Once More on Translating INSNA; on Languages and a Great English Writer Who Knew Plenty of Them and Created New; on Networks, Mathematics, Structural Analysis, and Few Other Matters

Letter to the readers of *Connections*

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Dear Colleagues,

1. Those of you who remember the letters I sent to *Socnet* September 18 and 24, 2003, should not be surprised by the form of discourse (scholarly analyses mixed with informal stories) of the epistle I'm sending now to our journal instead of Socnet, which would be impossible for the XL size of my message. Although I was not first to notice some flaws in the "decoration" of *Connections*' back cover (the exchange of messages began September 10, 2003), my old letters form the bulk of what appeared under the title "Translating INSNA" by the end of 2003 in issue 25/2. My thanks go to all who took part in that discussion, and, first of all, to Bill Richards who took care of compiling and editing all email messages to document for the readers of *Connections* that "scintillating conversation," to quote the message Barry Wellman later sent to Socnet.

Let me begin from few comments and additions to Bill's report. My most intense and longest communication concerned translating INSNA into Russian. The small network which took up the task formed in part spontaneously, in part due to my actions. The network consisted of Gueorgi Kossinets and Olga Mayorova, two Russian speaking correspondents from the U.S.A., Elena Pukhova, a Socnet subscriber from St.Petersburg, as well as of two old acquaintances of mine, Boris Mirkin from Novosibirsk, now working in the UK, and Volodymir Paniotto from Kiev, two mathematical social scientists I located in the cyberspace with the help of Google and invited to discuss the issue, being confident of their competence in network analysis.

Working with the whole *ad hoc* group was an interesting new experience for me. I realized that the task of reaching *consensus* in the matter of translating scientific terms may be unexpectedly hard. Nevertheless, the group I coordinated was able to offer concrete solutions. Bill was kept informed all the time on our proceedings. He decided to include in the collection of email letters to be published in *Connections* 25/2 also the messages which circulated inside the Russian speaking circle only. The result of the group work, or two alternative Russian translations, can be found in the Table given on page 117 in *Connections* 25/2. The version finally rewritten to the back cover (Международная Сеть для Анализа Социальных Сетей) is OK except for one mistyped letter (**Ь** instead of ь in Сеть).

2. The task of translating INSNA into Spanish turned out to be much simpler. Bill and I received feedback from a number of Spanish-speaking colleagues (let me pass special thanks to Maria Angela Petrizzo from Spain who corrected my *l'análisis* to *el análisis*). I did not try to form a group because my knowledge of Spanish (based on previous knowledge of French and Italian) wouldn't suffice to coordinate discussion. Instead, I sent a letter to my Canadian-Argentinian friend, Martha Foschi, professor emerita at the University of British Columbia, native and educated speaker of Spanish with perfect command of English and highest competence in the

social sciences. Martha not only corrected my draft Spanish translation, but explained why the correct translation should have the form she proposed.

Let me quote from her letter here (it was not included in the collection edited by Bill).

> "I am glad to answer your question. My translation would be: *Red Internacional para el Análisis de Redes Sociales*
>
> The reasons are as follows:
>
> (1) I would not use the article *las* before *redes sociales* on the assumption that the intention is to analyze any network (or many networks), not some in particular. *Las* points in the direction of specific networks.
>
> (2) It is OK to use *el* before *análisis* because one specific type of analysis (let's say, scientific analysis), is implied.
>
> (3) The Spanish word for 'analysis' has an accent on the second 'a'
>
> (4) Whether one uses *la* before *Red Internacional* is somewhat tricky. I would not use the article if I were listing the names of organizations (thus *Red Internacional ...*, *Sociedad Latinoamericana de Psicologia*, etc.). However, if I were to state something about any of these organizations as part of a sentence, I would say *la Red Internacional consiste de ...* "

I suggested accepting Martha's translation as the ultimate solution of the problem. Since Bill had received the same translation from others, the task was completed with success and the Spanish translation could appear in the Table as a single item.

What I liked most in Martha's letter is that she had addressed the problems, possibly trivial for the speakers of the languages having *articles*, but by no means so for her correspondent, a native speaker of a language having neither *a* nor *the*.

> The absence of articles in Polish does not limit too dramatically the communication efficiency because the context usually determines whether "boy" means "a boy" or "the boy." If one needs to stress that reference is being made to a definite member of the set of boys, the counterpart of *pronoun* "this" can be used. English, which has a richer collection of *determiners*, is poorer in other respects. It has only one word *boy* to denote "young male person/child," while Polish has *chłopiec, chłopak, chłopczyk, chłopaczek, chłopczyna, chłopaczysko* where only the first word is "objective," while the other express how the boy is perceived by the speaker.

The translations of INSNA into French and Italian chosen for *Connections* (*Le Réseau International pour L'Analyse des Réseaux Sociaux*, *La Rete Internazionale per l'Analisi delle Reti Sociali*) are similar to the Spanish translation. However , unlike the latter which has *de* instead of *de las* as suggested by Martha, they have *des* and *delle* instead of *de* and *di*, respectively. It seems to me that the choice between"*of* noun-in-plural" and "*of the* noun-in-plural" is sometimes difficult even for native speakers of the languages ("of languages"?) which do have articles. When I put the phrase *analisi delle reti sociali* into Google (April 3, 2007), I received some 900 locations, but the phrase with *di* also occurred fairly frequently (some 750 results). For the analogous French phrases *analyse des/de réseaux sociaux*, I received 14 200 results for *des* and 7100 results for *de*. By contrast, *análisis de las redes sociales* appeared some 1000 times, which is a tiny minority compared with some 85,000 results obtained for the standard Spanish name with *de*. 85,000 is still much less than some 940,000 web pages with the English name, but the number of Spanish pages is large indeed. Is the language which Tolkien liked most of all Romance languages becoming the second language of science?

As regards the first occurrence of *Network* in INSNA, *Le Réseau* and *La Rete* contrast with *Red* without *La* in the Spanish translation. The Rumanian version also begins from the counterpart of *the*, although to see this you must know that the definite article is put in Rumanian (and few other languages) at the end of a noun (so we get *reţeaua* from *reţea*; the translation seems to be OK, except for mistyping WordPerfect character 1,185, or *ţ*, as 1,89, or þ – a letter used in Old

English).

INSNA or *the INSNA*? Martha would say that it is a "somewhat tricky" question. But it may well be that Romance languages have different rules for articles, even if their grammars are very similar. The vocabularies of French, Italian, and Spanish also reveal similarity. One might think that Spanish and Italian are more similar to each other than to French, as seen in the sequence *réseau-rete-red*, but in *parole-parola-palabra*, it is the Spanish word that does not fit its French and Italian counterparts.

The French name for INSNA appeared very early (see the first issue of INSNA bulletin available in the scanned form on INSNA website). It is interesting that the spelling errors, now corrected, absent in the original French version, were first noticed by nonnative speakers of French. The Spanish-speaking community of social network analysts have created their own "language space" you can enter through the gate on INSNA homepage. Do *les francophones* also have their own journals or discussion lists? I don't know. French academics seem to be less active in international organizations in which their language is not granted equal status with English.

> This reminds me an episode from my learning English. When the teacher, a native speaker from Britain, asked me to give an example of an "unreal if-clause," I answered to tease him: "If French imperialism were more vigorous than English, I would have to learn French instead of English." Actually, I learned both languages and mastered French well enough to write a paper without the help of a translator, even if it was a pretty tedious task. Today I wouldn't be able to repeat that feat because I stopped learning other languages for *practical* use as soon as I realized that the knowledge of English was a *sufficient and necessary* condition for survival in the world of science.

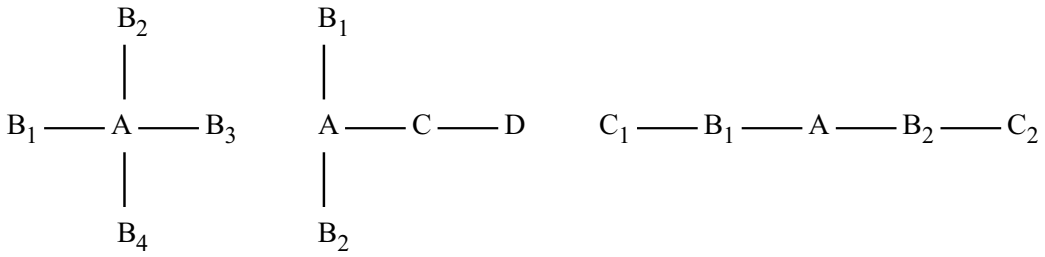
3. To comment on American-French (more generally, cross-Atlantic) scientific relations, let me make three deliberately provocative claims.

1. Philosophers-prophets like Jacques Derrida have an easier way to the American academic world and a higher chance for acceptance of their intellectual products than foreign "hard" scientists.

2. Hard scientists are also welcome in the US, but the hosts tend to perceive the "brain drain" as a search for diamonds that need to be cut in inspiring and demanding intellectual environment of American universities. Actually, when young Gérard Debreu (1921–2004) came to the US in early 1950s to win 30 years later (1983) the Nobel prize in economy for his contribution to the general theory of economic equilibrium, he was able to succeed due to his excellent training in mathematics he had received in *Ecole Normale Supérieure*.

3. Publishing in English rather than French, while staying in Europe, does not necessarily help. Claude Flament's *Applications of Graph Theory to Group Structure* appeared in English (1963) prior to the French edition. However, his book, to be sure, cited in several places in Wasserman and Faust's *Social Network Analysis* (1994), has not even been mentioned in the chapter "Group Structure: Attraction, Coalition, Communication, and Power" written by Collins and Raven for the *Handbook of Social Psychology* (vol. IV, 1969), although their overview of theory and research on communication networks seems to be really comprehensive. However, "Today, Flament's work is widely recognized as foundational in the field" – says Linton Freeman in his recent book (*The Development of Social Network Analysis*, 2004) in which European contribution to SNA has been given a more extensive coverage.

Flament was probably first to notice that the communication networks displayed below, in which node *A* is central, differ not only with the degree of centralization, but they have different number of "positions" (classes of automorphically related nodes), and the latter structural parameter may be more suitable for explaining why problem-solving groups vary in effectiveness. The concept of automorphic equivalence (see Wasserman and Faust 1994, 12.3) was rediscovered in SNA in early 1980s.



I met Claude Flament (now professor emeritus in Aix-en-Provence) in 1974 in Poland at the UNESCO conference (see *Connections* 25/2, p. 110). Some time later I got familiar with his book which inspired me to write 2 papers. One of them ("Processus d'équilibration et sous-graphes équilibrés d'un graphe signé complet") was published in 1976 in French in *Mathématiques et Sciences Humaines*. Another paper, whose Polish title reads in English as "On the Notion of Structure in Sociology and Mathematics. Graphs as Models of Social Wholes," appeared in 1986 in a Polish sociological quarterly (*Studia Socjologiczne*). I did not try to submit an English version of that paper to an international journal because I thought that a paper containing only "deep insights" but no "hard" results (a mathematical theorem or at least some analysis of some data) would be unlikely to be accepted for publication.

My most sophisticated purely mathematical paper (dealing with some combinatorial issues concerning signed graphs) appeared in 1980 in the *Journal of Graph Theory*. I remember that an anonymous referee told me to remove all theorems already known which I had embedded in the text (with a proper attribution) to show my own results in a broader context. The reviewer didn't say explicitly "We publish only *hard* and *new* results," yet the message addressed to the young author was quite clear. I complied with the request, even if somewhat disappointed, as my paper, stripped of quoted old results, seemed to me less elegant. Nevertheless, this adventure taught me to put up with, and even to internalize, the tough rule which helps historians of science to correctly attribute results.

What I and many people who had to live for many years under the communist regime did always admire in the Anglo-American culture is high evaluation of *individual* achievements. I liked Barry Wellman's statement he sent to Socnet January 5, 2004: "I founded INSNA, and for 12 years I ran it alone out of my hip pocket." In December 1996, I asked Barry and Steve (Borgatti) about the beginnings of INSNA as I wanted to include some information about it in the entry *Social Network* I was then writing for the Polish Encyclopedia of Sociology (vol. 4 with my two articles, *Social Network* and *Mathematical Sociology*, appeared in 2002). Taking into account Barry's reply, I placed there the following text (it is translated here from Polish; the name of INSNA was left in the Polish text in its original English form):

"In 1978, on the initiative of Barry Wellman, an international association was formed, named International Network for Social Network Analysis (INSNA). Its aim is to facilitate exchange of information between researchers competent in particular substantive fields and sharing interest in the analysis of relational data."

My formulation ("on the initiative of") is a bit less "individualistic" than Barry's to reflect the fact that a single person can't create a network without others willing to cooperate.

4. Now a few words about translating INSNA to German. Again I and Bill Richards got replies from a couple of Socnet subscribers. Besides Jana Diesner who contacted both me and Bill, each of us received feedback from different people. A specific problem to be solved in this case was how to translate into German the term SNA. Both English and German admit of the formation of compound nouns. I received a letter from Wolfgang Sodeur with some technical comments on this matter. Being aware of my minimum knowledge of German, I decided to leave the group discussing the German translation of INSNA. However, when I and Bill brought together the translations proposed to us, we were able to select two versions which appeared independently in both subgroups. They are given as German *a* and German *b* in the Table and differ with the translation of SNA: *soziale Netzwerk Analyse* appears in *a* and *Analyse sozialer Netzwerke* in *b.* Version *a* was chosen by Bill for the back cover. However, *soziale Netzwerk Analyse* was found by Google less than 100 times, while *soziale Netzwerkanalyse* nearly 800 times. Thus – according to statistical criterion – the latter term should be treated as the standard German counterpart of SNA.

Wolfgang's letter was inspired by my analysis *(Connections* 25/2, p. 107) of the triply compound word *Social Network Analysis*, namely, I distinguished two readings of SNA

(1) SNA = (Social Network) Analysis = Analysis of (Social Networks);

(2) SNA = Social (Network Analysis) = Social (Analysis of Networks).

Now, when I looked at Czech and Slovak translations given in Bill's Table, I must add the third reading

(3) SNA = Social (Network Analysis)

which differs from (2) in that *network analysis* is not considered equivalent to *analysis of networks*.

Which of three representations, (1), (2) or (3), is correct? The answer was given by Barry Wellman in his message sent to Socnet January 16, 2004.

"Finally, there is a discussion of whether 'Social Network' is singular or plural in 'Social Network Analysis'. Definitely plural, but using 'Social Network' as an adjective, which we can do in English, means that the plural is implicit. I could have used the more cumbersome 'Analysis of Social Networks' which would have been both clear and clunky."

Barry is certainly one of few people whose answer to the question of what is SNA can be taken as *Roma locuta causa finita*. However, his assertion that "the plural is implicit" seems to reflect his knowledge of SNA rather than on his general competence as a native and educated speaker of English. Is "formal language theory" equivalent to "theory of formal languages," "theory of formal language," "formal theory of language," or "formal theory of languages"? Why "theory of general systems" becomes "general systems theory" rather "general system theory"?

Are there any general rules which help recognize the structure of *triply* compound names like "social network analysis" or "network exchange theory"? I didn't find such a topic in the grammar of English (*A Practical English Grammar*, 1968; published as part of Collier-Macmillan English Program) which my teachers recommended as the best manual when I learned English at an advanced level. As regards *network analysis*, I learned from that source that a sequence of two nouns is either a *noun-noun compound* or a *noun-noun phrase*. In a noun-noun *compound*, the two nouns are never separated and form a single item in the English vocabulary. In a noun-noun *phrase*, the components are not so tightly bound. The first noun is a *modifier* which can be replaced by another modifier, a noun or adjective, e.g., "brick house, wooden house." Noun-noun phrases are always written as two words, while noun-noun compounds are often, though not always written as one word (e.g., Christmas tree, teapot).

Is *network analysis* a noun-noun phrase or a noun-noun compound? Consider two sentences "What house would you like to buy, a wooden one or a brick one?" and "Is content analysis more suitable than the network one for the study of information flows among the members of a discussion list?" If the second question is accepted as a correct English sentence, then *network analysis* is a noun-noun phrase rather than a noun-noun compound. Note that the distinction between phrases and compounds is based on actual rather than potential English vocabulary. You will not find *Easter tree* in any dictionary, yet this expression is as "legal" as *Christmas tree* insofar as both are obtained by applying the same general rule.

Suppose that English-speaking Christians have developed a new custom of decorating their homes with trees on Easter. To name such a tree, they don't need to create a new term because the rule which makes English so powerful language generates the noun *Easter tree* grammatically interpreted as a noun-noun phrase. However, if the English-speaking community feels that the difference between the two holiday trees should be marked in a stronger way (say, because a Christmas tree is supposed to have needles while an Easter tree should have leaves), the actual vocabulary must be enriched with a new lexical unit, say, *Eastree*. Instead of inventing a new word, one can decide that the sentence "Which holiday tree do you like more, the Christmas tree or the Easter one?" is incorrect, which amounts to treating *Christmas tree* and *Easter tree* as two noun-noun compounds rather than two noun-noun phrases.

I'm not competent enough to analyze similar constructions in German, so let me only quote Google results. The German name for SNA, still found on the back cover, *soziale Netzwerk Analyse*, occurred in some 100 cases. Clearly, it is being superseded by *soziale Netzwerkanalyse* which had nearly 800 occurrences. The third version, *Analyse sozialer Netzwerke* was found on nearly 700 web pages.

The problem with translating noun-noun phrases and compounds into Slavic languages has to do with the fact these languages do not admit a noun as modifier of another noun. One must not translate *snail mail* as *ślimak poczta*, although such a "translation" would probably be obtained if the two-noun string were put into a computer program like that used by Bill (I still remember the fun I had when I saw *pletenka analiz* in the first Russian translation). The correct translation of *snail mail* is *poczta ślimacza* or *ślimacza poczta* where *ślimaczy/ślimacza* (masculine/feminine form) is the adjective derived from *ślimak* (the difference between noun-adjective and adjective-noun has a stylistic value in Polish, usually one of the two orders is stylistically "neutral"; by contrast, in French, *homme grand* and *grand homme* differ in meaning).

Unfortunately, adjectives cannot be constructed for many nouns both in Polish and in English. The latter language has the noun-noun phrase, which is a very effective construction, but sometimes we need a regular adjective as a modifier. For example, "power generated by unequal vulnerability to exclusion" could be called "exclusion power," but this term may well be read as "power of exclusion." Hence the need to derive an adjective from "exclusion." Actually, the term *exclusionary power* has already appeared in sociological literature. I have also used it in my papers on exchange networks, even if my WordPerfect spell checker refuses to accept the word *exclusionary.*

Whereas English vocabulary doesn't contain an adjective derived from *network*, some Slavic languages do have such a word (the three adjectives are given in their masculine variant): сетевой (Russian), *sieciowy* (Polish), *sieťovy* (Slovak). Therefore, if *network analysis* is a noun-noun phrase which means "a certain way of analyzing certain objects, the one characterized by the use of networks to represent these objects," then *analiza sieciowa* (and its Russian and Slovak counterparts: сетевой анализ and *sieťová analýza*) is the best translation. However, if *network analysis* simply means "analysis of networks," that is, "all or some ways of analyzing a particular category of objects called 'networks'," then these translations into three Slavic languages may not be accepted.

5. Those who learn English as a *foreign* language are sometimes more sensitive to its structural properties than those who acquire the ability to produce grammatically correct statements, being unaware of the rules they apply to generate these statements. Having discovered the power of English as a medium for *scientific discourse*, many enthusiastic users of *scientific English* are ready to supplement Wittgenstein's saying "What can be thought at all can be thought clearly. What can be said at all can be said clearly" (*Tractatus logico-philosophicus*, 4.116) with "What can be said clearly can be said in English." However, it may well be that English is not as precise as is generally believed. The meaning of some compound terms cannot be recognized on the grammar level. Then the decision on how to *understand* such a term falls upon the "guy who thought up the name" (to quote again Barry's letter) and those who followed his suggestion. Linguistically, the decision involves the choice of one of few plausible *structural* decompositions of a complex expression. Nouns having the form of a sequence of three nouns are especially interesting in this respect. Let me consider an example from my own research field. The term *Network Exchange Theory*, abbreviated to NET, was coined by Barry Markovsky as he disclosed in his paper "Network Games" (*Rationality and Society* 9, 1997: 67-90). He was the first author of a seminal paper "Power Relations in Exchange Networks" (*American Sociological Review* 53, 1988, 220–236) co-authored by Willer and Patton. More recently (1999) NET re-appeared as the title of a book, edited by David Willer. IF NET is to mean "Theory of Exchange Networks," then it might serve as a collective name of all theories which deal with "exchange networks." However, Willer and associates have been using NET, despite its nonspecific language form, as their "trade mark" of their *specific* network exchange theory, the one which has grown out of Markovsky,

Willer and Patton's 1988 paper.

