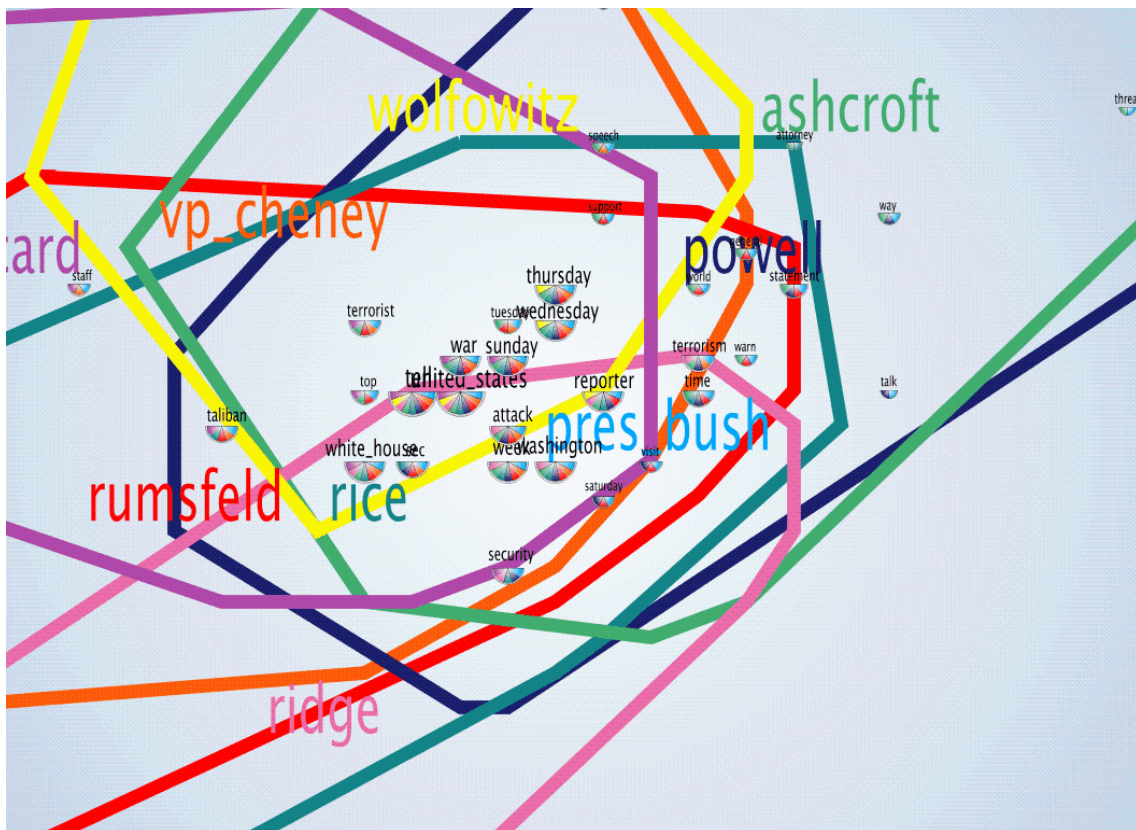
Roles and Role Similarity and Autonomy

The analytical focus of CRA is typically oriented to the most central elements of the graph, which represents words with high "connecting power" in the text. The similarities and differences, how different actors are connected to central words, are one form of information that helps in understanding potential *role similarity* in a given set of documents. As we set out to understand the inner workings of the Bush team we are also interested to learn about the relative autonomy of members. A closer look at words of different centrality might therefore provide additional information for understanding such roles.

In order to analyze whether similarities and differences in the roles of the team members are exclusively generated by words of high degree or constitute exclusive pair-wise, triple or quadruple co-occurrences of words, we decompose the matrix of word co-occurrences for the whole graph into separate matrices, each matrix

containing words of a given degree. Since the number of words that are exclusively connected to only one of the team members is a crude measure for the *autonomy* of the roles in the Bush team, we start with a summary table. It describes the number of words to which each of the team members is exclusively connected, and how many connections he/she has to other members of the team (summarized by the distribution of degree). Table 1 below gives the absolute numbers, how many words are exclusively connected to each of the team members, and the distribution of connections at higher levels of degree.

Table 1. Exclusively connected words and number of words by degree connected to each of the team members.

	Bush	Cheney	Rumsfeld	Powell	Rice	Ashcroft	Ridge	Wolfowitz	Card
unique	731	39	74	42	12	48	28	7	42
degree 2	217	37	80	33	14	47	41	9	14
degree 3	79	23	50	31	6	31	17	4	8
degree 4	36	15	31	19	6	23	11	4	11
degree 5	29	19	26	21	12	10	13	5	10
degree 6	9	7	8	7	2	7	6	3	5
degree 7	9	9	10	9	10	10	6	3	4
degree 8	0	0	0	0	0	0	0	0	0
degree 9	2	2	2	2	2	2	2	2	2

The overall distribution in Table 1 is strongly skewed; most of the words are exclusively connected to single team members, only a few of the links that connect to team members occur via words that have degree 5 or higher. Counting the number of exclusively connected words, which we interpret as a measure of ascribed autonomy in the news texts, it is clearly evident, that President Bush is the most dominant actor in Reuters News. He is exclusively connected to 731 out of 1444 words that define the complete graph; more than 50 percent of all words are connected only to him and to nobody else. The rank-order of autonomy starts with Pres. Bush (1) followed by Rumsfeld (2), Ashcroft (3), Card (4), Powell (5), Cheney(6), Ridge (7), Rice (8) and Wolfowitz (9).

Role similarities between the team members are based on the number of jointly shared words. The similarities between all members of the team are created mainly through a small number of high degree words. The table below gives the specific words for degree 5 and higher. As mentioned before only some of them are

meaningful for understanding these roles. Many higher level words describe the setting, temporal attributes and institutions.

Table 2. Words with degree greater than 4.

Degree	words with degree > 4
degree 5	bin_laden, official, action, pentagon, secretary, nbc, office, public, national, possible, conference, terrorism,
degree 6	afghanistan, american, day, sec, comment, time, friday, include, attack, monday, country, defense, fox, administration, government, meet, plane
degree 7	Interview, washington, week, thursday, wednesday, reporter, sunday, war, white_house, pres_bush
degree 8	-
degree 9	united_states, tell

At the level of exclusive dyadic connectedness only those words that have degree 2 (i.e. words that are linked to exactly two actors and never occur with any of the remaining others) are used. As can be read from Table 3, such pair-wise exclusive word sets connect almost all of the team members with President Bush only. In the news analysis we find no direct overlap between the team members themselves; there are only very few words of degree 2 that connect any other pairs of the team.

