

students in higher education; and Institutional members include libraries, museums, and other educational institutions. The main criterion for membership is a professional or scholarly interest in the study of social networks. Members must also pay dues.

Although most members are American social scientists, the INSNA serves the international community (members come from about 80 countries), and is multidisciplinary, covering anthropology, biology, business and management, communication science, economics, geography, political science, mathematics, statistics, psychology, social work, sociology, computer science, and other academic disciplines. In recent years, membership applications from management and communication fields have increased, whereas those in anthropology and psychology have declined. Members in some academic fields have founded their own professional associations based on the INSNA model, such as the International Association for Relationship Research, which has its own conferences, journals, and newsletters.

The INSNA is governed by a board of directors, officers, committees, and bylaws. The board of directors consists of an elected president, vice-president, past president, treasurer, and other members. Their duties include managing the INSNA's general affairs, including assets, budget, membership applications, and dues; establishing rules, procedures, and policies; and overseeing the appointment of committees and nonelected positions. Officers are either elected by members or appointed by the board, and serve a three-year term of service. The organization also includes committees for awards, conferences, finances, publications, and the Web. The activities of the INSNA are summarized in its annual meeting, annual report, and annual audit of financial records.

Despite its position as the flagship association in presenting social network analysis, the ISNA's membership numbers remain small. In 1977 the Association began with approximately 175 members, increasing to about 300 within two years. Today, the membership consists of more than 1,500 individual members. The INSNA is comparatively young and has come a long way in a short time. Increasing interest in social network analysis means that the association will continue to grow and develop.

Gareth Davey  
Hong Kong Shue Yan University

**See Also:** History of Social Networks 1976–1999; Mailing Lists; Network Analysis Software; Newsletters; Nonprofit Organizations; Scholar Networks; Special Operations Community Network (SOCNET).

### Further Readings

Freeman, Linton. *The Development of Social Network Analysis: A Study in the Sociology of Science*. Vancouver: Empirical Press, 2004.

International Network for Social Network Analysis. <http://www.insna.org> (Accessed September 2010).

Mullins, Nicholas. *Theories and Theory Groups in Contemporary American Sociology*. New York: Harper and Row, 1973.

Wellman, Barry. "Networking Network Analysts: How INSNA (the International Network for Social Network Analysis) Came to Be." *Connections*, v.23/1 (Summer 2000).

---

## International Networks

The application of network-analytical methods, when applied to the study of international relations, examines the origins, characteristics, theoretical frameworks, and method choices. Several studies originate from the world-systems perspective, including a series of studies that demonstrate chronological developments in methods and data handling. This perspective applies a rather strict definition of international relations—that is, where nation-states constitute the actors in networks.

Whether manifested as trade, migration, alliances, physical infrastructure, diplomacy, warfare, tourism, colonial exploitation, free-trade agreements, foreign investments, or cultural exchanges, international relations come in many forms, and are just as old as the system of national-states. Although nation-states (with their own specific rules of law and policymaking institutions) constitute the highest-level decision-making bodies in the geopolitical hierarchy, international relations matter to both the developmental trajectories and internal dynamics of both individual nation-states and the global system as a whole. To paraphrase the old saying, no country is an island.

### Analysis of International Relations

Reflecting its highly generic and transdisciplinary nature, social network analysis has proved to be a for-

midable companion when analyzing various types of international relations. The provision of novel ways to formally depict and measure the properties of the somewhat elusive concepts of globalization makes it possible to address hypothesis concerned with different aspects of globalization and the structures and normative significance of international interactions. In addition, such studies also prepare the way for the formulation of novel theories and models of global dynamics and development, which is of particular relevance in disciplines such as economics, where formal quantitative methods are often seen as a prerequisite for addressing and highlighting certain ideas and theories.

Although the various manifestations and traces of globalization can be found in nearly every corner of the world, the role and perceived significance of international relations in different scholastic fields has shifted over time—as particularly evident within development thinking. In the modernization debate of the postwar era, endogenous factors took precedence over exogenous ones. The internal properties of nation states—capital formation, production structures, factor endowments, education levels, and so forth—were seen as determining the prospects for development. In the 1960s and onward, this view was contested with its inverse. Stemming from structuralist thinking in Latin America, dependency thinking subsequently transformed into the world-systems perspective, deeming the prospects for national development as almost solely determined by external relations, such as trade, colonialism, political allegiances, foreign investments, and so forth.