In my old paper "A Tentative Formalization of Network Exchange Theory" (in *Structure, Exchange, and Power. Studies in Theoretical Sociology*, edited by Sozański, Szmatka, and Kempny, 1993) written in Polish, I used the term *sieciowa teoria wymiany*, having deciphered "Network Exchange Theory" as "Network (Exchange Theory)", which amounts to interpreting NET as the network variant of exchange theory. The term *exchange network* has been used by three rival approaches, the *Power-Dependence Theory* (Emerson, Cook, Yamagishi), the *Elementary Theory* (Markovsky, Skvoretz, Willer), and the approach (proposed by Bienenstock and Bonacich) based on representing an exchange network as a *multiperson game in characteristic function form*. What I found most important when I became familiar with *many* specific network exchange theories (presented in the special issue of *Social Networks*, 1992/3-4, edited by D. Willer) was the emergence of a new *network* perspective on exchange rather than the discovery of a particular class of social systems whose behavior would the subject matter of *a* (or possibly *the*) "theory of exchange networks."

Intuitively, an exchange network is a *social system* with *network structure* imposing some limitations on the interaction process through which *actors* gain valued *resources* from *bilateral transactions*. The *category* of *exchange networks* can now be defined with full mathematical rigor (see my recent paper "On the Core of Characteristic Function Games Associated with Exchange Networks" in *Social Networks* 28/4, 2006, 397–426). If so, then the name "theory of exchange networks" (in Polish, *teoria sieci wymiany*) has no less definite meaning than, say, "theory of groups" in mathematics. The third interpretation of NET as "(Network Exchange) Theory=Theory of Network Exchange" (*teoria wymiany sieciowej*) makes sense as well. NET would then be a theory of exchange *in* networks, or a theory which regards networks as the *locus* of exchange processes.

Let us analyze in turn triply compound nouns which begin from a regular adjective, e.g. "Social Exchange Theory." The translator must now choose between two interpretations, "Theory of Social Exchange" and "Social Theory of Exchange" (in Polish, *teoria wymiany społecznej* and *społeczna teoria wymiany*). A similar choice must be made between "Analysis of Social Networks" and "Social Analysis of Networks" or "Social (Network Analysis)" (in Polish, *analiza sieci społecznych* and *społeczna analiza sieci* or *społeczna analiza sieciowa*; the Slovak and Czech counterparts of the last variant appear in the Table given in *Connections* 25/2).

What should a translator do when he can't find someone as competent as Barry Wellman who could help him make the right choice? The difficulty has to do with the fact that "social (network analysis)" is a member of the family of expressions such as "social (statistical analysis)=social statistics" or "social (linguistic analysis)=social linguistics= sociolinguistics", but the family is not *semantically* homogenous. Two *syntactically* similar compound nouns, *social statistics* and *social linguistics*, differ with their meanings and it is *not* the difference between *statistics* and *linguistics* that counts here. Certain statistical methods may have been invented to analyze the data collected by sociologists, yet those methods themselves are by no means "social." Similarly, "Social (Network Analysis)" is not a "social" type of "network analysis," being rather an application of "network analysis" to "social entities" just as "Social (Statistical Analysis)" consists in applying statistical analysis to "social data." By contrast, the aim of *social linguistics* is *not* to analyze social phenomena by means of linguistic methods, but to explain structure and dynamics of natural languages by invoking certain *social* processes occurring in groups whose members use a given language to communicate among one another. If the fact that the pronoun *thou* ceased to be used in everyday English is explained by a tendency working within the language structures (say, the process of simplifying the grammar), then it is a linguistic explanation of a linguistic fact. If one claims that *you* replaced *thou* because the nature of interpersonal relations in the British society had changed, which in turn entailed a change in the language spoken by the British, then it is a "social" (or rather sociological) explanation of the linguistic fact.

Lastly, let me remark in this connection that apart from *social linguistics* there exists a sociological subdiscipline, which can be called *linguistic sociology*. It studies "grammars of social actions" (see

the pioneering works of Thomas Fararo and John Skvoretz).

6. The English word *social* seems at first sight to present no pitfalls for the translator. However, one must realize that the counterpart of *social* in a given language belongs to the family of words which share the common *root* and hence to some extent co-determine the meaning of the adjective chosen as the most adequate translation of *social*. In Latin, the morpheme *soci* occurs in *socius* (noun: someone's companion or member of a company; adjective: joint), *socio* (I join), *socialis* and *societas*. The latter two words entered into English as *social* and *society*. Similar words are found in the Romance languages. In Russian the source word is общий (*obshchiy*) which can be translated to English as *common* or *general* ("common to all"). Общество (*obshchestvo*, society) is a noun derived from this adjective by adding the suffix *-stvo* (*-hood*); общественный (*obshchestvennyi*) is in turn the adjective derived from общество just as *societal* is derived from *society* in English. Unlike *societal* which is a rather bookish word, общественный is a common word, yet the meaning it "inherits" from общество narrows down its usage, so that социальный (*sotsialnyi*) had to have been borrowed (Latin→French→German→Russian) to cover a wider range of meanings, in particular the meaning of "social" in "social network" (социальная сеть).

The sequence of Russian words общий→общество→общественный shows a remarkable similarity with the sequence of Greek words κοινός→κοινωνία→κοινωνικός (*koinos, koinōnia, koinōnikos*; ō stands for the letter *omega* which is read similarly as o=*omikron*; read "koi" as "key"; accents over vowels show stress always marked in Greek). Both sequences are built according to the same pattern and the corresponding words in the two languages have the same meaning. This observation prompts the hypothesis that the Eastern, Greek "lung" (to quote John Paul II who used to say that Europe should breathe with two spiritual lungs) tends to identify the meaning of "social" with that of "common."

Comte might have been aware of this peculiarity of Greek when he named the new science *sociologie* rather than *koinologie*. As it were, he could point to the inadequacy of the Greek root to defend his decision against the purists who blamed him for having produced "a hybrid term compounded of Latin and Greek parts" (L. Coser. *Masters of Sociological Thought*. 1977, p. 3).

> Comte learned ancient Greek in a *lycée* in Montpellier like my father some 80 years later in Lvov. Tolkien who learned Greek in Birmingham few years earlier wrote of his first contact with this language: "The fluidity of Greek, punctuated by hardness, and with its surface glitter captivated me. But part of the attraction was antiquity and alien remoteness (from me): it did not touch home." (H. Carpenter . *J.R.R Tolkien. A Biography*. 1995, p. 35).
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> Greek is becoming more and more forgotten language, although educated people still know that most scientific terms come from Greek. Regrettably, *Kyrie eleison* (Lord have mercy on us) kept by Western Christians in the Latin mass until Vaticanum II along with Hebrew words *Amen* and *Hosannah* is rarely heard today in Catholic churches in the original Greek form which the ancient Latin-speaking Christians decided to retain unchanged.
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> My first encounter with Greek took place some 40 years ago. I tried to decipher Greek inscriptions under the scenes from *Iliad* painted on the walls of the entrance hall of the Nowodworski high school in Cracow. Greek was no longer taught; only one class learned Latin, as an alternative to English, French or German, the second foreign language taught besides Russian. I got familiar with Greek alphabet when I began to study mathematics at the Jagiellonian University.

To verify the translation of INSNA into Greek given in *Connections*, I consulted the minimum Greek-Polish and Polish-Greek dictionary which presents the vernacular (*dhēmotikē*; ē stands for the Greek letter *eta* pronounced in contemporary Greek as English "ee" in "feet"; *dh* stands for the voiced English *th* as in "the") variety of modern Greek rather than the official (until 1976) "purified" (*katharevousa*) variety closer to ancient Greek. My translation of INSNA into δημοτική γλώσσα (*glossa*) is as follows

Διεθνές Δίκτυο για την Ανάλυση Κοινωνικών Δικτύων

(*Dhiethnes Dhiktyo gia tēn Analysē Koinōnikōn Dhiktyōn*). If I had an opportunity to consult a native educated speaker of Greek, I would ask him if των (*of the*/*des*/*delle*) should be put between

Ανάλυση and Κοινωνικών. The translation given in *Connections* does not contain the word Ανάλυση which, however, must have been in the first translation, as can be inferred from leaving the article την in place (*gia tēn Analysē*=for the analysis). If the aim of the modification was to replace "IN for SNA" with "IN for SNs", then για (for) should be followed by τα Κοινωνικά Δικτύα. If "IN of SNs" were intended, then the replacement of την with των would do.

I guess what the reader may think now. How did this guy figure out that the Greek translation should look like this? Let me answer this question in detail. My knowledge of Greek has so far been confined to recognizing letters. Even now I know practically nothing about Greek verbs and tenses. Anyway, I decided to attack the problem of translating INSNA into Greek with the arms I had at hand. I was equipped with the dictionary, but the knowledge of words is useless until you get familiar with the *nominal system* of a given language – the only *subsystem* of the *grammar system* you need to know in this case. Fortunately, I found the description of this subsystem (which deals with *articles*, *nouns*, *adjectives*, and *prepositions*) in the appendix to my minimum bilingual dictionary and in the Internet. First, I noticed that Greek has 3 *grammatical genders* (masculine, feminine, and neuter) and three gender variants of the definite article (the counterparts of German *der*, *die, das*). Next I noticed that articles, nouns and adjectives have *genitive case* and *accusative case*, the latter being used with prepositions. What remained to be done was to look up two nouns, two adjectives, and a preposition in the dictionary and to put each noun and adjective in the right case, using the pattern given in the *declension* table. Having found δίκτυο as the counterpart of *sieć*, I had to choose in turn a proper declension pattern out of four *paradigms* given in the table for neuter nouns ending with -ο. Having noticed that some patterns differed only with stress, I chose δικτύων rather than δίκτυων as the genitive plural. I trusted the person who had translated INSNA into Greek for *Connections* as I thought that he or she probably knew better *spoken* Greek and thus was more competent than me in the matter of stress. At the last step, I had to check if Διεθνές is correct because such a neuter counterpart of masculine Διεθνής didn't fit the pattern given in my source. When I looked into *Wikipedia* article on Greek grammar, the problem was solved: the pattern -ης/-ης/-ες (m/f/n) is pretty rare so it was omitted in a minimum grammar description attached with the minimum dictionary. I also learned from Wikipedia that Greek spelling was simplified in 1982: the Parliament decided to mark stress by only one symbol (*acute accent*). Ancient Greek had more diacriticals (see WordPerfect character map 8).

Let me close this section of my letter with the following conclusions: (1) the task of correcting errors on the back cover of *Connections* is feasible; (2) you can learn a lot about languages from the Internet.

7. While Greek and Russian reduce the social to the common, Latin does distinguish between *socialis* and *communis* and so do many other West European languages. It is natural to expect that the opposition of the two concepts will be weaker in the language spoken in the country lying *between* East and West. Indeed, Polish adjectives *społeczny* (social) and *wspólny* (common) grow from one root *społ*/*spół* . The *morpheme* of which *spół* and *społ* are phonetic variants (*ó* is always pronounced in Polish as *u*; it was pronounced in Old Polish as French *au*) corresponds to Latin *co-* (*col*/*com*/*con)* and Greek *sy-*(*syl*/*sym*/*syn*). These prefixes which come from *cum* and *syn (*the counterparts of *with* in Latin and ancient Greek) convey the meaning of "togetherness" as, for instance, in Latin *connexio* (tying together) and Greek *symbiosis* (living together).

It is interesting that *spół* is a combination of *z* and *pół* where *z* is a preposition (equivalent to English *with*) and a prefix (its history can be traced back to Sanskrit *sa-*). *Pół* means "half," but in Russian, a language from the same Slavic family, пол (*pol*) means not only "half" (prefixed to nouns, e,g. полчаса, half an hour) but "sex" (пол=floor is a different unrelated lexical unit). While etymological dictionaries relate пол only to Albanian *palë* (pair), I would relate *społ* to Latin *copula* (it became *couple* in English) represented as *co-pula*, where *pula* is derived (according to www.etymonline.com) from a proto-Indo-European word *ap*=take, reach. Hence the conjecture that ancient Slavs perceived sexual relationship as the *prototype* of any social relationship. Note that the first social relationship described in the Bible is a combination of *communis* and *socialis*. Eve was given by God to Adam to become his *socia*. Adam accepted her

as his companion as soon as he noticed that Eve and himself share *common* human nature, or both belong to the same species different than animal species Adam had seen before.

The simplest Polish word containing the morpheme *społ* is *społem* which means "together" (*społem* is rarely used in current Polish, as it was replaced by *razem*; note that *spolu* means "together" in Czech). The other members of the family are: *spółka* (company), *społeczny* (social), *społeczeństwo* (society as a whole), *społeczność* (the noun – derived from *społeczny* in the same way as "weakness" is derived from "weak" in English – does not mean an attribute, but a local or professional community), *wspólny* (common), *wspólnota* (community), and many words beginning from *współ* or *spół* such as *współpraca* (cooperation) and *spółdzielnia* (a cooperative). Note that in Polish "society" comes from "social" (*społeczny→społeczeństwo*) not conversely (historically, the adjective *społeczny* comes from the noun *spółka*). In Russian and Greek the morphological relation is reversed (общество→общественный, κοινωνία→κοινωνικός). However, the secondary nature of "society" is felt rather weakly, so that *społeczny* can also mean "societal." In addition to this, Polish has native words corresponding to Latin words with *soci* (*socius* can be rendered as *towarzysz*, and *societas* as *towarzystwo*, hence *Polskie/Międzynarodowe Towarzystwo Socjologiczne*, Polish/International Sociological Association). There also many imports from Latin obtained from the words derived from *communis*.

> If a particular semantic field is rich and diverse in a given language, then acquisitions from other languages are accepted only if there is no other way to introduce a new term with a special meaning. *Social work* must have appeared in Polish as *praca socjalna* because *praca społeczna* already had the meaning of "voluntary work for the benefit of other people, usually a local community" (not necessarily the kind of work which has to do with helping the poor). *Social security* must have been translated into Polish as *bezpieczeństwo socjalne* rather than *bezpieczeństwo społeczne* because the latter word might be confused with *bezpieczeństwo publiczne* (protection of a state and its citizens against crime, terrorism and other subversive actions).

In German, the common and the social spring from two different roots. Toennies might have been inspired by the opposition existing in his native language when he introduced his well known distinction between *Gemeinschaft* (community) and *Gesellschaft* (society, association, company). Социальный (*sotsialnyi*) appeared in Russian to fill in the gap in the indigenous vocabulary. *Sozial* was borrowed by German from French (indirectly from Latin) for similar reasons as well as to neutralize the opposition between *Gemeinschaft* and *Gesellschaft*. The most fundamental term of Max Weber's sociology, "social action" ("Action is 'social' insofar as its subjective meaning takes account of the behavior of others and is thereby oriented in its course", *Economy and Society*, Part I, Chapter 1, Section 1) appeared in Part II of *Wirtschaft und Gesellschaft* as *Gemeinschaftshandeln* (see p. cii in G. Roth's *Introduction* to the English edition of Weber's *opus magnum*), which may reflect the author's rootedness in German cultural tradition which in this respect resembles more the Byzantine East than the Latin West. In Part I, which was written later, Weber took a more universalistic stance: *Gemeinschaftshandeln* was replaced with *soziales Handeln* which became since then the generic term. Similarly, *Gemeinschaft*, primarily used to denote any social group, was replaced by *Verband*. In Section 3, Chapter 1, Part I, he introduced the general notion of a "social relationship" (*soziale Beziehung*) covering both types (characterized in detail in Section 9): the "communal" type (*Vergemeinschaftung*) and the "associative" type (*Vergesellschaftung*).

In other languages here considered, the ideas expressed in Latin by the adjectives *communis* and *socialis* are complementary rather than contrasting. The meaning of *socialis* is individualist and particularistic. *Socii* form a *societas* to attain their goals through cooperation or simply to enjoy the company of one another, they can also ally to pursue a common goal and build up group solidarity, but the most elementary "social fact" is that they meet and interact. The meaning of *communis* is collectivist and universalistic. The members of a *community* unlike *socii* who hold their individual shares must share something collectively. The concepts of the social and the common can be illustrated by the following pictures.

While in (1) actors *A* and *B* are related *directly* to each other, in (2) *A* and *B* are related in the same way to an object *X*. In some circumstances this may give rise to an *indirect* tie between *A* and *B*. (1) and (2) roughly correspond to the concepts of *organic* and *mechanical solidarity*. The second form of social solidarity appeared to Durkheim more fundamental, which can be inferred from his definition of *social fact*. Linguists have often yielded to the charm of his *social ontology*, yet many of them regard *language* as a theoretical *construct* needed to account for the fact of *symbolic communication* between people. Thus, instead of defining the set of the users of a given language as the set of those who *know* the vocabulary and grammatical rules, one can define it as the set of people who *understand* what they *say* (speak or write) to one another.

> In 1987, when Yugoslavia was still one nation I and my colleague visited Croatia under the exchange agreement between the Jagiellonian University and the University of Zagreb. As usual, I took with me a minimum bilingual dictionary, now to translate into Polish from *Serbo-Croatian*, the common language of Serbs using the Cyrillic alphabet, and Croats using the Latin one. Our hosts who knew that Poland still suffered from food shortage showed their hospitality by inviting us to a restaurant for a big feast. Neither earlier nor later in my life have I eaten so much meat, but I remember even better a salad with sheep cheese because of our hosts' reply to my remark concerning it. When I said that I had enjoyed the taste of that salad for the first time when I visited Bulgaria in 1974, I heard: it's impossible, you must have eaten something else, it's *our* Croatian salad. If someone told me then that in few years Serbs would kill Croats in Vukovar and Croats would kill Serbs in Krajina, I would not believe, yet the story about the salad helped me understand the fact that many Croatian and Serbian linguists have proclaimed the split of *Serbo-Croatian* into two distinct languages. Here is my translation of INSNA into Croatian: *Međunarodna Mreža za Analizu Društvenih Mreža*. Would it be intelligible to the speaker of Serbian if rewritten in Cyrillic? By the way, since *drug* in the sequence *drug→društvo→društveni* means *socius*, the understanding of the social in *Serbo-Croatian* seems to be western type (social≠common).

A *common* relationship of *A* and *B* with *X* may take various forms, such as sharing values, being subject to the same law or ruler, having common ancestors, belonging to certain sets, in particular, those defined by pointing out some attribute shared by *A* and *B*. If *X* is a common ruler endowed with the power to control the horizontal "ties and bonds" between his subjects *A* and *B*, then organic solidarity may not develop. This variety of mechanical solidarity was known from experience to all who had to live under communism.

A semantical opposition between (1) and (2), if it exists in a given language, may be weakened by deriving *relational* terms from "common." English verb "communicate" is a relevant example. Similar words are also found in Russian (сообщить, *soobshchit'*, communicate; общаться, *obshchat'sia*=maintain relations) and Greek (ανακοινώνω, I communicate). Such verbs are absent in German and Polish. Polish does without *mediating* between the social and the common because the root from which *społeczny* and *wspólny* have grown is itself relational. In German, the opposition remains unmediated. I don't know a native German verb derived from the root *gemein* to denote an interpersonal *relationship*. Does it have anything to do with the historical fact that the Germans have always had difficulty with inventing a reasonable model of social integration lying in the middle between two extremes: a *Gesellschaft* of shareholders, and *ein Volk* or *ein Reich* built over the *Gemeinschaft* of those who share *ein Blut und ein Führer*? With growing influx of Spanish speaking immigrants, the U.S.A. will face a similar problem: should the use of English (Webster's "American language") remain part of the American identity or should *pluribus* in the principle *E pluribus unum* cover the acceptance of multilingual society?

To carry out such analyses (as it were, of a more *hermeneutic* than purely linguistic nature) one must consult *etymological* dictionaries in order to know the history of words. The German word *Gesellschaft* is morphologically related to *Geselle* in the same way as *societas* is related to *socius*, yet I would not be able to discover that the relationship is also semantical if I consulted only my small German-Polish dictionary where "apprentice" rather than "companion" is given as the only

meaning of *Geselle*. Consider another example. The English word *spell* has a different connotation in "spell a word" than the noun *spell* in "the wizard recited a spell." My hunch that the two meanings of *spell* must be somehow related failed me – I learned from *Webster's New World Dictionary of the American Language* that there are, in fact, two different words, one coming from *Old French* and the other from *Old English*. Similarly, *net* in *net profit* comes from OF while *net* in *network* comes from OE. When I bought the cheap pocket-size edition of WNWDAL and noticed that the etymologies are given also in that version of Webster's dictionary aimed at the *mass* market, I had to give up my European bias against American culture as allegedly primitive.