Table 3. Co-occurrences for words of degree 2.

degree two	Bush	Cheney	Rumsfeld	Powell	Rice	Ashcroft	Ridge	Wolfo	Card
Bush	0	29	69	26	7	37	32	7	10
Cheney	29	0	3	1	1	2	1	0	0
Rumsfeld	69	3	0	2	2	0	2	1	1
Powell	26	1	2	0	0	2	2	0	0
Rice	7	1	2	0	0	1	0	1	2
Ashcroft	37	2	0	2	1	0	4	0	1
Ridge	32	1	2	2	0	4	0	0	0
Wolfow	7	0	1	0	1	0	0	0	0
Card	10	0	1	0	2	1	0	0	0

While the corresponding matrix for words of degree 3 looks very similar to that of degree 2, the co-occurrence matrix for words of degree 4 (Table 3) exhibits more structure. Even here President Bush is connected with most of the words and is

especially connected to Rumsfeld (46). These words connect four members of the team each. The almost empty sub-matrix between the other team members however becomes more populated; 17 links are induced between Rumsfeld and Powell . Whereas Rumsfeld shares 14 links with Ashcroft, 13 links with Vice President Cheney and 8 links with Ridge. The number of shared words between Powell and Ashcroft, however, is only 3; between Powell and Cheney no more than 4; and with Ridge 2. Finally there are 8 words that connect Ashcroft and Ridge.

Table 4. Co-occurrences for words of degree 4.

degree four	Bush	Cheney	Rumsfeld	Powell	Rice	Ashcroft	Ridge	Wolfo	Card
Bush	0	21	46	30	6	29	16	4	6
Cheney	21	0	13	4	0	4	1	0	3
Rumsfeld	46	13	0	17	2	14	6	0	2
Powell	30	4	17	0	3	3	2	2	1
Rice	6	0	2	3	0	0	0	1	0
Ashcroft	29	4	14	3	0	0	8	1	3
Ridge	16	1	6	2	0	8	0	0	1
Wolfow	4	0	0	2	1	1	0	0	0
Card	6	3	2	1	0	3	1	0	0

Summary of Analysis I

In this part of the analysis we have explored the overall aggregated network of words, which summarizes the events after September 11. The subset of the complete network we have used so far contains all the words that are directly connected to any of the members of the Bush team. We have used a layered grid approach to arrange the nodes of this graph. Assigning actors and words to different layers, and optimizing this arrangement for line length, orders the positions of the words and team members simultaneously. The resulting optimized grid layouts reveal many systematic properties. To access these, we have made use of convex hulls and hues that help to identify how certain node sets are positioned in the layout. Adjacent positions of same-colored items identify the connectedness of single team members to certain types of words. Using pie symbols for the words answers two questions: which of the actors is connected with which words, and words of which degree, when the sizes of the pies are used as symbols for nodal degree.

Identifying different roles in the Bush team from the time-aggregated CRA graph of the news ticker items leads to the following conclusions. President Bush is not only exclusively connected to a very large number of words in Reuters news ticker, but he is also the dominating center for most of the words that connect any of the team members. This is especially true for all words that connect any two members of the team. Whenever a team member is connected to such a low degree word, it is connected to the President. Despite a functional differentiation of tasks and

responsibilities, the dominating pattern in Reuters news is that of a team that is highly coordinated through President Bush.

Some indication of role differentiation in the team can be found when one looks for overlap in the words that have a higher degree (words that are connected to several team members). Here we find Rumsfeld, Ashcroft, Ridge and Cheney more closely tied together than other members of the team. Rumsfeld plays a more central role than Powell. Looking at the same data from the perspective of frequency of links by using the weighted degree (counting also how often a certain word is connected with the same actors), we can further identify meaningful word centers of high degree that are exclusively tied to Rumsfeld or Powell. Whether these findings represent more than a functional division of roles between a Secretary of Defense and a Secretary of State, however, can not be decided on the basis of the time aggregated dataset alone. Nonetheless, there is no question that the reporting on military actions in Reuters news outweighs the reports on international political initiatives that are connected to the Secretary of State.

Analysis II: Changes Over Time

In the following series of analyses we examine the relationship among team members and words across all 66 time periods. However, as was the case in the previous analysis, Bush is so dominant in the network that he obscures the view of the possible roles of the remaining players, particularly Rumsfeld and Powell. Thus we drop Bush from the analysis and concentrate on the remaining eight team members.

There are three primary types of matrices that will be analyzed in this section. The first is a 988 x 988 matrix containing the relations among the 988 words that have a connection to at least one team member (the n x m matrices described earlier were transformed into a series of n x n symmetrical matrices). The second includes two sets of 2-mode matrices (8 x 66 and 8 x 56) that provide information on the degree and betweenness centralities, in terms of connections to words, of the eight members over both a 66- and a 56-day time period. Finally, a series of 6 n x n word matrix time slices are explored at critical points in the 66 day time period (e.g., at the beginning of the air campaign, at the beginning of ground offensive).

The first set of analyses involves an examination of degree and betweenness profiles for the eight team members over the 66 days of the Reuters news tickers. This is followed by a multidimensional time-series correspondence analysis (Greenacre 1984: 267) of both centrality measures over-time. Finally, several interrupted time series analyses examine 3D visualizations of aggregate and selected time slices, using kinemages as viewed in Mage. A "kinemage" (kinetic image) is an authored illustration presented as an interactive computer display (Richardson and Richardson 1992). Although originally developed for visualizing biological molecules, kinemage format and display are content-neutral, making it useful in other fields as well, such as for studying social, semantic, and ecological networks (Johnson, Richardson, and Richardson 2002; Johnson et al. 2001; Freeman 2000; Freeman, Webster, and Kirke 1998).

Centrality Profiles Over Time

The purpose of this centrality (Freeman 1979) analysis concerns a visual examination of the dominance and importance of the eight team members in terms of their connections to words in news reports over the 66 days. Figure 6 provides a series of graphs showing the betweenness centralities for each of the eight team members over the 66 days of reporting. As is evident from the graphs, structural connections to words in the first few days following the attacks on the WTC and Pentagon overwhelm an understanding of centralities over most of the 66 days possibly reflecting a flurry of activity by a wide range of White House staff. Cheney, Powell, Ashcroft, Rumsfeld, and Card all display high levels of betweenness centrality in the first few days following the attacks.