In the 1980s, the focus of the debate shifted back: Even though export trade was seen as a possible engine of growth, the neoclassical resurgence implied a refocus on the internal properties as main determinants of national, and by extension global, dynamics. A similar phenomena occurred within economic geography: Whereas many of the methods of its quantitative revolution in the 1960s and 1970s focused on relational structures between spatial points of economic agglomeration, a counterrevolution struck the discipline in the 1980s, once again shifting the pendulum back to a focus on local and regional properties as the main determinant of spatial economics. Today, remnants from this “structural era” in economic geography can be found within the sub-branch of transport geography, where many of the formal methods for measuring centrality

are practically identical to methods used in contemporary social network analysis.

Whether due to methodological advances in network analytical methods, observation-driven reevaluations of existing disciplinary postulates, or periodical swings in methodological pendulums, a renewed interest has emerged in more formal approaches for studying international relations. Within economic geography, Eric Sheppard has proposed a return to positional analysis, arguing that more emphasis should be placed on the web of structures and flows that connect economies in space. Within political science, Emilie Hafner-Burton and colleagues have pushed for a more theory-driven usage of network analytical methods to better understand how the network of international relations affect global dynamics. Within sociology, the manifestations of a rapidly growing digital infrastructure, from Tahrir square in Egypt to Facebook friend lists, had led to new perspectives and theories on social interaction. Where Manuel Castells’ networked society and formal network methods are independently supported, the two lines of thought have gained significant impetus from each other. Even within neoclassical economics, notoriously conservative when it comes to methods, a renewed interest in the significance of exchange structures can be seen in the neophyte subdiscipline of new economic geography.

### Application of Network Methods to Data

The application of network methods to data on international relations can be divided into three phases. Representing the first phase, Steven Brams’s study of 1966 is in essence a cluster analysis, applying a transaction-flow model and hierarchical decomposition on binary data on trade, diplomatic exchanges, and membership in intergovernmental organizations. The second phase is represented by the series of studies by David Snyder and Edward Kick in 1979, Roger Nemeth and David Smith in 1985, David Smith and Douglas White in 1992, and Matthew Mahutga in 2006, explicitly done from a world-systems perspective. From the late 1990s, the third phase, according to Hafner-Burton and colleagues, is represented by studies where network analytical methods were better integrated with the issues deemed to be at the core in political science.

Many of the studies in the two latter phases, beginning with the 1979 study of Snyder and Kick, share several characteristics. First, several of these studies



*U.S. Ambassador to Japan John Roos visits disaster victims at a shelter in Ishinomaki, near Sendai, Japan, on March 23, 2011. A tsunami and earthquake devastated Japan on March 11, galvanizing international networks of aid, searches, and online posts.*

formulate their research questions from the world-systems perspective, a transdisciplinary, social-scientific framework that explicitly stresses the importance of nation-exogenous factors and international structures for shaping the three-tiered structure of core, periphery, and semiperiphery. Second, most of these studies are based on commodity trade data, partially or exclusively. Presumed to be highly significant in the world-systems tradition, detailed data on bilateral trade flows since the mid-20th century between most nations is readily available for analysis. Third, many of these studies assess the viability of core-periphery models to describe the global system of international relations: similar to the 1979 study, many studies utilize methods and heuristics for role analysis, such as blockmodeling, to identify the stratification of nation-states into these typological subsets that correspond to distinct roles in the world of global interactions.

This initial study used datasets on four different types of international relations: commodity trade, diplomatic ties, military intervention, and treaty membership, each given equal prominence in snapshot blockmodels for 118 countries during 1965. Using the Concor algo-

rithm for measuring structural equivalence, Snyder and Kick's study identified 10 distinct role-sets, which they argued reflected the trimodality assumed by the world-systems perspective. Whereas the nontrade datasets were initially in binary format, the trade-flow data was coded into this format through a system wide dichotomization: trade flows exceeding \$100,000 for two years between 1963 and 1967 were coded as a tie. Due to missing data, trade between the 11 Comecon countries was assumed to exist, whereas trade between the 24 nonreporting countries were assumed to be nonexistent.

