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Conceptual Modeling of Networked Organizations: The Case of Aum Shinrikyo

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1.1. OVERVIEW

In an open dynamic environment, autonomous agents form a network organization (NO) by engaging in active connections with other autonomous agents in order to achieve common goals. In some situations, due to an agents' scale of dynamism, these connections may include agents that have had no previous experience (i.e., no prior associations); thus, agents are required to coordinate their actions and cooperate toward a common goal. As a result, agent members of network organizations are more likely to cohesively collaborate as a means to build and maintain their network. Moreover, a NO behaves as a complicated system interwoven with commonplace social relationships, not as a closed system. Thus, the magnitude of these networks' interactions and the pace of social change that they produce is context specific. To this end, this chapter will describe the general construction (i.e., formation and internal structure) of a network organization as they can affect the internal and external ties and interactions of agents within the NO. This chapter will also present the methods of agent-based modeling as a means to define specific tools (e.g. norms, roles, capabilities, utilities) that inherently affect agent behaviors and help them to socially connect with other agents through the formation, modification, and expansion of the organization. A case study of a terrorist organization known as Aum Shinrikyo (Aum) will be analyzed using a classic bottom-up perspective of influence on autonomous agents through the social structure. As this study theorizes that average global utility will decrease when there is a strong fluctuation in agent contributions, the bottom-up perspective will be able to

address these fluctuations. Furthermore, a dynamic explanation is considered for any prospective fluctuations prevalent in small groups, as large groups are more likely to be involved in a collective action. Consequently, using Netlogo as a prototyping platform, a simulation is implemented to illustrate that such fluctuations may have a dramatic impact on the average utility of the group.

1.2. INTRODUCTION

Within the past decade, there has been an increasing amount of research on what is characterized as a NO. Unlike living organizations (i.e., traditional organization), network organizations exhibit how participants are linked to one another through various social structures. Inactive agents, who have not been linked with any of the others, are simply omitted from the organization and the structure is evaluated without them. Agents in NOs are typically active collaborators producing particularistic-seeming ties among them for the aim of maintaining a sense of continuity toward their organizational goals. This has narrowed our perspectives when perceiving organizations. In light of this, this chapter elucidates on evaluating and modeling NO using a real world case study.

Agents Theory frequently applies organizational models in order to model coordination in open multi-agent system (MAS) environments (Easley and Kleinberg 2011, Eisenhardt 1989). This will allow it to adapt dynamically to environmental changes. Two perspectives should be considered when modeling NOs: (1) structural perspectives include nodes (e.g., agents, resources, objects), ties (e.g., norms, role, resource access, etc.), as well as ontology and (2) functional perspectives that classify the various types of activities and ties within a NO. To this end, it becomes clear that organizational modeling plays an important role in evaluating open dynamic MAS.

There exists a systematic overlap in NOs between type of structure and quotidian social networks, which results in mobilization pathways and organizational subdivisions. This is elicited from tracing an agent's sustained set of interactions favoring the nuanced relationship between the set and social structure. Dynamic social interactions can help NO resilience while fragment confrontation does not since the magnitude and pace of a NO is situation specific (Easley and Kleinberg 2011, Hartmann, et. al. 2008). For instance, in terrorist organizations, agents are dynamically changing their actions based on direction from the leader of the group in retaliation to actions by society.

More broadly, emergent properties of agents' actions based on their attributes and norms about organizational behavior help in forming a NO. For this, different forms of NO should be theorized explicitly to assist with introducing Agent-Based Modeling (ABM) into the case study of the terrorist network Aum. The network organizational structure may be characterized in different types including hierarchies, holarchies, coalitions, teams, congregations, societies, federations, markets, and matrix organizations (Easley and Kleinberg 2011, Horling and Lesser 2005). A hierarchical organization, such as the case with Aum, is the traditional structure used in many organizations.

In hierarchical structures, those in higher rankings possess wider, more global organizational scopes and greater authority than those individuals who rank below them. The resources travel up the hierarchical structure in order to provide a broader view for NOs, whereas control has the opposite tendency (i.e., travel down). If the problem space is divided into layers and task partitioning can parallel the problem structure, hierarchy is a good paradigm (Easley and

Kleinberg 2011, Horling and Lesser 2005). A hierarchical organization begins with at least three agents and two levels to form a network; this includes the upper-level (e.g., leader), who is in control of the data streaming since it produces a global view and the lower level (e.g. subordinate), who responds to the commands of the leader. This type of hierarchy can affect the characteristics of global and local behavior (Easley and Kleinberg 2011, Horling and Lesser 2005).