Figure 6. Betweenness profile by ego after initial attack on the WTC and Pentagon.
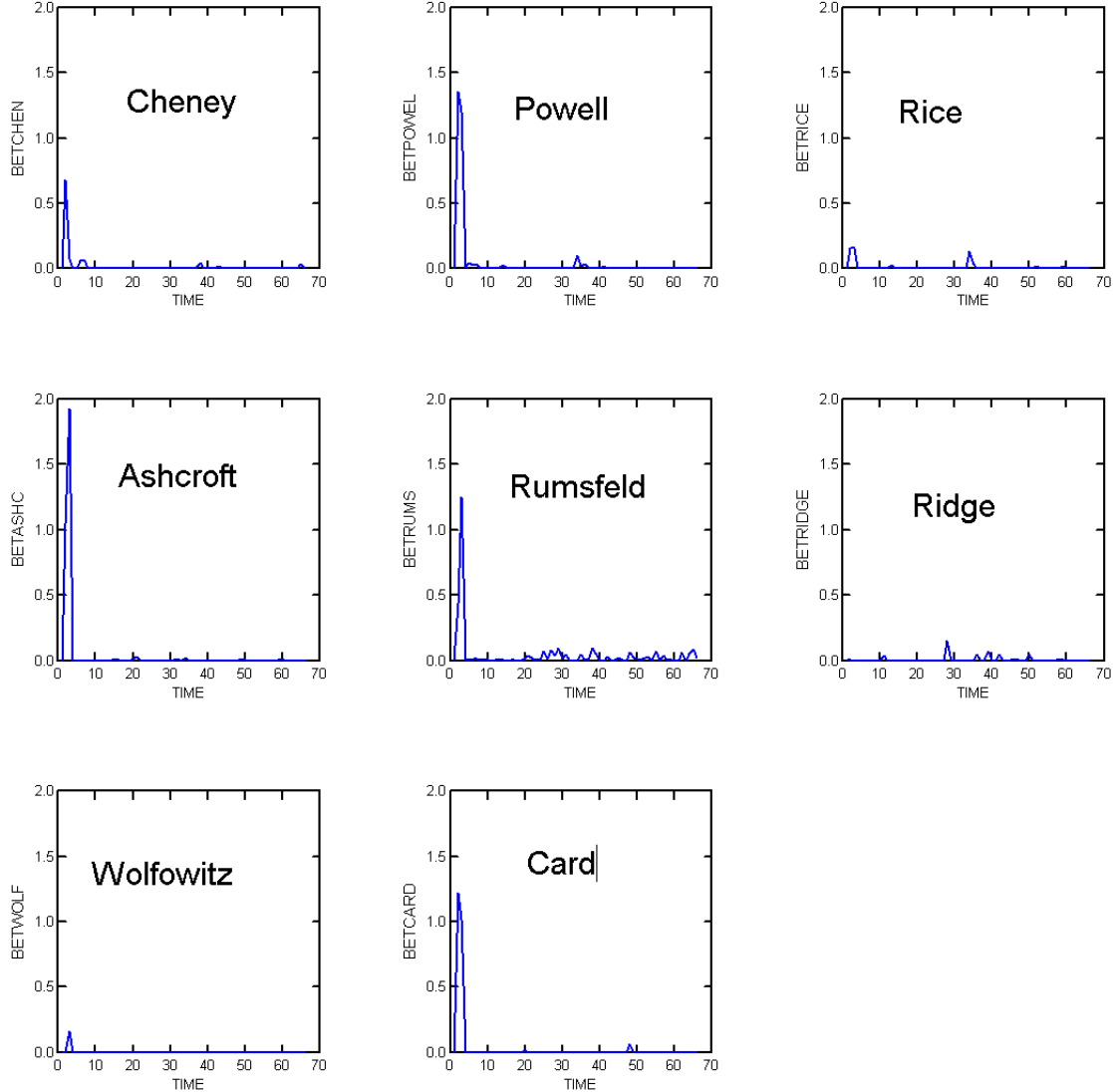

To better understand centrality profiles over this time period, Figure 7 provides a series of graphs showing betweenness centralities following the initial news reporting on the attacks, more specifically after day 10. This series of graphs reveals a clear domination by Rumsfeld in terms of betweenness centrality over the 56 days of the