8. The *performative meaning* of spells ("say 'friend' and enter") fascinated the author of *The Hobbit*. He appreciated the "decorative" value of *spelling* no less than the Editor of *Connections* who adorned the back cover with samples of text looking exotic for those knowing solely English. The *Appendices* to *The Return of the King* tell much about the alphabets and very little about the grammar of Middle-earth languages. Tolkien made his English-speaking readers aware of the existence of a multitude of languages having each its own mysteries, but he did much less to shake the belief of "naive" native speakers of English that other languages differ from English only in that they have bizarre words. The reader of *The Lord of the Rings* will not learn from the *Appendices* how the Common Speech differs from Elvish languages in grammatical structure. The difference Tolkien wanted to stress is that ē *koin*ē *dialektos* of Middle-earth serves to enable communication within and between all "races," while Elvish languages are more suitable for magic and poetry than for everyday use. Thus, he claimed that some languages are a better medium for elevated discourse. Unlike the "foul" language of orcs, or Black Speech whose sounds themselves hurt the ears, and esthetically neutral Common Speech, *Quenya* and *Sindarin* are – according to Tolkien – characterized by a kind of musical beauty. Does the Greek name of INSNA sound beautiful? For me, yes. Try to read aloud *Diethn**e**s D**i**ktyo gia tēn An**a**ly*sē *Koinōnikōn Dhikt**y**ōn*, with stress on vowels marked bold (read *gia* as "ya").

Tolkien's philosophy of language has a more irksome point than his belief in natural inequality of languages. His work is, to be sure, the most impressive eulogy on Western civilization ever written, but one fundamental principle underlying this civilization has apparently been forgotten or neglected by the author. It is the principle that you must not exclude from the *moral* community anyone with whom you can *communicate*. The principle, most radically rejected by those responsible for the Holocaust, was professed, in particular, by Christian missionaries who objected to the extermination of "native Americans" by the conquerors of the New World.

Orcs had "developed as many barbarous dialects as there were groups or settlements of their race," but in the Third Age they "used for communication between breed and breed the Westron tongue" – the Common Speech used also by other races. However, these humanoids have never been taken prisoners by the noble races nor any attempt has ever been made to bring them out of darkness to light. Tolkien's ethics was not unequivocally Manichaean (see Tom Shippey's excellent books: *The Road to Middle-earth*, 1993, and *JRR Tolkien, Author of the Century*, 2000) but certainly more Manichaean than Christian, as if the author believed against his Church that there is no way back from Shadow. However, one must remember that *The Lord of the Rings* is not a holy book but a fairy tale. And in fables speaking monsters are not converted but killed. By the way, Tolkien also wrote a short story (*Farmer Giles of Ham*) in which an English-speaking dragon is not killed but gets nearly domesticated.

Tolkien has been appreciated in the Western world, including his homeland, yet highbrow critics are still reluctant to rank *The Lord of the Rings* among top masterpieces of English literature. I learnt a little about this when I came to London in July 1995 to attend the *International Conference on Social Networks*. As usual on such occasions, I did a lot of sightseeing. In Westminster Abbey, I asked an usher to lead me to the memorial plaque devoted to Tolkien. He responded to my request with a question "Do you think Tolkien should be commemorated here?" I said "I think so because he is the greatest English writer." Such a bold answer annoyed my guide as he heard the opinion he apparently didn't share, in addition, expressed by a foreigner as he could easily recognize from my accent. Recall that it happened in 1995 when nobody knew that Tolkien would become the author of the (20th) century. The usher's next question was more or less like that addressed to Bilbo by Smaug (see Shippey 2000, p. 38): "Who are you and where do you come from, may I ask?" I was not surprised at all, as I knew that hobbits are a somewhat xenophobic people. They don't like to be taught by outsiders. Today, I would say that there is another reason for which the English should put (if they didn't yet) a memorial for Tolkien in their national shrine, namely, they should be grateful for what he

did to create a positive image of his compatriots. Many Tolkien's fans from outside England tend to think that the English must be likable folks if it is true that the author portrayed them as hobbits.

There is a lot of information about Tolkien's languages in the Web, yet it is not quite clear what comes from Tolkien himself and what was added by Tolkienologists. I asked about this Ryszard Derdziński, Polish specialist in Tolkien's languages. He said that Tolkien endowed *Quenya* and *Sindarin* with complete grammatical systems so that producing meaningful statements became possible. Here are Richard's translations of INSNA into two Elvish languages.

Mittanórëa Raimë Minasuriéva Lienatsion (Qyenya)
Minarnadui Rem e Cened an Gwaith-Rem (Sindarin)

Richard claims that *Raimë* and *Rem* (*net*) appear in the dictionaries created by Tolkien himself.

As a *philologist*, Tolkien was interested in the history of words, especially *proper names*. He was not a *structural* linguist, yet he did appreciate the role of grammar, even if he skipped that topic in *Appendices E* and *F* – as I guess – because he knew that ordinary readers of *The Lord of the Rings* wouldn't be interested in the grammatical structures of Elvish languages. Anyway, it was the finding of a manual of Finnish *grammar* (as it were, very different from English) that gave rise to Tolkien's interest in new language worlds far from those he had already been familiar with (Latin and Greek, Romance and early Germanic languages). He wrote about his encounter with Finnish that it "was like discovering a complete wine-cellar filled with bottles of an amazing wine of a kind and flavor never tasted before." (*The Letters of JRR Tolkien*, 1995, p. 214). "*Beauty*: that was what pleased him in Welsh; the appearance and sound of the words almost irrespectively of their meaning." (Tolkien's biography by Carpenter, p. 64).

Quenya and Sindarin are based on Finnish and Welsh, respectively. Let the readers of *Connections* judge themselves if Professor Derdziński's translations of INSNA into Quenya and Sindarin show some affinity with the Finnish (two versions) and Welsh names given on the back cover.

9. Once we know how INSNA looks and sounds in Greek, let's try to construct the Latin name. By the way, what about the third least known sacred language of the Europeans? Does INSNA have any members in Israel who could provide the Hebrew name? It would be nice to put it next to the Arabic name which is already on the back cover if I correctly recognize the writing.

Is a Pole the right person to propose the Latin translation of INSNA? Latin was used by all educated people for 6 out of 10 centuries of Poland's history and was taught to the Polish nobility in Jesuit schools until the age of Enlightenment. The language of ancient Romans was probably easier to learn for Polish than British students because it shares with Polish many grammatical constructions alien to English.

Having found in a Latin grammar *genetivus pluralis* of neuter nouns like *mare* (sea) and *rete* (net), I present below my Latin translation of INSNA:

Rete Internationalis pro Investigatione Retium Socialium

Like Greek Latin is a "xenophobic" language. That's why I decided to put here *investigatio* (*investigatione* is the *ablative* form required by the preposition *pro*) which is a more general term than analysis. *Investigatio* sounds nice and serious, and makes the whole phrase purely Latin.

In *ancient* Greek, *analysis* (ανάλυσις, simplified to ανάλυση in modern Greek) means loosening (ties) or becoming loose, releasing (from bonds), and solving (a puzzle). Latin does without this word because it has its own verb *solvo* (solve, dissolve) and the derived noun *solutio*. Similarly, in Polish you can *rozwiązać* (*roz-* is a prefix corresponding to Greek *ana-*, while *wiązać* means "to tie") any tie, including marriage, as well as a problem or equation. *Analysis* appeared in the philosophical and scientific discourse owing to Aristotle who gave to this term a more abstract meaning. In this meaning, the term passed to all European languages.

"He that breaks a thing to find out what it is has left the path of wisdom" replied Gandalf to

Saruman saying "The white light can be broken" (unfortunately, the intellectual duel between Gandalf and Saruman the First Deconstructionist turned into a fight with staffs in the movie version of the *The Fellowship of the Ring*). A linguistic structural analysis of the type I'm doing here does not break a simple thing into components hidden behind apparent unity or homogeneity. What is analyzed is already recognized as a complex whole. What remains to be done then is to identify the components and to describe the ties between them. In order to reveal a tie, one must often "loosen" it, for example, by considering a replacement of Christmas with Easter in "Christmas tree."

10. The least specific component of INSNA is the preposition *for* joining IN with SNA. Barry Wellman sent to Socnet the following comment on this matter.

"In the colloquy, 'for' is seen as meaning a Tool. But the meanings I had in mind were more on the line of people who are doing and/or promoting social network analysis. There is a similar construction in 'Science for Peace'"

In light of what Barry wrote, it becomes clear that *for* in *IN for SNA* points to "purposiveness" rather than strict "instrumentality" ("a pill for a headache") and certainly not to "substitution" ("Some people take science for religion") or "causality" ("The university is famous for having a Nobel prize winner among its faculty"). In other words, *for* has the same meaning as Latin *pro* in *Scientia pro Pace* or *Missa pro pace* (the title of a recent composition by Kilar).

It was the knowledge of the Latin preposition *pro* that helped me grasp the meaning of English *for* in *Science for Peace*. However, Latin ceased to be the language which provides the users of other languages with a system of "standard" meanings. What remained is the use of Latin names in the biological sciences (to check that the English word *starling* and Russian word скворец, *skvorets,* mean the same, it suffices to know the Latin name of this bird, *sturnus*). The role of Latin as the language of *international* scientific discourse is played today by English. Thus, a translator of INSNA into his native language should first consult a monolingual dictionary of English to get familiar with all uses of *for* (17 in *Oxford Advanced Learner's Dictionary*), trace the one which fits best *IN for SNA* and find next the best counterpart in his own language. The problem faced on this last step is that the system of prepositions in the translator's native language may considerably differ from English.

In general, languages vary in the way in which relations between words are expressed. English and Romance languages use prepositions only (with minor exceptions as *Saxon genitive* in English and *genitive* case in Rumanian, *un om=a man*, *unui om=of a man*, *omul=the man*, *omului=of the man*). German and modern Greek have both prepositions and cases which form a relatively simple system compared to Latin and most Slavic languages. Hungarian and Finnish, instead of cases and prepositions, have *many* case-like endings (often called *postpositions*) which are glued to the basic form of a noun.

Bulgarian is an exception among Slavic languages. The lack of cases (even the genitive case is expressed by the preposition *na=of*), the presence of articles and a more elaborate system of tenses make this language a sort of English with Slavic vocabulary. My translation of INSNA into Bulgarian is as follows.

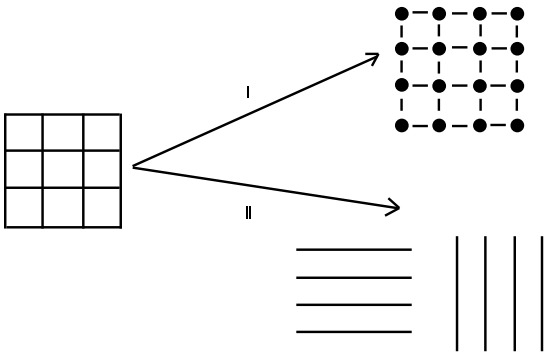
Международната Мрежа за Анализа на Обществени Мрежи

(*mezhdunarodnata mrezha za analiza na obshtenstvenni mrezhi*). The difference between Serbo-Croatian *za analizu* and Bulgarian *za analiza* is worth commenting, yet I will spare you the explanation, turning your attention only to the fact that Southern Slavs have a common word for *net* (*mreža*, Serbo-Croatian; мрежа, Bulgarian) different from that of Eastern and Western Slavs (*sít'*, Czech; *sieć*, Polish; *sieť*, Slovak; сеть, Russian).

11. Unlike Slavic and Romance languages, Germanic languages have *network* (*Netzwerk*, German) besides *net* (*Netz*). The *Oxford Advanced Learner's Dictionary of Current English* (7th edition, 2005) does not treat *-work* as a suffix, possibly because there are too few nouns which end up with

work. I know only three such words, *framework*, *network*, and *patchwork*, which all seem to represent something more *elaborate* (*labor*=work) than a frame, net or patch. According to that dictionary, a *network* is: (1) a complicated system of roads, lines, tubes, nerves, etc. that cross each other and are connected to each other; (2) a closely connected group of people, companies, etc. that exchange information; (3) a number of computers connected together; (4) a group of radio or TV stations. My pocket edition of *Webster's New World Dictionary of the American Language* doesn't have (3) – it was published in 1987 – and the counterpart of (4) is marked as particular to the Radio and TV special vocabulary. The two general meanings of *network* are presented in WNWDAL by means of the following succinct descriptions: "(1) an arrangement of parallel wires, etc. crossed at intervals by others so as to leave open spaces; and (2) anything like this, as a system of interconnected roads, individuals, etc." The first statement invokes both stuff ("wires, etc.") and "geometric" shape of the defined object, yet it does not force us to interpret a network as a *system* made up of certain *components* and *connections* between them. The same can be said about the second, more *abstract* statement ("anything *like* this").

He that breaks a thing – the one named *network* in Webster's dictionary – to find out what it is can do this in at least two ways shown below. He that performs the analysis of type I has not left the path of wisdom but entered the path of *graph theory*.



When you visit the INSNA homepage in order to *see* a *social* network, you will find a picture of a group of people seen through the magnifying glass, symbolizing *scientific* research. Imagine you are a *sociologist* new to SNA who would like to guess what it is from the picture without reading the text under it. Your first thought would probably be that *Social Network Analysis* is an alternative name for the *Interaction Process Analysis* or *SYMLOG* (observation techniques devised by Robert Bales (1916–2004) to study small discussion or decision-making groups). To show that SNA deals with social *relational* structures, one needs a picture in which *social actors* and *ties* between them are drawn as points and lines. However, a *sociogram* – as being only a *visualization* of a social relation – should not be confused with the relation itself.

For me – as a *mathematical* sociologist – SNA or at least its most essential part consists in *modeling* complex *social objects* by *directed* or *undirected graphs*, and related set-theoretic constructs. In the simplest case, a *social network* is a *directed graph* $G=(X,R)$ such that X is a *finite* set whose elements (called *points*, *nodes* or *vertices* of G) are certain *social* entities (members of a small social group, Florentine families, nation-states, etc.), while R is a *social* relation in X. *Binary relations* in X are subsets of the *Cartesian product* $X\times X$ which is defined as the set of all *ordered pairs* (x,y) where $x,y\in X$. The term *social* can be referred to any subset R of $X\times X$ if ordered pairs in R meet a condition stated in terms of some *sociological data*. To give an example, let xRy if and only if x chooses y when asked to name his friends in X. In general, it is up to a *social scientist* to distinguish between social and nonsocial objects, and similarly between social and nonsocial relations. In the eyes of a mathematician, these distinctions do not matter because mathematics deals with *formal*, *structural* or *abstract* properties of *any* complex entities; roughly speaking, the properties that are independent of the material, concrete nature of the

elements which make up a given whole. For example, to study *structural* properties of the digraph (X,R) where $X=\{M,T,D\}$ and $R=\{(M,D),(T,D)\}$, you need not know that T, M, and D stand for myself, my wife, and our daughter and R is the parenthood relation.

A *directed graph* (*digraph*, for short) is a special case of a *mathematical object*, or a *set endowed with a structure of a given species*. *Structure* as a generic term appeared in Bourbaki's *Eléménts de mathématique* (Livre I: *Théorie des ensembles*, Chapitre 4: *Structures*; Paris 1957; see N. Bourbaki, *Theory of Sets*, 1968 which is the English translation of Book I of this voluminous treatise written by a group of French mathematicians using the nickname Nicolas Bourbaki).

> Binary relations are just one general type of structures. Two other most important general types are *algebraic* structures and *topological* structures. Algebraic structures have the form of operations satisfying certain axioms (e.g. associativity), an *operation* in X being defined as a mapping from $X\times X$ to X. A *topological* structure in X can be defined as a *family* $\boldsymbol{T}$ *of open sets*, or a collection of subsets of X which meets the following axioms: (1) the empty set $\varnothing$ and X are open sets; (2) the *intersection* of any two open sets is an open set (if $A\in\boldsymbol{T}$ and $B\in\boldsymbol{T}$ then $A\cap B\in\boldsymbol{T}$); (3) the *union* of any collection of open sets is an open set.
>
> That's how unbelievably *simple* are conceptual foundations of *algebra* and *topology*, two basic mathematical disciplines built over *set theory*. The topology axioms should be intelligible to anyone familiar with elementary set-theoretic terms (*union* and *intersection* of two or more sets), even if one doesn't know that they suffice to build a rich mathematical theory which gives a formal shape to the concepts of closeness, convergence and continuity. Unfortunately, the students of the social sciences are usually apprehensive of *structuralist mathematics* because they feel uneasy in the world of *abstract* entities where intuition supported by sensual experience may fail. Those who, like Thomas Fararo (*Mathematical Sociology. An Introduction to Fundamentals*, 1973), embark on teaching more abstract mathematics to sociologists usually begin from introducing "visible" structures, such as the 2- or 3-dimensional Euclidean space, the definition of a general *metric space* being given at the next step.
>
> Let me quote this definition which is both simple and intuitively meaningful. A set X with a mapping d (called *distance* or *metric*) of $X\times X$ into the set of real numbers is called a *metric space* if d satisfies the following simple axioms: (1) $d(x,y)\geq 0$, $d(x,y)=0$ iff $x=y$; (2) $d(x,y)=d(y,x)$; (3) $d(x,y)\leq d(x,z)+d(z,y)$. If X is a two-dimensional plane, then the *Euclidean distance* of two points of X is defined as the length of the *segment* joining them, and Axiom 3, known as the *triangle inequality*, acquires a more concrete *visible* meaning.
>
> Given a metric space (X,d), for any $x\in X$ and any $r>0$, the set $B(x,r)=\{y\in X: d(x,y)<r\}$ is called the (open) *ball* with *center* x and *radius* r (the ball consist of all points whose distance from x is smaller than r). A subset A of X is said to be *open* if for any $x\in A$ there is an $r>0$ such that $B(x,r)\subset A$. The last definition is the gate from the world of metric spaces to the world of general *topological spaces*.

In general, to define a *species of structure*, one has to specify its *type*, or to show how to *construct* any *structure* S of the given species from the elements of the *base set* X. Next, if needed, one can narrow down the range of structures that will form the given species by imposing certain axioms on X and S. For example, having defined binary relations, one can define in turn a *subspecies* of this species by adding the *axiom of symmetry*: for any $x,y\in X$, if xRy, then yRx. xRy and $R(x,y)$ are commonly used ways of writing the condition $(x,y)\in R$. Sometimes (yet not here) this alternative notation is used to inform that R is a *two-argument predicate* for which a *set-theoretic interpretation* has not yet been indicated rather than a relation in a *fixed domain* X.

A mathematical object of the form (X,R), where R is a *symmetric* binary relation, is called an *undirected graph* or simply *graph*. Graphs are also defined as mathematical objects of the form (X,L) where L is a collection of nonempty subsets of X, each of them having at most two points, or exactly two points according to the prevailing convention. Elements of L are called *lines* or *edges* of a graph. By representing any pair $\{x,y\}$ in L with two ordered pairs (x,y) and (y,x), we get a symmetric binary relation in X, and conversely, given a symmetric relation R in X, we construct L as the set of $\{x,y\}$ such that xRy.

Although some material is always needed to construct a structure S, the *substantive* nature of the elements of X is unimportant because one may replace (X,S) with any other mathematical object (Y,T) such that T is of the same species and the two objects are *isomorphic*, that is, there exists a 1–1 mapping φ of X onto Y which transforms S onto T. Given two directed graphs, $G_1=(X_1,R_1)$

and $G_2=(X_2,R_2)$, φ is an isomorphism of G_1 and G_2 if and only if it meets the following condition: $\varphi(x)R_2\varphi(x')$ if and only if xR_1x', for any $x,x'\in X_1$.

For example, consider the digraph (*drawn* as $M\rightarrow D\leftarrow T$) which is a *graph-theoretic model* of my nuclear family. You will not learn from the digraph alone that *T* and *M* are *hombre y mujer* and are married. Similarly, if I didn't tell you this, you wouldn't know that the arcs (*T*,*D*) and (*M*,*D*) *formally* express the fact that Tadeusz and Maria are biological parents of Dominika. All structural information about the modeled object provided by the model is also contained in the digraph $1\rightarrow 2\leftarrow 3$ obtained from $M\rightarrow D\leftarrow T$ by replacing 3 mortals with 3 eternal natural numbers.

Although graph theory can help sociology clarify its understanding of structure, certain important general theoretical distinctions cannot be expressed in the mathematical language. An *empirical* structure may mean either a *constraint* on social behavior or an observed *pattern*, but the intended interpretation cannot be deduced from the model itself. To give an example, let us take as *X* a set of places in a town and define *R* by the following condition: *xRy* iff *x* and *y* are joined by a street which is open to traffic in the direction from *x* to *y*. The relation *R* formally depicts the *constraint* on the movement of vehicles in the urban space. Suppose that, for some *x* and *y*, *xRy* but *not yRx*. Then the street joining *x* an *y* is either too narrow or the one-way traffic has been imposed by a *social norm*. Thus, the distinction between *physical* and *social* constraint doesn't find expression in the model.

