CONNECTIONS

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Stephen P. Borgatti, Editor

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News

Articles

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1998 CALENDAR

January	February
• **Linguistic Society of America**. Jan 8-11 January. Grand Hyatt, New York, NY	•
March	**April**
• **Association for Computing Machinery (ACM).** March 1-5, San Jose, California.	• **Pacific Sociological Assoc.** April 16-19. San Francisco, California. Cathedral Hill Hotel • **INFORMS/CORS.** Montreal, April 26-29. • **Society for Applied Anthropology**. April 22-26. San Juan, Puerto Rico. becky_joseph@nps.gov
May	**June**
• **Sunbelt International Social Networks Conference.** May 28-31. Barcelona, Spain.	•
July	**August**
• **World Congress of Sociology.** July 26 - Aug. 1, Montreal.	• **American Sociological Assoc.** Aug 21-25. San Francisco, USA • **Academy of Management.** August 9-12. San Diego, California. Marriott Hotel
September	**October**
• **American Political Science Assoc.** September 3-6. Boston, MA. • **ICES98: Second International Conference on Evolvable Systems: Biology to Hardware.** Sept 24-26. Lausanne, Switzerland	• **INFORMS.** October 25 - 28. Seattle, WA

November	December
•	• **American Anthropological Assoc**. Dec. 2-6. Philadelphia, PA.

1999 CALENDAR

January	February
•	• **Sunbelt International Social Networks Conference.** Feb 17-21. Charleston, SC www.heinz.cmu.edu/project/INSNA
March	**April**
•	•
May	**June**
•	•
July	**August**
•	• **American Sociological Assoc.** Aug 6-10: Chicago, Illinois. • **Academy of Management.** Aug. 8-11. Chicago, IL Hyatt Regency Chicago
September	**October**
• **American Political Science Assoc.** Sept 2-5. Atlanta, GA	
November	**December**
• **American Anthropological Assoc.** Nov 17-21. Wash., DC.	

NETWORK NEWS

Changes in CONNECTIONS

New publishing schedule. Several years ago, CONNECTIONS came out in April and October. Over time, we slowly moved the dates forward so that work on the journal could be done when school wasn't in session. The later dates also had the advantage that the final issue in a volume could contain all the remaining abstracts from a given calendar year. But there was also a problem: the second issue of any given year would actually arrive in subscribers' hands in the next calender year. That's the case with the issue you are reading right now. This confuses some people, who think they missed out on an issue, while others think the issue is just horribly late. (Had a little trouble with this issue, Steve? <nudge> <nudge>.)

So we're making a change. But rather than change the actual schedule, what we're really changing is the labeling. The first issue of each volume will now be sent to the printers in January, and the second will be sent in July. So is this issue the first issue of volume 21? No. We could have done that, but then volume 20 would have only had one issue, which seems improper and might have lead some indexing organizations to drop CONNECTIONS. So what we are doing is publishing two issues nearly back to back. We have quite a few manuscripts in the queue, so we can afford to do this. However, we obviously cannot have abstracts in both issues, and it makes little sense to have two separate Ties & Bonds separated by a just a few weeks, so this issue will not contain either of those regular features -- look for them in 21(1).

Should CONNECTIONS continue as a hard-copy journal, or should it go 100% webzine? If we eliminate the paper version, we can cut INSNA dues in half. We can also put out more issues per year and we can give CONNECTIONS a special positioning in the market -- it could become **the** place to publish papers containing color graphics, animation, software, etc. I'm strongly in favor of it and would like to implement this step in 1999. What does the membership think?

Editorship of CONNECTIONS. In the last issue, I reported a plan to have Candy Jones (jonescq@bc.edu) take over my INSNA subscription functions while I took over her duties as Editor of CONNECTIONS. The INSNA board has now approved that switch, so with this issue I officially begin my tenure as editor.

INSNA membership. Candy Jones (jonescq@bc.edu) and her assistant Lorie Flacker (flacker@bc.edu) handle all membership and subscription functions, as they have been doing for several months now. Please contact them directly.

Sitges

1998 Conference. The ‘98 International Social Network conference will be held in Sitges (near Barcelona, Spain). The dates are Thursday, May 28 to Sunday, May 31, with some workshops on Wednesday, May 27. The meetings are jointly organized by:

- Alain Degenne Degenne@criuc.unicaen.fr
- José Luis Molina Jlm.OPS@hermes.asertel.es
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Registration information can be found on the INSNA web site, and also on the next pages in this issue.

Steve Borgatti
INSNA Coordinator

Article

CONNECTIONS 20(2):13-22

An Analysis of Communication Networks Among Tampa Bay Economic Development Organizations

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University of South Florida Technology Deployment Center

INTRODUCTION AND BACKGROUND

In 1995 a federally-sponsored agency in Tampa, Florida undertook an applied social network analysis study. This agency, the Technology Deployment Center, needed a study to assess the dozens of economic development organizations in the Tampa Bay area, each with their own missions, strategies, planning and information resources. Social network analysis was selected for its strength in assessing communication, relations, and cooperation, and inter-organizational environments. As a network study of inter-organizational communication, the study presents a snapshot of Tampa Bay area public organization networks in the rapidly changing field of urban economic development. The research also contributed to a master's thesis.

The Technology Deployment Center (TDC) at the University of South Florida is a community-directed program for conversion of a high-technology Federal nuclear weapons production facility. This facility, the "DOE Pinellas Star Center" in Largo, Florida, has served as one of the engineering, prototyping, and special components plants for the US nuclear weapons complex for over 30 years. Recently, however, it was scheduled for closure as part of Federal realignment plans. In response to the impending closure, the TDC was initiated in 1995 and has received over $13 Million from the US Department of Energy and US Department of Defense to convert the Pinellas STAR Center resources to commercial use. One of the few successful programs of its kind, the TDC transitions the Pinellas Star Center's technologies to the private sector through technology development grants and projects to improve local industry infrastructure.

Prior to integrating its economic activities with local resources, the TDC needed to assess the region's economic development environment. The TDC decided that a quantitative and current study should be performed to help determine an appropriate role for the University and that social network analysis would be an appropriate method for such a study. The explicit goals of this study would be:

- To identify levels of communication;
- To assess overall levels of inter-agency coordination;
- To identify leading economic development agencies;
- To identify sectors of development / economic activity;
- To follow up and quantify a 1991 report on the Tampa Bay area economy and economic development organizations performed by Stanford Research Institute (SRI).

RESEARCH DESIGN

In order to assess levels of communication and coordination among economic development organizations in the Tampa Bay area, a written survey was designed. 37 organizations with significant development missions were identified through the 1991 SRI report, phone books, and key economic agencies in the Tampa Bay area. A survey questionnaire was designed to elicit information from which could be constructed a matrix of interorganizational relations and frequency of formal communication. Respondents -- the directors of each surveyed organization -- a completed the one-page questionnaire by indicating that they communicated formally with each other organization on the list daily, weekly, monthly, yearly, or never. Additional economic contacts could be 'written in' for future studies. The questionnaire was administered to the survey population in August, 1995 by mail, with phone and facsimile follow-up. Responses were compiled by September 1, 1995; 31 of 37 organizations provided network communication data for the study. Results were collected into a weighted matrix of network contacts for the 31 responding agencies.

It was intended that social network analysis would be applied to this matrix to identify levels of interorganizational communication, clusters of development activity, and leading organizations. Four network measures were selected to obtain these objectives: centrality, equivalence, centralization, and density. These network parameters are defined in the following way:

Centrality is commonly used to identify network leaders. High network centralities are associated with reputations of power and influence over community affairs or economic sectors (Mizruchi and Galaskiewicz 1994). Two centrality measures were selected: Freeman's degree centrality and Freeman's closeness centrality. Closeness centrality is most frequently used to measure relative access to network resources and information, and can also be interpreted as measuring the degree of independence from others in the network. Similarly, degree centrality measures the overall network activity of individual actors.

In the case of this communication study, access (Freeman's closeness **centrality**) and control (Freeman's betweenness centrality) were identified as the most useful for indicating levels of network coordination. Network **centralization** (or global centrality) measures the degree to which an entire network is focused around a few central nodes (Scott 1991). This has particular relevance for an inter-organizational study of coordination and leadership. Turk (1977) claims that interagency network centralization can be equated with coordination. Similarly, Tichy (1980) defines global network centrality as the degree "to which relations are guided by the formal hierarchy," and Irwin and Huges (1992) refer to network centralization as the degree to which an inter-organizational network is "dominated by a few places."

Equivalence is used to identify sets of network actors with similar roles in the network; in this case, economic 'clusters' of development communication / activity. Structural equivalence measures the extent to which certain participants occupy similar positions and serve similar functions, or roles, within the network. Rogers (1974), Galaskiewicz (1979), Galaskiewicz and Krohn (1984), and Knoke (1983) each describe inter-organizational structural equivalence as being based upon organizational function and activity (discussed in Mizruchi and Galaskiewicz 1994). As far as the Tampa Bay economic development network is concerned, these groups are most likely to be defined by the agencies' missions or service delivery specializations. When agency activities are viewed from an economic perspective, they may be referred to as sectors, or 'clusters', as they are in the 1991 SRI report.

Finally, **density** may be used to measure levels of uncentralized inter-organizational cooperation. Turk (1977) uses the term "coordination" to refer to increased levels of centralized leadership. However, he concedes that public agencies can coordinate their activities without external direction. This describes a form of coordination that does not involve leadership or centralized direction, but that is instead based upon decentralized cooperation. Based on this, it is useful to also examine the overall level of network integration between organizations. Integration and network cohesion are generally measured using the density measure (Scott 1991).

RESULTS AND ANALYSIS

The four network measures presented in the research design were individually analyzed, with the results for each presented below[(2)]

Table 1
Freeman's Centrality Scores for Surveyed Tampa Bay Economic Development Organizations Based Upon Communication Frequency

Organization	Code	Closeness[a]	Degree[a]	Closeness[b]	Degree[b]
Committee of 100	100	96.77	57	2.07	1.68
Community Reuse Organization (CRO)	CRO	65.22	30	-0.94	-0.45
Department of Defense (DOD)	DOD	63.83	24	-1.08	-0.92
Department of Energy (DOE)	DOE	78.95	43	0.37	0.58
Economic Development Administration	EDA	73.17	35	-0.18	-0.05
Enterprise Corporation of Tampa Bay (TEC)	TEC	93.75	66	1.78	2.39
Enterprise Florida	EF	71.43	30	-0.35	-0.45
Florida Department of Commerce	DOC	85.71	50	1.02	1.13
Florida State Economic Services	ESD	76.92	29	0.17	-0.53
Greater Pinellas Park Chamber of Commerce	GPP	68.18	22	-0.66	-1.08
Hillsborough Cty City-County Planning Commission	HCP	65.22	32	-0.94	-0.29
Hillsborough Cty Commerce Department	HCC	83.33	44	0.79	0.65
Hillsborough Cty Metropolitan Planning Organization	HCM	81.08	40	0.57	0.34
Hillsborough Cty Planning Development Department	PDD	61.22	20	-1.33	-1.23
Lockheed Martin Specialty Components (LMSC)	LM	69.77	34	-0.51	-0.13
Metropolitan Tampa Bay Capital Initiative	MTB	96.77	65	2.07	2.31
South Tampa Chamber of Commerce	STC	60	14	-1.44	-1.71
Southern Technology Applications Center	STA	85.71	42	1.02	0.5
St. Petersburg Area Chamber of Commerce	SPC	69.77	26	-0.51	-0.76
St. Petersburg/ Clearwater Economic Development Council	CED	83.33	49	0.79	1.05
Tampa Bay Economic Development Corporation	TED	78.95	38	0.37	0.18
Tampa Bay Partnership	TBP	76.92	40	0.17	0.34
Tampa Bay Regional Planning Council	RPC	69.77	29	-0.51	-0.53
Tampa Downtown Partnership	TDP	73.17	40	-0.18	0.34
Tampa Port Authority	TPA	88.24	44	1.26	0.65
Tampa / St. Pete Minority Business Development Center	MBD	65.22	17	-0.94	-1.47
United States Small Business Administration	SBA	83.33	39	0.79	0.26
University of South Florida Division of Sponsored Research	DSR	71.43	35	-0.35	-0.05
University of South Florida I3 Center	I3	63.83	22	-1.08	-1.08
Univ. of S. Florida Tech. Deployment Center (TDC)	TDC	66.67	28	-0.8	-0.6
Westshore Alliance	WA	60	22	-1.44	-1.08

[a]Relative. [b]Standardized

Table 1 presents the results from the centrality analysis, consisting of Tampa Bay area organizations that participated in the survey, their respective survey codes, and the relative centralities for each. Combined, the Freeman's Closeness and Degree measures identified a single group of agencies with unusually high centralities, including the Enterprise Corporation of Tampa Bay (TEC, now essentially incorporated into the University of South Florida's College of Business), the Florida Department of Commerce (now privatized as Enterprise Florida), the Metropolitan Tampa Bay Capital Initiative, the Southern Technology Applications Center (STAC), the St. Petersburg / Clearwater Economic Development Council, and the Tampa Port Authority.

The centralization index based upon Freeman's closeness measures for the Tampa Bay network is .46, and the Freeman's betweenness centralization index is .05.

These results can be compared to previous studies, such as a network study by Wolfe (1995) of 588 Tampa Bay social service organizations. In this study, the closeness centralization was .58 and the betweenness centralization index was .23. This comparison study attempted to identify linkages between organizations serving families and children in Hillsborough and Pinellas (central Tampa Bay area) counties, in five different areas: staff, program, fiscal, client, and administrative linkages. The comparison study itself referred to an earlier, 1985 study wherein the social service network betweenness and closeness centralization scores were even higher.

A few conclusions can be drawn from these comparisons. Even though the economic development network was less than a tenth the size of the comparison network, it had lower levels of centralization. The closeness centralization score is moderately low, implying low-to-medium levels of centralized access to economic development resources. The betweenness centralization score is also relatively small, indicating the network does not exhibit much control by a few organizations over economic information resources. In sum, the overall level of centralized coordination in Tampa Bay economic development is low.

Figure 1 presents a multi-dimensional scaling of the network adjacency matrix.[(3)]. In general, organizations (identified by codes from Table 1) near the center of the graph have higher centralities (and consequently higher levels of information access and leadership potential). Furthermore, the relative proximity of an organization to another organization on the graph is roughly indicative to shared communication levels. Formal interaction between any two organizations with a frequency of monthly or greater is indicated by a connecting line between those organizations. "Clusters" of organizations (as indicated by structurally equivalent sets) are differentiated by color and shape.