analysis. Another interesting feature of these graphs is the apparent similarity in betweenness profiles over this time period between Powell and Rice. Figure 8 provides a direct comparison of betweenness profiles showing a striking degree of similarity between Powell and Rice over the 56 days (r = 0.86, p<0.0001). This stands in contrast to a comparison of Powell and Rumsfeld (Figure 9) who are somewhat out of sync with one another (r = -0.18, p< 0.2), particularly between days 32-33.
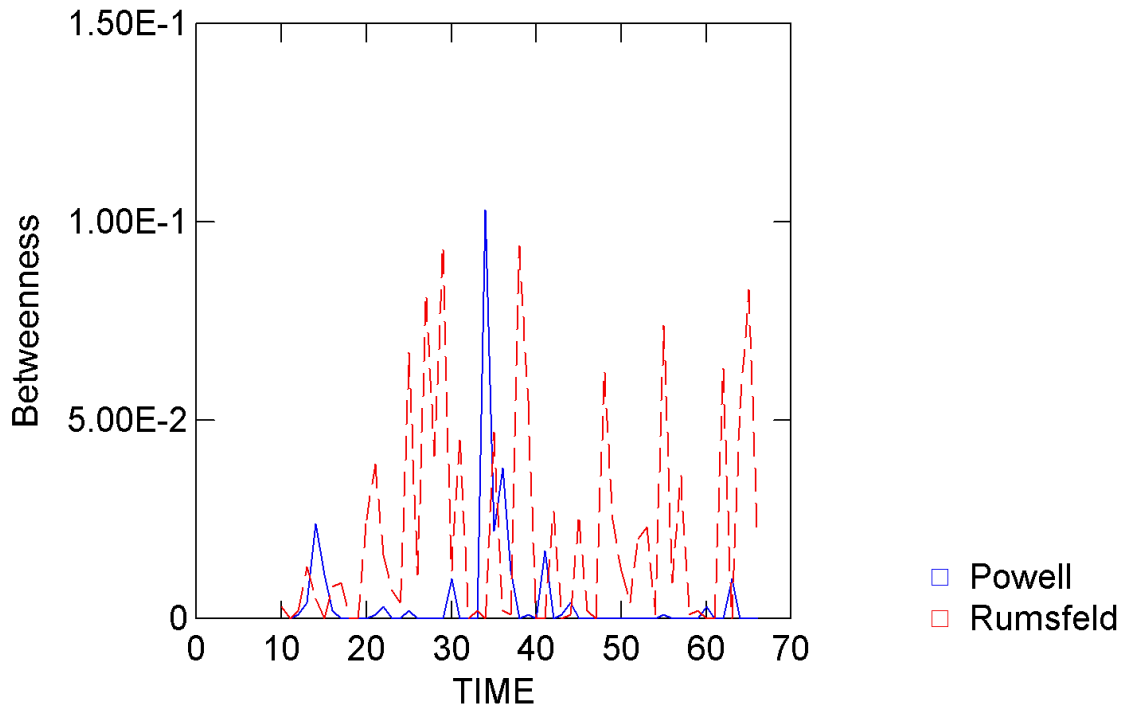
Figure 7. Betweenness profile by ego after day 10.
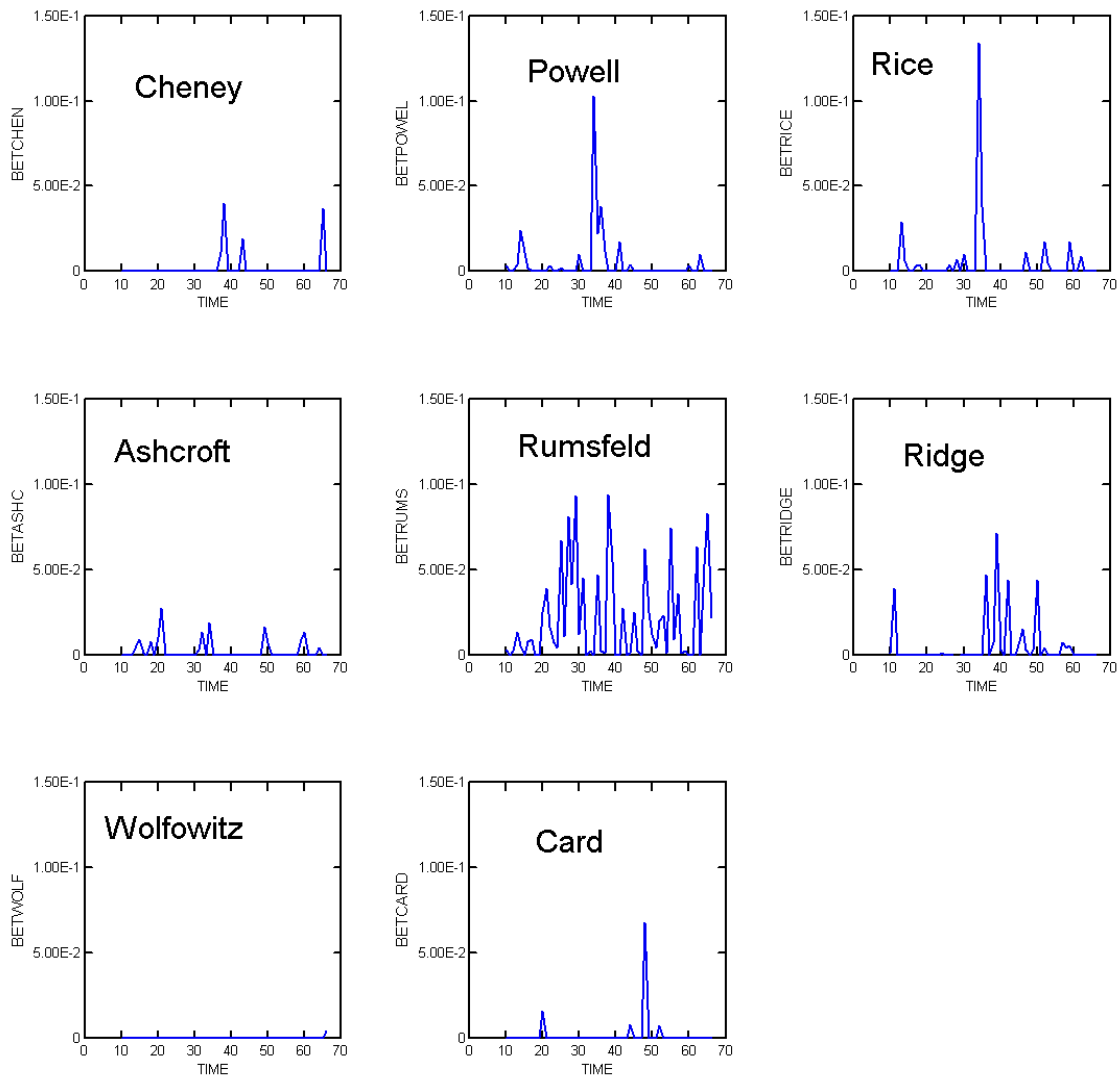
Figure 8. Comparison of betweenness profiles after day 10 for Powell and Rice (r = 0.86, p<0.0001).
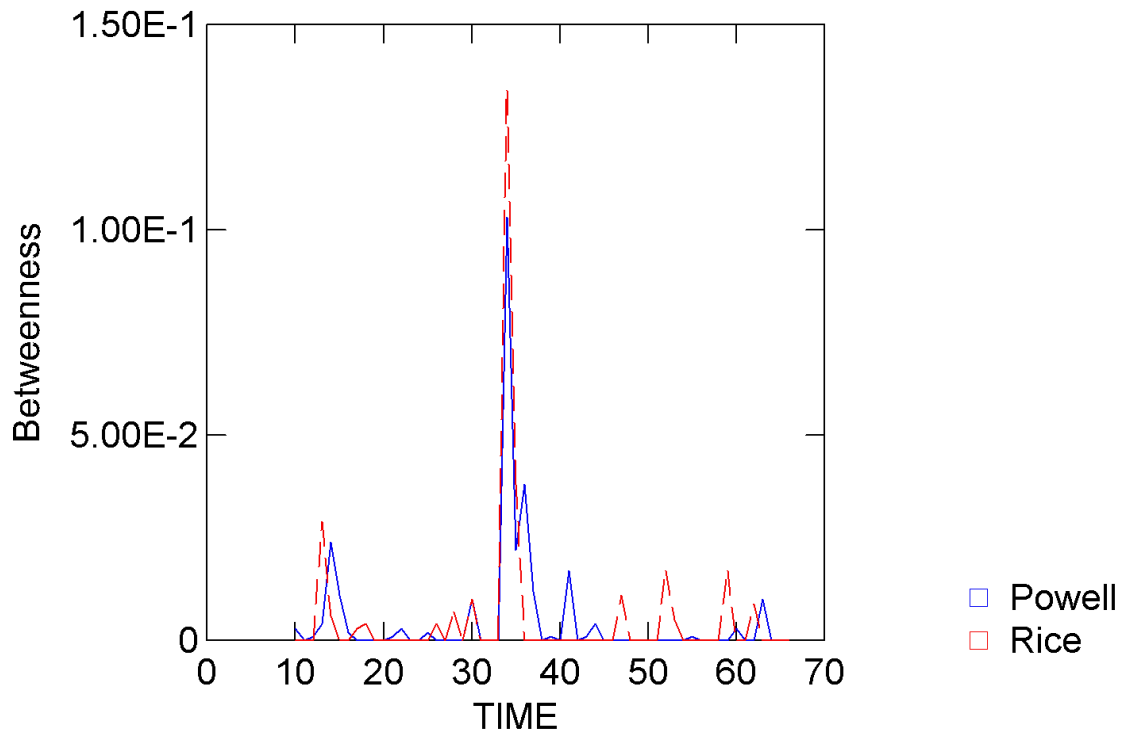
Figure 9. Comparison of betweenness profiles after day 10 for Powell and Rumsfeld (r = -0.18, p<0.2).