There are several models proposed for analyzing, designing, and building NOs. Nevertheless, most of them are grounded on real object-oriented or knowledge-based models. Matson and DeLoach (2005) showed the procedure of building an adaptive and fault tolerance organizational model through their study of the Gulf War in 1990. This study has mimicked the command and control procedure developed by Krackhardt and Carley (1998) in order to evaluate the battlefield information system. Previous works that have also been developed in the area of using MAS for modeling network organizations vary depending on the organization type studied. In Alqithami and Hexmoor (2012b), the authors modeled their organization in terms of how rapidly an organization adapts to new interiors and what is the fastest way possible. Their model was based on four major components: (1) role of the agents inside the organization, (2) utility of each actor, (3) their capability, and (4) de facto norms. Similarly, Hexmoor (2011) used a model to describe his organization depending on the team capabilities, roles, departments, and norms. These models, however, are abstract and non-specific in evaluating NOs even though they have been useful. This chapter proposes that earlier models can be enhanced with formalisms incorporating network complexities while building upon their ABM.

Presented in the next section, is a case study analyzing terrorist organizations using the classic top-down direction of influence from autonomous agents to social groups. It addresses the fluctuations of individual contributions to global NO utility. Such fluctuations may have a dramatic impact on the average utility of a group (i.e., this utility decreases when there is a strong fluctuation in the individuals' contributions to the global utility). We consider this a dynamic explanation for the fact that large groups are more likely than small groups to get involved in collective action, pointing to fluctuations as stronger in small groups.

1.3. AUM SHRINRIKYO

1.3.1. The network organization of Aum Shrinrikyo: From finances to recruitment

In 1984 a charismatic and partially blind guru named Chizuo “Shoko Asahara” Matsumoto founded a yoga school and publishing house he then called Aum, Inc. (Bellamy 2013; Danzig, et al. 2011; Staff 1995; START 2013; Walsh 2001). Establishing only a few clients when the shop first opened, Asahara soon decided to try and increase his client populace by utilizing the popular Japanese magazine “Twilight Zone” to release a public announcement that depicted him as a deity having the capability to levitate (Bellamy 2013; Danzig, et al. 2011; Walsh 2001). Although the group was not yet religious, it wasn't long before his newfound messianic reputation throughout Japan attracted a number of people wanting to obtain the same power to levitate (Bellamy 2013; Danzig, et al. 2011). It wasn't until 1985, after a trip to North-Japan in search of self-discovery, Asahara began advocating esoteric mysticism to his members despite the fact that he possessed all six terrorist leader characteristics¹ identified by Parachini and

¹ The six terrorist leader characteristics include (1) charismatic leadership, (2) no external constituency, (3) apocalyptic ideology, (4) loner or splinter group, (5) a sense of paranoia and grandiosity, and (6) defense aggression.

Tucker (1999). Preaching meditation, introspection and non-violence to his members enabled him to formalize his group of approximately 24 members into an organization, and they changed their name to Aum Shinsen-no Kai (translated as “Group of Gods/Supreme Beings”) by 1986 (Bellamy 2013; Danzig, et al. 2011; Walsh 2001).

It was also during this time that Asahara began claiming he could prevent a catastrophe in which he foresaw developing from a “materialist and spiritually void society” (Danzig, et al. 2011). However, in order for him to prevent the cataclysm he asserted that he would need to open centers around the world and acquire thousands of spiritually enlightened practitioners; thus, Asahara urged laypeople to renounce their society and contribute donations for their initiation as a practitioner. Although money came from their various front companies (i.e. businesses) selling services, literature, tests, and advanced courses, it was through its members (i.e. membership fees and donations) that Aum procured the majority of their funding (Parachini and Tucker 1999; Staff 1995; START 2013). By the fall of 1986, his scam to collect money from unsuspecting followers had worked, and he was able to begin opening monastic communities throughout Japan (Bellamy 2013; Danzig, et al. 2011).

Then, in 1987, the organization changed their name again, this time to Aum “Aum” Shinrikyo (translated as the “Supreme Truth”), as well as began shifting their spiritual beliefs to one requiring blood rituals (Danzig, et al. 2011; Staff 1995; START 2013; Walsh 2001). According to Danzig, et al. (2011), Aum had generated so much popularity over a two-year period, through recruitment efforts and word-of-mouth, that by 1987 the organization had grown to include nearly 1,300 members with 30 monks and nuns, around 2,300 members by 1988 with 117 monks and nuns, and almost 4,000 members by 1989 with 390 monks and nuns. It was also in 1989 that the Tokyo Metropolitan Government finally granted Aum official religious corporation status (Danzig, et al. 2011; Staff 1995; START 2013). Upon registration as a legally recognized religion, Aum gained many privileges from the Japanese government such as de facto immunity from official oversight and prosecution, as well as massive tax breaks (Danzig, et al. 2011; Staff 1995; START 2013).