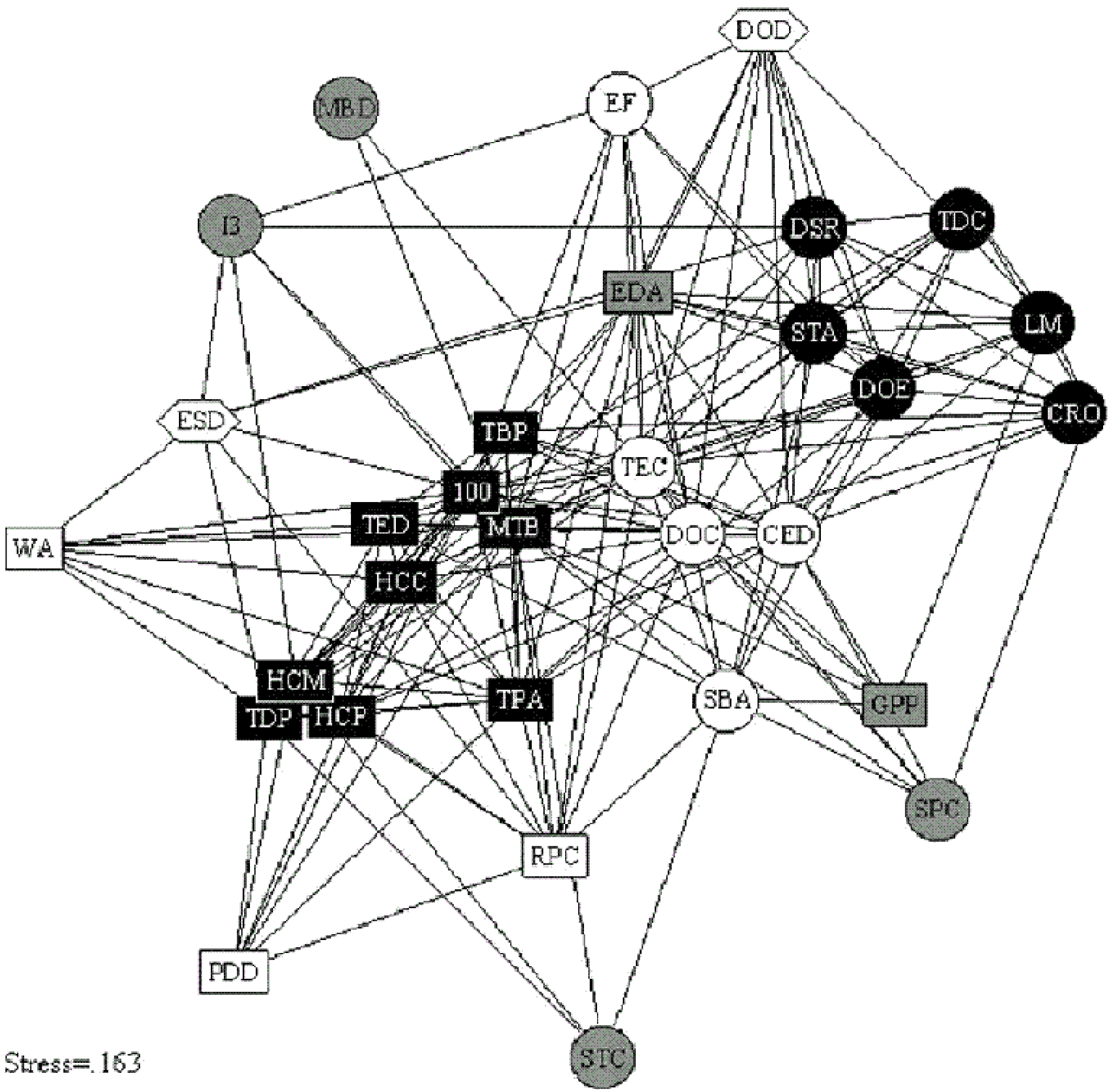

Figure 1. Communication links.

Results from the equivalence analysis are presented in Figure 2, consisting of a hierarchical cluster diagram. This diagram identifies various levels of structurally equivalent sets in the network. It was observed that a number of technology-oriented organizations had similar functions, and that criterion level 0.184 was the most inclusive level that maintained them as distinct, socially relevant sets.

Using identification codes from Table 1, organizations in Fig. 2 connected horizontally by gray blocks at a particular level share set membership at that level. The sets identified as structurally equivalent at level 0.184 have been listed in Table 2, with a tentative explanation of the roles they may perform in the network[(4)].

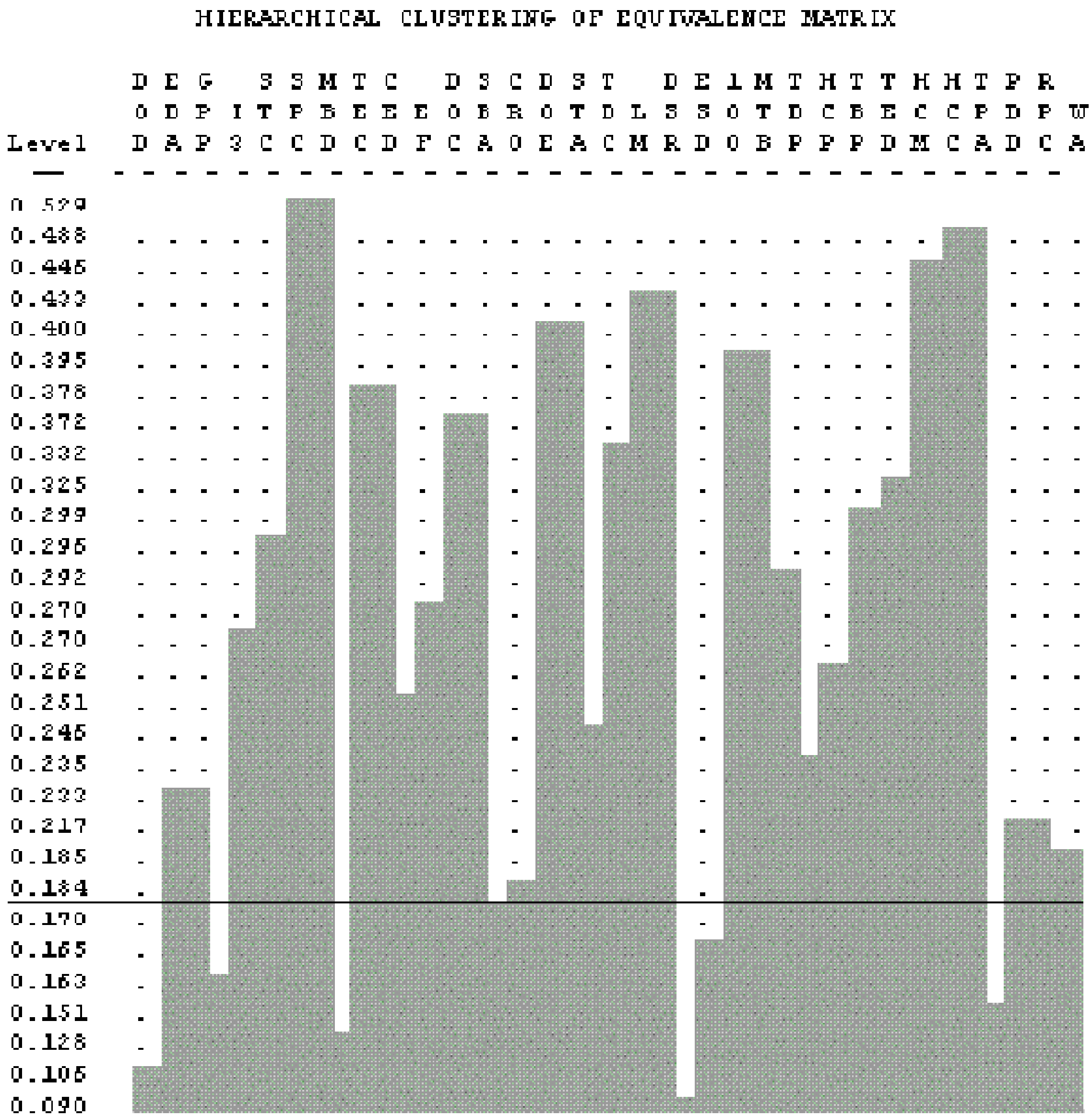

Figure 2. Network Structural Equivalence Using UCINET's Profile Similarity Algorithm

In this study, the matrix has 31 nodes and 409 active links, resulting in a density of .44. The Tampa Bay economic development network is considerably more integrated than the social services network compared for centralization scores, which had a density of .062 (Wolfe 1995). Considering the small size of the network and overlapping interests and resources, this number suggests that the overall communication network is at least moderately integrated or cohesive.

The sets identified by structural equivalence were highly suggestive of specialized economic 'sectors', and appeared highly compatible with open-systems models of economics (Tichy 1980, Katz & Kahn 1971) or similar applied models of technology development (such as presented by Mohawk Research Corporation 1989). Future network studies integrated with a comprehensive model of economic and organizational development may confirm structural equivalence as a useful tool for identifying and planning organizational roles in regional economics or as an alternate method for economic cluster analysis.

Table 2

**Survey Organization Equivalence
Sets Identified Via Hierarchical Clustering**

Business and Economic Development

- Committee of 100
- Metropolitan Tampa Bay Capital Initiative
- Tampa Bay Partnership
- Tampa Downtown Partnership
- Hillsborough County City-County Planning
- Tampa Economic Development Corp. (TEDCO)
- Hillsborough County Metropolitan Planning
- Hillsborough County Commerce Department
- Tampa Port Authority

High-Technology & Defense Conversion

- Pinellas Community Reuse Organization
- Department of Energy (DOE)
- Southern Technology Applications Center (STAC)
- Lockheed-Martin Specialty Components (LMSC)
- USF's Technology Deployment Center (TDC)
- USF's Division of Sponsored Research (DSR)

Enterpreneurship

- Enterprise Corporation of Tampa Bay (TEC)
- Enterprise Florida
- Florida Department of Commerce
- US Small Business Administration
- St. Petersburg / Clearwater Economic Development Council

Local Chambers & Specialized Business

- USF's I^3 Center
- South Tampa Chamber of Commerce
- St. Petersburg Chamber of Commerce
- St. Pete/ Clearwater Minority Business Development Center

Infrastructure Planning

- Greater Pinellas Park Planning Development
- Tampa Bay Regional Planning Council
- Westshore Authority

Local Chambers and Peripheral

- US Economic Development Administration
- Greater Pinellas Park Chamber of Commerce

In general, social network analysis has served to support some of the observations made in the SRI report, particularly concerning low levels of coordinated leadership: "A major obstacle to progress is the reality that Tampa / Hillsborough's current leadership for economic development is seriously fragmented" (1991). However, this study has also suggested that Tampa Bay area organizations work both with and without the cooperation of other agencies in general policy categories. Recently, these conclusions have been echoed by independent consultants hired to assess Tampa Bay's industries, who stated that there is a high level of parallel, but unlinked, effort among Tampa Bay economic development organizations, as high technology industries (microelectronics, telecommunications, biotechnology, and aerospace) are becoming increasingly recognized as critical to all aspects of regional economy, including education, social services, labor, industry, power and more; in the words of Cornell and Nuese (1997):

"[economic development through] information technology is bubbling through 'grass roots' cooperation between Tampa Bay organizations. Although many organizations in the community are working in the same direction, they have not reached 'critical mass' necessary to make the significant leap to the next level of industrial / economic activity."

Turk argues that the natural state of public agency networks is uncoordinated (1977). In an environment where agencies must compete for some resources yet cooperate to accomplish certain goals, they will resist efforts to be incorporated with other organizations or become otherwise centrally directed. In the survey network, such low coordination may then be expected for a network of public / private economic development organizations. However, the centralization and density results suggest that Tampa Bay economic development organizations temporarily cooperate in projects of shared interest, but that this cooperation is neither comprehensively planned nor directed. Agencies with particularly high centralities, however, may serve as leaders in identifying critical issue areas or sources of information concerning the state of the region's economy.

CONCLUSIONS AND IMPLICATIONS

Economic development is a constantly changing process between organizations that increase and decrease in influence. Soon after this survey was conducted, increasing interest among Tampa Bay economic development organizations began to develop around high-technology issues. This has resulted in large industry initiatives such as the "I-4 High Technology Corridor" consortium led by the University of South Florida and the University of Central Florida, which incorporates the efforts of dozens of organizations and corporations with an interest in transforming regional industrial infrastructure (Weatherman & Page 1997). Currently, the I-4 Corridor Council is one of the single most active and influential organizations in the Tampa Bay region. It is expected that this development has caused significant changes to the network presented in this article, probably increasing overall network density, the centrality of individual organizations, and enlarging technology-oriented equivalence sets.

Exceptionally high levels of public investment are required to initiate high technology industries. Recognition of this fact probably gives considerable impetus to regional technology initiatives, but without a coordinating entity it may lack the momentum necessary to actually transform regional industrial infrastructure. The extent to which the University of South Florida or the I-4 Corridor Council serves to fulfill this leadership role will be demonstrated by the success of large-scale economic initiatives in 1998 and 1999.

The Technology Deployment Center has aligned itself with other key organizations and groups to further its mission. As a snapshot of inter-organizational environments, this study may be of value to other regional development agencies and organizations seeking rapid assessment, planning, or research and planning tools.

REFERENCES

Borgatti, S.P., M.G. Everett, & L.C. Freeman. 1992. *UCINET IV Version 1.00*. Columbia: Analytic Technologies.

Cornell, Jon E. & Charles Nuese. 1997. *The Role of the Tampa Bay Area in the Florida / I-4 Corridor Microelectronics Initiative*. Report presented to the USF/UCF I-4 Corridor Council. Tampa, Florida: Concurrent Technology Enterprises, LC.

Galaskiewicz, J. 1979. *Exchange Networks and Community Politics*. Beverly Hills, CA: Sage.

Galaskiewicz, J. & K. Krohn. 1984. Positions, Roles, and Dependencies in a Community Interorganization System. *Sociological Quarterly* 25: 527-550.

Irwin, Michael & Holly Huges. 1992. Centrality and the Structure of Urban Interaction: Measures, Concepts and Applications. *Social Forces* 71 (1): 17-52.

Katz, Daniel & Robert L. Kahn. 1971. Organizations and Open-Systems Theory: A Summary. In *Readings in Organization Theory: Open-System Approaches*. John G. Maurer, ed.: 13-19. New York: Random House.

Knoke, D. 1983. Organization Sponsorship and Influence Reputation of Social Influence Associations. *Social Forces* 61: 1065-1087.

Krackhardt, David, J. Blythe, & C. McGrath. 1994. *Krackplot 3.0: An Improved Network Drawing Program*. Connections 17 (2): 53-55.

Mizruchi, Mark S. & Joseph Galaskiewicz. 1994. Networks of Interorganizational Relations. In *Advances in Social Network Analysis: Research in the Social and Behavioral Sciences*. Stanley Wasserman and Joseph Galaskiewicz, eds.: 230-253. Thousand Oaks, California: Sage Publications.

Mohawk Research Corporation. 1989. *From Invention to Innovation: Commercialization of New Technology by Independent Small Business Inventors*. Washington, D.C.: U.S. Department of Energy.

Rogers, David. 1974. Sociometric Analysis of Interorganizational Relations: Application of Theory and Measurement. *Rural Sociology* 39: 487-503.