This similarity between Powell and Rice is further illustrated from a multidimensional time-series correspondence analysis (CA) of the betweenness profiles of the eight

team members over the 56 days of reporting. Figure 10 is a three-dimensional kinemage of the CA of betweenness centralities after day 10. The red nodes represent team members while blue balls represent each of the 56 time periods. Vectors linking days are directed and move from day 10 through day 66. The vectors linking days were included to explore possible patterns across time periods. The points in space can be rotated by left clicking in the kinemage and then left clicking in the space and moving the mouse in the desired direction of rotation. The letter ?t? can be hit to reduce or increase line thickness for better clarity.

In an interactive examination of Figure 10, it is instructive to click off the ties between time periods (click on the "Ties" check box on the right) in order to better view both the relationships among team members in terms of profile similarities and the relationship between members and the various days (it is also helpful to rotate the kinemage in order to discover different views of the three-dimensional relation among team members and days). As would be expected from the betweenness profile analysis above, both Powell and Rice are very near one another in space. There are four "arms" in the three-dimensional space, each being related to one or more team members. Of course Powell and Rice represent one such arm with their shared relationship to days around 14-15, 34, 41, 47 and 63. Cheney represents another arm with his strong identification to day 43, while both Card and Ridge reflect the two remaining arms in space. Card is associated with days 44 and 48 and to some degree day 20. Ridge is associated with a series of days including days 40-42, 28, 46, 36, 39, and 58. Ashcroft has patterns similar to Rice and Powell although at a much weaker level (Ashcroft and Powell, $r = 0.33$, $p<0.01$; Ashcroft and Rice, $r = 0.34$, $p<0.01$). Wolfowitz is found near day 66, which is the only detectable day in which he had a betweenness score greater than zero. Finally, Rumsfeld, clearly the most dominant member of the team in terms of betweenness centrality, is found at the intersection of all four arms reflecting his dominance in this measure of centrality across the 56 days.

Figure 10. *Kinemage 1:* **Correspondence analysis of the betweenness centralities by time after day 10.** Kinemage can be explored by placing curser in black space, left-clicking and rotating the mouse in the desired direction of rotation.

Similar to the betweenness centrality analysis above, we now turn to an analysis of degree centrality. Figure 11 shows the degree centrality of the eight team members over the 66-day time periods. Powell is by far the most central member within the initial 10 days following the attack, but this dominance diminishes after day 10. Again Rumsfeld is the most dominant member of the team following day 10, with Ridge being of importance between days 35 and 60. This is reasonable considering his post as Head of Homeland Security was not established until some time after the attacks. In keeping with the previous analysis on betweenness centrality, Figures 12 and 13 show the comparison in degree profiles between Powell and both Rice and Rumsfeld after day 10. Rice and Powell have a significant similarity in degree profiles over the 56-day period, but not to the same extent as betweenness centrality ($r = 0.47$, $p <0.0001$), and Powell and Rumsfeld have an almost inverse relationship ($r = -0.23$, $p< 0.09$).