After Aum’s religious legalization, membership again rose dramatically from 4,000 members in 1989, to include nearly 10,000 members by 1992, and approximately 50,000 worldwide by 1995 (Parachini and Tucker 1999; Staff 1995; START 2013). Moreover, Aum’s 1989 net worth of less than 430 million yen (approximately 4.3 million USD) more than doubled, growing to well over 100 billion yen (1 billion USD) by 1995 (Staff 1995; START 2013). As a result, Aum began utilizing their government immunities and extensive capital to expand their operations to include bases in six other countries including: Australia, Germany, Indonesia, Russia, Taiwan, and the United States, with more than 130 front companies worldwide (Parachini and Tucker 1999; Staff 1995; START 2013). Operating out of a number of these newly established front companies, similar to that of the yoga school in Japan, members began purchasing chemicals and biological agents, developing software and data mining, procuring weapon materials from Russia, Australia, Sri Lanka, Zaire and North Korea, as well as acquiring helicopters from Russia and training pilots in the United States (Parachini and Tucker 1999; Staff 1995; START 2013; Vogel 1999). At the same time, Aum began reorganizing and expanding their leadership in order to assemble their own militia (Parachini and Tucker 1999; Staff 1995; START 2013).

Aum had a strategy to recruit from the military, officers of the Japanese Self Defense Force (JDF)—placing high priority on the First Airborne Brigade—and the police as a means to further their militarization and intelligence functions. Furthermore, they targeted Japan’s top universities in order to actively recruit students and professionals. Having acquired a considerable amount of

brilliant members—who have obtained degrees in such fields as medicine, biochemistry, architecture, biology, and genetic engineering—each department or ministry was run by those whom many considered the “best and brightest” of their fields (Staff 1995). Subsequently, Aum shadowed the structure of the Japanese government and organized into a hierarchical organization with 21 identifiable ministries and departments with each one headed by 21 of the 23 closest members to Asahara (Table 1.1) (Danzig, et al. 2011; Hudson 1999; START 2013). Reserving the title of supreme leader for Asahara, his wife Tomoko Ishii/Matsumoto and his mistress Hisako Ishii were second and third in command respectively; six individuals were considered “Senior Advisors,” and six individuals were not only involved in the groups biological and chemical program, but Asahara considered them his “Inner Circle Members.” Despite Aum’s structure being developed in a hierarchical fashion, with the exception of the three Followers Agencies (Western, Eastern, and New) and the Ministry of Science and Technology, the remaining 17 agencies did not oversee anyone, as they were only responsible for the coordination of any event that utilized their skills and services. Ultimately, due to the secrecy of Asahara’s master plans, only one or more of the 23 individuals under Asahara coordinated and implemented all major attacks, and the approximately 50,000 followers were generally not even involved in minor attacks since they were mainly recruited to generate revenue.

Table 1.1 Aum's system of ministries

Affiliation	Name
Founder	Shoko Asahara
Household Agency	Tomomasa Nakagawa
Secretariat	Reika Matsumoto
Ministry of Commerce	Yofune Shirakawa
Ministry of Construction	Kiyohide Hayakawa
Ministry of Defense	Tetsuya Kibe
Ministry of Education	Shigeru Sugiura
Ministry of Finance	Hisako Ishii
Ministry of Foreign Affairs (Public Relations)	Fumihiro Joyu
Ministry of Healing	Ikuo Hayashi
Ministry of Health and Welfare	Seiichi Endo
Ministry of Home Affairs	Tomomitsu Niimi
Ministry of Intelligence	Yoshihiro Inoue
Ministry of Justice	Yoshinobu Aoyama
Ministry of Labor	Mayumi Yamamoto
Ministry of Post and Telecommunications	Tomoko Ishii
Ministry of Science and Technology	Hideo Murai
Ministry of Vehicles	Naruhito Noda
Eastern Followers Agency	Eriko Iida
New Followers Agency	Sanae Ouchi
Western Followers Agency	Kazuko Miyakozawa

Source: Hudson, R. 1999. The sociology and psychology of terrorism: Who becomes a terrorist and why? *Federal Research Division*. Washington D.C.: Library of Congress. *As well as:* Brackett, D. 1996. *Holy Terror: Armageddon in Tokyo*. New York: Weatherhill.