Scott, John. 1991. *Social Network Analysis: A Handbook*. Newbury Park, California: Sage Publications.

Stanford Research Institute, Center for Economic Competitiveness. 1991. *Tampa and Hillsborough County In Transition: A Strategy for Economic Prosperity*. Menlo Park, California: SRI International.

Tichy, Noel. 1980. A Social Network Perspective for Organization Development. In *Systems Theory for Organization Development*. T. G. Cummings, ed.: 115-162. Great Britain: John Wiley & Sons, Ltd.

Turk, Herman. 1977. *Organizations in Modern Life*. San Francisco: Jossey-Bass.

Weatherman, Lynda L. & Drew Page. 1997. *I-4 High Technology Corridor Initiative (briefing)*. Orlando, Florida:GTE Corp.

Wolfe, Alvin W. 1995. *Regular Equivalence Clusters in Large Networks Containing Hierarchies: Problems of Interpretation*. Paper presented at the International Social Networks Conference. July 7, 1995, London, England.

Endnotes

1. University of South Florida Technology Deployment Center; 4202 East Fowler Avenue, PHY114; Tampa, Florida 33620

2. Network analysis was conducted using the UCINET IV network analysis program (Borgatti, Everett and Freeman 1992).

3. The MDS figure was generated using the Krackplot 3.0 network drawing program (Krackhardt, Blythe, and McGrath 1994).

4. Shared set membership does not imply redundancy, as these organizations may have different strategies, resources, and clientele populations.

Article

CONNECTIONS 20(2):23-33

The Small World of the University: A Classroom Exercise in the Study of Networks[(1)]

William B. Stevenson, Barbara Davidson, Ivan Manev and Kate Walsh[(2)]
Boston College

A small world study is an easy way to introduce students to the challenges and rewards of network studies. Hypotheses about networks can be formulated and easily tested during the course of a term. Here, hypotheses about the communication patterns among undergraduates were tested by creating a small world study with an administrator as a target. Undergraduates were found to prefer to pass small world folders among their own class and did not pass folders to lower classes. Graduate students, faculty and staff were more closely connected to the administration as compared to undergraduate students, and freshmen were particularly isolated in communication networks. Women relied more on homophilous ties to pass folders compared to men, and both sexes relied on homophilous ties when passing folders across occupational boundaries.

The "small world" problem has a rich and interesting history in the study of social networks. Milgram (1967), noting that people sometimes run into friends (or friends of friends) in locations far from home and exclaim "My, it's a small world!", formulated the problem as: "Starting with any two people in the world, what is the probability that they will know each other?" (Milgram, 1967: 62). This small world problem had originally been articulated in an unpublished paper by Pool and Kochen finally published in 1978. Using a mathematical model, Pool and Kochen (1978) speculated there was a one in 200,000 chance that two Americans would know each other, assuming that each American knows about 500 others. Thus more than 50% of the time any two Americans can be linked if two intermediaries are allowed.

Milgram's genius was to develop a simple methodology for actually studying how people are linked to others. Milgram gave a folder to a "starting person" who is instructed to send the folder to a "target person". If the starter does not know the target, then the starter is instructed to send the folder to someone else the starter knows that might be able to send the folder to the target. Thus the researcher can determine how closely linked any two people are in a population. In the original Milgram study, starters in Kansas tried to get folders to the wife of a divinity student in Cambridge, Massachusetts, and starters in Nebraska tried to get folders to a stockbroker in Sharon, Massachusetts. In the Nebraska study, Milgram found five intermediaries was the median number of links between the starter and target.

Milgram has developed a simple low cost way of studying networks and social structure that would seem to be well suited to a class project in the study of networks in organizations. In this paper we discuss the usefulness of conducting a small world (SW) study as a class project and report on our findings of the small world of the university.

The Small World Study as a Class Project

A SW study can be a useful tool for studying the network connections between individuals in organizations as a classroom exercise. First, a SW study offers an opportunity for students to think about the nature of networks. Second, the students can consider the SW technique in the context of other network research methodologies. Third, a SW study can provide an opportunity to delineate an organization's informal network patterning.

In addition, a SW study provides an opportunity to consider the problems of developing and executing a research project. The SW experiment provides the students with the opportunity to hone rudimentary research skills. As a group, the students can consider (and confront) their own implicit and explicit hypotheses about networks. They can work through methodological design issues, such as ways to test hypotheses, formulate sample sizes, conduct studies, perform appropriate data analyses and determine a study's overall contribution. A SW study enables the student to confront the barriers to network based research such as garnering the cooperation of organizational respondents and generalizability to other populations. Working through these issues as a group enables the student to learn different approaches to the same question or problem from each other. The collegial nature of the classroom enables the students to discuss and defend their approaches with one another.

Research Hypotheses. To keep our study relatively simple, we decided to focus our attention on undergraduate students and how they would contact an administrator. We assumed that undergraduates would interact with each other and be somewhat isolated from other groups in the university. This led us to formulate a number of hypotheses about their communication patterns.

Previous SW studies had indicated that respondents are likely to pass folders to someone they know (Stevenson and Gilly, 1991; Travers and Milgram, 1969). Since network connections are likely to develop as an individual spends more time in the organization, we would expect, for example, that freshmen would have less connections to others as compared to seniors. Thus:

> **Hypothesis 1**: The longer the time at the university, the more likely a student is to initiate a successful chain of communication to a target.

Small world studies are interesting in organizations because there is a formal organizational structure that may alter the contacts between individuals. Milgram was not oblivious to the social structure that alters otherwise random networks of acquaintances in society. He and others have found that selecting the next link is based on friendship, residence of the target, and occupation of the target (Travers and Milgram, 1969) and successful, i.e., completed chains, involve participants with higher occupational prestige and more weak, infrequent relations than unsuccessful chains (Lin, Dayton, and Greenwald, 1978). Small world studies in the organizational setting have shown that barriers between professional groups exist and these barriers make it difficult for SW folders (and other communication) to cross these barriers (Lundberg, 1975; Stevenson and Gilly, 1993). Therefore we expected that it would be difficult for folders to cross boundaries between professors, staff members, administrators and students. Thus:

> **Hypothesis 2**: Small world folders are more likely to be passed within a class than between classes and occupational groups in a university.

Previous studies had indicated a funneling effect in both organization and societal studies. Studies in both organizations and the larger society have found that folders converge on a small number of sociometric "stars" before reaching the target person. In the societal case, Travers and Milgram (1969) found, that of 64 letters sent, 25 percent of the letters reached the target through one neighbor, and three penultimate links accounted for 48 percent of the completions. Stevenson and Gilly (1993) found that folders converged rapidly on a small number of managers in an organization, and Lundberg (1975) found that chains funneled through a small number of people in both his society and organizational studies. We would expect in this case that students would pass SW folders to staff and faculty as repositories of knowledge about the organization.

> **Hypothesis 3**: Small world folders will converge on faculty and staff before reaching the target.

It has often been noted that ties between people tend to be homophilous. For example, Travers noted in the original Kansas study that females were more likely to send to females and males to males. Furthermore, other SW studies have shown that those who are culturally (Bochner, Buker, and McLeod, 1976) and racially similar (Korte and Milgram, 1970) are more likely to be linked. Sex differences were the most prevalent measure of diversity in this university population. Therefore:

> **Hypothesis 4:** Small world folders are more likely to be passed to members of the same sex.

Methodology

The hypotheses were developed in the class based on previous studies and hunches about networks. The folder was created in class after examining other examples of SW folders. Then the folder creation and data analysis work was divided among the class members.

As a first step in conducting a SW study, a target person and starting people were identified by the class. We thought it would be interesting to see how the undergraduates were connected to the administration of the university. This is an interesting question since most undergraduates have very little contact with the administration beyond the registrar, financial aid, or housing office. We picked the undergraduate dean of the school of management as the target. The undergraduate dean was picked because he was located in the building where most of the classes are held and would be easy to physically access.

However, the students could not simply hand the folder to the dean. We stipulated in the folder that the students needed to have had contact with the person they were forwarding the folder to. As shown in the Appendix, we wanted the students to forward the folder "to someone you have had several conversations with outside the classroom". Similar to most SW studies, we were interested in the preexisting ties that connect people to each other in a university. We did not want to restrict the ties to strong friendships for fear that the folders would never reach the administrator. Also, we wanted the students to be able to forward the folder across occupational boundaries. We did not want the students to simply hand the folder to a professor, secretary, or the student sitting next to them in class, so we stipulated that they had to have several conversations outside the classroom with the next link in the chain.

In order to study the difference in acquaintance chains among the four classes, folders were distributed equally to freshman, sophomores, juniors, and seniors. Folders were initially distributed in selected classes. The freshmen were randomly selected in a required freshman ethics class. Sophomores and juniors were randomly selected in two required introductory classes in organizational behavior. Seniors were sampled in an elective course.

The number of folders to be distributed led to extensive discussion. Previous SW studies in the larger society had completion rates of approximately 21-22% (Lundberg, 1975, Travers & Milgram, 1969; Korte & Milgram, 1970), but Lundberg had found a completion rate of 57% in his organizational study as compared to a 21% rate in his society study. We estimated that our completion rate would be closer to 50% given that the study was going to be distributed in classes most of which were conducted in the same building as the target. In addition, we did not want to deluge the administration or any potential funnels with folders. Accordingly, we estimated that sending out 60 folders equally distributed to those in the four categories of students would yield about 30 completed chains. We thought this would be an adequate number for the analysis of the simple crosstabulation of results that we planned.

This was a very useful discussion, because rarely do students consider the problems of non-response and how it is linked to the ability to analyze data. This discussion forced the students to consider how the data would be analyzed and the implications of the research design for the testing of their hypotheses. Once the number of folders were determined, we distributed them in classes. Folders were distributed at the end of class to prevent them from being casually passed among the class.

Each starter was given a folder, shown in the Appendix, and asked to pass it to the target. The folder described the study, named the target, and asked the respondent to pass the folder on. Each person who received the folder was asked to write their name in the folder and give some brief identifying information about themselves. This was done for two reasons. First, we wanted to know information about links in the chain. Second, consistent with other SW studies, we did not want to folder to get caught in a loop between people. It was assumed that the respondent would not send the folder backwards in the chain after looking at the list of those who had received the folder.

Anticipating that many students might funnel the folder to department secretaries as easily accessible administrative contacts, a memo was sent to all secretaries alerting them about the study and asking them to call the professor in charge of the study with any concerns. (No one called him.) The undergraduate dean was given a box for the collection of folders. The professor dropped by the dean's office periodically to check the box. The last folders were turned in about two weeks after the study began.

Results

As shown in Table 1, 16 of 60 folders (27%) reached the target with a mean of 1.25 links between the starter and the target. This was a lower than expected completion rate and chain length, but not out of line for SW studies in general. Small world studies in organizations have shown, given the relatively clear boundaries in organizations, the number of intermediaries between a starter and target is smaller, and more chains are likely to successfully reach their target in SW studies in organizations as compared to the larger society. For example, Travers and Milgram found the mean number of intermediaries in his original study was slightly more than five, Lundberg (1975) in a study comparing SW chains in the larger society versus two organizations found the mean number of intermediaries for the society study was slightly more than five, but the mean for the organizations was slightly more than three. Stevenson and Gilly (1991) found that only one or two intermediaries were necessary to deliver a problem to someone who could solve it in a hospital setting.

Table 1
Starters and Intermediate Links for Returned Folders[1]

Folder #	Gender[2]	Status[3]
1	F F F	SO SO SE
2	F F	SO SE
3	F M F	JU GR GR
4	M F	JU JU
5	F F F	SO SO SO
6	M M	JU JU
7	F F	JU JU
8	M	SO
9	F	FR
10	M F M	SE SE SE
11	F F	JU FA
12	M F F	JU JU ST
13	F M	SO FA
14	F M	SO FA
15	F M M M	SE SE SE FA
16	M M	SO FA

(a) The first listed individual for every folder received the folder directly from the researchers. The last individual handed it to the target. (b) F=female, M=male. (c) FR=freshman, SO= sophomore, JU=junior, SE=senior, GR=graduate student, ST=staff, FA=faculty

According to Hypothesis 1 we expected that folders starting with more senior students would reach the target. This was not entirely the case. Eighty-one percent of the completed folders were started by sophomores and juniors, but only 2 (13%) of the folders were started by seniors, leaving one completed folder started by a freshman. However it was the case that the upper-class students were more involved in the completed chains. Only one of the 37 starters or intermediate links was a freshman. This study was conducted during the second semester of the school year and may show the isolation of the freshmen.

Table 2 provides some confirmation that SW folders would stay within student groups until being passed to an administrator as suggested in Hypothesis 2. This table also shows the hierarchy of student communication links. No student ever passed a folder to a student in a lower class.

Table 2 also shows how folders converged on faculty, graduate students and staff. Given that 7 out of the 8 folders that reached these groups were passed directly to the target administrator, it is apparent that these groups felt more closely connected to the administration. However, according to Hypothesis 3, folders should have converged on these groups before reaching the target. This was not necessarily the case, as only 44% of the penultimate links were in these groups.

Table 2

Links Between Respondents and the Target[a]

from \to	FR	SO	JU	SE	GR	ST	FA	Target
FR	-	-	-	-	-	-	-	1
SO	-	3	-	2	-	-	3	2
JU	-	-	4	-	1	1	1	3
SE	-	-	-	4	-	-	1	3
GR	-	-	-	-	1	-	-	1
ST	-	-	-	-	-	-	-	1
FA	-	-	-	-	-	-	-	5

(a) FR=freshman, SO=sophomore, JU=junior, SE=senior, GR=grad, ST=staff, FA=faculty

This result shows the contradictory impacts of the barriers to communication stated in Hypothesis 2 and the efficiency of the organizational hierarchy for communication as stated in Hypothesis 3. That is, assuming that the student did not directly know the administrator, a student who wanted to get the folder to the administrator quickly would have been wise to pass to the faculty, graduate students or staff people who 88% of the time would pass the folder directly to the administrator. As shown in Table 1, in only two cases did the starter student pass the folder directly to the target administrator. However, since they were limited to those with whom they had several conversations, undergraduate students were unlikely to use this direct strategy and stayed mostly within their class until they could find an effective penultimate link.

Table 3
Movement of Folders By Gender
Among Undergraduates Only[a]

From \ To	Female	Male
Female	6	2
Male	3	2

(a) Not counting target

Homophilous ties were also expected to guide the folders as stated in Hypothesis 4. Looking only at folders passed **to and from undergraduates**, Table 3 shows that this homophilous tendency is especially pronounced among undergraduate women: 6 out of the 8 paths that originated from undergraduate female students went to other females. It was expected that crossing a boundary between classes or job categories would be more difficult, and this difficulty may lead to more homophily in boundary crossing. Table 4 shows that overall (including all job categories) women were more likely to pass folders within their gender, and the bottom panel shows that both sexes were more likely to pass folders across boundaries while keeping the folder within their gender. This is not an artifact of the distribution of sexes across boundaries. The undergraduate classes are evenly distributed in gender, the staff are overwhelming female, and while the majority of the faculty are male, there is a large minority of females.