Figure 11. Degree profile by ego.
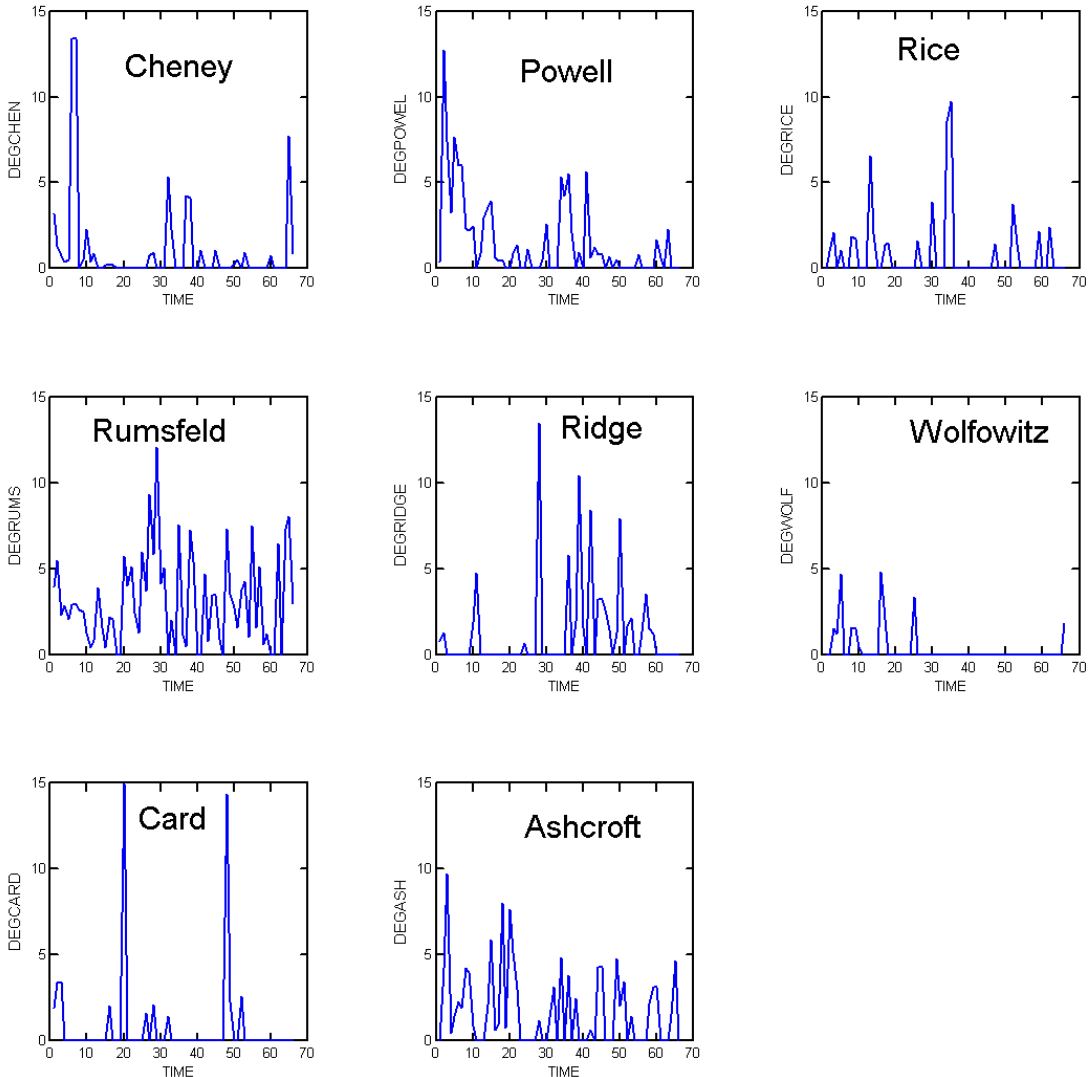
Figure 12. Comparison of degree profiles after day 10 for Powell and Rice (r = 0.47, p<0.0001).
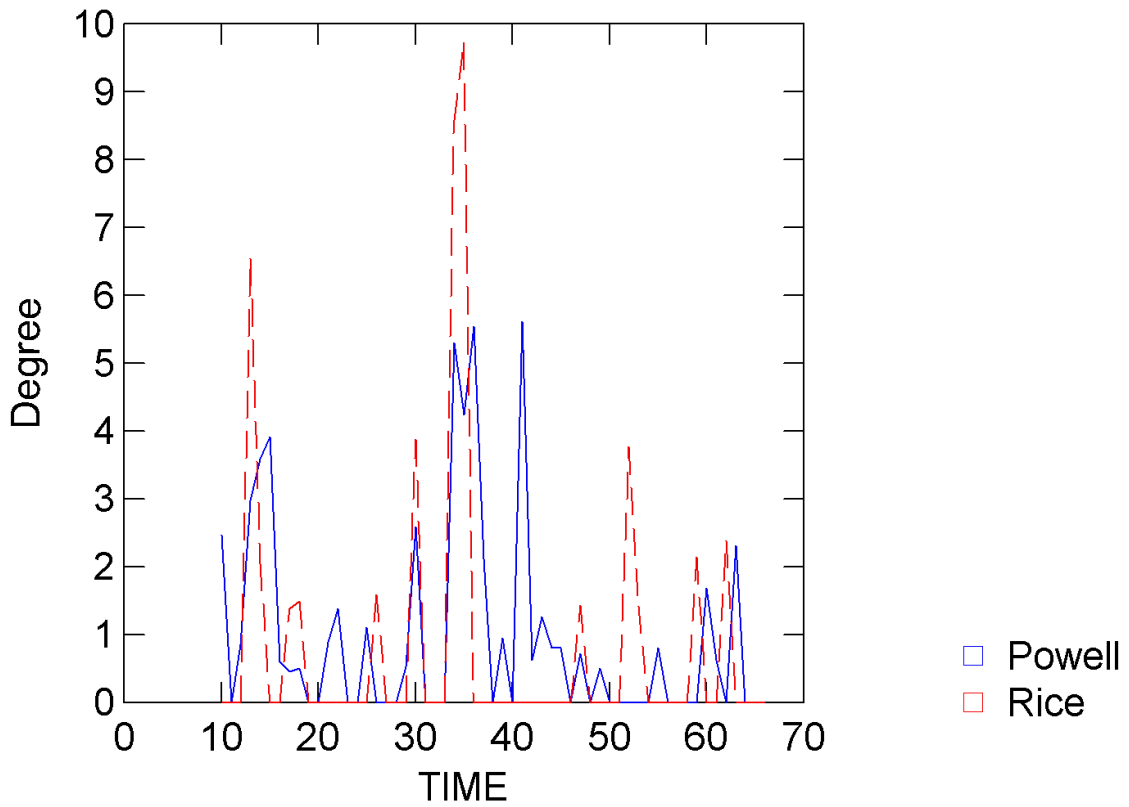
Figure 13. Comparison of degree profiles after day 10 for Powell and Rumsfeld.
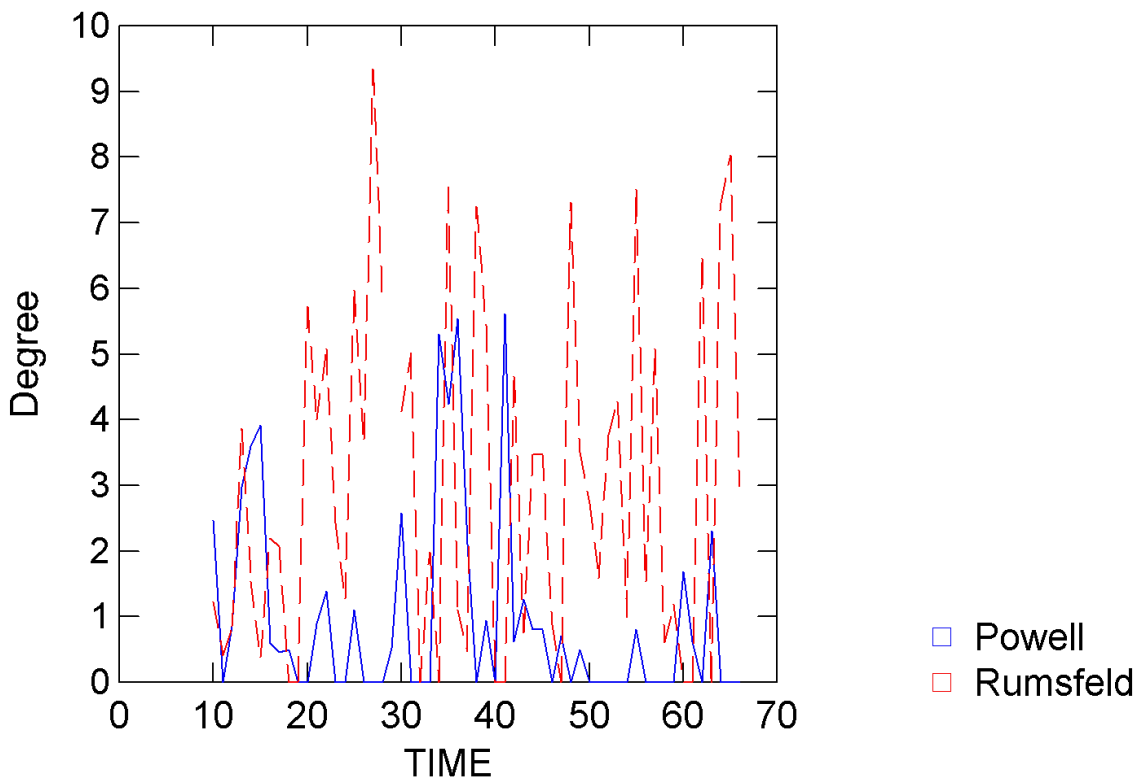
Figure 14 is a kinemage of a correspondence analysis of the degree centrality of the eight members over all 66 days of reporting. Clicking off the "Ties" again reveals the relationships between team members and days in terms of degree profiles. The structure of the CA is similar to that found in Figure 10 in terms of the various ?arms? in the three-dimensional space, although such arms are not as well structured and clear. Similarly, Rumsfeld is in the center of the space revealing his dominance in degree centrality over most of the 66 days of reporting. Clicking off the check box next to "Times" provides a clearer view of the spatial proximities among the eight members of the team with respect to degree profiles.

Figure 14. *Kinemage 2:* Correspondence analysis of the degree centralities by time. Kinemage can be explored by placing curser in black space, left-clicking and rotating the mouse in the desired direction of rotation.