1.3.2. Mass violence in the name of religion

Having an idea that Aum should become a government entity rather than one of religion, Asahara and 25 members of his inner circle attempted to run for office in the 1990 Japanese parliamentary elections. However, despite Aum's many efforts in campaigning under the Shinrito ("Supreme Truth") Party, no members were elected (Danzig, et al. 2011; Pate and Ackerman 2001; Staff 1995; START 2013). As a result, Asahara became infuriated with the Japanese government and accused them of rigging the elections; thus, Asahara evolved his world view into one of apocalyptic nihilism (Pate and Ackerman 2001; START 2013). It was under this new world view that Asahara started justifying murder on spiritual grounds and transforming his teachings around cultic behaviors—predominately involving Buddhism, but included an amalgam of New Age thought, Hinduism, Christianity, elements of Nostradamus' prophecies, and science fiction—which encouraged followers to confront the Japanese establishment through various acts of terrorism (Pate and Ackerman 2001; START 2013; Walsh 2001).

Over the span of five years, Aum had initiated 17 chemical and biological warfare (CBW) attacks—10 using chemical and 7 biological—with goals ranging from assassination to mass murder; fortunately, ten of those attempts failed (Ballard, et al. 2001; Tucker 2000). According to Ballard, et al. (2001), of the 7 biological agent attacks, four attacks used anthrax and three used botulinum, where all 7 of these attacks were unsuccessful as they were nonvirulent microbial strains. For instance, in order to test the dissemination device, 6 key Aum members (Fomihiro Joyu, Seiichi Endo, Hideo Murai, Kiyohide Hayakawa, Kazumi Watabe, and Masaya Takahashi) and several other unknown members sprayed *Bacillus Anthracis* "Anthrax" from the roof of their Tokyo midrise office building in 1993. However, the attack attempt failed as the cult had acquired a nonlethal vaccine strain (Ballard, et al. 2001; START 2013). Conversely, of the 10 chemical attacks, four attacks used Sarin, four attacks used VX, one attack used Phosgene, and one attack used Hydrogen Cyanide (Ballard, et al. 2001; Tucker 2000). For instance, in an attempt to kill three judges who were presiding on a fraud case against Aum in 1994, 7 key Aum members (Seiichi Endo, Hideo Murai, Tomoitsu Niimi, Tomomasa Nakagawa, Yasuo Hayashi, Masami Tsuchiya, and Satoru Hashimoto) disseminated Sarin gas into a residential neighborhood in the city of Matsumoto. Although they did not kill the targeted judges, they killed seven people and injured 144 others, who indicated symptoms of headache, vision impairment, nausea, etc. (Ballard, et al. 2001; START 2013). However, it wasn't until 1995 that Aum committed their first and last, large-scale attack on Japan.

By March of 1995, Aum had accumulated enough chemicals to make Sarin gas to kill millions of people, and after approving the next attack, Asahara assigned the task of field supervisor to Yoshihiro Inoue and the task of carrying out the attack to Hideo Murai. Upon assignment, Murai met with Ikuo Hayashi (Treatment Minister), Tomomasa Nakagawa (Asahara's personal doctor), and Seiichi Endo (Health and Welfare Minister) to develop the plan, which resulted in the decision to use Sarin gas. It was also decided that Ikuo Hayashi, Toru Toyoda, Yasuo Hayashi, Masato Yokoyama, and Kenichi Hirose were to place the Sarin bags on their designated train lines. At the same time, it was decided that Tomomitsu Niimi, Shigeo Sugimoto, Kouichi Kitamura, Katsuya Takahashi, and Kyotaka Sotozaki were designated as lookouts and drivers for the attack (Staff 1995). And on March 20, 1995 five containers of Sarin were released in Tokyo's subway in an attempt to impede an investigation into Aum's activities. Utilizing these 10 key members of Aum, they carried out the attack at the central crossing of the