Table 4
Movement of Folders Across Gender Groups for All Job Categories[a]

All Undergrads	Female	Male
Female	8	5
Male	4	4

Across Status Boundaries	Female	Male
Female	4	3
Male	0	2

(a) Link to target not counted

Discussion

The results, although extremely tentative due to the low response rate, were interesting. Students exhibited a hierarchy of communication with upper-class students never passing folders to lower-class students. Graduate students, staff, and faculty seemed to be much more closely tied to the administration as they overwhelmingly passed the folder directly to the administrator. However, undergraduate students were somewhat isolated from other groups as they passed folders within their own classes and infrequently passed folders to other groups such as the faculty who could deliver the folders directly to the administrator. Freshmen seemed particularly isolated, as only one of the 21 starter or intermediate links were freshmen. Women relied more on homophilous ties to pass folders compared to men.

The results are interesting, however certain compromises were made in the research methodology which weakened the results. In other SW studies, the intermediate respondents are asked to return a postcard describing themselves so that chains that do not reach the target can be analyzed. In this case, we decided not to try to attach postcards to the folder since the university lacked an internal mail system for undergraduates, and not including postcards would keep the complication and cost of the folder down. The tradeoff, however, was that we received much less information on the links between individuals in the chains of communication. One alternative that we considered was to interview the first and additional links of non-completed folders to trace the incomplete folders. Time constraints prevented us from implementing this strategy.

A more elaborate study with postcards for intermediate links would produce a richer data set that could be amenable to more sophisticated data analysis. The thrust of the class was to learn network concepts and methodologies rather than statistical techniques. If the instructor was willing to devote the time to teaching statistics, a richer data set could be used to compare the sequences produced by successful and unsuccessful chains (Abbott, 1990); Markov models could be used to model the transitions from one link to the next to determine the distance between groups (Hunter & Shotland, 1974); and logistic regression could be used to test which characteristics of the respondents affect the probability of forwarding to the administrator (Stevenson & Gilly, 1991) or crossing boundaries (Stevenson and Gilly, 1993).

Additional studies could produce many variations on this SW exercise. For example, different targets could be chosen across academic schools to determine how students would communicate across academic boundaries. The gulf between undergraduate and graduate students could be explored. The students could be given a problem to solve having to do with their life at the university and be asked to forward the folder to the person who could solve it in order to determine problem-solving networks. Many other variations on this basic technique are possible.

The study was successful in terms of a class project. Students were given the opportunity to develop network hypotheses and test them over the course of a semester. The study was relatively quick and very low cost and provided an introduction to the difficulties and promise of conducting network research.

REFERENCES

Abbott, Andrew. 1990. A Primer on Sequence Methods. *Organization Science* . 1:375-392.

Bochner, Stephen, Eloise A. Buker, and Beverly M. McLeod. 1976. "Communication Patterns in an International Student Dormitory: A Modification of the "Small World" Method." *Journal of Applied Social Psychology* . 6:275-290.

Hunter, John E. And R. Lance Shotland. 1974. "Treating Data Collected by the "Small World" Method as a Markov Process." *Social Forces* . 52:321-332.

Korte, Charles and Stanley Milgram. 1970. "Acquaintance Networks Between Racial Groups: Application of the Small World Method."*Journal of Personality and Social Psychology* . 15: 101-108.

Lin, Nan, Paul W. Dayton, and Peter Greenwald. 1978. "Analyzing the Instrumental Use of Relations in the Context of Social Structure." *Sociological Methods and Research* . 7:149-166.

Lundberg, Craig C. 1975. "Patterns of Acquaintanceship in Society and Complex Organization: A Comparative Study of the Small World Problem." *Pacific Sociological Review*. 18: 206-222.

Milgram, Stanley. 1967. "The Small World Problem." *Psychology Today*. 1: 61-67

Pool, Ithiel de Sola, and Manfred Kochen. 1978. "Contacts and Influence" *Social Networks* . 1: 5-51.

Stevenson, William B. And Mary C. Gilly. 1991. "Information Processing and Problem Solving: The Migration of Problems Through Formal Positions and Networks of Ties." *Academy of Management Journal*. 34:918-928.

Stevenson, William B. And Mary C. Gilly. 1993. "Problem-Solving Networks in Organizations: Intentional Design and Emergent Structure." *Social Science Research* . 22: 92-113.

Travers, Jeffrey, and Stanley Milgram. 1969. "An Experimental Study of the Small World Problem." *Sociometry* . 32:425-443.

Appendix

Small World Folder

March, 1996

Dear Fellow University Member,

How are you connected to the rest of the university? How could you reach someone that you don't know personally? We are interested in these questions and need your help in a study we are doing on social networks at the university. The object of the study is to trace how this letter is forwarded to reach a target individual. We hope that you can help us out. It is really simple to participate and won't take a lot of your time.

You have received this letter from a friend or acquaintance. All we ask is that you follow the instructions on the next page and forward this letter to someone who is more likely than you to reach the target individual.

John Doe, Associate Dean for Undergraduate Studies in the School of Management, has agreed to serve as the target person in this study. The goal of this study is to transmit this folder to John Doe using only a chain of friends and acquaintances.

If you have any questions, please contact me at ext. 1234. Thanks for helping us learn more about how the university is "connected"!

Sincerely,

William Stevenson
Associate Professor

HOW YOU CAN TAKE PART IN THIS STUDY

1. Add your name to the attached roster so that the next person who receives this letter will know who it came from.

2. If you have had several conversations with John Doe, deliver this folder directly to him.

3. If you do not know John Doe, **do not try** to contact him directly. Instead, **deliver this folder to someone you have had several conversations with outside the classroom, who is more likely than you to know John Doe**. (This person may be a faculty member, staff member, administrator or student.)

4. If you find yourself receiving a large number of these folders, please contact Dr. **_______** at ext. 1234.

ROSTER

		--- check all that apply ---		
Print Your Name on next available line below:	**Length of Time at University**	**University Affiliation**	**School**	**Sex**
1.____________________	____ years	__ Student __ Staff __ Faculty	__ SOM __ Other	__ Male __ Female
2.____________________	____ years	__ Student __ Staff __ Faculty	__ SOM __ Other	__ Male __ Female
3.____________________	____ years	__ Student __ Staff __ Faculty	__ SOM __ Other	__ Male __ Female
4.____________________	____ years	__ Student __ Staff	__ SOM __ Other	__ Male __ Female

		__ Faculty		
5.____________________	____ years	__ Student __ Staff __ Faculty	__ SOM __ Other	__ Male __ Female
6.____________________	____ years	__ Student __ Staff __ Faculty	__ SOM __ Other	__ Male __ Female
7.____________________	____ years	__ Student __ Staff __ Faculty	__ SOM __ Other	__ Male __ Female
8.____________________	____ years	__ Student __ Staff __ Faculty	__ SOM __ Other	__ Male __ Female
9.____________________	____ years	__ Student __ Staff __ Faculty	__ SOM __ Other	__ Male __ Female

Endnotes

1. We wish to thank Ray Luechtefeld and Juha Lehtinen for their help in conducting the study.
Please contact the first author with any comments or questions at 617-552-0458, email: stevenw@bc.edu

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Article

CONNECTIONS 20(2):34-55

A Dynamic Analysis of the Mexican Power Network (1)

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Introduction

We have undertaken the project to understand the configuration, function and role of the Mexican network of power. Previous studies have focused on the recruitment and education of Mexican political leaders and rulers (Camp 1980), the path of their political careers (Smith 1979), their technical skills (Centeno 1994), the creation of cliques (Camp 1990) and the development of networks as an instrument for delivering benefits to their constituents (González-Matinez, 1995). It is our objective here to examine the network's topology, function and centrality values.

In previous publications we have described the network's historical evolution (Schmidt and Gil 1994), the creation of cliques inside the network (Schmidt and Gil 1993), the control of the basic political functions in the political system with emphasis on presidential succession (Schmidt and Gil 1991), and the role the network plays in insuring political stability and controlling conflict (Schmidt and Gil 1995). At length, we were able to develop an index to analyze the centrality of actors and cliques (Gil and Schmidt 1996).

Although we have explored all these facets, our analyses have failed to investigate the dynamic changes that take place in the network. In previous articles we have analyzed the network as a whole, without assuming any changes. Even though the network retains the same function over time, its configuration undergoes modifications as a result of internal and external alterations, creating a cycle of mutually-determined variation: changes in the network affect the country, and changes in the country impact the network.

In this article we address the dynamic change of the network, assuming that the disappearance and inclusion of new actors changes the concentration of power. We consider disappearance to be fixed by date of death and inclusion of new actors to be marked by the time they became politically active. Both disappearance and inclusion occur continually, and in both cases the concentration of power changes because the disappearance of actors eliminates connections and the inclusion of actors creates different cliques, redefining centrality within and among cliques.

The information supporting this analysis is kept at REDMEX, a data base developed by the authors at Laboratorio de Gráficas, which is housed at the Institute for Applied Mathematics (IIMASS) located at the UNAM. The REDMEX data base currently contains about 5,400 entries detailing personal and political information on members of the Mexican government, including the executive, legislative (congress and senate), and judicial branches as well as officials of government-owned corporations and state governors. Each computer record contains sixteen indicators such as personal information (age, parents, spouse), education, political activities (political party membership), membership in social groups (e.g., labor unions, peasant organizations), elected positions, congressional positions, government positions, professional activities, academic positions, publications, membership in professional groups (e.g., Mexican Association of Computer Science), awards and decorations, international representations, and commissions (mostly refers to the military). The analysis for this paper takes into account the network's 37 core actors, who have played a central role in Mexican politics after the 1910 revolution, including all the presidents and some of the actors they and others, especially historians and political scientists, have described as influential. Our analysis of connectivity explains which of these actors influence political events -- mainly the control of the presidency -- and defines the cliques and their changing values. The dynamic approach shows the evolving values of cliques over time and the varying ways in which actors in different cliques intersect.

The Mexican Network

The Mexican network of power is a hypergraph. For this article we have analyzed only the core, which comprises 37 actors. We discovered that the network is actually a superimposition of structures, where an actor often belongs to various networks simultaneously. Figure 1 shows the hypothetical case where one politician belongs to four different networks.

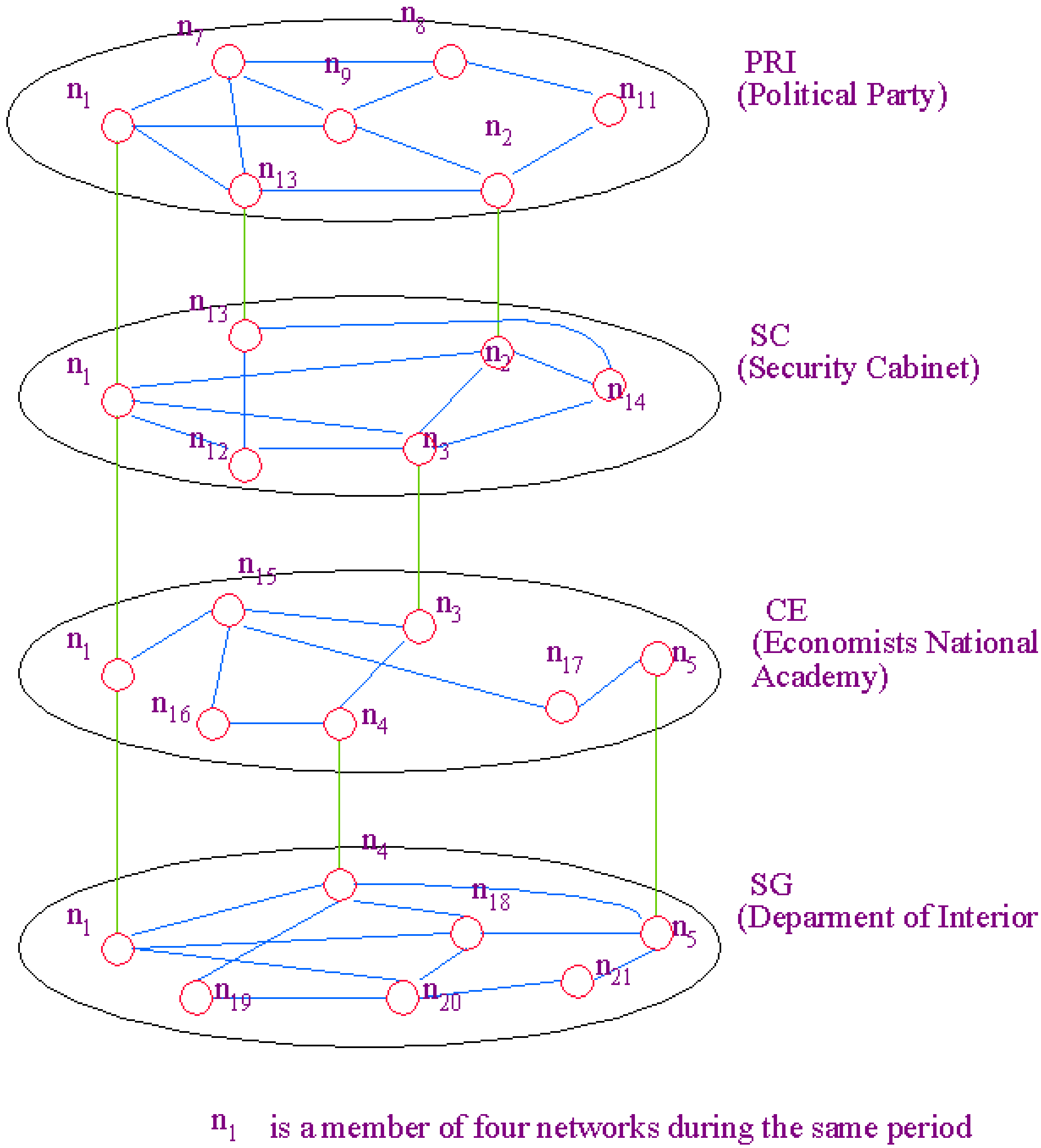


Figure 1. Superimposition of networks (associations). A hypothetical example.

In this hypothetical case, one actor belongs to the ruling PRI party, to the Department of the Interior (this department belongs to the national security cabinet, which is another network) and also to a professional association for economists.

A network is formed by dyads interconnected by links, representing formal, informal and organizational relationships. A network is the logical sum of networks or subnetworks. This can be summarized as:

$$N = N_1 \cup N_2 \cup \ldots \cup N_m$$

where N_j and N_k (for j not equal to k) may have common nodes.

Each group or subnetwork (N_j) represents the points of coincidence of a set of groups based on their common belonging (school, sports, business, political participation), or a common interest (political power). The group's bonding creates a distinctive sense of belonging which impacts the nature of the network.