Ron Breiger's study of 1981 also used a multiple-network approach focusing on trade flows of four different commodity groups, using the fuel commodity dataset as a reference. Breiger also used the Concor algorithm to derive a blockmodel for 1972; however, being critical of the dichotomization of trade data conducted by Snyder and Kick, Breiger instead modified the flow matrices by dividing them with the mean exports and imports of each country. However, Breiger also argues for a "natural wedding" between blockmodeling and world-systems analysis, with the former highly compatible with the foundations of the latter.

Roger Nemeth and David Smith's study from 1985, covering 86 countries during 1970, begin with a factor analysis of 53 major commodity types, identifying five distinct groups of commodities sharing similar flow patterns. Selecting the three most significant commodity types in each of these groups, collapsing these into five trade flow matrices, this nondichotomized data was subsequently used as input to the Concor algorithm, repeatedly splitting the largest sets until arriving at eight would-be, role-similar positions. Followed by blockmodeling of the commodity groups, Nemeth and Smith identify four world-systemic strata, dividing the semiperiphery into a stronger and weaker subset.

In 1992, David Smith joined forces with Douglas White in the first study on international relations that employed the REGE algorithm for estimating regular equivalence. Whereas structural equivalence implies that actors have similar ties to the same alters, regular equivalence relaxes this definition. Instead, regularly equivalent actors have similar ties to actors which, in turn, are deemed to be regularly equivalent. In addition to this methodological improvement, Smith and White's study was longitudinal: Using the distinct commodity groups identified from Nemeth and Smith in 1985, this 1992 study was complemented with data for 1965 and 1980. Contrasting the rather discrete, role-set partition generated by the Concor algorithm, the REGE algorithm produces continuous data, allowing for a more open interpretation of classification of countries into different world-systemic strata. Through a procedure for optimum scaling, Smith and White identify a trimodal, world-system structure for each of these years, with each of the two noncore strata divided into upper and lower positions. By comparing membership into these positions over the three time periods, Smith and White examine the possibilities of mobility in the world system.

Matthew Mahutga's followup study in 2006 continues Smith and White's longitudinal study by adding data for 1990 and 2000, using four of the original five characteristic commodity groups identified in Nemeth and Smith, but applying a log-10 transformation of the trade flow data prior to analysis. Whereas the chosen data and method are similar to the preceding study, Mahutga identifies five world-systemic strata for the three first years, whereas the two peripheral strata merge for 1990 and 2000. Tracking the interstrata flow directions of the individual commodity types, Mahutga's conclusion

reflects the pessimistic outlook often found in world-systems studies: the structure and recent transformation of the contemporary world system, reflecting a new international division of labor as indicated by patterns of commodity flows, continue to favor the core nations.

### Deviating from World Systems Approaches

Many studies of international relations deviate from the characteristics of the string of studies based on world systems. Martin Srholec's REGE-based, role-analytical study from 2006 applies a core-periphery taxonomy, but without being situated from a world-systems perspective. The 2001 study by Michael Sacks and colleagues, inspired by the world-systems perspective, applies a centrality-like measure of structural autonomy rather than role analysis. Ron Breiger's 1981 study only covers 24 of the 34 member countries of the Organization for Economic Co-operation and Development (OECD), severely restricting the interpretations of its findings. Although several studies look at trade in either broader commodity groups or individual commodity types, a plethora of other types of international relations have also been analyzed, such as telecommunications (George Barnett in 2001 and Jungho Choi and colleagues in 2006); military conflicts (Zeev Maoz and colleagues, and Jang Kim and Barnett, in 2007); bio-physical resource transfers (Carl Nordlund in 2010); airline traffic (David Smith and Michael Timberlake in 2001); historical monetary exchanges (Marc Flandreau and Clemens Jobst in 2005); and national memberships in international organizations (Jason Beckfield in 2008).