subway, right near the main police station (Ballard, et al. 2001; Parachini and Tucker 1999; Pate and Ackerman 2001; START 2013; Tucker 2000; Vogel 1999). Sitting outside in the get-away vehicle nearby, Tomomitsu Niimi waited for Ikuo Hayashi while he released one of the five containers carrying Sarin gas onto the Chiyoda Line. Similarly, Koichi Kitamura and Katsuya Takahashi waited outside in their own get-away vehicles while Kenichi Hirose and Toru Toyoda each released their containers of Sarin gas onto two different trains of the Marunouchi Line. While, at the same time, Kiyotaka Tonozaki and Shigeo Sugimoto also waited outside in their own get-away vehicles while Masato Yokoyama and Yasuo Hayashi each released their containers of Sarin gas onto two different trains of the Hibiya Line. The attack, conducted during peak Monday morning rush hour, killed a total of twelve people and injured over 5,000 others (Ballard, et al. 2001; Parachini and Tucker 1999; Pate and Ackerman 2001; START 2013; Tucker 2000; Vogel 1999).

Within the first 24 hours of the attack, the Japanese Metropolitan Police had designated 4 members of Aum as National Police Agency's (NPA) most wanted suspects and arrested at least 41 others who were suspected of either murder or murder accomplice (NPA 1996). In the months following, police tracked down and arrested Asahara, many of the main leaders of the sect, as well as nearly 200 other members of Aum for their involvement in the subway attack and other terrorist activities. However, it wasn't until June 2012 that Tokyo police finally arrested the last fugitive, Katsuya Takahashi, wanted from the attack. Currently, thirteen members including Asahara are on death row, while hundreds more have been released or received prison sentences, which they are still serving (Ballard, et al. 2001; Reuters Staff 2012; Staff 1995; START 2013; Vogel 1999).

1.3.3. Where are they now?

Despite their terrorist activities, the Japanese government did not outlaw Aum. In 1999, Fumihiko Joyu, former Aum Minister of Foreign Affairs (i.e. Public Relations), became the new head of the organization after the arrest and subsequent trial verdict of Asahara (Ballard, et al. 2001; Staff 1995; START 2013). Under new leadership, Aum has not only apologized for its past acts of terrorism and paid reparation to the victims of the Tokyo underground Sarin attack, but they have also undergone many revisions. Such revisions have included changing their name to Aleph in 2000, redefining Asahara as "founder" rather than "Supreme Leader," as well as forbidding members from killing anyone who was against the group, among many others (Ballard, et al. 2001; Staff 1995; START 2013). However, not all followers of Aum have appreciated the new direction of Aleph and have decided to branch off into a new group. While Joyu continues to lead Aleph, Tatsuko Muraoka and Asahara's biological children lead the splinter group. Muraoka continues to follow Asahara's original teachings, and it has been discovered that their group has committed various illegal activities since the 1995 Tokyo subway attack (see also Ballard, et al. 2001; Staff 1995; START 2013). For instance, the cult hacked into several computer networks belong to nuclear power plants located in Russia, Ukraine, China, South Korea, Taiwan, and Japan. Joyu has claimed that Aleph has no connection with these plans (Ballard, et al. 2001; Staff 1995; START 2013). However, according to START (2013; no page), authorities have reported that although there has been considerable depletion in membership, "approximately 1,650 people in Japan and 300 in Russia still believe in Asahara's teachings. The cult holds 50 seminars a month for current and potential members. Aleph has offices all over Japan, including Tokyo, and reportedly maintains approximately 100 safe houses throughout the

country. It has been reported that at least 700 members are monk-like devotees and that mind control techniques are still part of Aleph's activities.” Moreover, because enough suspicion has remained around the group, Japan has passed a law allowing authorities to monitor Aum or Aleph activities for three years with the ability to extend monitoring capabilities at the end of each 3-year period. The last extension of this monitoring law occurred in January 2006 (START 2013).

1.4. NETWORK ORGANIZATION MODELING

1.4.1. Agent-based modeling of network organizations

Modeling the hierarchical structure of a NO requires the basic understanding of agent characteristics such as behaviors, norms, and roles. The interactional types and patterns of agents inside and outside the NO largely influence the aforementioned characteristics and often result in increased homophily. Homophily, a type of collaboration, is an agent's objective to associate and bond with other agents that have similar objectives to their own and can be divided into one of two types, status-homophily and value-homophily. Status-homophily argues that agents are more likely to collaborate with others rather than merely by chance when they have similar social statuses. Value-homophily claims that agents are more likely to collaborate with others despite their social status, as long as they think similarly (Currarini and Vega-Redondo 2013, Easley and Kleinberg 2011). For instance, Asahara had a tendency to allow only a very small fraction of members (i.e., the 23 leaders and select followers) to know the "master plan" of the group. Although all members were technically considered an internal tie, the members who did not know the master plan operated as an external tie since they were only there to provide funding. Furthermore, non-members also operated as an external tie. Thus, external ties affected the distribution of in-group ties from the baseline form of homophily. As such, ignoring other agents' attitudes and assembly mechanisms, only a small concentration of individuals committed their major attacks. Thus, it must also be noted that collaboration is a more demanding process than cooperation² because it allows agents to share information, share resources, and evaluate a program of activities in order to accomplish a certain goal and then generate common value together (Alqithami and Hexmoor 2012c, Currarini and Vega-Redondo 2013, Easley and Kleinberg 2011).