Interrupted Time Series: 3D Visualizations of Aggregate and Selected Time Slices Using Mage

We now turn to a visual examination of the aggregate network and a series of networks at important time points within the 66 days of reporting. The following kinemages are meant to explore the nature of words connected to each of the eight team members that will help in understanding team member roles and shared relations to words. In addition, the manner in which the kinemages are constructed is meant to show the power of Mage in allowing for the simplification of rather complex network visualizations through Mage?s ability to interactively rotate the graph and turn on and off categories of nodes, arcs and node/arc sets.

In an attempt to facilitate the simplification of networks in this section, particularly the aggregate network (all 66 days), the words in the total data set were classified into categories deemed important to the analysis. The words were coded into one of six categories. The first and most obvious of these are the "Egos" themselves which include each of the eight team members. The second category includes all other remaining proper names (with the exception of first names only), which is referred to as "Actors." These include such names as *musharraf*, *arafat*, *ari_fleischer*, etc. The third category includes all words that refer to formal roles, ranks, and statuses and is referenced as "Roles." These include words such as *commissioner, investigator, undersecretary, general, governor,* etc. The fourth category of terms involves words representing both organizations and nations and is termed "Orgs/Nat" or sometimes simply "Orgs." This category encompasses words like *postal-services, aclu, navy, iran, china, pakistan,* etc. The final category is called "Terms" and includes all remaining words not classified within the previous five categories. Although the "Terms" category, the largest of the six, could have been broken down further into a number of possible other categories, it is important to note that large numbers of category sets makes the dyadic comparison of links both within and between sets increasingly more complex as numbers increase (both visually and practically).

Aggregate Analysis

Figure 15 is a kinemage of the relations among all 988 words linked to at least one of the eight team members over the 66 days of reports. Three-dimensional coordinates were obtained with the use of a spring embedder (Fruchterman-Reingold) found in Pajek (Batagelj and Mrvar 2002). An examination of the kinemage reveals a rather complex network of relations among words. However, the graph can be readily simplified and explored progressively by removing and then replacing categories of both arcs and nodes. Along the right side of the kinemage are various boxes that will turn on and off entire node categories, nodes, and or node labels. In addition, all arcs ("Ties") or specific arc sets (e.g., EGOS <-> EGOS, ACTORS<->EGOS) can be turned on and off. One way to simplify and explore the graph involves clicking off all arc sets under the "Ties" box. Next, turn off each of the categories with the exception of "EGOS" by left-clicking on each of the category boxes. This will leave only the eight team members in three-dimensional space, and they can be rotated for inspection. Links between team members can be observed by clicking on the arc set representing "EGOS<->EGOS" ties. At this point, categories can be progressively added and removed in order to explore the overlap and uniqueness of words within categories that are associated with each of the eight team members. For example, by clicking on the "ACTORS" box and subsequently clicking on the "ACTORS<->EGOS" box, links between team members and actor terms can be explored. In this case Rice and Powell share *arafat, fox*, and *bin_laden* in common. In terms of unique actor terms, Powell has *pervez, kharzai*, and *musharraf* connected only to him while Rice has *hussein* connected uniquely to her. Rumsfeld has *reagan, pm_blair*, and *frank* unique to him.

A similar examination of roles finds Powell with no unique role terms connected exclusively to him. He does, however, share *al-qaeda* with Rumsfeld and *sec(secretary)* with Rice, Cheney and Rumsfeld. Rice has *advisor* unique to her and Powell shares *president* with Rumsfeld. With regard to organizations and nations ("ORGS/NAT") Powell has the words *china, united_states, iran*, and *israel* unique to him and shares *afghanistan* with Rice. Powell is linked to Rumsfeld through the terms *afghanistan, pakistan, iraq, united_states*, and *pentagon*, revealing a high degree of overlap between the two when it comes to mostly Arab nations.

"TERMS" can be examined in a similar manner. However, the large number of terms contributes to a complicated graph. In order to simplify the graph and explore the connections among terms and team members, the "labels" box under "Terms" should be turned off and individual nodes can be identified by left-clicking on the node of interest and the label for that node can be read in the lower left corner of the graph. As can be seen from an examination of the network of relations Rumsfeld, by far, has the largest number of unique terms connected exclusively to him (the ring of blue nodes projecting out from each of the team members represent nodes uniquely connected to each member).

Analysis of Time Slices

We now present a series of kinemages providing snapshots of networks at various times over the 66 days of reporting. Time slices were selected on the basis of important events that happened during this period. For example, day 27 is the day on which the air campaign began in Afghanistan (Figure 17). Each of the kinemages will be structured and analyzed in a manner similar to the discussion above with respect to Figure 15.

Figure 15. *Kinemage 3:* **Aggregation of all 66 time periods comparing ties between inner circle and organizations, roles, important actors and other terms.** The complexity of this kinemage can be reduced by clicking on and off the nodes, labels, and/or edges. The words were categorized into five groups to better facilitate visualization. EGOS consists of all team members (excluding Bush), ORGS/NAT consists of organizations and nations, ROLES contains various role terms (e.g., *major, administrator under secretary*), ACTORS consists of proper names other than team members, and TERMS contains all other words. The kinemage can be rotated to reveal various aspects of the structure.

>

Moving through an examination of connections between the team members and words within the five categories we can see that the most active team members two days after the attack on the World Trade Center and the Pentagon were Powell, Card, and Ashcroft (Figure 16). Powell and Cheney are linked during this period and, although Rumsfeld is present in this period, he has a relatively small number of words uniquely connected to him. Card is the only team member to have "ACTORS" connected to him and involves the terms *feldman* and *casey*. This is, of course, early in the 66-day period, with most of the news reporting focused on the event itself. More actors? names would come into play in subsequent days, as there was more speculation on who was behind the attacks and on administration attempts to build a coalition on the war on terrorism. With respect to organizations and nations Card, Rice, and Ashcroft are connected to the word *white_house*, while Powell is not.

By day 27, marking the beginning of the air campaign in Afghanistan, only Rumsfeld and Cheney are present in the news. Rumsfeld dominates this period and Cheney is tangentially in the news, mostly regarding his residence in an *undisclosed* location. In another eight days, the news is dominated by Rumsfeld, Powell and Rice (Figure 18) during a period when the United States is coming under increasing criticism for collateral damage in the course of the air campaign. Rice and Powell are mutually connected to the words *security* and *washington* while Powell and Rumsfeld are tied to *day, sec*, and *washington*. With regard to "ACTORS" Rice is connected to *yassar_arafat*, Powell to *musharraf*, and Rumsfeld to *myers*. Powell has no role terms tied uniquely to him and shares *sec* with Rumsfeld. Unique to Rice is *interviewer* and *adviser* while Rumsfeld is uniquely connected to *general*. There is also no overlap during this period with respect to organizations and nations. Powell is exclusively connected to *india* and *pakistan*, Rice to *united_states* and *afghanistan*, and Rumsfeld to *taliban*. Connections to terms also reflect possible differences in roles among the three team members during this period. For example, Powell is connected to *talk* and *diplomatic* while Rice is connected to *war* and Rumsfeld to *warn* and *convoy*. Although the three team members have similar levels of centrality during this period, it appears that they were dealing with separate concerns. Powell is dealing with diplomatic issues surrounding the troubles between Pakistan and India while Rice and Rumsfeld are dealing with issues surrounding the war in Afghanistan and collateral damage.