To describe a traffic *pattern*, you need to construct another digraph with the same point set *X*. Let *xR'y* if the observed intensity of the traffic from *x* to *y* exceeds a given level. If you forget the empirical definitions of two relations in *X*, you will not be able to guess which of them models the constraint on traffic and which shows the traffic pattern. However, if the interpretation of *R* and *R'* is known, one can define *conformity* by means of a purely mathematical formula $R'\subset R$. Most of what can be said clearly can be said in the language of mathematics.

Directed graphs suffice to model many empirical systems, yet sometimes one needs more general constructs. If a street joining *x* with *y* has more than one lane and a car going from *x* to *y* can change lanes before reaching *y*, then the ordered pair (*x*,*y*) adequately renders the possibility of traveling from *x* to *y*. However, (*x*,*y*) will also be used to describe the situation in which there exist two separate roads from *x* to *y* such that when one of them is chosen at *x*, then a change to the other road is no longer (physically or socially) possible. In order to give a formal meaning to the above distinction, one has to introduce *arcs* as the second type of unspecified elements and allow for the existence of two or more distinct arcs from *x* to *y*. Formally, given two *base sets*, the set of points *X* and the set of arcs *A*, the *structure F* is defined as a mapping of *A* into $X\times X$. The mathematical object (*X*,*A*; *F*) thus obtained was called a *net* by Harary, Norman, and Cartwright in their classical work *Structural Models. An Introduction to the Theory of Directed Graphs* (1965).

Any net (*X*,*A*; *F*) generates a binary relation *R* in *X*: $R=\{(x,y)\in X\times X: (x,y)=F(a) \text{ for some } a\in A\}$. Two distinct arcs *a* and *b* are said to be *parallel* if $F(a)=F(b)$. A directed graph can now be defined as a net having no parallel arcs. The absence of parallel arcs implies the existence of a 1–1 correspondence between *A* and *R*. As a consequence, one can eliminate *A* and *identify* arcs with ordered pairs of points.

12. I read *Structural Models* soon after Flament's *Applications of Graph Theory to Group Structure*. I would still recommend Harary, Norman, and Cartwright's book as the best source of knowledge about graphs for social scientists. I had the pleasure and honor to meet the first author in 1995 during the XVth Sunbelt (4th European) social network conference which was held in London.

> Having presented my own paper, I did no longer show up at Docklands, yet when I learned that Frank Harary was there, I could not miss the opportunity to see the pope of graph theory, so I joined the line of those waiting in the lobby for an audience. When my turn came, Harary asked me to put down the cigarette and stand a few steps away from him. I did what he wanted me to do (two months later I stopped smoking for ever) and our conversation could begin. I said to Harary that I had always

admired his art to combine work in pure mathematics with interest in graph theory applications in the social sciences. He replied that he had devoted most of his life to *mathematical* graph theory, so the combination of his mathematical and nonmathematical activities had actually been highly imbalanced.

Nevertheless, social psychology owes to him the formalization of Heider's concept of balance as a structural property of a *signed graph* modeling a cognitive system ("On the Notion of Balance of a Signed Graph." *Michigan Mathematical Journal* 2, 1953:143–146). I also remember a note, co-authored by Per Hage, *Sex in Bipartite Graphs* which appeared in 1994 in *Connections* 17/1 (by the way, that issue of our journal is still missing on INSNA website). The problem discussed there can be stated as follows. Consider an undirected graph such that its point set consists of *m* boys and *n* girls, and an edge joining *i*th boy with *j*th girl means that they are permitted to enter into a *monogamous* marriage. For which *bipartite* graphs does there exist a *matching* which *covers* all boys (that is, no boy remains single)? The answer is given by the *König-Hall theorem*.

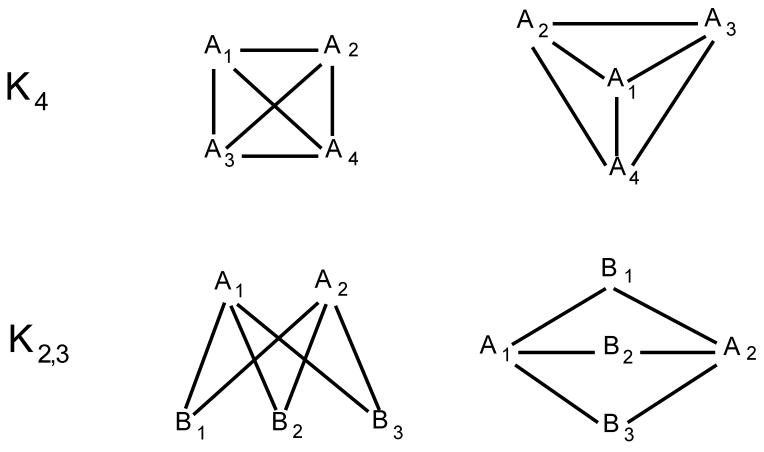
When I read Hage and Harary's note, I didn't notice at once its relevance for the study of *one-exchange networks*. The seed was sown, but a couple of years had to lapse until I discovered that the theory of *matchings* and *coverings* (Ore, *Graphs and Their Uses*, 1963; Harary, *Graph Theory*, 1969, Chapter 10) could be used to formalize the concept of *exclusionary power* and its *strong* and *weak* variety. Armed with the König-Hall theorem, I was able to prove, in particular, a necessary and sufficient condition for a one-exchange network to be *strong power*. You will find these results in Chapter 3 of my book *The Mathematics of Exchange Networks* (Chapters 3,4,5 are available on my web page since 2004); see also my recent paper in *Social Networks* 28 (2006/4).

I planned to dedicate my book to Frank Harary, yet I failed to finish it before he died (January 4, 2005). Harary dedicated his major work (*Graph Theory*, 1969) to the famous Polish mathematician, Kazimierz Kuratowski (1896–1980). The dedication, illustrated with the *pictures* of K_5 and $K_{3,3}$, reads as follows.

To Kasimir Kuratowski
Who gave K_5 *and* $K_{3,3}$
To those who thought planarity
Was nothing but topology.

Let me explain the meaning of this pretty technical statement, as it has to do with the topic I've been discussing in this section of my letter, namely, the distinction between abstract (invisible) and concrete (visible) structures.

K_n is an *n*-point *complete undirected graph*, that is, the edge set of K_n coincides with the set $\mathcal{P}_2(X)$ of all 2-element subsets of an n-element set X. $K_{m,n}$, called the *complete bipartite graph*, is an undirected graph such that its point set X is a union of two disjoint sets X_1 and X_2, having, respectively, m and n elements, and its line set consists of *all* pairs with one point in X_1 and the other in X_2. K_4 and $K_{2,3}$ are displayed below in two ways. The second picture differs from the first one in that the lines corresponding to any two edges do not cross or their intersection reduces to a common endpoint of the two lines.



In general, to construct a *geometric representation* of a net $(X,A; F)$ in the *Euclidean plane* (more generally, in a metric or topological space), one must first establish a 1–1 correspondence between X and a set $\{P_x: x\in X\}$ of points of the plane. Next, to any arc $a\in A$ such that $F(a)=(x,y)$, there must be assigned a curve C_a from P_x to P_y. A *curve* is formally defined as a set of the form $C=\{f(t):t\in[0,1]\}$ where f is a *continuous* mapping of the closed interval $[0,1]$ into the plane. If $f(0)=P_x$ and $f(1)=P_y$, C is called a *curve from P_x to P_y*. Such a curve is drawn as a continuous line joining the two points, with an arrow showing the direction ($P_x \rightarrow P_y$). A representation of a net in the Euclidean plane is called *planar* if the curves corresponding to any two arcs intersect at best at one or two their common endpoints. A *planar net* is defined as a net which admits of a planar representation. The existence of such a representation does not depend on whether the net contains parallel arcs or loops.

The term *loop* is referred to any arc whose beginning and end coincide. The absence of loops, or the condition that $(x,x)\notin R$, for any x, is usually included in the definition of a directed graph (in particular, Harary, Norman, and Cartwright use this condition to distinguish digraphs from relational systems). I do not recommend this convention because loops naturally appear in some important interpretations of arcs. If X is interpreted as the set of states of a dynamical system and relation R describes inter-state transitions, then an arc (x,x) in R means that the system cannot leave a state x. Some social relations may also have loops; for example, if a soccer player is asked to point out all his team members who contributed most to the team's victory, it would be unreasonable to prevent him from naming himself.

Planarity does not depend on the direction of arcs, either. Therefore, to solve the problem of characterizing planar nets, it suffices to consider only undirected graphs. Moreover, if $\{x,y\}$ and $\{x,z\}$ are the only lines of a graph which contain a point x, then the graph obtained by removing x from X and replacing $\{x,y\}$ and $\{x,z\}$ with $\{y,z\}$ is planar iff the original graph is planar. All *isolated* and *hanging points* (those which occur in no line or exactly one line) can also be deleted, so that one needs a criterion for planarity only for the graphs such that $deg(x)\geq 3$ for any $x\in X$, the *degree* of x being defined as the number of lines having x as their common endpoint.

Kuratowski proved that such a graph is planar iff it does not contain a *subgraph* isomorphic with K_5 or $K_{3,3}$. K_4 and K_5 are not isomorphic because they differ in number of points. However, both graphs contain all connections possible in a finite set of points, so they have very similar structure. Despite this similarity K_5 can't be drawn in the plane in same way as K_4 is drawn in the second picture! The possibility to visually represent an *abstract* system in such a way that its *image* has certain *topological* properties depends on the system's structure, yet the structure itself is defined as a set-theoretic construct which need not be conceived as existing in any visible τόπος (place). The aim of Harary's dedication was apparently to remind those for whom graph theory was *nothing but topology* that a graph is a more abstract system than the layperson may guess from its name (γράφω, I write). On the other hand, the Wikipedia article devoted to Harary has the following curiosity: "Lore also claims that, when asked to referee, Harary rejected any paper that did not contain a picture."

13. Given a net $(X,A; F)$ and a nonempty set V, one can construct a *V-valued net* as a more complex mathematical object $(X,A,V; F,v)$ with an additional structure defined as a mapping v of A into V. Similarly, we get a V-valued directed and undirected graph. In mathematics, new concepts are always defined with the intention to point out new research areas, interesting in themselves or bearing on actual or potential applications in other mathematical disciplines or empirical sciences. If a new species of structure is defined with the use of an *auxiliary* base set V, one usually assumes that V is structured itself. For example, the theory of *signed graphs* deals with undirected graphs whose edges are assigned values in the two element set $\{+,-\}$ which is endowed with an algebraic operation $\bullet$ defined by the following formulas: $+\bullet+ = -\bullet- = +$, $+\bullet- = -\bullet+ = -$.

The most important auxiliary set used to construct many species of structure is certainly the set of *real numbers* $\mathbb{R}$. In structural mathematics, $\mathbb{R}$ is defined as a set endowed with an *order relation* ($\leq$) and two algebraic operations, *addition* ($+$) and *multiplication* ($\cdot$).

These three interrelated structures in $\mathbb{R}$ are assumed to satisfy a number of axioms which can be divided into five groups:

(A) Axioms which define the continuous order relation. (A1) For any $r,s\in\mathbb{R}$, if $r\le s$ and $s\le r$, then $r=s$; (A2) For any $r,s,t\in\mathbb{R}$, if $r\le s$ and $s\le t$, then $r\le t$; (A3) For any $r,s\in\mathbb{R}$, $r\le s$ or $s\le r$; (A4, *continuity*) For any $S\subset\mathbb{R}$, the set $M(S)=\{r\in\mathbb{R}$: for any $s\in S$, $s\le r\}$ is either empty or has the smallest element noted *sup*(S) and called the *upper bound* of S ($r_0\in M(S)$ is the smallest element of $M(S)$ if $r_0\le r$, for any $r\in M(S)$).

(B) Axioms characterizing addition in $\mathbb{R}$. $(\mathbb{R},+)$ is a *commutative group*, that is: (B1) For any $r,s,t\in\mathbb{R}$, $r+(s+t)=(r+s)+t$ (*associativity*); (B2) there is an element in $\mathbb{R}$, labeled 0, such that $r+0=0+r=r$, for any $r\in\mathbb{R}$; (B3) For any $r\in\mathbb{R}$, there is an element labeled $-r$ such that $r+(-r)=(-r)+r=0$; (B4, *commutativity*) For any $r\in\mathbb{R}$, $r+s=s+r$.

(C) Axioms characterizing multiplication in $\mathbb{R}$. $(\mathbb{R}-\{0\},\cdot)$ is a commutative group, that is: (C1) For any $r,s,t\in\mathbb{R}-\{0\}$, $r\cdot(s\cdot t)=(r\cdot s)\cdot t$; (C2) There exists an element in $\mathbb{R}-\{0\}$, labeled 1, such that, for any $r\in\mathbb{R}$, $r\cdot 1=1\cdot r=r$; (C3) For any $r\in\mathbb{R}$, there is an element labeled r^{-1} such that $r\cdot r^{-1}=r^{-1}\cdot r=1$; (C4, commutativity) For any $r,s\in\mathbb{R}$, $r\cdot s=s\cdot r$.

(D) The axiom connecting the two operations in $\mathbb{R}$: (D1) For any $r,s,t\in\mathbb{R}$, $(r+s)\cdot t=r\cdot t+s\cdot t$.

(E) Two axioms relating order to addition and multiplication: (E1) For any $r,s,t\in\mathbb{R}$, if $s\le t$, then $s+r\le t+r$; (E2) For any $r,s,t\in\mathbb{R}$, if $0\le r$ and $s\le t$, then $r\cdot s\le r\cdot t$.

The axiomatics for real numbers given above comes from my notes I wrote up when I attended the lectures of *Mathematical Analysis* by Professor Stanisław Łojasiewicz (1926–2002). He designed his two-year course as a self-contained deductively ordered exposition of *la mathématique tout court* rather than *Calculus* only. I replaced here *les mathématiques* with *la mathématique* after Bourbaki who decided to "correct" ordinary French in order to stress the double unity of mathematics, methodological and substantive, which consists in the use of one deductive method to study a multitude of *espèces de structure* which, however, are all obtained by applying the same set of simple construction procedures.

Łojasiewicz started his lectures from introducing basic set-theoretic concepts. He assumed only the prior knowledge of *natural numbers* as if he agreed with Kronecker that God gave us only this most fundamental (and now we know most mysterious) *mathematical domain*, leaving to ourselves the construction of the rest of the *mathematical world*. Having just mentioned Cantor and Dedekind's theorems on the *existence* of a mathematical object $(\mathbb{R},\le,+,-)$ satisfying axioms (A1)–(E2) – such an object is called a *continuous ordered field* – Łojasiewicz did not spare his students a detailed proof of the fact he found more important than the possibility to *construct* real numbers, namely, the fact that any two continuous ordered fields are isomorphic. "Uniqueness up to isomorphism" is required of any auxiliary mathematical object which is used to construct more complicated objects. The set $\{+,-\}$ with sign multiplication is a *two-element group* which is unique up to isomorphism.

Tortured with trigonometric equations in high school, I chose sociological studies. Fortunately, for me, yet to the dismay of all my colleagues, *formal* logic was then in the curriculum. Having felt the foretaste of abstract mathematics for the first time at the classes of logic, I enrolled in parallel mathematical studies which I completed in 1975 with M.Sci. degree. Out of many outstanding professors of mathematics whose lectures I attended during my studies at the Jagiellonian University I must name Łojasiewicz – the one to whom I owe the discovery of *mathematical structuralism*, the discovery which also had a decisive influence on my understanding of *social* structure and sociological structuralism.

"A *network N* may be regarded as a graph or directed graph together with a function which assigns a positive real number to each line." (Harary, *Graph Theory*, 1969, p. 52). The term *network* – defined so or a bit more generally as an $\mathbb{R}$-valued digraph or graph – which appeared in mathematics at least 50 years ago, gained *theoretical* importance due to the *maximum flow minimum cut theorem* proven in 1956 by Ford and Fulkerson (Wikipedia informs that an independent proof was published at the same time by Elias, Feinstein, and Shannon, mathematicians known for their contributions to *information theory*). The *algorithm* Ford and Fulkerson had invented to prove their theorem and the theorem itself became widely known when the authors published the results in their book *Flows in Networks* (1962). In *applied mathematics* (more exactly, its branch called *operations research*), the term *network analysis* has since then been associated with solving certain *optimization problems* stated in network contexts, first of all, the problem of determining the maximum flow in a *transportation network* where arcs are interpreted as *channels* (roads, pipes, etc.) and weights as their *capacities*. The maximum flow minimum cut theorem has also had an impact on *pure* graph theory. Network flows are the topic of the *first* chapter of Berge's book *Graphes et hypergraphes* (1970, an English translation was published 3 years later).

The translation of Berge's first book on graphs *Théorie des graphes et ses applications* (1958) which appeared in 1961 was to my knowledge the first handbook of graph theory published in English. The next two books *Theory of Graphs* (1962) and *Graphs and Their Uses* (1963), the second being addressed also to nonmathematical audience, were written by the Norwegian mathematician Øystein Ore. Let me mention another early book missing in the SNA bibliography given in Wasserman and Faust's work (1994): Robert B. Busacker and Thomas L. Saaty, *Finite Graphs and Networks. An Introduction with Applications*, 1965.

Claude Berge was no less prominent figure in graph theory than Frank Harary. Unfortunately, his passing away (2002) unlike Harary's went unnoticed in *Connections*. A long time ago, when I dealt with signed graphs, I read the chapter on *cyclomatics* in *Graphes et Hypergraphes*. More recently, I needed Berge's theorem on matchings to analyze one-exchange networks. I have never met the author in person. I suppose that Claude Flament could tell us many interesting stories about his great teacher.

In discussing hypergraphs, Wasserman and Faust refer to Berge's monograph *Hypergraphs. Combinatorics of Finite Sets* (*Hypergraphes. Combinatoire des ensembles finis*, 1987; English translation, 1989) which was published when the author found that graphs and hypergraphs deserved of separate books. A *hypergraph* is a mathematical object of the form (X,E) where X is a finite set of *points* and E – called the *set of generalized edges* or simply edges – is a nonempty collection of nonempty subsets X. If every edge consists of one or two points, we get the ordinary notion of an undirected graph (with loops permitted). Every hypergraph can be represented by a bipartite graph whose point set is a union of X and E and the line set consists of all pairs $\{x,e\}$ such that $x\in X$, $e\in E$, $x\in e$. Hypergraphs and bipartite graphs have been used in SNA to model *affiliation networks* (see Wasserman and Faust 1994, Chapter 8).

My interest in hypergraphs has to do with my recent study of "blocking coalitions" (see section Voting Games on my web page) in the *theory of voting*, an important branch of *mathematical political science.* A hypergraph (N,W) where N and W are referred to as the set of *voters* and the set of *winning coalitions*, respectively, is called a *voting game* if the following axioms are met: (1) $N\in W$; (2) If $C\in W$ and $C\subset D$, then $D\in W$; (3) if $C\in W$, then $N-C\notin W$.

A *social* scientist will find basic information on networks in Harary, Norman, and Cartwright's book. In the last chapter of *Structural Models,* we read (p. 363): "Many different kinds of 'values' may be assigned to the lines of a network ... Although we shall deal primarily with numerical values, nonnumerical ones are also permitted." Myself, I would prefer to reserve the term *network* for $\mathbb{R}$-valued nets, digraphs or graphs, however, without the restriction, which appears in the statement quoted from Harary's *Graph Theory*, that only *positive* real numbers are admitted as weights. If so, a signed graph can be identified with a network whose edges are assigned each one of two numbers 1 or −1.

Every time we use real numbers in empirical sciences, we have to point out the intended *level of measurement*. In particular, a real number assigned to an arc may be interpreted as a quantitative estimate of how *strong* a network tie is, say, how strong is the affection of x for x'. The intended level of measurement has implications for the way in which *network isomorphism* is defined. Under interval measurement, two $\mathbb{R}$-valued nets $(X,A,\mathbb{R}; F,v)$ and $(Y,B,\mathbb{R}; G,w)$ are said to be isomorphic if there exist: a 1–1 mapping φ of X onto Y, a 1–1 mapping α of A onto B, and real numbers r and s where $r>0$, such that: (1) the underlying nets $(X,A; F)$ and $(Y,B; G)$ are *isomorphic through* (φ,α), that is, for any $a\in A$, we have $G(\alpha(a))=\varphi^*(F(a))$, where φ^* is a 1–1 mapping of $X\times X$ onto $Y\times Y$ such that, for any $x,x'\in X$, $\varphi^*((x,x'))=(\varphi(x),\varphi(x'))$; and (2) for any $a\in A$, $w(\alpha(a))=rv(a)+s$, that is, the weight of arc α(a) corresponding in B to arc a in A is related to the weight of a through a linear transformation preserving order. If the intensity of a tie is assumed to be measurable on a ratio scale, then condition (2) in the definition of nets' isomorphism simplifies to $w(\alpha(a))=rv(a)$, so that arcs with 0 value can be located independently of measurement scale.