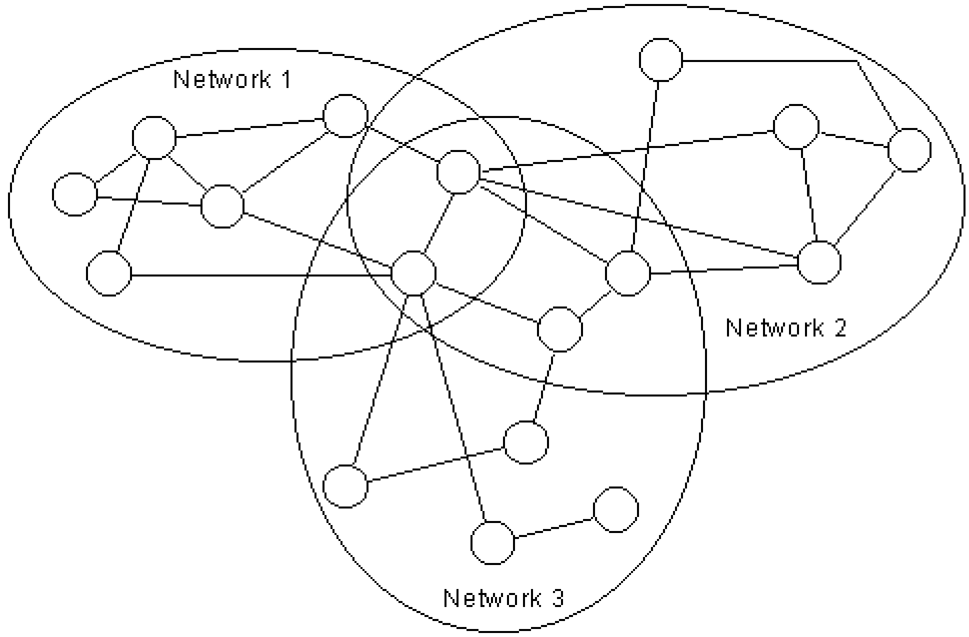


Figure 2. Intersection of networks.

The topology of a network shows the flow of information and pattern of relationships. Networks can be more or less centralized, and network analysis helps identify cliques, the number of connections, paths (shortest, longest), groups, factions, etc. A very centralized network usually shows cohesion and includes influential cliques.

The influence individuals have within the network is determined by their centrality, which results from participation, simultaneously or over time, in various networks. Individuals who participate in the intersection of networks (Fig. 2) have more influence because they become a central node with different resource mobilization capabilities (Schmidt and Gil 1995 and Gil and Schmidt 1996).

The Mexican Political System

The president is the most powerful actor in the network, due to constitutional and meta-constitutional attributes (Carpizo 1978, Schmidt 1991). In his career his power increases along with the creation of new connections and reaches its highest point when he becomes president; however, some actors, who eventually are placed in different network intersections, might have a higher power index and be active beyond any single presidential administration.

It is important for an actor to have connections with other cliques because the intersection of cliques facilitates the mobilization of multiple resources and can determine an actor's political career, even a solidifying a bid for the presidency, as we showed was the case of Ruiz Cortines, who became president in 1952 (Schmidt and Gil 1993). The intersections also explain the network's cohesion and why some groups remain in power for extended periods of time. Still, we have to assume that the disappearance of some actors and inclusion of others has to alter the intersections and redistribute influence and power.

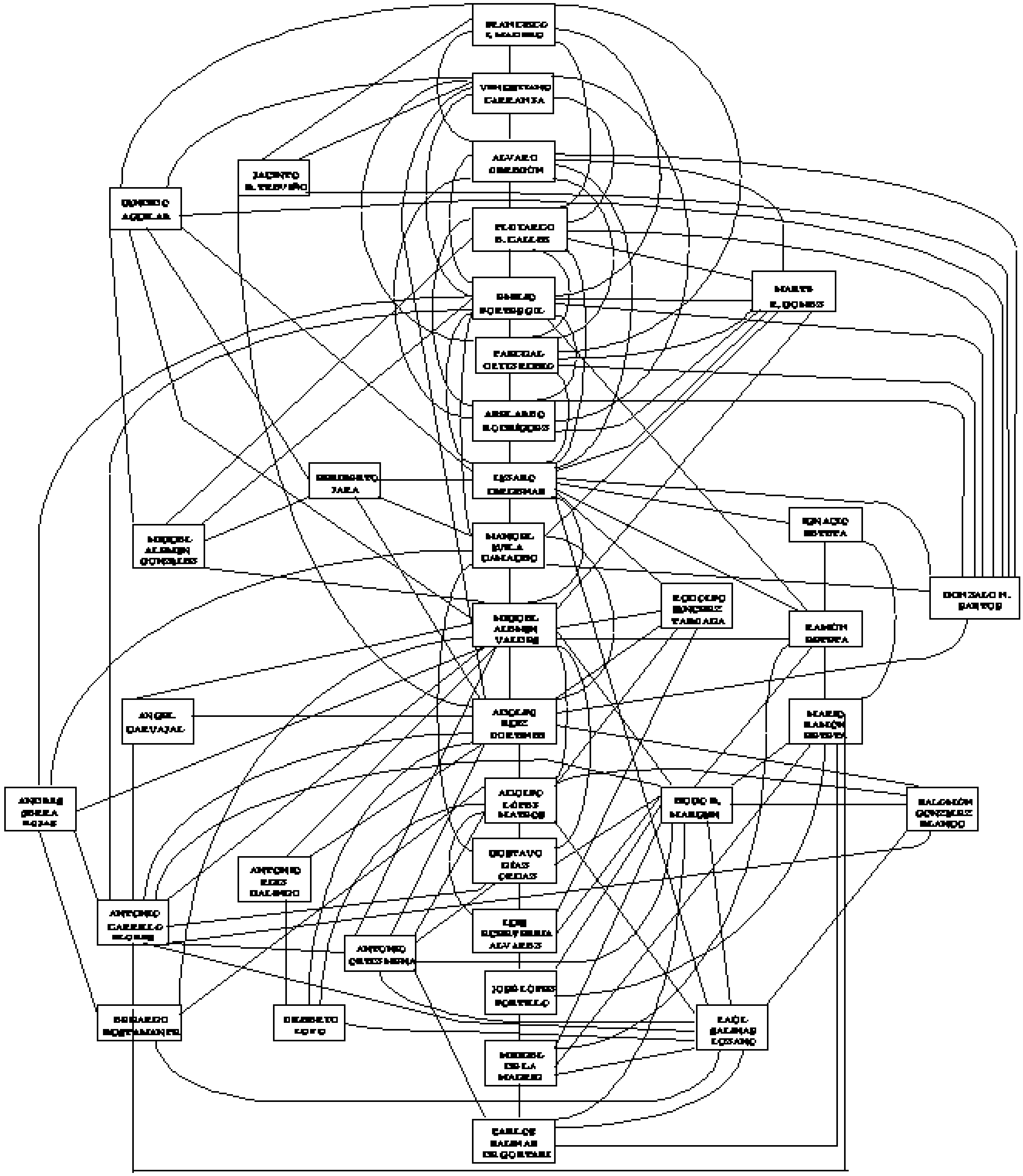


Figure 3. The core of the Mexican power network, 1920-1990.

The Dynamic Approach

In this article we analyze the changing nature of the power core by slicing its evolution into decade-long segments. The general figure includes all presidents since the 1910s up until 1994, a period in which we identify three generations. The first was involved in the 1910 revolution, was strongly connected to the revolutionary army (e.g., Cárdenas) and disappears around the 70s.

Table 1
Individual Centrality, 1920-1990

		1920-90*	1940	1950	1960	1970	1980	1990
1	Madero, Francisco	0,502						
2	Carranza, Venustiano	0,564						
3	Obregón, Alvaro	0,550						
22	Alemán González, Miguel	0,518						
4	Calles, Plutarco E.	0,564	0,657					
25	Sánchez Taboada, Rodolfo	0,548	0,583	0,591				
9	Avila Camacho, Manuel	0,601	0,722	0,705				
18	Aguilar, Cándido	0,561	0,602	0,583				
6	Ortiz Rubio, Pascual	0,550	0,657	0,568	0,540			
26	Beteta, Ramón	0,583	0,593	0,576	0,558			
7	Rodriguez, Abelardo L.	0,537	0,657	0,568	0,540			
23	Jara, Heriberto	0,529	0,611	0,583	0,514			
12	López Mateos, Adolfo	0,596		0,629	0,667			
8	Cárdenas, Lázaro	0,706	0,889	0,795	0,710			
19	Treviño, Jacinto B.	0,476	0,509	0,492	0,486	0,448		
33	Loyo Gilberto	0,482			0,536	0,504		
11	Ruiz Cortines, Adolfo	0,662	0,685	0,720	0,732	0,688		
20	Gómez, Marte R.	0,570	0,676	0,621	0,580	0,479		
21	Santos, Gonzalo N.	0,594	0,750	0,674	0,609	0,489		
5	Portes Gil, Emilio	0,654	0,741	0,652	0,645	0,546		
13	Díaz Ordaz, Gustavo	0,553		0,538	0,565	0,592		
30	Ruiz Galindo, Antonio	0,482		0,508	0,529	0,529	0,446	
10	Alemán Valdés, Miguel	0,737	0,722	0,795	0,761	0,742	0,738	
28	Carvajal, Angel	0,487		0,508	0,536	0,538	0,506	
31	Carrillo Flores, Antonio	0,623			0,688	0,742	0,738	
24	Beteta, Ignacio	0,469	0,519	0,477	0,446	0,353	0,417	
32	Bustamante, Eduardo	0,535		0,545	0,565	0,600	0,667	0,633
36	González Blanco, Salomón	0,518	0,472	0,508	0,551	0,583	0,583	0,583
29	Serra Rojas, Andrés	0,531	0,546	0,568	0,551	0,558	0,560	0,425
34	Ortiz Mena, Antonio	0,575			0,609	0,642	0,631	0,633
35	Margáin, Hugo B.	0,614				0,708	0,821	0,883
37	Salinas Lozano, Raúl	0,614	0,537	0,568	0,645	0,617	0,690	0,800
15	López Portillo, José	0,434				0,492	0,607	0,683
14	Echeverría Alvarez, Luis	0,480			0,438	0,475	0,512	0,558
27	Beteta, Mario Ramón	0,507				0,525	0,655	0,750
16	De la Madrid Hurtado, Miguel	0,493					0,607	0,733
17	Salinas de Gortari, Carlos	0,498						0,733

*This column shows the whole network values without any cuts. Source: Jorge Gil-Mendieta, S. Schmidt, J. Castro and A. Ruiz, REDMEX data base, 1997. Laboratorio de Gráficas, IIMAS-UNAM.

The second appears around the 1940s, has some family connection to the first generation (e.g., Miguel Alemán) and includes some actors who are still present today. The third generation enters the network between 1970 and

1980 and has family connections to the second generation (e.g., Carlos Salinas de Gortari)[(5)]. In the general graph (Figure 3, Table 1) the centrality index (I_n)[(6)] is higher for those with a direct role during the 1910 revolution and those having connections with them, but as we move along we will see an important distribution of values.

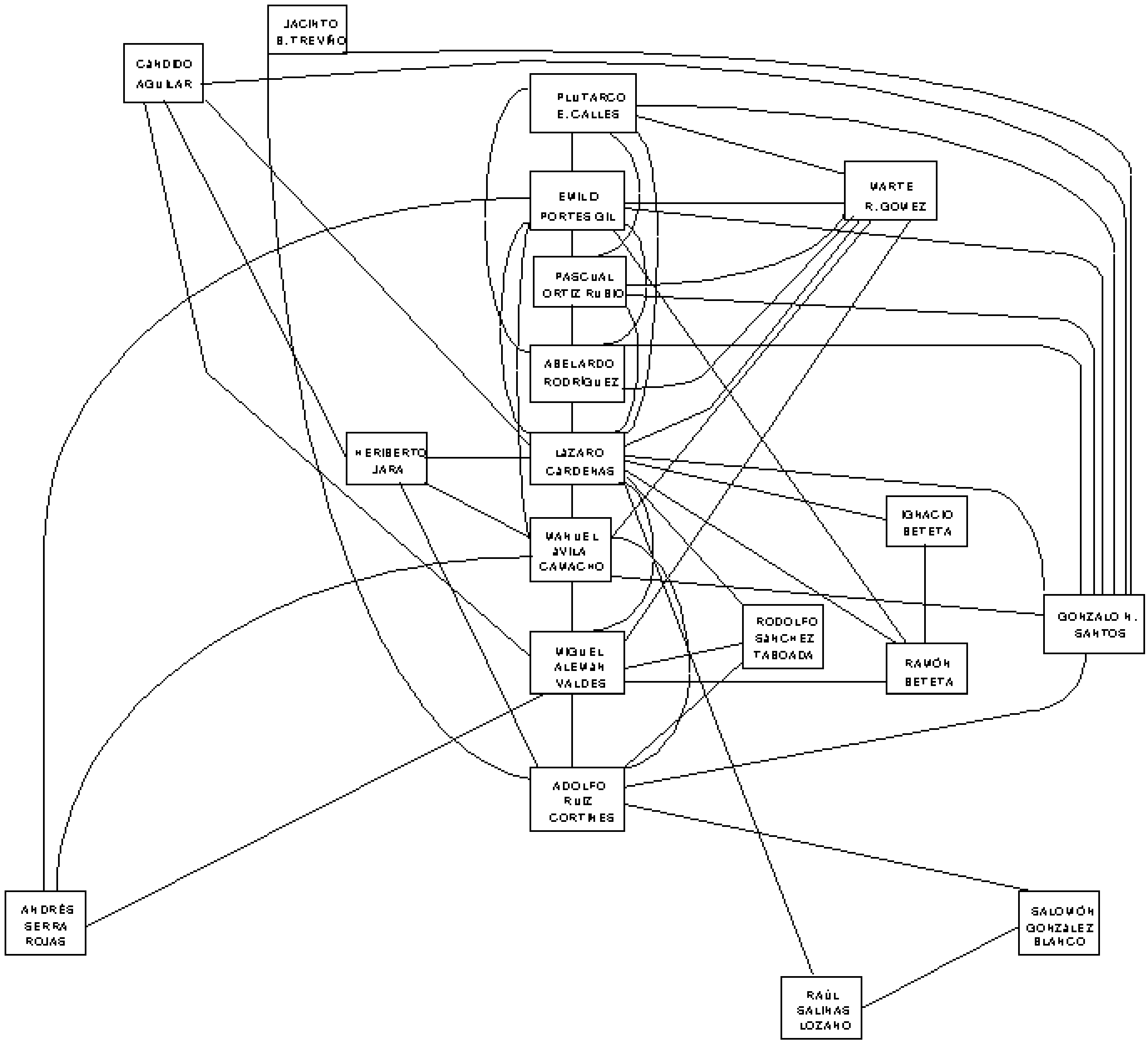


Figure 4. The Mexican power network, 1940.