In a similar vein, there are several network-analytical studies of global structures where nation-states do not constitute the actors—in essence, where relational datasets are not necessarily international. For instance, the research field of contemporary world-city networks has yielded several studies where network-analytical methods have been applied to intercity relations—ties that explicitly, but not exclusively, are of an international type. Data on various types of international relations are more readily available than data on intercity relations, but the latter often reflects and directly bears on studies on international relations. Another example is the Valdis Kreb's 2002 study of terrorist cells and similar transnational networks. Although a global phenomena, the nationality of actors in such networks are best seen as properties (i.e., attributes) of actors rather than corresponding to actors per se.

Similar to how different types of international relations were combined in the study by Brams, a common trait of studies by Kick and colleagues is the simultaneous analysis of several relational types, where trade flows of various commodities constitute one type of tie alongside data on diplomatic relations, trade agreements, military interventions, and so forth. Although other authors recognize the importance of noneconomic ties as a normative force affecting global and national dynamics, other scholars have typically refrained from such analyses of multilayered datasets, instead restricting themselves to particular types of international relations. Whereas the combination of several types of data might better capture the multifaceted nature of globalization and international dynamics, analyses where all types of international relations are put on “equal footing” can also be misleading. Conducting multiple-network analyses of different datasets, such as commodity trade, military interventions, diplomatic ties, and treaty membership implicitly equalizes these datasets in determining the overall structure and properties of the global system. Some types of international relations are more normative than others; a relational tie representing a full-scale military invasion would be a more defining moment for a country than the establishment of a new trade tie.

### The Challenge of Dichotomous Data

Many methods and algorithms of social network analysis are designed with dichotomous data; occasionally, data on international relations indirectly underlines (and undermines) an implicit, egalitarian assumption on the relational capacity of actors. As standard social network analysis is concerned with interpersonal relations, an implicit assumption is that the actors in such networks share a similar capacity for the number and strength of ties. Such an assumption makes it theoretically more feasible to dichotomize would-be valued data using a common, systemwide cutoff value prior to analysis. When studying international relations, however, such an assumption can be problematic, especially with trade flow data. For example, whereas U.S. exports of wheat to Egypt only constitute a fraction of total U.S. exports, the very same trade flow represents about a quarter of total wheat imports to Egypt.

This dilemma with handling valued datasets with large value spans has been approached in different ways. The 1979 Snyder and Kick study (as well as subsequent studies by Kick in 1987), chose to dichotomize trade

data using a systemwide cutoff value. If trade between two countries exceeded \$100,000 for at least two years between 1963 and 1967, the trade flow was coded as a tie. Critical of such a dichotomization, Breiger, in 1981, chose to calculate mean imports and exports for each country, and subsequently subtracted these from the trade flow matrices. In 2001, Sacks and colleagues used dual row and column normalizations of trade flow data when calculating their measures of structural autonomy. Whereas Nemeth and Smith (in 1985) and Smith and White (in 1992) preferred to use the original trade flow data, Mahutga (in 2006) applied a log-10 transformation on the raw trade data in order to obtain results deemed as viable. In addition, to counter for differences in relational capacities of the countries, most of these studies prune their datasets by removing smaller countries as determined by population size.

The two commonly used algorithms for role-set identification—Concor for structural equivalence and REGE for regular equivalence—works reasonably well when applied to valued datasets. While both have been used to classify countries into the core-periphery typology as perceived by world-systems scholars, there is an interesting connection between method and conceptualizations exists: Available network methods occasionally seem to redefine the concepts derived from previous, more qualitative work. Having been heavily criticized as a method for identifying structural equivalent actors, Concor actually fails at identifying core and peripheral actors, even in the simple typological form. Still, Concor-based studies nevertheless typically treat the results as being more accurate than previous, attribute-based classifications.

Although REGE seems to do a better job at capturing how cores and peripheries are perceived in the qualitative world-systems literature, such labels are nevertheless first and foremost qualitative, not formal categories specified through quantitative analysis and network methods. Similarly, the core-periphery function of Steve Borgatti and Martin Everett in 1999, widely disseminated through the Ucinet software package, has a different definition of optimal core-periphery structures than what is perceived in the qualitative literature: In order to obtain a perfect fit with their optimal core-periphery model, peripheral actors must have ties to several core actors, which differs from how peripheralness is perceived in the qualitative literature. This phenomena of novel methods reconceptualizing existing

social-scientific concepts is likely not just constrained to role analyses of contemporary world-systems; the relationship between maps and terrains could very well be mutually directed in other research fields as well.