In an $\mathbb{R}$-valued *digraph*, numerical weights are assigned to ordered pairs which form a binary relation R in a finite set X of points. To extend the value function v to $X\times X$, we can assign 0 to all ordered pairs outside R. Let the points be labeled $x_1,...,x_n$. Then, by replacing X with $\{1,...,n\}$, we we can represent the $\mathbb{R}$-valued digraph by an *n×n real matrix* $V=(V_{ij})$ whose *ij* entry equals the value of v for (i,j). The *matrix representation of a network* conveys the same information as the network itself if and only if $v(x,x')>0$ for any $(x,x')\in R$. If the latter condition is not met, then one

couldn't guess from a zero entry in the matrix if an ordered pair is not in R or it is in R but it has been assigned the zero weight. Clearly, ratio measurement must also be assumed for weights for otherwise R would depend on the scale chosen.

14. The presentation of the *mathematics of SNA* would be incomplete without discussing *multirelational systems* which are mathematical objects of the form $(X; R_1,..R_k)$ where $R_1,..R_k$ are binary relations in X. A multirelational system can be regarded as a network $(X,A,\mathbb{R}; F,v)$, where $A=\{(x,x',i): xR_ix'\}$, $F(x,x',i)=(x,x')$, $v(x,x',i)=i$. Such a representation proves useful when $R_1,..R_k$ are interpreted as *ordered* variants of some gradable (yet not measurable in a stronger sense) relationship. For example, an arc (x,x',i) may mean that a member x of a group X has assigned rank i to x' when asked to list other members of X from most to least preferred partner for collaboration. If numerical values are used solely to label relations (mutually exclusive or overlapping), then there is little benefit from representing a collection of relations as *one* $\mathbb{R}$-valued *net*.

As an example of a *qualitative* multirelational system, consider a set X endowed with 3 relations P, M, and S, which can be interpreted, respectively, as *parenthood* ($xPy = x$ is a parent of y), *marriage* ($xMy = x$ is married to y), and *sex identity* relation ($xSy = y$ is of the same sex as x). I have often used this example to explain to my students a few key concepts (those italicized in the passage given below) of the *logical analysis* of formal languages.

> Thus, P, M, and S are *primitive terms* of an *axiomatic theory* of kinship. To build such a theory, one has to point out a number of *well formed statements* that will play the role of *axioms* from which *theorems* could be *deduced*. These same statements would then function as *meaning postulates* needed to jointly give intended meanings to the primitive terms and to restrict the range of their admissible *semantical interpretations*. To give concrete examples, let us first characterize each of 3 relations separately by means of the following axioms: (1) P is *antisymmetric*, that is, for any $x,x'\in X$, if xPx', then *not* $x'Px$ (actually, the parenthood relation is usually assumed to meet the stronger condition of *acyclicity*); (2) M is *symmetric* and *irreflexive* (one may not marry oneself); (3) S is an *equivalence relation* (*reflexive*, *symmetric*, and *transitive*) which induces in X exactly two *equivalence classes* (this is all what can be said on sex without introducing *predicates* "male" and "female").
>
> Let us append to these axioms three other axioms to establish certain relationships among the three primitive relational terms: (4) if xPx', then *not* xMx' (the simplest incest taboo); (5) If xPz and yPz and $x\neq y$, then *not* xSy; (6) if xMx' then *not* xSx'. Notice that Axiom 5 is *satisfied* if P formally describes *biological* parenthood, but it need not be so if P is interpreted as *legal* parenthood. Spain unlike Poland is not a *model of the theory* containing Axiom 5.
>
> A speaker of a natural language for which a *logical formalization* is possible may be unaware of *accepting* a given statement on the basis that it is a meaning postulate. When they hear someone referring the term "marriage" to a relation which holds between two people of the same sex, they respond with saying that "it is not a true marriage" instead of – as a logically educated man should say – "you speak a language in which 'marriage' has a different meaning than it has in my language; if you try to change the *standard* meaning of the term in *my* language, you will face my resistance against the *Kulturkampf* you've launched."
>
> An anthropologist *as scientist* can study the cultures in which marriage is understood in accordance with meaning postulate 6 as well as those in which it has been lifted. However, a scholar is also a member of a definite *cultural community* and as such has the right to remain faithful to the culture he has chosen. When I taught social research methodology at the Jagiellonian University (currently offering "gender studies" at the Institute of Sociology), I used to say to my students at the end of the first lecture which I always devoted to the language of science and the language at large: if you become members of parliament and decide on a bill on equal rights to same sex couples, use at least a different word than marriage for the relation you are going to define in the legal language.

Given a multirelational system, further relations can be *defined* in X by applying to the *primitive relations* two constructions of prime importance to all modern mathematics: the inverse of a binary relation and the composition of two binary relations. Let me recall their definitions given in the most general context in which the term *binary relation* is referred to any subset of the Cartesian product $X\times Y$ of two sets (a subset R of $X\times Y$ is called a relation *between X and Y*; if $X=Y$, R is said to be a relation *in X*). The *inverse* (the term *converse* in also frequently used) of a relation R between X and Y is a relation, noted R^{-1}, between Y and X, made up of such $(y,x)\in Y\times X$ that $(x,y)\in R$. The *composition* of a relation S between X and Y and a relation T between Y and Z is a

relation, noted $T \circ S$, between X and Z defined as the set of those $(x,z) \in X \times Z$ which meet the condition: there is a $y \in Y$ such that $(x,y) \in S$ and $(y,z) \in T$. The construction is feasible, in particular, for any two binary relations in a set, and the output called the *compound relation* is a binary relation in the same set. Thus, by assigning $R_1 \circ R_2$ to any two relations R_1 and R_2 *in* X, we can endow the set of all binary relations in X with an associative algebraic operation.

The *algebraic* approach to the study of binary relations is not alien to SNA. At the very beginning of Chapter 11 (*Relational Algebras*) of their book, Wasserman and Faust (1994, p. 426) warn the reader that he "should be aware at the outset that this chapter contains some of the most sophisticated mathematics in this book." Actually, no matter how *simple* is a mathematical concept, it will be recognized as too sophisticated by those sociologists who tolerate *abstraction* only in "grand theory" or "theories of the first generation" (see J. Szmatka and T. Sozański. "On Four Myths of Sociology and Three Generations of Sociological Theories." *Polish Sociological Review* 1994 no. 3: 219–233) and abhor *formalization* for the complication it allegedly involves.

> I always encourage my students to command the formal language of relations. To learn what they have learned I begin from the tasks like these: (1) given the parenthood relation P as a *primitive* term, try to *define* the *grandparenthood* relation and the *sibling* relation (having at least one common parent), using the notions of composition and inverse; (2) express formally another instance of incest taboo, say, the prohibition of marriage between siblings. *Formalization tasks* usually appear too difficult for sociology students, so I give them in turn *interpretation tasks* such as: (1) express informally the meaning of kinship relations such as, for instance, $P^{-1} \circ P$; (2) what can you say about a society in which $P \circ P^{-1} \subset M$? If such tasks are still too hard, there remain *visualization tasks* such as: draw a picture of your family, including close relations; use graphical symbols → and = to depict the parenthood and marriage relations.

15. "Although some group processes need to be described by means of 3-argument relations (e.g. '*A* tells his opinion on *B* to *C*' or '*A* forms a coalition with *B* against *C*'), *binary* relations usually suffice for modeling interactions between the members of various social groups."

I mentioned *ternary* relations in the above statement (quoted from my article "Sieć społeczna." Pp. 28–33 in *Encyklopedia Socjologii*, vol. 4. Warsaw 2002) in order to suggest an extension of SNA beyond the paradigm in which elementary *units of analysis* are ordered or unordered *pairs* of *social actors*. The dominant *dyadic paradigm* allows for analyzing triadic substructures, yet the source of *information* on a *triad* is the data concerning the three dyads contained in the triad. Hypergraphs are also represented as bipartite graphs with two "ontologically" different types of nodes (actors and sets of actors) – which is a special case of what is called in SNA a *two-mode network*.

To study *ternary* relations like those given in the cited passage, one may need to devise new formal tools. I have not yet made an inquiry into this subject nor am I going to do it in the near future, but I can't help but improvise the following definition that might be useful for studying interpersonal communication in small groups. Consider a ternary relation R in a finite set X; if an *ordered triple* (x,y,z) is in R, we write $R(x,y,z)$. Let us call the relational system (X,R) *bipartite* if X is a union of two nonempty disjoint sets X_1 and X_2 such that, for any x, y, z in X, $R(x,y,z)$ implies $x,z \in X_1$ and $y \in X_2$ or $x,z \in X_2$ and $y \in X_1$. For example, let X be a group which consists of boys (X_1) and girls (X_2). If $R(x,y,z)$ stands for "x talks to z about y," then the class has a bipartite communication structure if boys talk only to boys solely about girls, and girls talk only to girls solely about boys.

16. Our tour around the store of formal tools offered by *discrete mathematics* to SNA has come to an end. Let us go back now to linguistic considerations to compare SNA with similarly constructed terms which are many in science. Any term of the kind doesn't have a definite meaning until it is said both *what* is to be analyzed and *how* such-and-such analysis should be done. The term *data analysis* does not inform of the type of analysis, but solely of the object to be analyzed, namely, some *data*, which term, in its established, very general and abstract but still sharp meaning, is used to denote any collection of values of a set of variables defined on a given set of objects.

A *variable* can be defined – in set-theoretic terms – as a *mapping* of a set (its elements are called *units of analysis*) into another set. Usually, the latter set, or the set of *values*, is the set of real numbers. In particular, a *property* or *attribute* can be regarded as a variable with two values 1 and 0 which inform, respectively, that an object does or does not have a given property. Variables-mappings should not be confused with *logical variables* – symbols x, y, z, etc. (in formal languages) or common nouns (in natural languages) – that enable us to speak of any entities without the necessity to point out concrete elements of appropriate sets.

To prepare a body of data, one needs to construct units of analysis, define variables, and fill out a matrix by retrieving relevant information from a *source base*; the *ij* entry of the *data matrix* is the value of *j*th variable for *i*th unit of analysis All of these *conceptualization* and *coding* operations, which may be *analytic* in themselves, are a prerequisite rather than part of *statistical analysis* which consists in applying a number of special mathematical procedures (e.g., computing certain statistical parameters) to a *given* data matrix (by the way, *data*, the plural of *datum*, means *given* in Latin). By contrast, *content analysis* (see Babbie's *The Practice of Social Research*, Chapter 12) consists of procedures for transforming textual source base into data as well of statistical procedures for analyzing such data. The statistical component, for its little specific nature, contributes much less to the identity of content analysis.

Some procedures of *textual analysis* can be performed by computer programs, while other must be left to experts whose task is to analyze the meaning of what they read. *Hermeneutic* competence is something more than mere ability to decompose a piece of text into certain formal components and recognize their syntactical connections. Let the source base be defined, for example, as a collection of papers written in English which were published over a given time period in sociological journals. Take *papers* and *technical terms* as two types of units of analysis, and, for each term, define a variable on the set of higher level units by assigning to a paper value 1 or 0 if it does or does not contain a given lower level unit (both types of units are defined as pieces of text). Statistical analysis of the 0–1 variable associated with the term *network* could be the first step toward generating a comprehensive SNA bibliography. Nowadays, the term is becoming more and more popular with sociologists. While International Sociological Association still has *Research Committees*, similar bodies in European SA, set up in 1995, have been called *Research Networks*.

17. An explicit nonmetaphorical use of the term *network* in the social and behavioral sciences is at least as old as *sociometry*, the first variety of SNA, which, at its beginnings, was developing independently of *graph theory*, at that time placed by the mathematicians within *algebraic topology*, a pretty sophisticated purely mathematical discipline. Moreno's book *Who shall survive?* (1934) was published two years before *Theorie der endlichen und unendlichen Graphen*, the first *book* on graphs which was written in German by the Hungarian mathematician Dénes König. In the same year, as Harary remarked (*Graph Theory*, 1969, p. 5–6), Kurt Lewin proposed (in his *Principles of Topological Psychology*) that the "lifespace" of an individual be drawn as a "planar map" (in fact, a planar graph). However, regular exchange of ideas between social psychology and graph theory began after Lewin's death (1947) when Dorwin Cartwright and Frank Harary met in Michigan.

Cartwright's student, Alex Bavelas, didn't use the words "network" and "graph" in the paper "Communication Patterns in Task-oriented Groups" he published in 1950 in the *Journal of the Acoustical Society of America* (why not in *Sociometry*?). Nevertheless, his *analysis* of "communication patterns" makes use of graph-theoretic terms, even if full formalization was neither attained nor probably intended by the author. To find out how the functioning of a problem-solving group depends on the shape of a "communication pattern," Bavelas (or one of his collaborators) invented a task such that a group can solve it only if *all* members directly or indirectly exchange information among one another. Each of n persons receives an n-point set chosen from a fixed collection S of $n+1$ symbols (the set $S=\{+,\ast,\Box,\circ,\nabla,\diamond\}$ was used in experiments with 5-person groups). If these sets are all distinct, then they must have exactly one element in common. The task which consists in guessing this element by the group can be

considered finished as soon at least one group member has solved the puzzle, for the solution once found can be passed to other members along the same channels now used in the reverse direction.

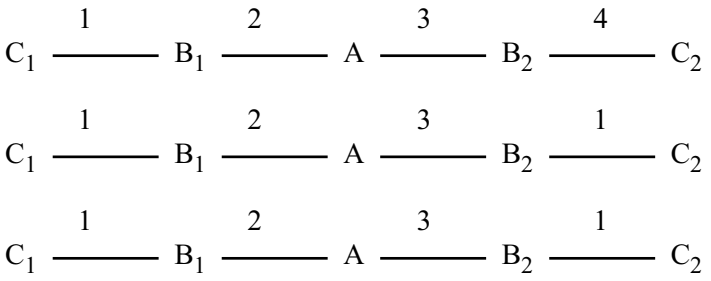
Bavelas' paper deals mainly with *social* processes in task groups, such as emergence of leadership. However, you will also find there a purely *mathematical* problem of what is the minimum number of units of time that an *n*-person group needs to pass all information to one member. A more precise formulation of the problem is as follows:

1. The minimum time is sought across all possible *n*-node communication structures under which the task is feasible. *Feasibility* under a given communication structure – conceived as a fixed *constraint* on inter-actor information flows – is equivalent to the *connectedness* of the *undirected graph* whose lines represent available two-way communication channels.

2. For any communication structure, one has to examine all *effective operational patterns*. A pattern is formally defined as a *directed graph* whose arcs represent dyadic information flows between actors connected by communication channels. *Effectiveness* means that the digraph in question has at least one node *reachable* from any other node through a *path.*

3. For any effective operational pattern, all communication *processes* which end up with solving the group task are compared with one another with respect to the number of successive *steps* which form a given process; any step may also consist of two or more simultaneous flows provided that no actor is involved in more than one flow.

For n=5, there exist 21 nonisomorphic connected graphs of which 4 (3 *trees* displayed in the first picture in this paper and the 5-point *cycle*) were studied by Bavelas and his associates. The line-shaped tree admits of 3 nonisomorphic patterns of which the first requires 4 steps as well, but the other two allow for 2 simultaneous flows in step 1, so that 3 steps are enough to gather all information by one actor.



A similar examination of all structurally distinct operational patterns compatible with the T-shaped tree leads to the conclusion that 3 is again the minimum necessary number of steps. The star-shaped tree determines 2 nonisomorphic operational patterns. In the first pattern, information goes from all 4 peripheral actors to the central actor; in the second pattern, the center receives messages from 3 peripherals and transmits all information, with its own contribution added, to the fourth peripheral actor. In either case, the communication process must run in 4 steps, by one step more than in two less centralized structures.

It is not difficult to show that the search of a communication structure which enables an *n*-person group to guess the common symbol in the shortest time t_n can be limited to *trees*, or connected graphs containing no cycles. Thus, t_5=3. Bavelas proposed a general formula for t_n which can be rewritten as $t_n=min\{k: n\leq 2^k\}$ (see p. 674 in the reprint of his paper available in the 2nd edition of *Group Dynamics. Research and Theory*, ed. by Cartwright and Zander, 1960). Unfortunately, he gave no proof.

Bavelas' article was translated into Polish by my late colleague Jacek Szmatka (1950–2001) to include it in the reader he published (1979) to provide sociology students with a selection of classical papers in group processes. When I taught microsociology at the Jagiellonian University, I always asked my students to read Bavelas' paper, as it gave me an opportunity to make them familiar with basic concepts of graph theory. I used to skip a rather dark passage concerning the minimum time for the task completion until Jacek's teaching assistant challenged me to demonstrate the formula for t_n. I gave in after a short attack, having only verified that the formula holds true for n=2,…, 9. If you know the

proof, please, let me know.

18. Bavelas was interested not only in the study of *group dynamics* but in *organizational* patterns that a task group can develop by itself or adopt when instructed by an external expert. I learned from Freeman's book on *The Development of Social Network Analysis* (2004) that Bavelas was not a mathematician; he had to rely on the assistance of R. Duncan Luce like Jacek Szmatka on mine. While Luce became a leading figure in mathematical social sciences (in particular, he was the co-author, with H. Raiffa, of *Games and Decisions*, 1957), Bavelas left MIT and "worked in industry for years and never returned to his experimental structural analyses" (Freeman 2004, p. 70). Why did he give up academic career? When I tried to learn more from the Internet about the young man whose picture was presented by Freeman on p. 69, Google brought me to a short note written in French for the Wikipedia as *une ébauche* à *compléter*. After a long search, I found at least (on a Spanish website www.infoamerica.org) that Alexander Bavelas was born in 1920.

The fate of paradigms or theories much depends on the personality idiosyncrasies of their authors. Before I read Freeman's book I had known that Moreno (1889–1974) was not a sociologist but a psychiatrist, yet I was not aware of the extent to which his contribution to sociology was overshadowed by his activities as a prophet and the leader of the "sociometric movement." If sociometry is cleaned from philosophical sauce with which Moreno used to serve his scientific products, what remains is a methodological toolkit for the study of *interpersonal attraction* in small groups as well as a *microsociological theory* with its main testable law called the *sociodynamic effect* which states that the number of received choices (or *indegree* in graph theory terms) tends to be unevenly distributed across group members (*points* of a digraph representing the group). *Sociometry as methodology* is characterized, first of all, by the use of s*ociometric questions* and *sociograms* as preferred ways of collecting and analyzing relational data.

Freeman conceives of sociometry and modern SNA as a general paradigm that is "motivated by a structural intuition based on ties linking social actors." The paradigm is grounded in systematic collection of empirical data and "relies on the use of mathematical and/or computational models." (Freeman 2004, p. 2–3). The fourth feature of SNA pointed out by Freeman, or the use of "graphic imagery," can be subsumed under the third because a visible, geometric model of a social system is also mathematical or computational (sociograms are now generated by computer programs).

In empirical sciences, *paradigms* contain both heuristic directives (*what* to study) and procedures for data collection and data analysis (*how* to study). In basic sciences, any paradigm also provides the researcher with a conceptual framework (often enriched with a *mathematical formalism*) for stating "tractable" *problems*, formulating specific *theories*, and designing empirical tests for them.

Inventing *general* paradigms is a favorite activity of "grand theorists" in sociology. Their books do not go beyond "structural intuitions." Workable paradigms which really guide research can be revealed through *metatheoretical analysis* of seminal papers. The *particular* structural paradigm which underlies Bavelas' article defines the category of objects to be studied as *task groups*, each of them being conceived as a *social interaction system* endowed with a fixed communication structure formally represented as the line set of an undirected graph and interpreted as *constraint on actions* of group members.

I have used the term "constraint" here and earlier (recall the distinction between the road network and traffic) more or less in the same way as did W. Ross Ashby in his book (1956) *An Introduction to Cybernetics*. By saying that a *constraint* has been imposed on a *variety* (set) of actions (system states, events, etc.) that can be observed in a situation I simply mean that the variety gets reduced (to a smaller set defined by some conditions) without specifying how the reduction has been brought about. For example, the variety of task-relevant communicative behaviors possible to happen in a task group gathered in a room can be narrowed down by permitting direct exchange of messages solely between definite pairs of group members. In Bavelas' research, such a constraint was introduced by means of *physical* channels: slots in dividers separating the cubicles in which the actors were placed. Since the paradigm takes the constraint as given, the same communication structure could have been enforced by instructing experimental subjects who may communicate with whom, that is, by means of a *social* norm vulnerable to violation, but assumed to be respected.