Table 2
Individual Centrality, 1940

		# of Nodes at Distance ...			
Node	**Name**	**3**	**2**	**1**	**Centrality**
8	Cárdenas, Lázaro	0	4	14	0,889
21	Santos, Gonzalo N.	0	9	9	0,750
5	Portes Gil, Emilio	1	8	9	0,741

9	Avila Camacho, Manuel	0	10	8	0,722
10	Alemán Valdés, Miguel	0	10	8	0,722
11	Ruiz Cortines, Adolfo	1	10	7	0,685
20	Gómez, Marte R.	2	9	7	0,676
4	Calles, Plutarco E.	1	11	6	0,657
6	Ortiz Rubio, Pascual	1	11	6	0,657
7	Rodriguez, Abelardo L.	1	11	6	0,657
23	Jara, Heriberto	0	14	4	0,611
18	Aguilar, Cándido	1	13	4	0,602
26	Beteta, Ramón	2	12	4	0,593
25	Sánchez Taboada, Rodolfo	0	15	3	0,583
29	Serra Rojas, Andrés	4	11	3	0,546
37	Salinas Lozano, Raúl	2	14	2	0,537
24	Beteta, Ignacio	4	12	2	0,519
19	Treviño, Jacinto B.	5	11	2	0,509
36	González Blanco, Salomón	9	7	2	0,472

Table 3
Clique Centrality, 1940

	# of Nodes at Distance			
Clique	**3**	**2**	**1**	**Centrality**
5,8,9,21	0	1	14	0,967
4,5,6,7,8,21	0	1	12	0,962
5,8,26	0	2	14	0,938
8,10,18	0	2	14	0,938
8,10,25	0	2	14	0,938
8,10,26	0	2	14	0,938
8,18,21	0	2	14	0,938
8,9,23	0	2	14	0,938
5,8,9,20	0	2	13	0,933
8,9,10,20	0	2	13	0,933
8,18,23	0	3	13	0,906
9,11,21	0	3	13	0,906
4,5,6,7,8,20	0	3	10	0,885
9,10,11	0	5	11	0,844
11,19,21	0	5	11	0,844
9,11,23	0	6	10	0,813
10,11,25	0	6	10	0,813
5,9,29	0	6	10	0,813
9,10,29	0	7	9	0,781
8,24,26	0	8	8	0,750

We made the first cut in 1940, including two generations of politicians (Figure 4, Table 2). By 1940, actors {1, 2, 3, 22}[(7)] have already disappeared. In the tables starting in 1940 we have included the number of distances between the actors, and the proper I_n and I_c values. In this cut, the first generation has the highest I_n values, and they are in full control of the political system. All presidents are generals and built their network connections during the revolution. Some members of the second generation (Miguel Alemán, Raúl Salinas Lozano) intersect between cliques and generations, and their I_n values are high. In 1940, 19 actors had 20 cliques showing high clique centrality (I_C) values (see Table 3).

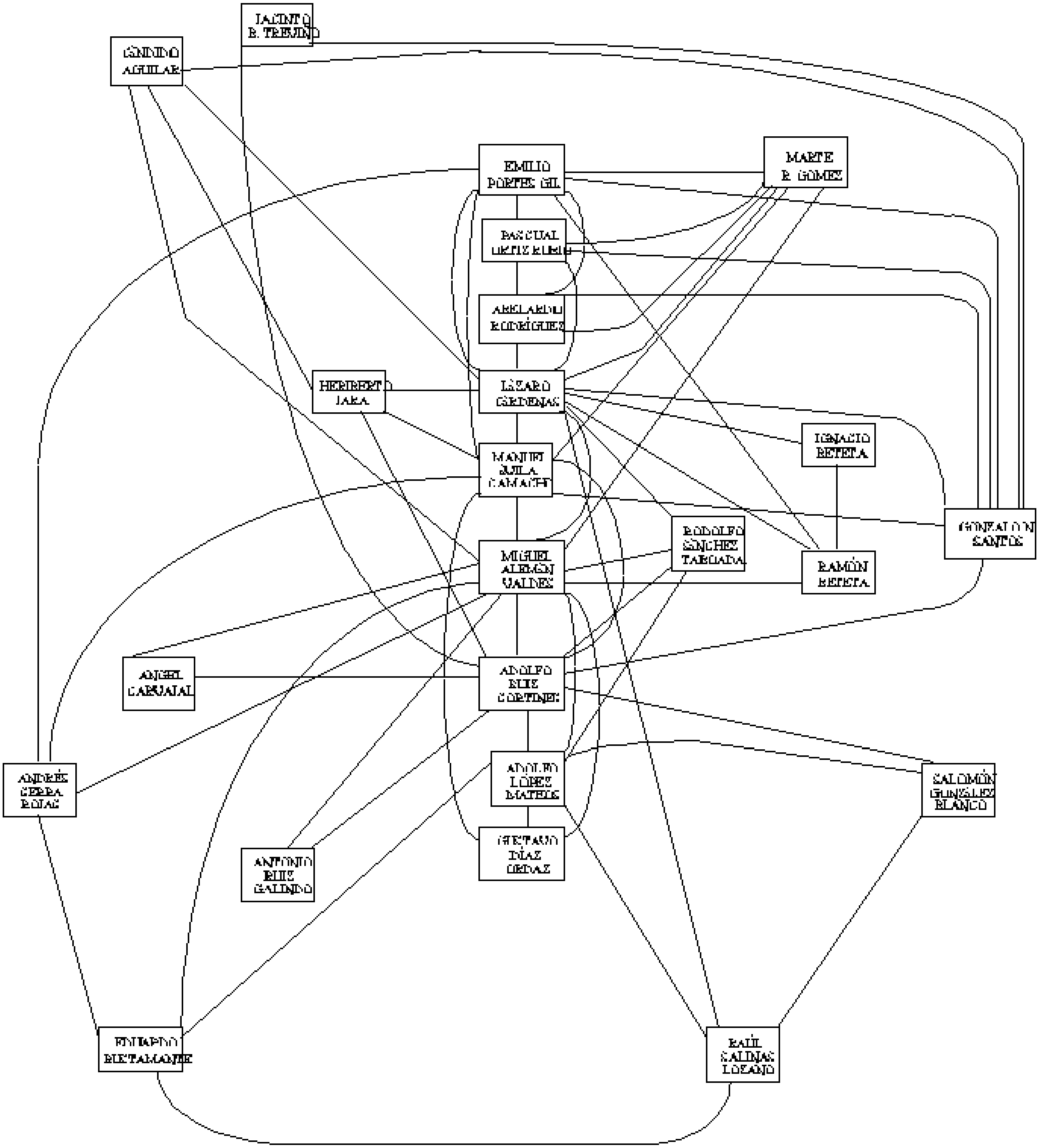


Figure 5. The Mexican power network, 1950.

Table 4
Individual Centralities, 1950

		# of Nodes at Distance ...	Centrality

Node	Name	3	2	1	In
8	Cárdenas, Lázaro	0	9	13	0,795
10	Alemán Valdés, Miguel	0	9	13	0,795
11	Ruiz Cortines, Adolfo	1	11	10	0,720
9	Avila Camacho, Manuel	0	13	9	0,705
21	Santos, Gonzalo N.	1	13	8	0,674
5	Portes Gil, Emilio	4	10	8	0,652
12	López Mateos, Adolfo	4	11	7	0,629
20	Gómez, Marte R.	2	14	6	0,621
25	Sánchez Taboada, Rodolfo	0	18	4	0,591
18	Aguilar, Cándido	1	17	4	0,583
23	Jara, Heriberto	1	17	4	0,583
26	Beteta, Ramón	2	16	4	0,576
6	Ortiz Rubio, Pascual	6	11	5	0,568
7	Rodriguez, Abelardo L.	6	11	5	0,568
29	Serra Rojas, Andrés	3	15	4	0,568
37	Salinas Lozano, Raúl	3	15	4	0,568
32	Bustamante, Eduardo	6	12	4	0,545
13	Díaz Ordaz, Gustavo	4	15	3	0,538
28	Carvajal, Angel	5	15	2	0,508
30	Ruiz Galindo, Antonio	5	15	2	0,508
36	González Blanco, Salomón	8	11	3	0,508
19	Treviño, Jacinto B.	7	13	2	0,492
24	Beteta, Ignacio	9	11	2	0,477

Table 5
Clique Centrality, 1950

	# of Nodes at Distance			
Clique	**3**	**2**	**1**	**Centrality**
8,10,18	0	2	18	0,950
8,10,25	0	2	18	0,950
8,10,26	0	2	18	0,950
8,9,10,20	0	2	17	0,947
9,10,11	0	4	16	0,900
9,11,21	0	4	16	0,900
10,11,12,25	0	4	15	0,895
10,11,28	0	5	15	0,875
10,11,30	0	5	15	0,875
5,8,9,21	0	5	14	0,868
8,9,23	0	6	14	0,850
9,11,23	0	6	14	0,850
9,10,13	0	6	14	0,850
9,10,29	0	6	14	0,850
5,8,9,20	0	6	13	0,842
5,6,7,8,21	0	6	12	0,833
8,18,21	0	7	13	0,825
11,19,21	0	7	13	0,825
10,12,32	0	7	13	0,825

10,12,13	0	7	13	0,825
10,29,32	0	7	13	0,825
5,8,26	0	8	12	0,800
8,18,23	0	8	12	0,800
5,6,7,8,20	0	8	10	0,778
8,24,26	0	9	11	0,775
5,9,29	0	9	11	0,775
11,12,36	1	8	11	0,767
12,32,37	0	13	7	0,675
12,36,37	0	14	6	0,650

In 1950, centrality starts moving to the second generation (Figure 5, Table 4). Members of the first generation are present with high I_n values (e.g., Adolfo Ruiz Cortines), but the second generation shows high I_n values (e.g., Adolfo López Mateos, who actually became president in 1958). In 1950, 23 actors had 29 cliques with I_c values (Table 5), so the network is very cohesive.

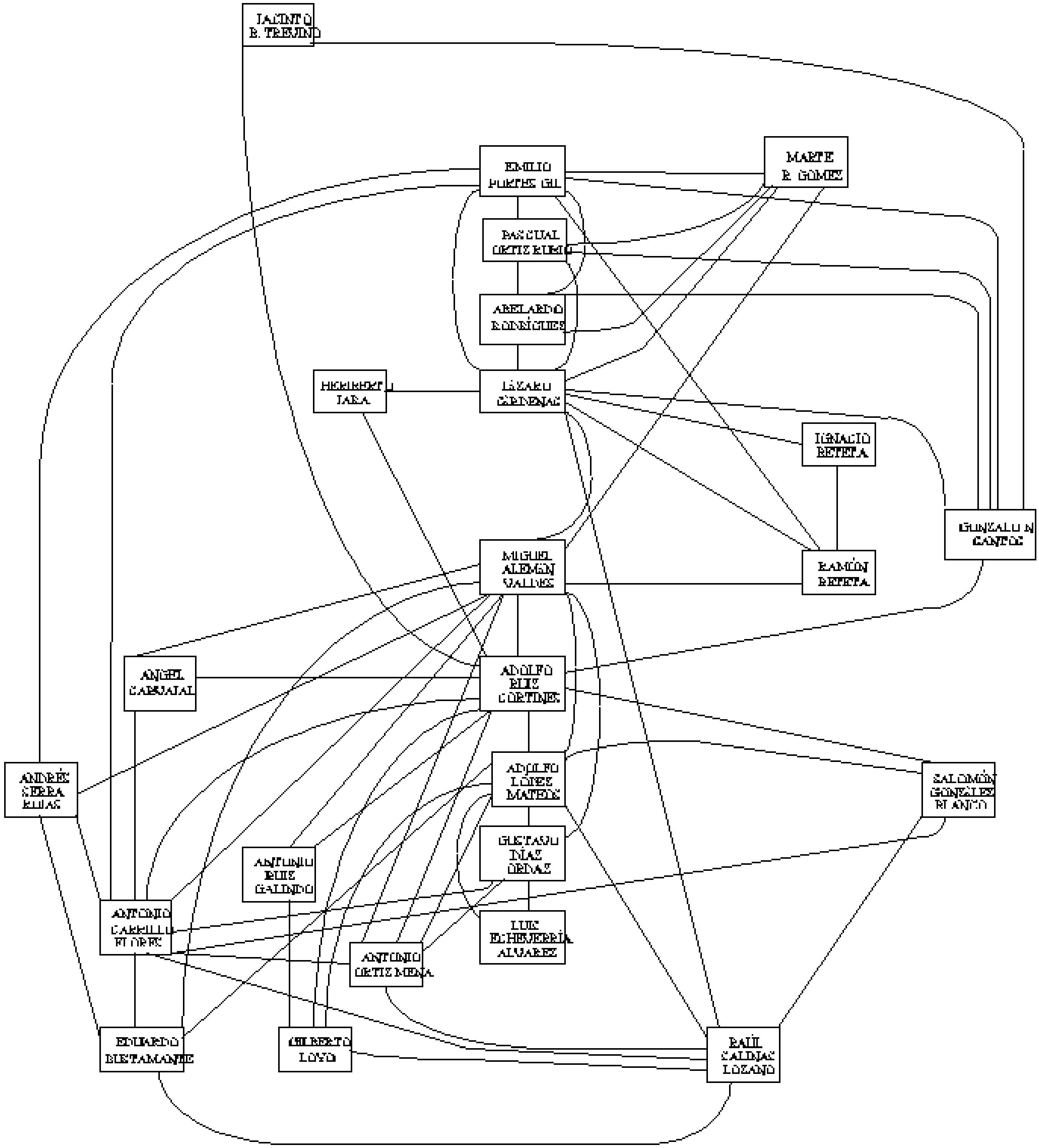


Figure 6. The Mexican power network, 1960.

By 1960, the revolutionary leaders start disappearing (Figure 6, Table 6) and the I_n values of some of them start to decrease. Heriberto Jara has a 0.611 in 1940 and 0.514 in 1960; Lázaro Cárdenas has a 0.889 in 1940 and 0.710 in 1960. The values for the second generation increase because they are already in power, even though the first generation still holds on to its influence. Twenty-four actors have 28 cliques and the I_c values (Table 7) of the second generation fall short of the I_c values of the first generation in 1940.