Carl Nordlund  
Lund University

**See Also:** Blockmodeling; Exchange Networks; Global Networks; Organized and Transnational Crime Networks; Strategic Alliance Networks; Terrorist Networks; World Systems Networks.

### Further Readings

- Barnett, George. "A Longitudinal Analysis of the International Telecommunication Network, 1978–1996." *American Behavioral Scientist*, v.44/10 (2001).
- Beckfield, Jason. "The Dual World Polity: Fragmentation and Integration in the Network of Intergovernmental Organizations." *Social Problems*, v.55/3 (2008).
- Borgatti, Stephen, and Martin Everett. "Models of Core /Periphery Structures." *Social Networks*, v.21/4 (1999).
- Brams, Steven. "Transaction Flows in the International System." *American Political Science Review*, v.60/4 (1966).
- Breiger, Ronald. "Structures of Economic Independence Among Nations." In *Continuities in Structural Inquiry*, edited by Peter Blau and Robert Merton. London: Sage, 1981.
- Chase-Dunn, Chris. *Global Formation: Structures of the World-Economy*. Oxford: Basil Blackwell, 1989.
- Choi, Jungho, George Barnett, and Bum-Soo Chon. "Comparing World City Networks: A Network Analysis of Internet Backbone and Air Transport Intercity Linkages." *Global Networks*, v.6/1 (2006).
- Flandreau, Marc, and Clemens Jobst. "The Ties That Divide: A Network Analysis of the International Monetary System, 1890–1910." *The Journal of Economic History*, v.65 (2005).
- Galtung, Johan. "A Structural Theory of Imperialism." *Journal of Peace Research*, v.8/2 (1971).
- Hafner-Burton, Emilie, Miles Kahler, and Alexander H. Montgomery. "Network Analysis for International Relations." *International Organization*, v.63 (2009).
- Kick, Edward. "World-System Structure, National Development, and the Prospects for a Socialist World Order." In *America's Changing Role in the World-System*, edited by Terry Boswell and Albert Bergesen. New York: Praeger, 1987.
- Kim, Jang and George Barnett. "A Structural Analysis of International Conflict: From a Communication Perspective." *International Interactions*, v.33/2 (2007).
- Krebs, Valdis. "Mapping Networks of Terrorist Cells." *Connections*, v.24/3 (2002).
- Krempel, Lothar, and Thomas Plümper. "International Division of Labor and Global Economic Processes: An Analysis of the International Trade in Automobiles." *Journal of World-Systems Research*, v.5 (2001).
- Mahutga, Matthew. "The Persistence of Structural Inequality? A Network Analysis of International Trade, 1965–2000." *Social Forces*, v.84/4 (2006).
- Maoz, Zeev, Ranan Kuperman, Lesley Terris, and Ilan Talmud. "Structural Equivalence and International Conflict." *Journal of Conflict Resolution*, v.50/5 (2006).
- Meier, Gerald, and Robert Baldwin. *Economic Development: Theory, History, Policy*. New York: Wiley, 1957.
- Nemeth, Roger, and David Smith. "International Trade and World-System Structure: A Multiple Network Analysis." *Review*, v.8/4 (1985).
- Nordlund, Carl. *Social Ecography: International Trade, Network Analysis, and an Emmanuelian Conceptualization of Ecological Unequal Exchange*. Lund, Sweden: Lund University, 2010.
- Sacks, Michael, Marc Ventresca, and Brian Uzzi. "Global Institutions and Networks: Contingent Change in the Structure of World Trade Advantage, 1965–1980." *American Behavioral Scientist*, v.44/10 (2001).
- Schwartz, Joseph. "An Examination of Concor and Related Methods for Blocking Sociometric Data." *Sociological Methodology*, v.8 (1977).
- Sheppard, Eric. "The Spaces and Times of Globalization: Place, Scale, Networks and Positionality." *Economic Geography*, v.78/3 (2002).
- Smith, David, and Douglas White. "Structure and Dynamics of the Global Economy: Network Analysis of International Trade 1965–1980." *Social Forces*, v.70/4 (1992).
- Smith, David, and Michael Timberlake. "World City Networks and Hierarchies, 1977–1997: An Empirical Analysis of Global Air Travel Links." *American Behavioral Scientist*, v.44/10 (2001).
- Snyder, David, and Edward Kick. "Structural Position in the World System and Economic Growth, 1955–1970: A Multiple-Network Analysis of Transnational Interactions." *American Journal of Sociology*, v.84/5 (1979).
- Srholec, Martin. "Fragmentation and Trade: A Network Perspective." In *Proceedings From the Eighth European Trade Study Group (ETSG) Annual Conference, Vienna*,