> The understanding of structure as "constraint on variety" is compatible with Durkheim's notion of *contrainte sociale*, yet the latter concept seems to have a richer meaning: people are assumed to behave in accordance with social norms because they are pressed by an external force coming from the group as a real social entity. Does the network form of "structural analysis" presume such a preconception about structure-constraint? The first of five "paradigmatic characteristics" stated by Barry Wellman ("Structural Analysis: from Method and Metaphor to Theory and Substance." Pp. 19–61 in *Social Structures: A Network Approach*. Ed. by B. Wellman and S.D.Berkowitz, 1988) reads as follows.
>
> "Behavior is interpreted in terms of structural constraints on activity, rather than in terms of inner forces within units (e.g. 'socialization to norms') that impel behavior in a voluntaristic, sometimes teleological, push toward a desired goal."
>
> "Structural constraints" in this statement can (yet need not) be conceived as external "forces" which determine people's behavior from outside more strongly than "inner forces" operating within social actors. While "hard" natural constraints can, in fact, be interpreted in terms of external *physical* forces, "soft" *social* norms constrain actors' behavior through certain internal *motives* which may vary across actors placed in the same situation. If the drivers use the road network in conformity with the Highway Code, they do it because they care about their safety or are afraid of being punished or feel a moral obligation to observe the law. The Code does not by itself force road users to refrain from illegal behaviors; they must be somehow motivated to obey the rules.
>
> Similarly, to explain the emergence of a structure-pattern under a structure-constraint, one also needs to assume that actors are driven to act by certain internal motives. The drivers choose their routes within the road system so as to achieve their particular goals. In task groups like those studied by Bavelas, the group members are instructed by the experimenter that they should all cooperate to solve the problem. The "orientation toward the group goal" is assumed to operate in the same way in all groups, so it is not an independent variable in this paradigm.

A paradigm can give rise to an empirical theory if it contains certain stipulations as to the choice of variables and inter-variable relationships. Under the mathematical representation particular to Bavelas' paradigm, a *social* group is characterized with the use of graph-theoretic *structural parameters*. The *structural group variables* obtained in such a way play the role of independent variables, while various nonstructural group variables (based of observed interaction) are taken as dependent variables. What one wants to know now is which structural variable provides the best explanation of the inter-group differences with respect to some measures of group performance and other dependent variables such as the mean satisfaction of group members. Bavelas and his associates chose for their experiment a small number of nonisomorphic communication structures selected so as to enable testing the hypothesis that group effectiveness is positively correlated with the degree of centralization of the communication structure. However, one had to wait some time for defining (and refining) graph-theoretic measures of centralization (see Wasserman and Faust 1994, Chapter 5).

19. The content analysis of *social network literature* would probably reveal prevalence of methodological papers and descriptive *case studies* illustrating the use of data analysis techniques. Jacek Szmatka who had become acquainted with SNA as participant of Sunbelt conferences was skeptical about *theoretical* potential of the approach which seemed to him a mix of reasonable but rather banal postulates (say, let's study relations rather than actors) with purely technical inventions (let's define another measure of centrality, maybe it will prove useful in some circumstances). However, it's an undeniable fact that SNA encompasses several *structural* paradigms and empirical theories formulated within them, in particular, a paradigm which is common to all *network exchange theories*. It shares with Bavelas' paradigm the understanding of structure as *constraint* on action, albeit a different type of actors' motivation is assumed (the actors are expected to maximize their individual payoffs rather than join their efforts to increase the group profit). Another paradigm, whose history can be traced back to the discovery of sociodynamic effect, guides research on interpersonal dyadic emotional ties which develop (spontaneously, Moreno would add) in any face-to-face group. Within this paradigm, which underlies, in particular, Davis-Holland-Leinhard studies (based on the so called *triad census*), the group structure is viewed as a relational *pattern* which forms in every set of people allowed to freely contact with one another. Theories of *structural biases* which fall under this paradigm claim

that social relations observed in real small groups should have definite structural properties (symmetry, transitivity) that would be unlikely to occur if group members chose co-members as friends at random. To carry out a statistical test of structural bias hypothesis, one has to compare empirical frequencies of certain configurations with the values derived for a baseline procedure for generating *random* structures-patterns.

To test structural theories, one needs relevant relational data. Wasserman and Faust explained what is meant by *social network data* by means of the following statement (1994, p. 29). "There are two types of variables that can be included in a network data set: *structural* and *composition*. Structural variables are measured on pairs of actors (subsets of actors of size 2) and are the cornerstone of social network data sets." The term "structural variable" is referred by the authors to *source network variables* whose values play the role of primary data for SNA. I will make two points in this connection. First, it is more convenient to use *ordered* rather than unordered pairs ("subsets of size 2") as most elementary units of analysis because an *undirected* "tie" between actors x_i and x_j can always be described by the assigning of the same value of an appropriate source variable to (x_i,x_j) and (x_j,x_i). Secondly, "structural" source variables are the "cornerstone" of SNA insofar as they allow us to define *proper structural variables*, not only collective but individual as well. As the authors themselves say on the same page, "composition variables" refer to "actor attributes" such as gender or age. Variables like these do not exhaust all types of individual variables.

20. Collective and individual variables, or properties of groups and group members, form the main division in the typology of sociological variables proposed by Paul Lazarsfeld (1901–1976) and Herbert Menzel (1921–1987). In their classical paper "On the Relation between Individual and Collective Properties" (pp. 422–440 in *Complex Organizations. A Sociological Reader*. Ed. by A. Etzioni, 1961), they divided individual variables into four types, *absolute*, *comparative*, *contextual*, and *relational*. The latter term is referred to properties of group members "computed from information about the substantive relationships between the member described and other members" (p. 431). The *indegree* of x_i ($\mathrm{id}(x_i)=|\{x_j: x_jRx_i\}|$) and the *outdegree* of x_i ($\mathrm{od}(x_i)=|\{x_j: x_iRx_j\}|$), known in sociometry as *popularity* and *expansiveness,* are simplest examples of individual relational variables. Lazarsfeld and Menzel's definition of a relational variable is too narrow; information about the ties within the set of "other members" may also be used to characterize the role of an individual within a structured whole. For instance, the knowledge of ties between a group member and other members does not suffice to define the property of being indispensable for enabling communication between any two group members (see the notion of a *cutpoint* in Wasserman and Faust 1994, pp. 112–113).

Collective variables were divided into three types, analytical, structural, and *global* variables, the third type being introduced as residual. *Analytical* variables are "obtained by performing some mathematical operation upon some property of each single member" (p. 427). *Structural* variables "are properties of collectives which are obtained by performing some operation on data about the relations of each member to some or all of the others" (p. 428). The simplest sociometric structural variable is obtained by assigning to any group X with a choice relation R the number $|R|$ of all choices made by the group members. Notice that $|R|=\sum_i \mathrm{id}(x_i)=\sum_i \mathrm{od}(x_i)$. Thus, a structural variable may be at the same time analytical.

Let us examine another collective variable given by Lazarsfeld and Menzel (p. 428) as an example of a structural variable: "the proportion of precincts of a city which are Negro enclaves" (an "enclave" is a precinct inhabited by people of a given race, surrounded by precincts inhabited by people of other races). Let X be the set of precincts and R a relation in X defined by the condition: x_iRx_j if x_i is *adjacent* to x_j (since adjacency is a symmetric relation, (X, R) is an undirected graph). The information on which precincts are adjacent to x_i is enough to compute the *degree* $d(x_i)$ of x_i (the common value of $\mathrm{id}(x_i)$ and $\mathrm{od}(x_i)$), but more information is needed to find out if x_i is or is not an enclave: one must also know the values of some nonrelational variable for the given precinct and its "neighbors." Lazarsfeld and Menzel used "sociometric popularity" as an example to illustrate the concept of relational variable. In a footnote, they stressed that a concrete method

for data collection (observation of' interactions or sociometric questionnaire) has no bearing on recognizing an individual variable as relational. The examples like the "proportion of Negro enclaves" prove that the authors admitted taking into account intrinsic attributes of "members" in defining relational (individual) and structural (collective) variables.

Similarly, the bulk of social network studies goes halfway to purely *formal* understanding of structural properties. Nevertheless, the approach which appeared in mathematics with the Erlangen program (the late 19th century paradigm in geometry which postulated the study of those properties of geometric objects which are preserved by various *transformation groups*) and culminated with Bourbaki's work is not alien to the social sciences as epitomized by the definition of structure given by Siegfried F. Nadel (1903–1956).

> In his book *The Theory of Social Structure* (1957)which came out soon after his untimely death, Nadel wrote (pp. 7–8): "Indicating articulation or arrangement, that is, formal characteristics, structure may be contrasted with *function* (meaning by this term, briefly, adequacy in regard to some stipulated effectiveness) and with *content*, *material* or *qualitative character*. ... Thus I can describe the structure of a tetrahedron without mentioning whether it is a crystal, a wooden block, or a soup cube; I can describe the arrangement of a fugue or sonata without making musical noises myself; and I can describe a syntactic order without referring to the phonetic material or semantic content of the words so ordered. This has an important consequence, namely that structure can be *transposed* [italics mine; Bourbaki would say more precisely: "transported from one base set to another by a 1–1 mapping] irrespective of the concrete data manifesting it; differently expressed, the parts composing any structure can vary widely in their concrete character without changing the identity of the structure. Our definition should thus be rephrased as follows: structure indicates an ordered arrangement of parts, which can be treated as transposable, being relatively invariant, while the parts themselves are variable." What helped the distinguished Austrian-British anthropologist to grasp the gist of mathematical structuralism was his solid competence in linguistics and musicology rather than his familiarity with the geometry of solids (he confused tetrahedron with cube).

Structural analysis in mathematics consists in studying *structural* or *invariant* properties (more generally, variables) of mathematical objects or their parts, structural properties being defined as those preserved by isomorphisms or automorphisms (the term *automorphism* is referred to any isomorphism of a mathematical object with itself). You will find more about mathematical structuralism and its relevance for the social sciences in Chapter 1 (*Structural Mathematical Sociology*) of my book (*The Mathematics of Exchange Networks*, in process; chapters already written are available on my web page). The key idea is remarkably simple: any *empirical* system of a given type (e.g., a *social* group) can be *represented* by a set endowed with a structure of a given species (e.g., a binary relation obtained, for instance, by asking each member of X to name his or her "friends" in X). Given such a representation, the values of any structural variable can be referred to empirical systems via their mathematical models. I would reserve the term *structural collective variable* for *empirical* variables obtained in such a way. Similarly, I would define a *structural individual variable* as a variable which assigns the same value to any two actors such that points x and y which represent them satisfy the condition $y=\alpha(x)$ for some automorphism α of the mathematical system representing a given social system. Thus, according to this definition, the number of choices made (*od*) and that of choices received (*id*) by a group member are structural individual variables, while the property of being an enclave is not structural.

Similarly, the variable V which assigns to any mixed sex group the number of "heterosexual" sociometric choices is not structural. To show this, consider the groups represented by the following directed graphs (symbols M and F denote sex categories): (1) $F_1 \rightarrow M \leftarrow F_2$; (2) $M_1 \rightarrow F \leftarrow M_2$; (3) $M_1 \rightarrow M_2 \leftarrow F$. The three digraphs are isomorphic, but the value of V for group (3) differs from the value for groups (1) and (2).

Intuitively, the fact that groups (1) and (2) have the same value of V seems to have something to do with their "structural similarity." To formalize this "structural intuition," one can represent any group by a relational system (X,R,S) in which S is an equivalence relation (the equivalence classes may correspond to the values of an absolute individual variable) and R is the choice relation. Two relational systems (X,R,S) and (X',R',S') are isomorphic through a 1–1 mapping φ of X onto X' if

(xRy iff $\varphi(x)R'\varphi(y)$) and (xSy iff $\varphi(x)S'\varphi(y)$) for any x,y in X. For example, two 3-person groups, (1) in which two girls love one boy and (2) in which two boys love one a girl are *structurally indistinguishable* because the mapping defined by the formulas $\varphi(F_2)=M_2$, $\varphi(F_1)=M_1$, $\varphi(M)=F$, is an isomorphism. The number of "heterosexual" choices can now be defined as the number of ordered pairs (x,y) which meet the condition: *xRy and not xSy*. By assigning this number to a group represented by a relational system (X,R,S), we get a structural variable which is no longer structural if the same group is represented by (X,R). Therefore, the meaning of the attribute *structural* depends on a particular mathematical representation of a given category of empirical systems.

21. What unites social network *methodology* and *structural paradigms* is the use of *social network data*. The particular nature of this type of data *co*-determines the identity of SNA as a scientific *macroparadigm* comprising many *microparadigms* some of which generate empirically testable theories. However, the network type of data is very inclusive, which entails the danger of too little specificity. In order to be productive, any sociological paradigm should not only provide a conceptual map for a wide range of social phenomena, but it should contain certain specific stipulations in order not to evolve into an overarching "theory of the social as relational."

In small group research, the data type criterion is sharp enough to distinguish the network paradigm from other paradigms. In *Interaction Process Analysis* (IPA) and its refined successor, *System for the Multiple Level Observation of Groups* (SYMLOG), behaviors are classified into 12 (IPA) or 26 (SYMLOG) categories. Since any behavior of a group member is also described in terms of who-to-whom (actor–to–actor or actor–to–group), at least part of SYMLOG source data falls under the network type. However, the information on, say, who asks questions to whom (a behavior that would be classified in SYMLOG in the B–F, or emotional-instrumental dimension), who praises whom (the P–N, or positive-negative dimension), or who tells whom to stop talking (the U–D, or domination-submission dimension) is ignored in constructing profiles of group members and portraying the group as a whole. As a consequence, the *field diagram* (see examples on SYMLOG Consulting Group's homepage: www.symlog.com) does not resemble the *sociogram*; SNA and SYMLOG differ with the output of *graphical* data analysis, too.

Any paradigm – as a *semiotic system* reconstructed from the *parole* of scientific products selected upon some relevance criterion – can be studied in separation from the *social system* formed by the scientists doing research and communicating with the use of the given paradigm. Trying to reveal essential features of SNA as a macroparadigm in the social sciences, I have followed this path and arrived at the conclusion that "analysis of social networks" amounts to "analysis of social network data". Indeed, one can't analyze any composite object without representing the source of knowledge about it in the form of relevant data.

Let me recall now that the ultimate aim of my inquiry is to offer directions as to how the term SNA should be translated from English into other languages. Anyone who has not coined the term to be translated should take into account the meaning attached with it by its "legal" users, in this case, members of INSNA, Socnet subscribers, readers of *Connections*, and last but not least, authorities on the subject matter. Thus, I should look now at SNA from the point of view of the *sociology of science*. It is the perspective taken by Freeman in his book which was based on meticulous historical and sociological research. In this essay, I can do no more than ask and try to answer a rather simplistic question: what's the feather that unites the *people* who flock together at Sunbelt conferences. My first observation is that SNA community, although characterized by *esprit de corps*, has avoided the danger of sectarianism: the diversity of microparadigms is approved of as a normal state. Some network analysts, those who love high-level metatheoretical reflection (their voice is heard pretty often in Socnet) would probably say that what unites the community is the common *Netzwerkweltanschauung* rather than the mere interest in the network type of data. There are many SNA-oriented sociologists who perceive network structures as another kind of Durkheimian "social facts" and regard the "vertical" relations between social actors and social systems as the primary *social datum*, yet they are probably outnumbered by those who give conceptual and theoretical priority to "horizontal" social "ties and bonds" between individuals.

> Most sociologists doing network research would probably agree with Freeman's (2004, p. 2) preliminary description of SNA. "The social network approach is grounded in the intuitive notion that the patterning of social ties in which actors are embedded has important consequences for those actors. Network analysts, then, seek to uncover various kinds of patterns. And they try to determine the conditions under which those patterns arise and to discover their consequences." You will find in this passage an echo of Durkheimian belief in behavioral *consequences* of the actors' "embeddedness" in a structure "capable of exerting over the individual an external constraint" (it's a piece of the definition of "social fact" given in *The Rules of the Sociological Method*) as well as Simmelian search for patterns of social interaction and interest in the study of the "*conditions* under which those patterns arise." Having in mind that a network structure can be interpreted either as a *constraint* or *pattern*, you can define many structural paradigms. The emergence of a normative pattern can be explained in terms of institutionalizing a behavioral pattern. For example, a road network may develop from the trails worn in the ground by the people traveling across the country. The reverse process is also possible. Roads which are rarely used get overgrown with grass and finally drop out from the road network. Similarly, some grammatical structures (e.g., the counterpart of English *past perfect tense* in Old Polish) tend to disappear if they are seldom used by the speakers of a given language. If you do experimental research on social interaction under network constraint, you must retain the clear-cut distinction between structure-constraint and structure-pattern. If your curiosity about the nature of "structure" is purely philosophical, you have an option to embrace the "dialectical synthesis" of the two concepts of structure given by Giddens' . His "theorem of the duality of structure" states that "structural properties of social systems are both medium and outcome of the practices they recursively organize"(A. Giddens, *The Constitution of Society*, 1984, p. 25).

22. The attribute *social* is commonly used in sociology, yet too few social scientists like Weber feel obliged to give it a *scientific* meaning in expressions like social action/relationship/group, etc. Sociologists write their papers and treatises in *natural languages*, in English, Japanese or other languages. They hardly ever care about the autonomy of sociological discourse, even if they occasionally invent special terms, such as "structuration."

> I mentioned Japanese because the Japan Sociological Association is second largest after ASA. Why the Japanese name for INSNA (let it be written in *romaji* to be easier to recognize) is still missing on the back cover of *Connections*? I suppose that the Japanese have a native word for fishing net and maybe for other kinds of nets as well. Why did they use the loanword *nettowaku* to translate *social network* as *shakai nettowaku*?

I have already argued that *ethnic languages* may provide their users with different ways of thinking of the social world. As regards the relationship between *language* and *thought*, linguistics has worked out few stances (the long quotation given below comes from D. Chandler's book *Semiotics for Beginners*, available online at www.aber.ac.uk/media/Documents/S4B).

> "*Mold theories* represent language as 'a mold in terms of which thought categories are cast' … *Cloak theories* represent the view that 'language is a cloak conforming to the customary categories of thought of its speakers' ... There is also a related view … that language and thought are *identical* … thinking is entirely linguistic: there is no 'non-verbal thought', no 'translation' at all from thought to language. … The Sapir-Whorf theory, named after the American linguists Edward Sapir and Benjamin Lee Whorf, is a *mold* theory of language. Writing in 1929, Sapir argued in a classic passage that: 'Human beings do not live in the objective world alone, nor alone in the world of social activity as ordinarily understood, but are very much at the mercy of the particular language which has become the medium of expression for their society… No two languages are ever sufficiently similar to be considered as representing the same social reality. The worlds in which different societies live are distinct worlds, not merely the same world with different labels attached' … In its most extreme version 'the Sapir-Whorf hypothesis' can be described as consisting of two associated principles. According to the first, *linguistic determinism*, our thinking is determined by language. According to the second, *linguistic relativity*, people who speak different languages perceive and think about the world quite differently. On this basis, the Whorfian perspective is that translation between one language and another is at the very least, problematic, and sometimes impossible."

Does the *Sapir-Whorf hypothesis* apply to the *language of mathematics*? I don't think so. I tend to believe that the language of mathematics reflects certain *universal* epistemic categories. When I say that "my family consists of 3 persons", I think of my family as a 3-element *set*. I think in such a way of my family because it *is* a set, not because I am "at the mercy of the particular language

which has become the medium of expression" for the tribe of mathematicians. The concepts inherent in my statement, *set*, *element*, *membership*, *cardinality* (number of elements) are not pure creations of my mind, they are grounded in a nonlinguistic and nonpsychological reality. Clearly, my family is something more than a set, yet when I say that it has 3 members, I can rely on the *set-theoretic ontology* which provides me with the simplest semantic interpretation under which my statement is meaningful and *nontautologically* true. Everyone who will read my statement about my family will learn something about a concrete set existing within the *real world*. Mathematics deals not only with abstract domains but provides *empirical sciences* with a common formal language (codified syntactically, semantically and pragmatically) so that the use of ethnic languages in science can be confined to *commenting* and informal *paraphrasing* formal discourse in order to make it intelligible for those who think in English, Japanese or in other languages. Is English more suitable for this purpose, is it more "mathematical" than Japanese? I don't know.

23. There is agreement among social network researchers as to the fundamental role of mathematics in their macroparadigm. Indeed, mathematical notions turn out to be indispensable for defining *social network data*. Should we supplement the *preliminary explication* of SNA ("analysis of social network data") with stipulations concerning the ways in which the source network data should be analyzed? Undoubtedly, one should not arbitrarily decide on which *types of analysis* applicable to this *type of data* should be placed inside or outside SNA.