More broadly, the type and pattern of interaction may not always result in congruent homophily since different types of ties can affect the structure and behavior positively. The development of ties transpires when an agent generates utilities with another agents while also relying on the organization to decide whether it will be a tie of inbreeding (i.e., connections restricted to one agent) or outbreeding (i.e., connections extended to a whole group) (Alqithami and Hexmoor 2012c, Currarini and Vega-Redondo 2013, Easley and Kleinberg 2011). Moreover, ties can be explicit or implicit, where implicit affinities can be seen inside the organization when the member has more than one interest to share. However, if any of those members have a connection with any other members of another organization, this connection will immediately be considered an explicit affinity. Therefore, implicit connections produce bonding which in result helps build homogenous networks, while explicit ties result in bridging several organizations to shape a heterogeneous society. The bonding matrix has a positive relationship to the role of

² Cooperation includes communication, information exchange, activity adjustment and resource sharing to accomplish compatible goals (Tuomela, 2000).

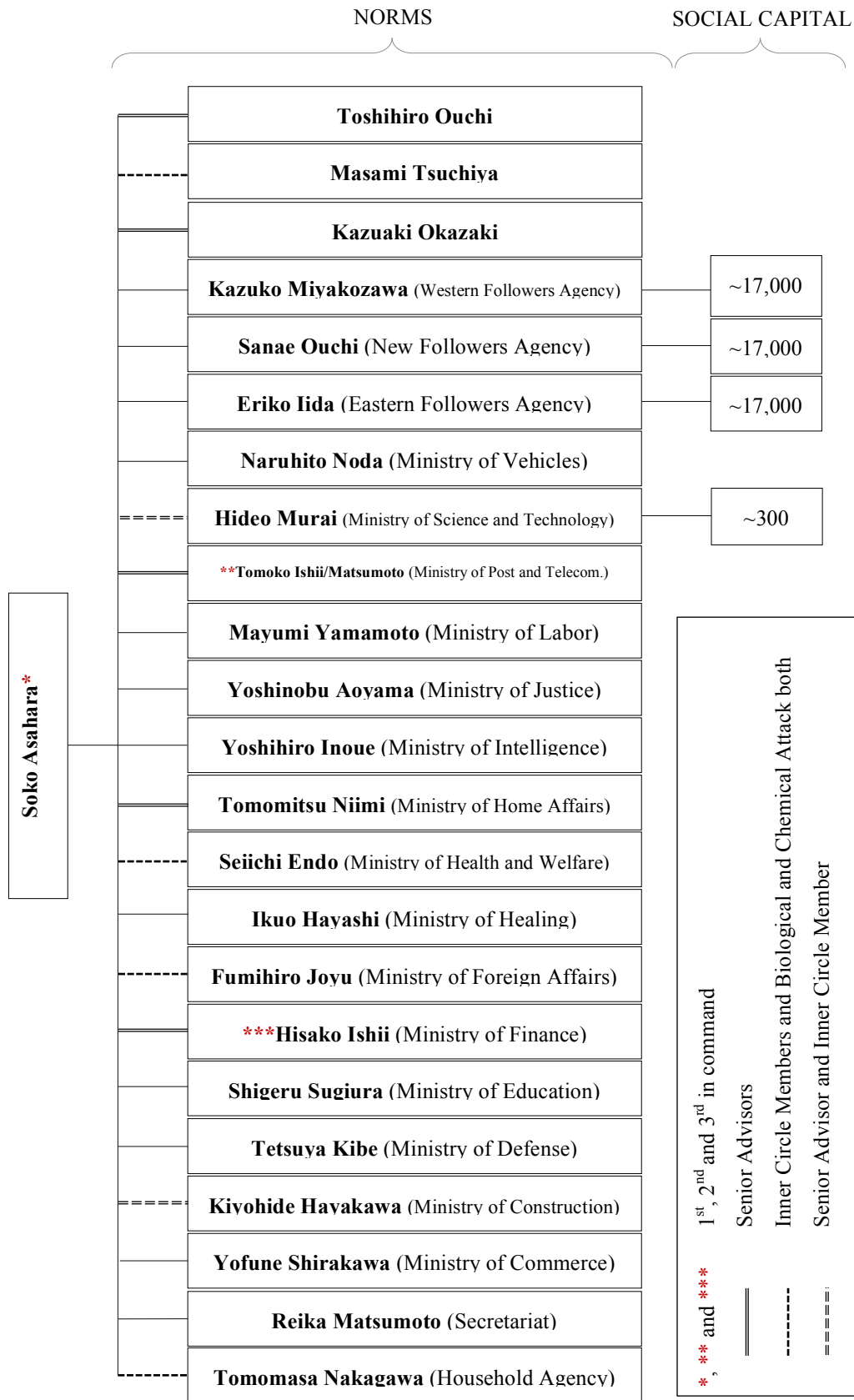
social capital among agents and is represented through the fraction of six times of the length of total vectors by the length of two paths (Alqithami and Hexmoor 2012a, Alqithami and Hexmoor 2012c, Easley and Kleinberg 2011). Relatedly, the bridging matrix measures outside connections (i.e., ties) to represent the betweenness among all participant members.³ As a result, the repeated interaction of bonding or bridging among agents inside and/or outside the organization produces a cohesive network. In other words, cohesion is made of a combination of bonding and bridging matrices and can play the same role as a clustering coefficient to measure the triadic closure in a sociogram (i.e., a graph) (Alqithami and Hexmoor 2012a, Alqithami and Hexmoor 2012c, Easley and Kleinberg 2011).