The final two kinemages provide the network of connections around the beginning of the ground campaign (Figure 19), and the day the Northern alliance entered Kabul

(Figure 20). The activity on day 51 is dominated by Ashcroft, while day 65 is dominated by Ashcroft, Rumsfeld, and Cheney. Rumsfeld and Cheney are directly connected and the three are jointly connected by such words as *united_states, war, military, wednesday*, and *taliban*. Powell is not present during this period.

Figure 16. *Kinemage 4:* Day 2 - Shortly after the terrorist attack on the WTC and Pentagon.

Figure 17. *Kinemage 5:* Day 27 - Beginning of U.S. air campaign in Afghanistan.

Figure 18. *Kinemage 6:* Day 35 - U.S. comes under criticism for collateral damage.

Figure 19. *Kinemage 7:* Day 51 - Beginning of U.S. ground campaign in Afghanistan.

Figure 20. *Kinemage 8:* Day 65 - Northern Alliance enters Kabul.

Summary of Analysis II

Rumsfeld was the most central (for both types of centrality) over the course of the 66 time points, although his prominence becomes clearer just prior to the beginning of the air campaign. Powell?s centrality varied highly and his role primarily concerned relations with other countries other than Afghanistan with very little overlap in other domains. Much of Powell?s activity was concentrated in the first few days following the attack on the World Trade Center. In addition, he had centrality profiles (both betweenness and degree) more similar to Rice than to any of the other team members, and overlapped highly with Rice with respect to foreign policy-related terms, possibly reflecting potential role conflicts. Additionally, Powell was associated with diplomatic efforts on a variety of fronts (some of which overlapped with Rice) while Rumsfeld and Rice were more associated with the war in Afghanistan and related issues. Cheney, Ridge, and Card had dramatically different centrality profiles from other team members, possibly reflecting their unique roles in the war on terrorism.

In a series of 3D visualizations, networks were examined at critical times during the 66-day period (e.g., beginning of air strikes, beginning of ground offensive). These kinemages of the CRA networks confirmed much of what was observed in the centrality profile analysis although with an expanded ability to explore the data at different points in time. As in the centrality analysis, Rumsfeld was the most prominent member of the team during this period. Analysis of other periods revealed that following Powell?s initial high connectance, he tended to have limited centrality over time and had a high degree of overlap of words with other members of the inner circle. Rumsfeld was the most central (for both measures) over the course of the 66 time points, although his prominence becomes clearer just prior to the beginning of the air campaign. There is a definite dominance of military related terms over diplomatic related terms, the realm of Powell.

Overall Conclusions From the Analyses

The formal job description for Powell places him clearly as the chief foreign policy advisor to the President:

"The Executive Branch and the Congress have constitutional responsibilities for U.S. foreign policy. Within the Executive Branch, the Department of State is the lead U.S. foreign affairs agency, and the Secretary of State is the President?s principal foreign policy adviser. The Department advances U.S. objectives and interests in shaping a freer, more secure, and more prosperous world through its primary role in developing and implementing the President's foreign policy." [U.S. State Department web site]

Rumsfeld?s official formal role in the administration is that of chief defense policy advisor:

"The Secretary of Defense is the principal defense policy advisor to the President and is responsible for the formulation of general defense policy and policy related to all matters of direct concern to the Department of Defense, and for the execution of approved policy. Under the direction of the President, the Secretary exercises authority, direction and control over the Department of Defense." [U.S. Department of Defense web site]

Given the foreign policy implications of September 11, the data suggest that Powell has played less of a role then might be expected given his formal status as the President?s chief foreign policy advisor and that Rumsfeld played more of a role than might be expected given his formal status as Secretary of Defense, at least as depicted in Reuters news tickers over the period analyzed. In the final analysis, however, there is no doubt that because the reporting of military matters and solutions in Reuters news far outweighed the reports on international political initiatives that would possibly be connected to the Secretary of State, Rumsfeld had a much greater presence in the news. What that means in terms of the workings of the White House inner circle is still open to interpretation. However, this does stand in stark contrast to earlier administrations and U.S. military interventions where, for example, Secretary of State Madeleine Albright in the late Clinton Administration spearheaded the war in Kosovo (in fact it has been referred to as Madeleine?s war). Nevertheless, we provide this visual analysis in the hope of showing the potential power of the visualization methods for exploring problems of the kind discussed here.

Concluding Remarks

We caution that the patterns that we have identified in this analysis are patterns that occurred in Reuters news tickers. Many factors affect how news is produced and which of these reach a final audience; governments have to present themselves in favorable ways to maintain trust and confidence in their effectiveness. This is especially true in times of crisis. Timing and coordinated presentation are one of the ways to achieve this, and non-disclosure and classification of certain information are another. News companies are intermediaries that collect and disseminate information to clients and customers. These organizations are by no means completely objective and do not just simply provide the facts. Maintaining successful customer relationships also means the need for news organizations to adapt to customer preferences; certain news stories might be less desirable than others while yet other slants may be more preferred or easier to communicate. Mass communication cannot be expected to be independent of what people like to hear and what editors (or owners) want to present.

Especially in times of significant events like September 11, news reports can be expected to reflect a complicated mixture of many influences. Until now empirical social science has had difficulty coping with the complexities of mass communication. The sheer amount of information transmitted in today?s system of mass communications has until very recently been completely out of reach of the analytical abilities of most social scientists. Modern computers, powerful analytical tools, advances in network analysis and recent developments in visualization techniques together with advances in applications of natural language computing technology, like CRA, promise to change all this.

The combination of methods used in this article, for example, seems therefore to be very well suited to:

> (1) explore and understand the social roles of individuals from an analysis of the overlap of words in different types of text (e.g., internal company memos, news transcripts),
>
> (2) compare patterns in the news from different companies (e.g., conservative versus liberal news organizations),
>
> (3) explore systematic differences for national perspectives (e.g., news reports for New England versus the South), and
>
> (4) detect shifts in focus by comparing different sources; how for instance government statements are transformed by news companies.

The identification of persistent patterns in the semantic structures of different sources, which are typically beyond the scope of individual observation, opens the way for a new understanding of the manner in which we are affected by institutions that surround us in our daily lives.

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