To give an example, consider applying *correlational analysis* (and related types of analysis, such as *factor analysis*, which use the *correlation matrix* as input) to the collection of matrices representing binary relations $R_1,\ldots,R_m$ in the same group X, where each relation is obtained by means of a different sociometric question. The ij entry of the matrix representing kth relation in X equals 1 or 0 depending on whether $(x_i,x_j)\in R_k$ or $(x_i,x_j)\notin R_k$. Statistical parameters can be computed for any real $n\times n$ matrix (n stands for the number of elements of X) because such a matrix, *displayed*, to be sure, as an array with n rows and n columns, *is* nothing else than a real-valued variable defined on the n^2-element set whose elements, written in the lexicographic order, are: (1,1), (1,2), …, $(n,n-1)$, (n,n). Statistical analysis can be done *per se* regardless of the particular nature of units of analysis. However, if the correlation matrix, determined for the set of 0–1 variables corresponding to m relations, is used in turn to construct a new relation representing, say, a *latent structure*, then this particular use of correlational analysis will certainly be subsumed under SNA. The same criterion applies to the types of network data analysis which make use of *matrix algebra*.

Among many types of analysis there is one which, in my opinion, lies at the core of SNA and co-determines its identity along the relational type of data. This type of analysis will be called here *structural* and distinguished from the mere study of relations. Thus, my *final explication* of SNA is *structural analysis of social network data*.

> "Structural" and"relational" are commonly treated as almost synonymous terms as exemplified in the following statement which appears at the very beginning of Freeman's book (2004, p. 2): "The kind of research that examines the links among the objects is called *structural* … In social science, the structural approach that is based on the study of interaction among social actors is called social network analysis."

Structural analysis – in the meaning I would like to propose here – requires that a social object be represented by a mathematical object (directed graph, net, network, multirelational system, etc.) obtained directly from or by processing some source data. The analysis itself consists in constructing *structural variables* according to precise definitions or at least general directions dictated by various descriptive or theoretical microparadigms in which these variables will be used alone or together with nonstructural variables. Recall that a variable is *structural* if its values are preserved by isomorphisms or automorphisms. The definition, which was given earlier in this letter for units of the highest and the lowest level of analysis (systems and their elementary components, say, social groups and their members) applies as well to intermediate "modeling units" (see Wasserman and Faust 1994, p. 44): dyads, triads, or larger subsets of a given set of social actors. To give an example, assume that a social group is mathematically represented by a digraph

$G=(X,R)$. A variable defined on the set $\mathcal{P}_2(X)$ of *dyads* is called *structural* if, for any *automorphism* α of G, it assigns the same value to $\{x,y\}$ and $\{\alpha(x),\alpha(y)\}$, for any $x \neq y$ in X. For instance, let $V(\{x,y\})$ be equal to 0, 1 or 2 if, respectively: (0) $(x,y) \notin R$ *and* $(y,x) \notin R$ (*null* dyad); (1) if $(x,y) \in R$ *and* $(y,x) \notin R$ or $(x,y) \notin R$ and $(y,x) \in R$ (*asymmetric* dyad); (2) if $(x,y) \in R$ and $(y,x) \in R$ (*mutual* dyad).

Thus, the attribute "structural" acquires a precise meaning in any empirical science no earlier than a mathematical representation has been proposed for empirical wholes to be studied and a notion of isomorphism is defined for mathematical objects that are to serve as models of empirical objects.

> Bourbaki's view of *la mathématique* as a science studying *ensembles munis de structures* is now being replaced by the multilevel ontology of the mathematical world of which the highest level is formed by various categories. A *category* is a "macroobject" made up of the *class* of *morphisms* and the *class* of *objects* (isomorphisms are then defined as a special kind of morphism). If the objects have the form of *sets* endowed with structures of the same species, then morphisms are defined as mappings with special properties (e.g., *continuous mappings* play the role of morphisms in the category whose objects are *topological spaces*). Any category of the kind is called *concrete* which term is also referred to the category of SETS whose objects are bare *sets* and morphisms are any *mappings*. Since the size of my letter has already exceeded 30 pages, I must refer the readers who are not familiar with the basics of the *category theory* to Chapter 19 in Fararo's *Mathematical Sociology* (1973). There is a trace of interest in category theory in SNA, namely, the classical paper by François Lorrain and Harrison C. White, "Structural Equivalence of Individuals in Social Networks" (*Journal of Mathematical Sociology*, 1, 1971, 49–80).
>
> Bourbaki's formalization of the notions of *structure* and *isomorphism* in mathematics renders very well what ordinary (that is, little interested in *metamathematics*) mathematicians do regardless of whether they are conscious of reproducing the structuralist paradigm. If you study graphs, groups, lattices, Banach spaces, etc., you don't need to know that algebraic operations or families of open sets are structures, and *homeomorphism* (topological isomorphism) and algebraic isomorphism (called simply *isomorphism*) fall under the general term *isomorphism* . New mathematical disciplines, like game theory, may long develop without a definition of isomorphism. When I was working on my paper "A Combinatorial Theory of Minimal Social Situations" (*Journal of Mathematical Sociology*, 17, 1992, 105–125) I found only one paper (A. Rapoport and M. Guyer. "A taxonomy of 2×2 games". *General Systems* 11 (1966): 203–214) offering a definition of structural similarity for *two-person games in normal form with ordinal payoffs*.

24. Simmel's ideas were couched in too informal language, Nadel's efforts to develop a symbolic notation for *role theory* were too amateurish. If the mathematicians read their treatises, they could not treat "formal sociology" as a serious attempt to bridge the gap between sociology and mathematical structuralism. On the other hand, Bourbaki's work became known to social scientists owing to Jean Piaget (*Le Structuralisme*, 1968; English translation, *Structuralism*, 1971), yet it could not inspire them to think in terms of *twin* notions, *structure* and *isomorphism* because it was presented too formally even for working mathematicians.

To show how the Simmelian concept of form can be formalized with the use of the mathematical notion of *isomorphism* (linguistically, the term means having the same form; ἴσος = equal, μορφή = form), I will quote a passage from my 1992 paper mentioned above.

"The objects obtained by endowing a fixed set with a structure of a given species in all possible ways, will be called *configurations*. Let us define an equivalence relation on the set of configurations by means of the condition that two configurations are equivalent iff they are isomorphic. The equivalence classes induced by this relation will be called *structural forms* and the partition of the configuration space they make up will be referred to as a *structural classification*." (p. 107).

To give an example, consider the set of all directed graphs $D_X=\{(X,R):R \subset X \times X\}$ with the same fixed n-element set X as the set of points. Elements of D_X (configurations) and structural forms are sometimes called, respectively, *labeled* and *unlabeled* digraphs. To draw an unlabeled digraph, one has to choose one configuration from among those which make up a given structural form and remove "labels" (say, numbers 1,…, n) attached with the points of the plane corresponding to

graph nodes.

In algebra, structural forms are called *orbits of the permutation group acting on the set* of configurations (see my 1992 paper for a short exposition of the mathematical "theory of group action on a set"). What I called "structural form" Fararo (1973) proposed as the *denotation* of the term "structure." Having defined "relational structure" in Section 5.16 of his *Mathematical Sociology*, he showed next that the same method of defining structure can be applied to sets endowed with algebraic operations. The method consists in *dividing the class of objects of a concrete category by the equivalence relation of isomorphism*. Then, "each concrete [relational] system can be said to represent the structure in which it is contained" (p. 122). According to Bourbaki, a structure is a "thing" that must be *constructed* from the elements of the base set, albeit the construction must be done in such a way that the intrinsic nature or possible internal complexity of elementary units of analysis is never taken into account. In order not to leave the safe ground of "naive" set theory in which there is no need to distinguish between *sets* and *classes*, I assumed that the relation of isomorphism is restricted to the *set* of systems with structures of the same species, but all built from the elements of a fixed base set. Then any two structured systems are *isomorphic* if and only if they have the *same form of structure*, which under Fararo's terminology would amount to having the *same structure*.

In ordinary English, "structure" has both material and formal connotations. In Oxford Advanced Learner's Dictionary (2005) the term is defined as: "(1) the way in which the parts of something are connected together, arranged or organized; a particular arrangement of parts; (2) a thing that is made of several parts, especially a building; (3) the state of being well organized or planned with all parts linked together." Notice that the first definition consists of two statements, which, if I interpret them correctly, ascribe different *logical type* to the defined object. The "*way* in which the parts are arranged" seems to have a higher logical type than an "arrangement of parts." The explication given in my pocket Webster's Dictionary (1987) shows that the "American language" prefers concreteness to abstractness: "structure" is defined there as: "(1) something built or constructed, building, etc. (2) the arrangement of all the parts of a whole; (3) something composed of related parts."

25."Masters of sociological thought" and "the practice of social research" still remain two pillars of teaching sociology at every university, and consequently successive generations of students have learned *philosophy* and *statistics* as main auxiliary disciplines. "New masters" seek inspiration in the works of philosophers of language (Giddens quotes Wittgenstein), yet the impact of *theoretical linguistics* on understanding structure in mainstream sociology has so far appeared fairly weak. If sociologists knew more about language structures, they would appreciate theoretical significance of the Simmelian concept of *social form*.

Piotr Sztompka (Polish sociologist, President of the ISA, 2002–2006), analyzed the definitions of "social structure" given by several leading 20th century sociologists ("The Concept of Social Structure: An Attempt at a Generalization." *Studia Socjologiczne* 1989 no. 3: 51–65, in Polish). He arrived at the conclusion that four fundamental ideas have shaped the meaning of the term "structure" in sociology: (1) the idea of relationships or interdependence between some elements; (2) the idea of order, regularity, repeatability or duration; (3) the idea of a deep, essential dimension hidden behind the surface of phenomena; (4) the idea of determination, control or influence on empirical processes. Nadel's formulation, which was also included in a small sample of definitions selected for an *ad hoc* content analysis, was trimmed by Sztompka (he left "ordered arrangement of parts," but skipped the property of being "transposable" and "relatively invariant, while the parts themselves are variable") to the effect that the (5) the idea of *form* is missing in the semantic field he has reconstructed. I suppose that (5) may have appeared to him already covered by (2). However, the difference between two ideas comes out in the comparison of their opposites, on the one hand, disorder, chaos or indeterminacy, on the other hand, content or matter.

While the distinction between content and form in social life is generally acknowledged to be Simmel's original contribution to social theory, the term *pattern* with the meaning akin to *form* is

not associated with any particular theoretical orientation in sociology. Both terms are also used in linguistics and semiotics.

Syntactic patterns in formal or natural languages are often conceived as forms to be filled with lexical content. For example, the learners of English are taught a number of *verb patterns* such as the NVN' pattern (noun+verb+noun). To produce a sentence according to this pattern, one must choose three words and arrange them in a sequence, having in mind that the second word must be a verb, while the other two words must be nouns. Note that in English, which is an *analytical* language, "John loves Ann" and "Ann loves John" are two different statements built according to the same *pattern* in which the order of words is essential. By contrast, in Polish, which like Latin is an *inflectional* language, "Jan kocha Annę," "Annę kocha Jan" are two *stylistic* variants of one statement in which the noun "Anna" appears in the *accusative case* ("Annę") to express the fact that Anna is the object of Jan's love.

If "Love Anns John" were an *acceptable* English statement (semantically, it would mean that an entity called "love" acts on John in the way called "Ann"), then the distinction between nouns and verbs wouldn't have to be introduced as part of the description of the NVN' pattern. The pattern, presented in the form SVO (subject+verb+object), would then admit any word in all three places. S, V and O stand here for three *roles* a word can play relative to other words in a statement. Since in English a word playing role S can also play role O, and conversely, roles S and O can be lumped together to obtain role N (marked also N' to allow for independent replacements in the pattern NVN').

In social anthropology, according to Nadel (1957, p. 12), we arrive at social structure "through abstracting from the concrete population and its behavior the pattern or network (or 'system') of relationships obtaining 'between actors in their capacity of playing roles relative to one another' [the phrase quoted after Parsons]." In linguistics, all words which play the same role, that is, they are *interchangeable* in a class of acceptable statements (*contexts*), are said to be in the *paradigmatic* relationship. The relationships between elements playing different roles in the same context are called *syntagmatic* (see Chandler's *Semiotics for Beginners* or Chapter 2 in Lyons' *Introduction to Theoretical Linguistics*, 1968).

Some *social interaction patterns* can be described as patterns in the language in which elementary units are names of *actors* and *actions*. For example, consider the pattern NVN'A and assume that the letter A admits of names of actions as substitutions, while actors' names can be placed in positions labeled N and N'. V is used to mark *social actions* such as orders or requests which are directed by an actor to another actor and express the former's intention to bring about a definite action of the latter. Let us illustrate the pattern NVN'A with the sentence |Tom|told|Peter|to-shut-the-door|. Strictly speaking, it is not a string in the symbolic language devised by the analyst, but rather the account of Tom's behavior written down in ordinary English by an observer who saw two persons standing near the door and heard one of them speak "Shut the door, please!" Note that the observer took into account the "subjective meaning" of Toms' action, as his record shows its orientation and intention.

Suppose now that the next record was |Peter|shut-the-door|. Such a statement falls under the pattern N'A. Assuming that the symbols N' and A, which also occur in the NVN'A pattern, are replaced with the same values in either pattern, we can form two complex sequential patterns N'A|NVN'A and NVN'A|N'A. The first of them may not belong to the grammar of the social interaction language because the sequence of actions described by two sentences |Peter|shut-the-door||Tom|told| Peter|to-shut-the-door| could never take place (under the assumption that the actors know what is going on in their common life space). If a linguist found such a record, he would probably conclude that Tom actually said to Peter "Thank you," but the observer, instead of having written |Tom|thanked|Peter |for-shutting-the-door|, misinterpreted Tom's action by classifying it under type V instead of type U containing responses to others' actions. The second pattern NVN'A|N'A yields grammatically admissible sequences of the form "an actor *a* told actor *b* to do something and *b* did what *a* had told him to do."

The study of such sequences lies beyond the scope of traditional linguistics which studies language structures on few levels from *phonemes* at the bottom to *statements* at the top. In *discourse analysis*, statements or acts are treated as building blocks of *monologs*/*narratives*, produced by a single speaker (actor), and *dialogs* in which two or more speakers (actors) jointly produce sequences of statements (acts). Dialogs are more interesting for the sociologist because syntagmatic relations within such sequences may reflect *sociolinguistic* relationships or *social* relationships such as power or status hierarchy. For example, one can account for an actor's positive response to another actor's request by attributing to interaction partners shared competence in *language etiquette*. On the other hand, the phenomenon of obedience would rather be explained in terms of the *power structure* in the set of actors.

> The user of a language is said to be *grammatically competent* if he can produce new statements structurally similar to those he came to know when he was learning the language with the help of a manual or (as do na(t)ive learners) through communication with already competent speakers. The production of grammatically correct statements need not be described as putting words into empty cells which form a *pattern*. According to the new (postChomskyan) structuralist linguistics, generating well formed statements should be modeled as a stepwise process which consists in applying a definite *rule* at each step. Every *rule* is characterized by its *scope of applicability*, or type of *input*, and operations that need to be performed to generate the *output*. Such a general explication of the term "rule" is sufficiently broad to cover logical *rules of inference* (with *premises* as input and *conclusion* as output), grammatical rules (in particular, *production rules* in *phrase stricture grammars*), mathematical *recursive formulas* (the *n*th term of a sequence is determined upon the knowledge of terms from 1st to $(n-1)$th), *voting rules* (e.g, the majority rule with votes of group members as input and group decision as output), and many other types of rules.
>
> For Giddens (*The Constitution of Society*, 1984, p. 21), the "rules of social life" are "techniques or generalizable procedures applied in the enactment/reproduction of social practices." "Social rules" never completely determine "social practices" because the actors who apply the rules (retrieve relevant procedures from memory) may also interpret the rules. The dialectical agency-structure relationship means that "agents" may also "enact" new practices instead of "reproducing" old ones. A "generalizable" way of action, once enacted, may be repeated in similar circumstances and thus give rise to a new rule in accordance with the principle of "duality of structure."

The words "rule" and "pattern" are often used interchangeably to denote any regularity (*regula* is a Latin word for rule): we say that something is regular if it follows a pattern or occurs frequently or repeatedly ("as a rule"). A more technical use of the term "rule," which has more "dynamic" connotations than "pattern," has become characteristic for new varieties of sociological structuralism (Thomas J. Fararo and Carter T. Butts. "Advances in Generative Structuralism: Structured Agency and Multilevel Dynamics." *J. of Mathematical Sociology* 24, 1999, 1–65). The understanding of structures as "patterns of social interaction" remains typical of "network structuralism." Although the notion of isomorphism has rarely been explicitly invoked by network analysts and more attention has been given to Simmel's relationism than formalism, the inventors of new methods for analyzing network data have often stressed that the concrete content of a "social relation" has no relevance to the analysis.

> R. Duncan Luce and Albert D. Perry wrote – at the very beginning of their paper "A Method of Matrix Analysis of Group Structure" (*Psychometrika* 14, 1949, p. 95, 95–116) – that "The types of relationships which this method will handle are: man *a* chooses man *b* as a friend, man *a* commands man *b*, *a* sends messages to *b*, and so forth." In their paper, which was published over fifty years ago (notice the genderless use of "man" banned in today's English), the authors-mathematicians found it appropriate to enlighten the readers-sociometricians that not only friendship but any social relation admits of a matrix representation. Recently, Freeman (2004, p. 2) has recalled that "important social relationships may link social individuals that are not human, like ants or bees or giraffes or apes. Or they may link actors that are not individuals at all … groups or organizations … nation-states or international alliances."

In fact, the actual range of SNA applications encompasses numerous empirical *social* wholes which differ very much among one another with the nature of their constituent components and inter-component relationships. Since substantive differences have no bearing on methodology, one can define *network analysis* as the way of analyzing empirical (physical, biological, social, semiotic) systems that is based on representing these systems as *networks* and on the use of *structural* variables in paradigms and theories which adopt such a representation. In the definition, the term "network" plays the role of a collective name covering directed graphs, nets, valued nets and digraphs, and so forth, so that "network analysis" denotes the types of structural analysis which correspond to particular species of structures, or mathematical categories, each having its own notion of isomorphism, necessary to give a definite meaning to the attribute "structural."

26. My preliminary linguistic analysis of "Social Network Analysis" has led to the conclusion that the triply compound name can be represented either as "Analysis of Social Networks" (it's the reading found self-evident by almost all translators and experts, including Barry Wellman) or as "Social (Network Analysis)" as suggested by some translations. Next, it turned out that SNA can

be defined as "network analysis applied to social systems." Thus, the translations of SNA based on the second representation need not be rejected. Such translations are possible (e.g., Polish: *Społeczna Analiza Sieciowa*; Russian: Социальный Сетевой Анализ, etc.) into the languages which have adjectives derived from "network" or expressions functionally equivalent to adjectives. In French, the phrase *de*+noun (e.g., *de base*) is such an equivalent. Thus, *L'Analyse de Réseau Sociale*, the name built similarly as, say, Bourbaki's term *ensemble de base principal*, could replace *L'Analyse des Réseaux Sociaux*. However, the latter term has already become standard due to long tradition. *L'Analyse de Réseau Sociale* is found very seldom in the Internet (3 Google results), but *L'Analyse de Réseau Social* was found nearly 400 times. Since *social* (singular masculine form which fits masculine noun *réseau*) and *sociale* (singular feminine form which fits feminine noun *analyse*) sound the same, the use of *social* instead of *sociale* in this phrase may be a spelling error. An alternative explanation is that the pattern noun+(de+(noun+adjective)) has been deliberately used instead of the pattern (noun+(de+noun))+adjective in order to say that the analysis in question consists in representing an object of unspecified nature by a social network.

In Polish social science terminology, *analiza sieci społecznych* (analysis of social networks) has become the standard term. The Google search located some 900 web documents with the term in the nominative case, while the alternative term, *społeczna analiza sieciowa*, was not found at all. However, *analiza sieciowa* (network analysis) occurred fairly frequently. I did not examine all 2900 results, but the "nonsocial" cases seem to be mainly economic or technological (operations research, computer science). The German term for NA, *Netzwerkanalyse*, was found in 260,000 documents of which a bit less than 800 cases were occurrences of *soziale Netzwerkanalyse* – the German standard counterpart of SNA built according to the pattern "Social (Network Analysis)." A rather small frequency of the German term for SNA need not prove little interest of German social scientists in SNA. It may well be that *soziale* is omitted because *Netzwerkanalyse* alone means SNA. To examine how often *Netzwerkanalyse* may have anything to do with the social sciences, I did the Google search with *soziale* plus *Netzwerkanalyse*. I received 52,500 results, which form some 20% of all documents containing *Netzwerkanalyse.* For Spanish, I compared the frequency of *análisis de redes* (I chose the variant with de+noun in plural as it had 155,000 occurrences, while the variant with *de red* had only 9200) with that of *análisis de redes sociales* (85,000). I obtained the value of 55% which is the highest among 5 European languages (French, German, Italian, Spanish, Polish) four which I was able to determine the counterparts of NA and SNA. As regards English, 80% of 1,180,000 web documents containing NA contains also SNA. I don't know how to explain this result.