September 2006. <http://www.etsg.org/ETSG2006/papers/Srholec.pdf> (Accessed March 2011).

Tong, Xin, and Reid Lifset. "International Copper Flow Network: A Blockmodel Analysis." *Ecological Economics*, v.61 (2007).

Wallerstein, Immanuel. "The Rise and Future Demise of the World Capitalist System: Concepts for Comparative Analysis." *Comparative Studies in Society and History*, v.16/4 (1974).

---

## Internet History and Networks

The history of the Internet, complex though it may be, does provide useful insights into the way that technology and society work together to create innovations that become widespread changes in the way humans interact and communicate, often in ways that are only tangentially related to the original reasons why those technologies first emerged. What emerges from this history is that social networking has both made the Internet, and the Internet has remade social networking, so that it is a commercialized, increasingly pervasive, and—above all—explicit form of everyday life.

### Technological Development

The Internet dates back to the early 1960s, principally in the United States, but with some parallel developments in other nations. At this time, electronic telecommunications between two parties were a matter of circuit-switched networks, each interaction having a dedicated circuit. The infrastructure was cables and switching gear to open and close the circuits. Broadcast communications provided an alternative but, in both cases, the principal characteristic was that receiver and sender were simultaneously "present" in the communication. The Internet, as it has come to be known, changed this approach: it was a packet-switched network that did not rely on open circuits and copresence.

Packet-switched networking was first suggested by Paul Baran in 1964, (with Donald Davies and Leonard Kleinrock independently working on the topic). Packet-switched networks did not require simultaneous connection. Rather than using a stream of data, such communications involved breaking the message into many small packets of information that, along with instruc-

tions on how to assemble the packets, could then be sent via diverse routes at different times to the recipient. So long as the recipient eventually received all packets and instructions, it did not matter which route the packets took. Computers were essential to this concept, providing storage, routing, and processing power.

The most significant early example was ARPANET—an experimental network created in 1969 by the U.S. government. ARPANET is commonly referred to as the forerunner of the Internet, although at the time, few people would have foreseen the revolutionary changes that the Internet would entail. ARPANET was not designed for human communication, instead serving as the testing grounds to share then-scarce computer resources among researchers in different locations. Yet, what soon became clear is that a network of connected computers could easily sustain people's communications with each other, even when not copresent in time and space.

There were similar innovations in other countries—within private companies for commercial exploitation, as public service networks, and as computer bulletin boards were a staple of hobbyists. These developments occurred without coordination but with enthusiastic hopes for a connected information society. The Internet emerged when these separate networks interconnected, using the Internet Protocol (IP) that Robert Kahn and Vinton Cerf designed in the 1970s: IP was the set of software rules to enable such interconnection.

### The Internet's Effects on Social Networks

But technological development does not tell all of the story: the Internet also emerges from the popularization and simplification of the equipment and software needed to connect and use it, the commercialization of online activity to sustain business development, and the spreading throughout society of the cultural meanings that made connectivity desirable and useful. Much of this additional development occurred in the middle to late 1990s. And despite the sudden decline in investments in technology in 2000 (the dot-com crash), the next decade has seen an intensification of the role of networking and connectivity. Critically, while the 1990s was the decade of the virtual community—of escape from the everyday into cyberspace—the 2000s has shown that the real power of the Internet emerges when it becomes integrated into that everyday world with no clear boundaries between online and offline.