Since a NO has periodic patterns of connections, ties have an effect on organizational performance as well as the agents' intra-organizational network, which are dependent on their types of state ties and event ties. State ties are measured concerning intensity, strength, and duration over continuous time, while event ties are measured on the subject of frequency over a discrete time slot. Ties have a positive correlation with the social capital of a NO (e.g., when the organization has a strong social capital, ties are also strengthened) (Alqithami and Hexmoor 2012a, Alqithami and Hexmoor 2012c, Borgatti and Halgin 2011, Easley and Kleinberg 2011). In the case of Aum, these kinds of ties evaluate (i.e., enable, limit, or constrain) the flow of information as members engage in various types of interactions. For instance, in 1995 the leader (i.e., Asahara) engaged in interactions (state type ties) with his members (i.e. the individuals who were justified with committing acts of terror) in order to commit on releasing Sarin gas (i.e., an event type ties) on five trains in the Tokyo subway system, killing 13 commuters and seriously injuring 5,000 others. However, this event would not have been accomplished had Asahara not been able to seed (i.e. grow or strengthen) his network.

1.4.2. The seeding of Aum Shrinrikyo

In general, the seeding of Aum is similar to many other network organizations in that Asahara was able to strengthen his ties in the yoga-shop before he started over-exaggerating his religious capabilities, thus bridging his ties. The seeding of his organization started when 23 members were seeking a foundation of faith in him as a means to fill a void in their scientific-based lives. Their beliefs were only a normative social influence through mirroring his behavior and attitude. And looking for more resources to spread his ideas and gain money (i.e., utility), Asahara began to build a hierarchical structure through the 23 primary members in order to attract more followers to Aum (Figure 1.1). More broadly, Asahara's norms facilitated coordinating agents' diversity, heterogeneity, and autonomy inside a NO instead of direct control of their socialites. It allowed the leader to determine satisfactions, punishments and rewards, as well as the control over agents' behaviors and interactions for consistent and efficient process. Furthermore, the leader used roles to determine and control the normative attitudes for his followers' interactions, which in result differentiated their ties. Oftentimes roles are applied endogenously or exogenously to a NO. In the present case study, it appears as though Aum's roles were exogenously applied since the leader was responsible for assigning roles during formation; however, it became self-organized over time (i.e., roles were endogenously applied).

³ Betweenness is the number of shortest paths from all vertices to all others that pass through that agent



Note: With the exception of the three Followers Agencies (Western, Eastern, and New) and the Ministry of Science and Technology, all agencies do not oversee anyone, as they are only responsible for the coordination of events that utilize their services. One or more of the 23 individuals under Asahara implemented all major attacks.