Table 6
Individual Centrality, 1960

		# of Nodes at Distance ...				
Node	Name	4	3	2	1	Centrality
10	Alemán Valdés, Miguel	0	0	11	12	0,761
11	Ruiz Cortines, Adolfo	0	1	11	11	0,732
8	Cárdenas, Lázaro	0	1	12	10	0,710
31	Carrillo Flores, Antonio	0	1	13	9	0,688
12	López Mateos, Adolfo	0	4	10	9	0,667
5	Portes Gil, Emilio	0	4	11	8	0,645
37	Salinas Lozano, Raúl	0	1	15	7	0,645
21	Santos, Gonzalo N.	0	3	14	6	0,609
34	Ortiz Mena, Antonio	0	3	14	6	0,609
20	Gómez, Marte R.	0	4	14	5	0,580
13	Díaz Ordaz, Gustavo	0	6	12	5	0,565
32	Bustamante, Eduardo	0	6	12	5	0,565
26	Beteta, Ramón	0	4	15	4	0,558
29	Serra Rojas, Andrés	0	5	14	4	0,551
36	González Blanco, Salomón	0	5	14	4	0,551
6	Ortiz Rubio, Pascual	1	8	9	5	0,540
7	Rodriguez, Abelardo L.	1	8	9	5	0,540
28	Carvajal, Angel	0	4	16	3	0,536
33	Loyo Gilberto	0	7	12	4	0,536
30	Ruiz Galindo, Antonio	0	5	15	3	0,529
23	Jara, Heriberto	0	4	17	2	0,514
19	Treviño, Jacinto B.	0	8	13	2	0,486
24	Beteta, Ignacio	1	12	8	2	0,446
14	Echeverría Alvarez, Luis	3	10	8	2	0,438

Table 7
Clique Centrality, 1960

	# of Nodes at Distance			
Clique	3	2	1	Centrality
8,10,20	0	4	17	0,905
8,10,26	0	4	17	0,905
10,11,28,31	0	4	16	0,900
10,11,31,34	0	4	16	0,900
10,11,12,34	0	4	16	0,900
10,11,30	0	6	15	0,857
10,12,32	0	7	14	0,833
5,29,31	0	7	14	0,833
10,13,31,34	0	7	13	0,825
10,12,13,34	0	7	13	0,825
11,19,21	0	8	13	0,810
11,12,33	0	8	13	0,810
11,12,36	1	7	13	0,802
11,31,36	1	7	13	0,802
10,29,31,32	0	8	12	0,800
31,36,37	0	10	11	0,762
31,32,37	0	10	11	0,762

31,34,37	0	10	11	0,762
5,6,7,8,21	1	8	10	0,754
12,33,37	0	11	10	0,738
12,32,37	0	11	10	0,738
5,8,26	1	10	10	0,730
11,30,33	1	10	10	0,730
12,36,37	0	12	9	0,714
12,34,37	0	12	9	0,714
5,6,7,8,20	1	10	8	0,702
8,24,26	1	12	8	0,683
12,13,14	3	10	8	0,667

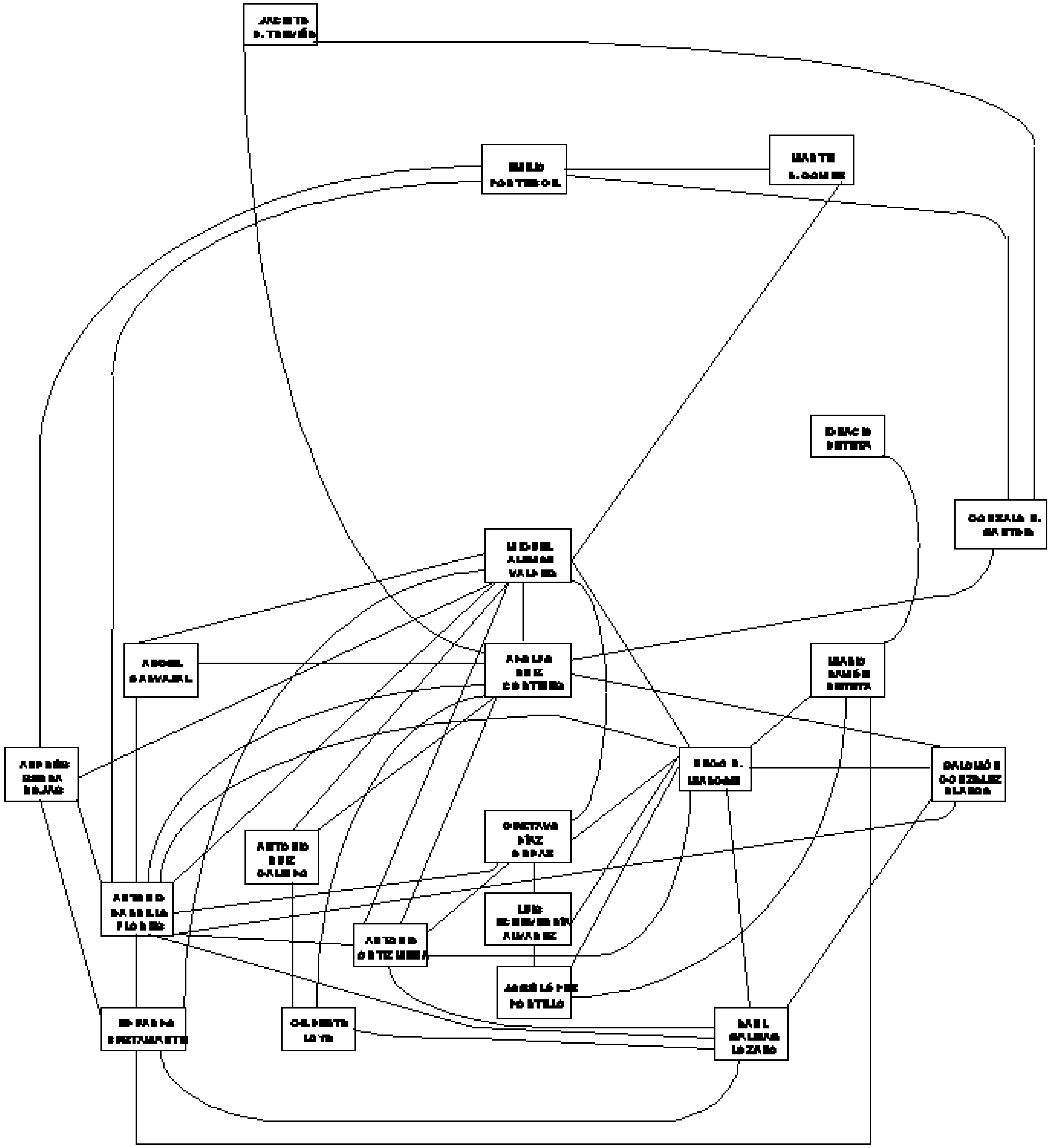


Figure 7. The Mexican power network, 1970.

By 1970, only a few members of the first generation (Figure 7) are alive, and their I_n values are low (Table 8). The values for the second generation continue to increase, but not to the extent of reaching the first generation levels. In 1970, 21 actors have 15 cliques with low I_c values (Table 9) in comparison to the previous decade. Hypothetically, we can assume that the network started losing cohesion.

Table 8
Individual Centrality, 1970

		# of Nodes at Distance ...	

Node	Name	5	4	3	2	1	Centrality
10	Alemán Valdés, Miguel	0	0	1	9	10	0,742
31	Carrillo Flores, Antonio	0	0	1	9	10	0,742
35	Margáin, Hugo B.	0	0	2	9	9	0,708
11	Ruiz Cortines, Adolfo	0	1	3	7	9	0,688
34	Ortiz Mena, Antonio	0	0	1	13	6	0,642
37	Salinas Lozano, Raúl	0	0	4	10	6	0,617
32	Bustamante, Eduardo	0	0	3	12	5	0,600
13	Díaz Ordaz, Gustavo	0	0	4	11	5	0,592
36	González Blanco, Salomón	0	0	2	14	4	0,583
29	Serra Rojas, Andrés	0	0	5	11	4	0,558
5	Portes Gil, Emilio	0	1	5	10	4	0,546
28	Carvajal, Angel	0	1	3	13	3	0,538
30	Ruiz Galindo, Antonio	0	1	4	12	3	0,529
27	Beteta, Mario Ramón	0	2	6	8	4	0,525
33	Loyo Gilberto	0	1	7	9	3	0,504
15	López Portillo, José	0	2	7	8	3	0,492
21	Santos, Gonzalo N.	1	3	4	9	3	0,489
20	Gómez, Marte R.	0	1	7	10	2	0,479
14	Echeverría Alvarez, Luis	0	2	9	6	3	0,475
19	Treviño, Jacinto B.	1	3	6	8	2	0,448
24	Beteta, Ignacio	2	6	8	3	1	0,353

Table 9
Clique Centrality, 1970

	# of Nodes at Distance ...					
Clique	**5**	**4**	**3**	**2**	**1**	**Centrality**
10,13,31,34,35	0	0	0	4	12	0.875
10,11,31,34	0	0	1	3	13	0.873
31,35,36,37	0	0	0	5	12	0.853
31,34,35,37	0	0	0	5	12	0.853
10,11,28,31	0	0	1	2	13	0.843
11,31,36	0	0	1	5	12	0.824
10,11,30	0	0	1	5	12	0.824
10,29,31,32	0	0	0	6	11	0.824
31,32,37	0	0	0	7	11	0.806
5,29,31	0	0	1	6	11	0.796
11,19,21	0	0	1	6	10	0.741
15,27,35	0	0	2	7	9	0.731
11,30,33	0	1	3	6	8	0.681
14,15,35	0	0	2	9	7	0.676
13,14,35	0	0	2	9	7	0.676

By 1980, some members of the third generation (Salinas) enter the network (Figure 8). The I_n values of some of the oldest members of the second generation (Miguel Alemán) start decreasing, even though the members of the second generation don't reach high values (Table 10). In 1980, the number of actors in the network's core decreases to 15, and the same happens to the number of cliques, which drops to 9 (Table 11). The number of intersections is also diminishing, reducing the number of influential actors.

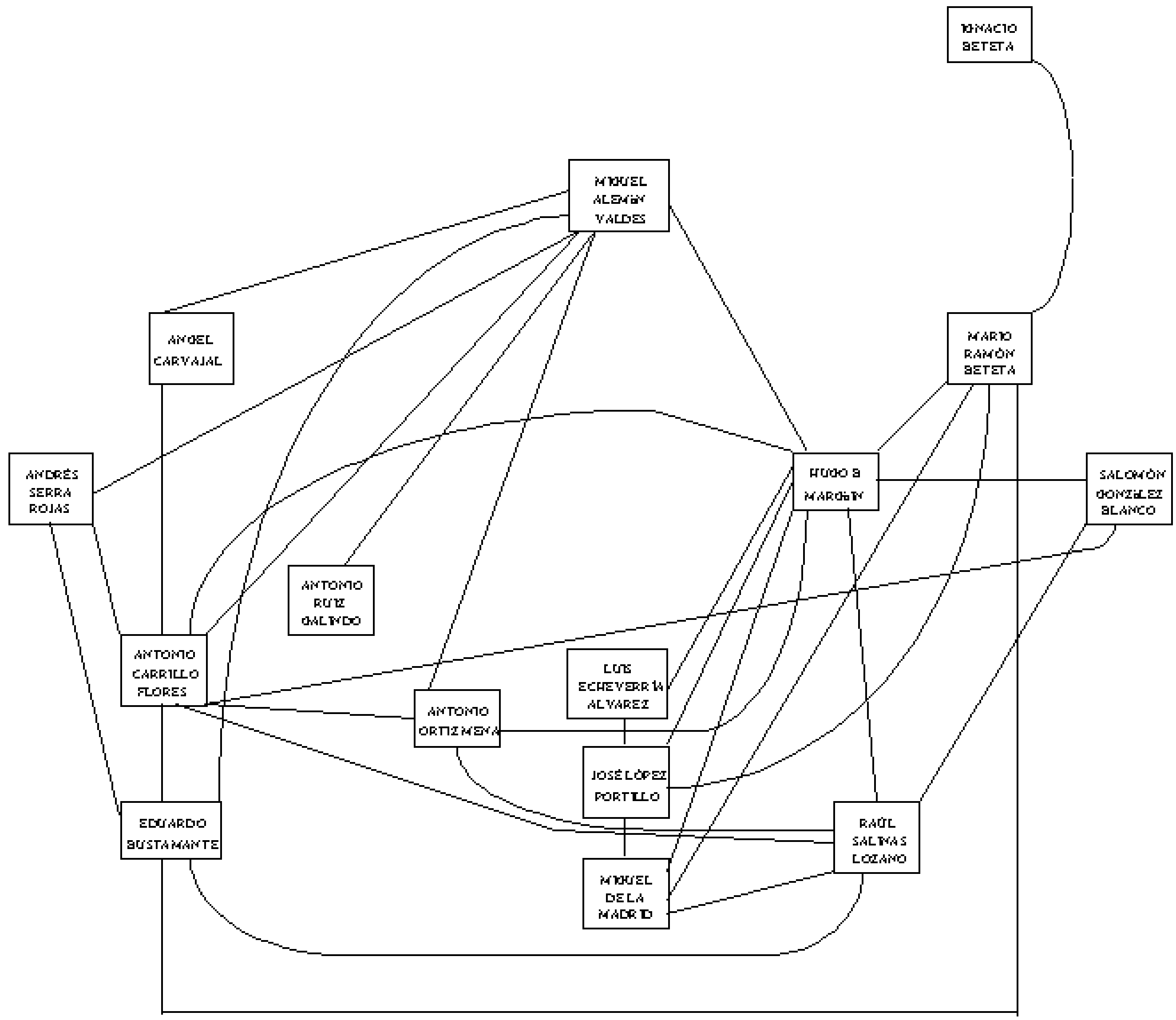


Figure 8. The Mexican power network, 1980.

Table 10
Individual Centrality, 1980

		# of Nodes at Distance ...				
Node	**Name**	**4**	**3**	**2**	**1**	**Centrality**
35	Margáin, Hugo B.	0	0	5	9	0,821
31	Carrillo Flores, Antonio	0	1	6	7	0,738
10	Alemán Valdés, Miguel	0	1	6	7	0,738
37	Salinas Lozano, Raúl	0	2	6	6	0,690
32	Bustamante, Eduardo	0	1	8	5	0,667
27	Beteta, Mario Ramón	0	2	7	5	0,655
34	Ortiz Mena, Antonio	0	1	9	4	0,631
16	De la Madrid Hurtado, Miguel	0	3	7	4	0,607
15	López Portillo, José	0	3	7	4	0,607
36	González Blanco, Salomón	0	2	9	3	0,583
29	Serra Rojas, Andrés	0	4	7	3	0,560

14	Echeverría Alvarez, Luis	0	5	7	2	0,512
28	Carvajal, Angel	1	4	7	2	0,506
30	Ruiz Galindo, Antonio	1	6	6	1	0,446
24	Beteta, Ignacio	2	7	4	1	0,417

Table 11
Clique Centrality, 1980

	# of Nodes at Distance			
Clique	**3**	**2**	**1**	**Centrality**
10,31,34,35	0	1	10	0,955
31,34,35,37	0	2	9	0,909
31,35,36,37	0	2	9	0,909
15,16,27,35	0	3	8	0,864
16,35,37	0	4	8	0,833
31,32,37	0	4	8	0,833
10,29,31,32	0	4	7	0,818
14,15,35	0	5	7	0,792
10,28,31	1	4	7	0,778

By 1990, the disappearance of the old politicians is complete, and the third generation is in power (Figure 9). The I_n values of actors (Table 12) who intersected cliques and generations are high (Raúl Salinas Lozano 0.800, Hugo B. Margáin 0.883), and new actors are attaining high ratings (Carlos Salinas 0.733). It is interesting, though, that while we made the cut in the middle of the Salinas administration, he did not have the highest I_n value among the members of the core and he did not reach the levels achieved by other actors in the 40s, 50s and 60s. The 11 actors had 6 cliques, most of them with high I_c values (Table 13), which suggests a small but cohesive group.