27. To translate a *scientific term* from one to another language, you can't rely solely on your knowledge of the two languages. You should know what the term actually means and what semantic field is associated with it in the relevant discipline. Similar problems arise in translating literary works. Sometimes the translator must read the whole book to find an adequate translation of a short passage which seems easy to translate because it is intelligible on the basis of the general language competence and its meaning is apparently independent of the context of the work as a whole. I will illustrate the problem, using some passages from *The Lord of the Rings* as examples. The digression which follows is very long, so the readers who are not yet friends of Gandalf may skip it.

> I read Tolkien's masterpiece in Polish translation in my early teens. Some 20 years later I read it all aloud to my daughter. After next 20 years, when I was writing this essay, I could make use of her collection of Tolkienalia. The first Polish translation we read appeared in 1960s. It was third after Dutch and Swedish translations, and first into a Slavic language. The high quality of Maria Skibniewska's work much contributed to Tolkien's popularity in Poland. When the second translation appeared in 1996–1997, Jerzy Łoziński (the translator), came under fire, first of all, for having ignored (so did the translators to many other languages) the author's wish to leave English proper names in the original form. In answering Skibniewska's questions, Tolkien wrote that "Englishry [of the book] should not be eradicated" (see *The Letters of J.R.R Tolkien*, edited by H. Carpenter, Letter 217). Richard Derdziński tried to convince me that the new Polish translation has some literary values, yet

I stopped reading as soon as I found on the first page of "Prologue" that hobbits are "a *harmless* (*nieszkodliwy*) ... tribe". Tolkien would never write that hobbits are harmless – I was 100 percent sure of that. Indeed, when I looked into the original, I discovered that "Hobbits are an *unobtrusive* but very ancient people". The adjective which was so hard to translate was rendered by Skibniewska as *skromny* (modest) . The same word was used by Maria and Cezary Frąc, the co-authors of the 3rd Polish translation. (The question of whether the latest translation, which appeared in the 21st century, is equally good as Skibniewska's translation, considered "canonical" by the host of Polish Tolkien lovers, is still awaiting an ultimate answer.)

There are less trivial problems for the translator than rendering words which have no exact counterparts in the target language (like "unobtrusive" in Polish). I will examine the translation of two passages which convey a fundamental idea that Tolkien wanted to recall to his contemporaries – the idea which has been known to Christians under the name of Providence. In *The Lord of the Rings* it is called, quite ordinarily, "chance" or "luck"(see Chapter 3 in Shippey's *J.RR. Tolkien, Author of the Century*), and means a mysterious power protecting the World from self-destruction by apparently accidental interventions. "God in his infinite freedom continually creates a world that reflects that freedom at all levels … He is not continually intervening, but rather allows, participates, loves." *Call it a chance*, but I found these words (quoted after a Vatican source) – supplied with the heading "God as an Agent-Based Networker" – in *Ties and Bonds* in *Connections* 27/2, 2006.

We see the first mode in which Providence works when Frodo undertakes his mission.

At last with an effort he spoke, and wondered to hear his own words, as if some other will was using his small voice. 'I will take the Ring,' he said, 'though I do not know the way.'

This mode of intervention consists in the co-acting of "some other will" with someone's will so that the right way is chosen. Frodo's Way ends at Mount Doom where the second mode of intervention turns out necessary to accomplish the Mission.

Then Frodo stirred and spoke with a clear voice, indeed with a voice clearer and more powerful than Sam has ever heard him use ... 'I have come,' he said. 'But I do not choose now to do what I came to do. I will not do this deed. The Ring is mine!'

After these words Providence intervenes again, now acting against Frodo's will: Gollum is allowed to take the Ring from him by force and "accidentally" falls with his "Precious" into the abyss.

In the movie version, Frodo's last *direct speech* beginning from *I have come* was shortened to *The Ring is mine*! The whole speech is rich in meaning, albeit Tolkien used rather simple words save for the word *deed* which adds solemnity to the whole statement (if Tolkien wrote in Polish, he could make use of the distinction, absent in English, between *robić* and *czynić*, two counterparts, ordinary and elevated, of *do*). Since the crucial word here is the verb *choose*, the idea of choice should be preserved in translation, if possible with marking the distinction between "I do not choose to do" and "I choose not to do". Shippey (2000, p. 140) claims that Tolkien deliberately used the first expression in order to say that "some other will" was speaking again through Frodo.

Let me elaborate Shippey's philosophical analysis by adding that at Mount Doom it was the *will to power* that made Frodo speak with a "clearer and more powerful voice". Whether it was his own will or the will of the Enemy, or the two, it was certainly different from that will which had used "his small voice" in Rivendell. *Inside* Christianity, the idea of will to power can be associated with Pelagianism, or the teaching that you don't need Grace to be saved as you can work out your salvation by your own deeds. Frodo endured the long way through the dungeons of Moria and Dead Marshes to the heart of the Enemy. He might have thought that what he had suffered gave him the right to say *The Ring is mine*, that is, to claim the *right* to use the Ring in the way reserved for higher beings than himself, namely, to control the will of others. Certainly, it is a risky interpretation. Frodo was not an ordinary mortal, yet he must have realized that his natural qualities could never be enhanced by the use of the Ring so as to give him "command of the souls" (Polish readers familiar with Mickiewicz will know what I mean). For his "race" the main principal sin was avarice rather than pride, so the temptation he experienced might differ from that which fell upon Galadriel (If the "Nordic Lady" took the Ring from him and replaced Sauron, her orc troops would resemble Hitler's *Wehrmacht* more than Stalin's Red Army; old Poles who remember both invaders say that the *Herrenvolk* had neat uniforms and did not rape).

Naive readers and critics, even if sympathetic to Tolkien, praise him for defending rural life against industrialism. The real importance of his work lies in that it is an apologia of Christianity against Nietzscheanism and its unintended consequence: 20th century totalitarianism. God is dead and there comes the time for the *Übermensch*, says Nietzsche. Tolkien replies to him: there is still hope that the meek, those who speak with "small voice," shall possess the land, because Providence has not yet dropped the world from its hands.

I omit further comments on Polish translations of the second passage to discuss in more detail the

problem of translating the first passage. The key phrase which appears in the narrator's statement preceding Frodo's words is *some other will*. Literal translating it into Polish is certainly the best option because the counterpart (*jakaś inna wola*) sounds very well. A translator who replaces "some other will" by "someone else's will" (Skibniewska) or loses the word "will" at all (Łoziński and the Frącs) makes the mistake which can be described as the stripping of the original of its originality. Tolkien did not write "someone's will" because, as I guess, he didn't want to prompt us the understanding of Providence as a Person, thus allowing to contemporary "righteous pagans" to perceive it as an impersonal power restoring order in the world and calling us to cooperate in doing this. The implicit religion of the noble "races" of Middle-earth neither presumes nor excludes the existence of a *personal* God demanding worship from his faithful. However, those who believe in Jesus Christ will feel at home in the world created by Tolkien because, as many commentators have already noticed, it is imbued with Christian spirituality.

Let me examine in turn the translations of Frodo's *direct speech*. His utterance consists of two parts, *I will take the Ring* and *though I do not know the way*, separated by the narrator's *he said*. Every attentive reader will notice that the two clauses do not fit each other, unlike two parts of the following apparently similar statement: "I will take the umbrella, though I don't know the weather later today." The simplest explanation of this incompatibility is that Frodo thought, in fact, "I will take the Ring to Mordor, though I do not know the way", but refrained from uttering aloud the horrible name of the "land where the shadows lie." However, the verb "take" in *I will take the Ring* may well have the meaning it has in "Do not take what is not given" which is the Buddhist precept corresponding to our "Thou shalt not steal."

While in Oxford Advanced Learner's Dictionary the first of many meanings of this common verb is explained as "to carry or move something from one place to another," the Webster's New World Dictionary gives in the first place: "to get possession of; capture, seize, etc." The Polish counterpart of *take* (actually, two verbs, *wziąć* and *brać* which differ in *aspect*; I must leave unexplained this linguistic concept) also combines these two basic meanings. As a consequence, the literal translation of *I will take the ring* as *Ja wezmę Pierścień* passes the retranslation test perfectly (that is, one must translate *Ja wezmę Pierścień* back into English as *I will take the Ring)*. As regards the second clause, *though I do not know the way*, its literal translation (*chociaż nie znam drogi*) appears in all Polish translations, as it is the only possible solution. The case of *I will take the Ring* is not that simple. The literal translation is found in the first edition of Łoziński's translation of *The Fellowship of the Ring*. However, the latest corrected edition (2001) has *Ja poniosę Pierścień* which can be retranslated to English as *I will carry the Ring*. Skibniewska and the Frącs (they always follow her in difficult places) have here *Ja pójdę z Pierścieniem* which means *I will go with the Ring*. It fits *though I do not know the way* even better than *I will carry the Ring*. However, such a correction bears on the interpretation of Tolkien's work. The meaning of "take" as" get possession of" should not be lost altogether because, as I believe, the author wanted to mark that Frodo claimed the property of the Ring.

Frodo, like his uncle Bilbo, is a *bourgeois* (see *The Road to Middle-earth* by Shippey, 1997, Chapter 3). For him, the Ring is a Thing, and as such must have a unique legal owner. When Frodo learns prior to the Council that Aragorn is the heir of Isildur whose property the Ring once was, he says to Aragorn: *Then it belongs to you and not to me at all.* Aragorn, as it were, born into the knight *ethos*, replies: *It does not belong to either of us ... but it has been ordained that you should hold it for a while*. During the session the property of the Ring remains suspended until Frodo says *I will take the Ring*. And he takes the Ring when his claim is accepted by Elrond the Chairman. What Frodo doesn't know is not only how to get to Mordor but what he will do or what will happen to him on his Way. That's why the name of Sauron's land is not explicitly mentioned. Although Frodo has now become the Ring-Bearer, he behaves like the Ring-Owner when he is ready to make a gift of it to Galadriel. Later, to be sure, he says to Faramir (the ideal type of an anti-Nietzschean hero; he says in Chapter 5 of Book 4: *I would not take this thing, if it lay by the highway*) that the Ring does not belong to him nor to *any mortal great or small*, yet he does not allow to "hold it for a while" even to those he has reasons to trust. But mere *owning* the Ring (not only using it, which for a mortal amounts to acquiring just one God's attribute: invisibility to the mortals) always involves getting *addicted* to it (Shippey 2000, Chapter 3). Frodo's addiction reaches the peak at Mount Doom, but the germ of his failure is already present at the very beginning of his Way. If you begin from saying in Rivendell *I will take the Ring,* you are doomed to say at Mount Doom *The Ring is mine*! Did Skibniewska deliberately replace "I will take" with "I will go" to give a more Pelagian interpretation to the *myth* of salvation told once again by the great English writer? Or she simply corrected what appeared to her a minor error? I don't know.

Although the Italians say *traduttore traditore* (the translator is a traitor), the search for an acceptably precise translation or at least admissible interpretation is not always hopeless. I would

render Frodo's statement as *Ja wezmę Pierścień i pójdę, chociaż nie znam drogi* (*I will take the Ring and will go, though I do not know the way*), assuming that Frodo's *good will* to go Mordor in order to renounce there the possession of the Ring forever has been blended from the outset with the temptation to keep the Ring for himself (which, as we know, threatens being possessed by the Ring).These two ideas are also combined in the movie version in which we hear Frodo say: "I will take it, I will take it – I will take the Ring to Mordor – though – I don't know the way" (the dashes stand for pauses).

Interestingly, Peter Jackson has also improved Tolkien's happy end. He added a scene which showed Grace at work in a more Catholic way than did Tolkien himself. When Frodo fails and Providence must do the job for him, he receives another chance to decide on his personal fate. He can either follow Gollum and *choose* Eternal Condemnation or grip his Friend's hand; in theological language, *freely accept* Grace – God's *freely given* help that is necessary for Salvation. And whereas Tolkien, having shown Gollum's Last Fall, proceeds immediately to "special effects," as if he were indeed a fantasy writer, his "translator" into the *language of motion pictures* shows us how Evil resists destruction to get defeated (the Ring melts) no earlier than the Friends' hands meet. Were your eyes filled with *catharctic* tears, when you saw this *icon*? *I will not say: do not weep; for not all tears are an evil* (Gandalf at the Grey Havens).

If you've read my essay, you might wonder if it is anyhow related to strictly scientific topics of my letter. But do classical sociological treatises really differ from *belles-lettres* with the type of *discourse*? The work of the "author of the century" and Weber's *Economy and Society*, which was recognized the sociological "book of the century" in a survey organized in 1998 by ISA, have more in common than comparable length (Weber's text in English translation has over 1400 pages).

In social science, says Giddens (1984, p. 283), "There is no more elemental concept than that of power. However, this does not mean that the concept of power is more essential than any other, as is supposed in those versions of social science which have come under a Nietzschean influence." As it were, power is the key idea in both books of the century, and both the German sociologist and the British lover of Germanic mythology thought of power in terms of an interplay of two *wills*. "'Power' (*Macht*) is the probability that one actor within a social relationship will be in a position to carry out his own will despite resistance, regardless of the basis on which this probability rests." (*Economy and Society*, Part I, Chapter 1, Section 16).

Power is not only most "elemental" social phenomenon but most mysterious as well. Science has still too little to say on the nature of will, so one must rely on literary accounts to learn how the will of *A* acts on the will of *B* so that *B* actually does, even if against his will, what he was told to do by *A*. We can agree with Wittgenstein saying: "There is a gulf between an order and its execution. It has to be filled by the act of understanding … Must I understand an order before I can act on it? – Certainly, otherwise you wouldn't know what you had to do! – But isn't there in turn a jump from *knowing* to doing?" (*Philosophical Investigations*, remarks 431 and 505). Wittgenstein's tentative answer is sociolinguistic: "understanding" and "doing" are parts of one communication competence attributed to the players of a *language game*. Weber would explain the "jump" by pointing either to the personal *charisma* of the order-giver or to his status within a social relationship. These are two possible determinants of the "probability" that an order, once understood, will be obeyed. Weber took for granted that some communication community must exist between two actors in order that one of them could impose his will on the other. Did he envision the existence of material devices which, like the Ring of Power, can be used to gain control over the others' will?

The Ring is a thing, it is not an entity having some internal power over its destiny, even if it is said of it that it "wants to be found" and "abandons its owners." Its maker, to be sure, endowed it with some behavioral autonomy, but the action of Providence is visible behind the Ring's disappearances and re-appearances. How does this "smart tool" work? We can only guess that it is a *medium* enhancing natural powers of its owner, in particular, his or her charisma. What is most important, however, is that the way in which it mediates the interaction between the will of its owner and others' wills is evil in itself. As a material thing, the Ring was designed for use by actors having body and soul. Having lost his flesh, the Ring-Maker could no longer use his tool himself, so his true intention was not to get the Ring back but to induce Frodo to accept the Ring (as a gift of the kind that Satan offered to Jesus tempted in the desert) and thus get incarnated again in a Noble Being. As we know

Providence thwarted this plan, working, paradoxically, through a Corrupted Being. Actually, real Incarnation is the exclusive privilege of Good. Evil can only "possess" a Noble Being and infect it with *Wille zur Macht* which must lead the Possessed to degradation.

28. My letter has turned into a long symphony with a couple of grave themes such as Language, Mathematics, Salvation and Power. *Scherzo* should precede the last movement, yet I'm leaving it for the end. But first I should tell you how my follow-up to "Translating INSNA" came into being. When I received (in January 2004) the hard copy of *Connections* 25/2, I noticed that the back cover had been "decorated" even more lavishly. The list of counterparts of INSNA, with coded English text as the last item, contained translations into few additional languages. Some of these translations differed in spelling from those shown in the Table on page 117. I guessed that the differences had probably resulted from manual rewriting. In particular, the Polish translation (*Międzynarodowa Sieć do Analizy Sieci Społecznych*) appeared on the back cover with 2 errors: the replacing of *n* by *h* in *Międzynarodowa* and the loss of the skew bar across *l* in *społecznych*. My first decision was to send a short note to the Editor of *Connections* with a request to correct the text in my mother language only. Meanwhile I got familiar with more languages and my note began to grow. It reached the size of some 15 pages in Spring 2004, but then I stopped writing because of other more important work. Harary's death in January 2005 spurred me to resume writing and add pages on the mathematics of SNA. In the middle of 2006, I overcame the temptation to investigate the translations of INSNA into further languages (Arabic and Chinese being most intriguing). I thought to myself that it's high time to show to the world the results of my work. The reading of Freeman's book caused further delay in submitting to *Connections* this strangest text I have ever written in any language.

29. Compared with other linguistic topics I've touched so far, *misspelling* is a minor problem. However, I must stress again the necessity to master the skill of exact rewriting meaningless strings, such as the word *Międzynarodowa* which tells nothing to those who don't know any Slavic language. In my old letter to Socnet, I argued how important that skill may be, namely, if a sample used to test a statistical hypothesis is too small, even few flawed data points may distort the result. Here is another, a more colorful story on unpleasant consequences of mistyping short texts. The story combines fiction with facts and takes place somewhere over the ocean. For the reasons that will become clear soon, I chose Alfred Tarski for the hero of a fictitious report. The story begins when the famous logician (born 1902 in Warsaw, died 1983 in Berkeley) comes to the booking office to buy a ticket for an international flight. He shows his passport to allow the person at the desk to enter his name into the computer's memory from where the name will be brought to the passenger list and printed on the ticket. The man rewriting the name is not expected to know that the guy flying to Europe is the one who was first to formally define the concept of truth. However, Mr.Tarski's last name is short and looks much less odd than, say, Brzezinski. To type it correctly, one need not even know that the passenger bears a typical Polish surname like many other of the sort, found, say, on the Ellis Island wall.

(My last name appears there in two variants, Sozanski and Sozansky, *y* probably indicates that an immigrant was registered by an immigration officer as coming from parts of Poland which were under German or Austrian rule in 1795-1918).

Taking into account what has been said so far, one should expect that the event that the word *Tarski* will be mistyped is highly unlikely. However, unlikely events occur more often than you can expect on the basis of common sense. Why such an event should not happen at the airport, once *Tarski* became *Tarksi* in the bibliography of a serious scientific book which appeared in 1978 in New York. Put "tarksi" into Google, to see how often that mistake has been made in English scientific texts! You will find few German papers, too, but twisting proper names seems to be American specialty. When "three American businessmen" showed to Tolkien the scenario for the animated motion-picture based on his work, he saw "Boromir rendered as Borimor" (Tolkien's biography by Carpenter, p. 229). However, this change may well have been done deliberately to get rid of a name with Slavic *-mir* which might seem too alien to the American public.

To continue the fictitious story, assume, therefore, that Tarski's surname was actually mistyped, yet the attendant made a different mistake than that I found in the bibliography of *Mathematical Sociology: An Introduction to Fundamentals*. Tarski like Fararo did not notice the error made by someone else (the airline worker or the typist who worked for the author of the book). He arrived at the gate and showed his ticket ...

> Let me interrupt now to tell my own story which took place in Los Angeles in 1994 on my way back from the ASA Meetings. They took my ticket and passport and told me to wait. Since I had not been informed why I had to wait, I thought that my name must coincide with that of someone wanted by the police. Watching other passengers passing through the gate, I was getting more and more upset. When I remained alone at the gate, an officer returned my documents and said "Your seat in the economic class has been sold to someone else. We are pleased to offer you a free seat in the business class." A big glass of champagne served at the beginning of the flight helped me forget the stress.

Let us go back to the adventure of professor Tarski, and suppose that it happened after September 11th. He had to wait with others to learn at long last that the flight was delayed because of the need to check once again the list of passengers. What happened? Tarski's name was rewritten as *Tariks*. The girl at the desk alarmed her supervisors, having seen a European-looking man bearing an Arabic name. Maybe, the reverse inconsistency would better justify the need to check the case, but the staff was trained to pay attention to anything odd. Why did the attendant think that Mr. Tariks was an Arab? Suppose that like my daughter she had taken a course on islam during her university studies. Hence she knew the Arabic word *tarika* (not far from *tariks*; note that *s* is next to *a* on the keyboard) which means "way", or "way to God" in the Sufi teaching.

That is the end of my tale and of the whole epistle. With best wishes.

Tad Sozański

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