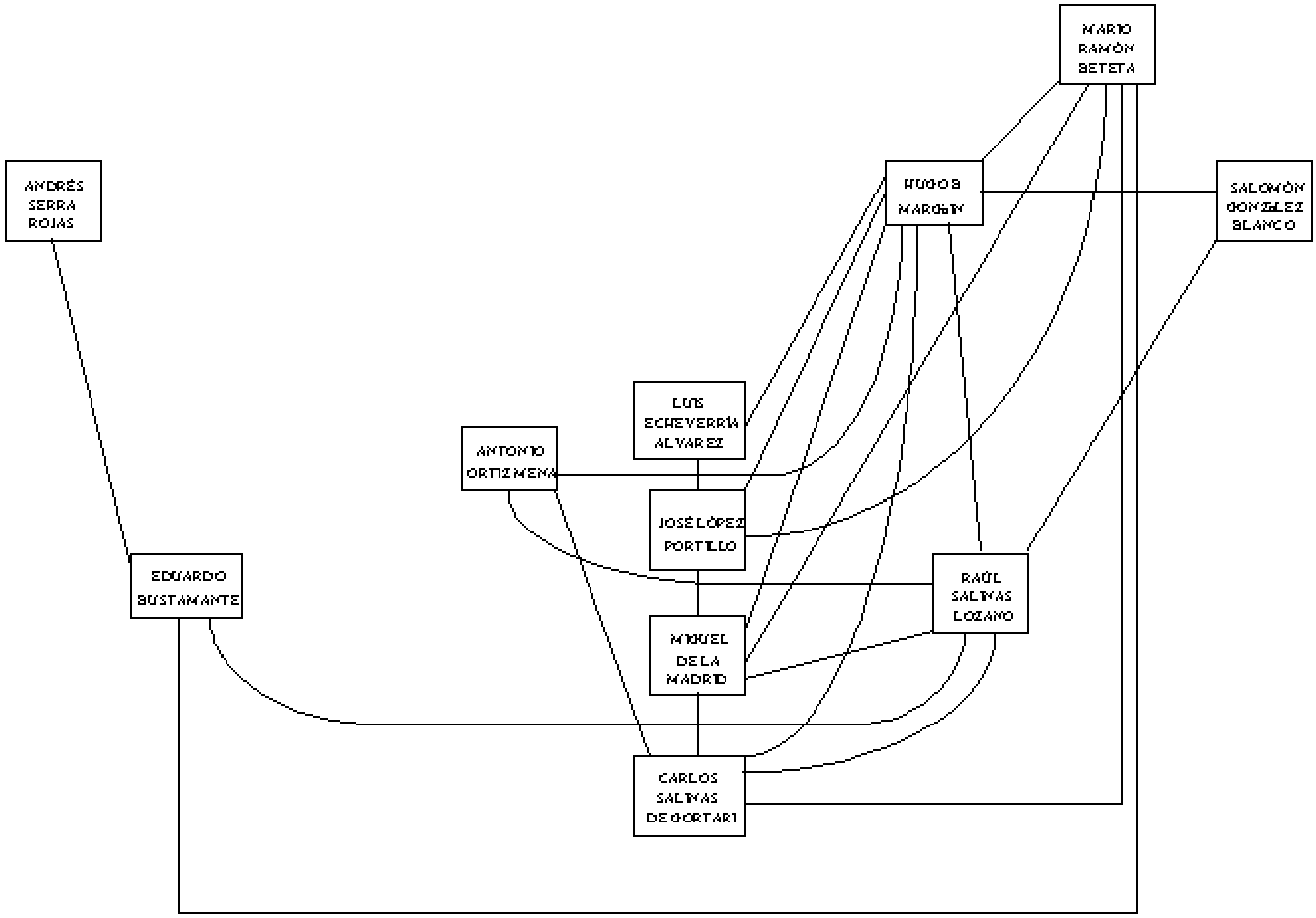


Figure 9. The Mexican power network, 1990.

Table 12
Individual Centrality, 1990

		# of Nodes at Distance				
Node	**Name**	**4**	**3**	**2**	**1**	**Centrality**
35	Margáin, Hugo B.	0	1	1	8	0,883
37	Salinas Lozano, Raúl	0	0	4	6	0,800
27	Beteta, Mario Ramón	0	0	5	5	0,750
16	De la Madrid Hurtado, Miguel	0	1	4	5	0,733
17	Salinas de Gortari, Carlos	0	1	4	5	0,733
15	López Portillo, José	0	1	5	4	0,683
32	Bustamante, Eduardo	0	1	6	3	0,633
34	Ortiz Mena, Antonio	0	1	6	3	0,633
36	González Blanco, Salomón	0	1	7	2	0,583
14	Echeverría Alvarez, Luis	1	1	6	2	0,558
29	Serra Rojas, Andrés	1	6	2	1	0,425

Table 13
Clique Centrality, 1990

	# of Nodes	

	at Distance			
Clique	3	2	1	Centrality
35,36,37	0	1	7	0,938
16,17,27,35	0	1	6	0,929
16,17,35,37	0	1	6	0,929
15,16,27,35	0	1	6	0,929
17,34,35,37	0	1	6	0,929
14,15,35	1	1	6	0,854

The analysis of cliques shows a trend, where the first generation had strong connectivity peaking in 1950. Connectivity for the second generation seems to be lower, and for the third higher, but the size of the network in general was constantly shrinking (Table 14).

Table 14
Clique Centrality, 1940-1990

1940		1950		1960		1970		1980		1990	
Clique	Cent.	Clique	Cent	Clique	Cent	Clique	Cent	Clique	Cent	Clique	Cent
5,8,9,21	0,967	5,8,9,21	0,868	5,6,7,8,21	0,754	11,19,21	0,681	10,28,31	0,778	35,36,37	0,938
4,5,6,7,8,21	0,962	5,6,7,8,21	0,833	5,8,26	0,730	10,11,28,31	0,843	10,29,31,32	0,818	17,34,35,37	0,929
5,8,26	0,938	5,8,26	0,800	8,10,26	0,905	10,11,30	0,824	10,31,34,35	0,955	15,16,27,35	0,929
8,10,18	0,938	8,10,18	0,950	8,10,20	0,905	10,29,31,32	0,824	31,35,36,37	0,909	14,15,35	0,854
8,10,25	0,938	8,10,25	0,950	5,6,7,8,20	0,702	10,11,31,34	0,873	31,32,37	0,833	16,17,27,35	0,929
8,10,26	0,938	8,10,26	0,950	11,19,21	0,810	5,29,31	0,796	31,34,35,37	0,909	16,17,35,37	0,929
8,18,21	0,938	8,18,21	0,825	8,24,26	0,683	10,13,31,34,35	0,875	15,16,27,35	0,864		
8,9,23	0,938	8,9,23	0,850	10,11,28,31	0,900	11,31,36	0,824	14,15,35	0,792		
5,8,9,20	0,933	5,8,9,20	0,842	10,11,30	0,857	31,35,36,37	0,853	16,35,37	0,833		
8,9,10,20	0,933	8,9,10,20	0,947	10,12,32	0,833	31,32,37	0,806				
8,18,23	0,906	8,18,23	0,800	10,12,13,34	0,825	31,34,35,37	0,853				
9,11,21	0,906	9,11,21	0,900	10,29,31,32	0,800	11,30,33	0,681				
4,5,6,7,8,20	0,885	5,6,7,8,20	0,778	11,12,36	0,802	15,27,35	0,731				
9,10,11	0,844	9,10,11	0,900	12,32,37	0,738	14,15,35	0,676				
11,19,21	0,844	11,19,21	0,825	12,36,37	0,714	13,14,35	0,676				
9,11,23	0,813	9,11,23	0,850	10,11,31,34	0,900						
10,11,25	0,813	10,11,12,25	0,895	10,11,12,34	0,900						
5,9,29	0,813	5,9,29	0,775	5,29,31	0,833						
9,10,29	0,781	9,10,29	0,850	10,13,31,34	0,825						
8,24,26	0,750	8,24,26	0,775	11,12,33	0,810						
		10,11,28	0,875	11,31,36	0,802						
		10,11,30	0,875	31,36,37	0,762						
		9,10,13	0,850	31,32,37	0,762						
		10,12,32	0,825	31,34,37	0,762						
		10,12,13	0,825	12,33,37	0,738						
		10,29,32	0,825	11,30,33	0,730						
		11,12,36	0,767	12,34,37	0,714						
		12,32,37	0,675	12,13,14	0,667						
		12,36,37	0,650								

Diminishing values in both indexes show a network losing cohesiveness, and the waning number of influential actors suggests less inclusion of new actors. These two trends explain many of the events that occurred in Mexico during the 90's: political assassination, political instability and turbulence and the end of political monopoly via opposition victories.

Conclusion

The Mexican network of power has played an important role in bringing about political stability due to many intersections that have helped transfer and mobilize political resources. Among the three generations of politicians identified in our research, the first had more connections, which can be politically relevant because it shows more cohesion and integration of the political elite producing political stability. As time progresses, In values (Table 1) and Ic values (Table 14) decrease, resulting in less integration and cohesion. Beginning in the late 80s the opposition parties began winning elections. In 1994, both the presidential candidate and the secretary general of the ruling PRI were killed, and since then an exodus of party members has begun.

The In shows that contemporary leaders, mainly in the 70s never reach high values, with the exception of Hugo B. Margáin and Raúl Salinas Lozano, who happen to be at the intersection of cliques and generations and became very influential. In fact, Raul Salinas's son became president in 1988.

The cut-off line for the exchange of values happened during the period 1970-80, when most of the revolutionary leadership finally disappeared. Something interesting is that some of the presidents from 1970 to 1990 do not have the highest In values, not even when we made five year cuts to be close to their administration, which suggests a weakening of their role[(8)].

By including and excluding actors, we discovered that a generation of actors disappeared in the 70s, and this coincides with a change in the whole political scene in Mexican politics. The type of politicians in power changed from the politicos with political experience and connections to the revolutionary leaders to bureaucrats (Schmidt 1991) who built political careers through the bureaucracy and accomplishments at school. This can be one of the most important indicators for political change in Mexico; moreover, political change in Mexico shows less cohesion and less political stability, much of which has to do with the weakening of the network of power.

Bibliography

Camp, Roderic. 1980. Mexico's Leaders: Their Education and Recruitment. Tucson: The University of Arizona Press.

__________. 1990. "Camarillas in Mexican Politics: The Case of the Salinas Cabinet." Mexican Studies, 6(1) Winter.

Carpizo, Jorge. 1978. El Presidencialismo Mexicano. México, D.F.: Siglo XXI.

Centeno, Miguel Angel. 1994. Democracy Within Reason. Technocratic Revolution in Mexico. University Park: The Pennsylvania State University Press.

Gil, J. and Schmidt, S. 1996. The Mexican Network of Power. Social Networks. No. 18.

Harary, Frank. 1969. Graph Theory. New York: Addison-Wesley.

Schmidt, S. and Gil, J. 1994. La red de poder en México. Este País, No. 44, Nov.

__________________. 1993. La Red de Poder Mexicana: El Caso de Miguel Alemán, Revista Mexicana de Sociología. No. 3, 103-117.

__________________. 1991. La carrera por la presidencia de México. Review of Latin American Studies, 3:2. pp. 197-233.

__________________. 1995. The Political Network in Mexico: Between Conflict and Stability. LASA XIX International Congress, Washington, D.C. September 28-30,

Schmidt, Samuel. 1991. The Deterioration of the Mexican Presidency, University of Arizona Press, Fall 1991.

Smith, Peter. l979. Labyrinths of Power: Political Recruitment in Twentieth Century Mexico. Princeton: Princeton University Press.

Appendix A. Technical note on the I_n and I_c Measures

Individual Centrality, I_n

The distance between two actors is the number of connections one actor has to follow to link to another. A very dense network reflects a cohesive network showing a high frequency of distances one and two.

The individual centrality measure is calculated as follows:

$$I_n = \frac{1}{N-1}\left(N_{d1} + \frac{1}{2}N_{d2} + \ldots + \frac{1}{m}N_{dm}\right)$$

where:

I_n is the centrality of node n

N_{dm} is the number of nodes at distance *m* from node *n*

$N = N_{d1} + N_{d2} + \ldots + N_{dm}$

Clique Centrality, I_c

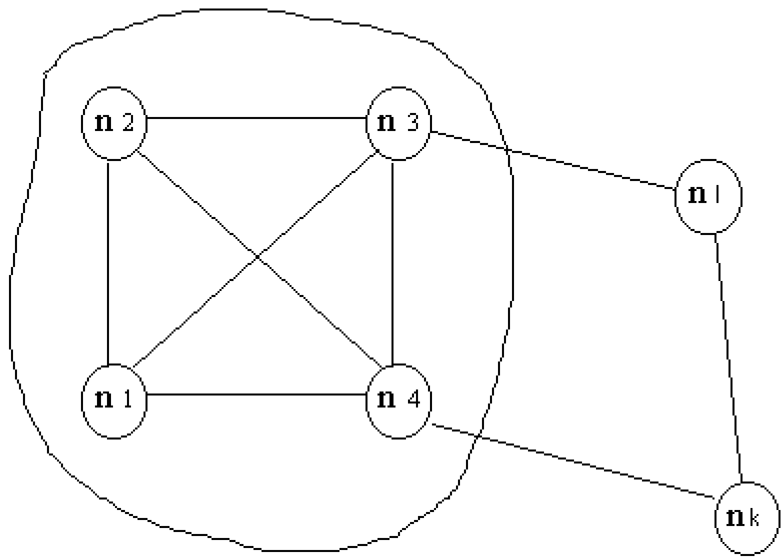
The clique centrality index represents the relative centrality of a group of nodes in a network, and it seems to be an excellent way to evaluate the power of each clique and its real power distribution in different times. It is defined as follows:

$$I_c = \frac{1}{N - N_c}\left(N_{c1} + \frac{1}{2}N_{c2} + \ldots + \frac{1}{m}N_{cm}\right)$$

where:

- I_c is the centrality of clique *c*
- N_{cm} is the number of nodes at distance *m* from clique *c*
- N_c is the number of nodes in the clique
- N is the number of nodes in the network

The distances between nodes belonging to the clique and those outside could be one or more (i.e.: two, three, ..., etc.), but we should take the minimum. For example:



Appendix Figure 1.

The distances from nodes 1, 2, 3, and 4 (all members of the clique) to node n_l are {2, 2, 1, 1} respectively. The minimum of all these distances is 1, therefore the distance from the clique as a whole to the node is defined to be 1.

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5. Some actors from the third generation (e.g., Salinas) have family connections to the first generation, but this is the exception and not the rule.

6. See Appendix A for an explanation of the In and Ic indexes.

7. The numbers assigned to each actor are arbitrary.

8. This was defined by Schmidt (1991) as the deterioration of the Mexican presidency.