Figure 1.1
 The hierarchical structure of AUM and its stages.
 Adapted from: Staff. 1995. *Global proliferation of weapons of mass destruction: A case study on the Aum Shinrikyo*. Senate Government Affairs Permanent Subcommittee. Also adapted from: Danzig, R., Sageman, M., Leighton, T., Hough, L., Yuki, H., Kotani, R. and Z. Hosford. 2011. *Aum Shinrikyo insights into how terrorists develop biological and chemical weapons*. Center for a new America security.

As previously mentioned, the formation of Aum was based on strong ties, which allowed the NO to grow virally with the acceptance of every new member, eventually accumulating over 50,000 members. It is obvious that the formation of Aum was based on three main parameters of a NO: capabilities, preferences, and resources. (1) Capability is what the member-agent has in order to handle certain tasks. The agents were chosen based on their knowledge and achievements. (2) Preference is considered when some of the leaders were considered senior advisors and allowed to have more power than others. (3) Resources are the most important key in forming this organization. The resources provided by lower-level followers helped him in structuring these ties in order to build a NO, as well as allowed the extension of their views and opening of several more base locations in different countries. Therefore, the capabilities of members within Aum played an important role since the leader attracted followers with higher educational and financial achievements. As such, this study simulates the primary formation of Aum when Asahara's aim was to have more power and control, not commit harmful actions or acts of terror. Moreover, it will show how each of the 24 primary members gains utility, and the person with the most utility maintains the position of supreme leader.

1.4.3. A simulation of Aum Shrinrikyo

In an organization, ties can differ depending on the aforementioned descriptions and may have varying values (i.e., from 0.0 (the minimum value) to +1.0 (the maximum value)) depending on the form of co-evolution. The three main forms of co-evolution that an organization uses in order to extend its connections are harmony, cohesion and spontaneity with the maximal or near-maximal values of their associated parameters (Figure 1.2).

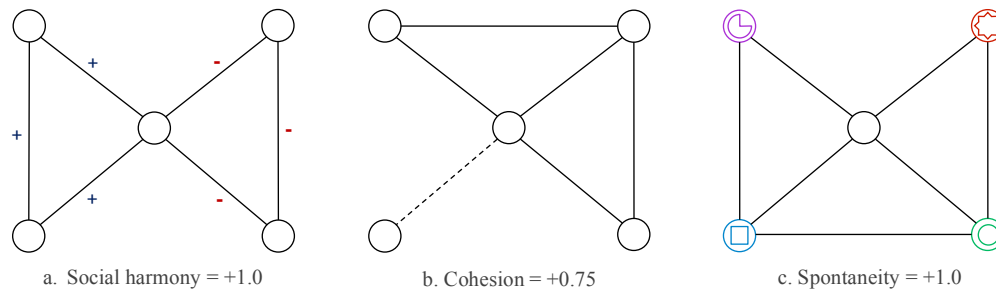


Figure 1.2

Three forms of co-evolution inside an organization.

Modified from: Alqithami, S. and H. Hexmoor. 2013c. *Qualities of interest for spontaneous networked organizations*. In *Proceeding of the 2013 AASRI Conference on Intelligent Systems and Control*, Canada.

In Figure 1.2 the three main forms of co-evolution are presented in their simplest forms, where Figure 1.2a presents a structure of network nodes in which harmony is the highest among agents. The positive or negative signs depict whether the social harmony was balanced or unbalanced. We assume that the harmony is equal to +1.0 when the whole network is balanced; otherwise it will be graded based in the balancing ratio. Figure 1.2b shows two types of cohesion, where the dashes present the local bridging, while the solid line presents bonding (Easley and Kleinberg 2011). The cohesion is equal to +1.0 when the organization has a fair amount of interactions, which can be generated inside the organization through bonding or

outside the organization through bridging (Alqithami and Hexmoor 2013c). Spontaneity, seen in Figure 1.2c, links the different types of agents who may behave irrationally, where the different shapes in the graph depict the various kinds of agents, actions, and future interests. Spontaneity is satisfied and presented by +1.0 when any agent ties with another agent of a different type, while it becomes less when the agent corresponds with others of similar capabilities, activities, and resources until the value reaches a minimum of 0.0. Leadership and connections are related to many open social environments. Thus, leadership affects more than the social harmony among the agents to further impact the cohesion of the organization. Furthermore, spontaneity indicates that separate agents may have implicit communications with one another indirectly based on shared affinities or interest.

These forms of co-evaluation are used to classify cooperation among agents in order to arrive to the total average utility of an organization such as Aum. The cooperation (δ) between two agents, i and j , is denoted as $\delta(i, j)$. Moreover, the agents' assignments were based on capabilities, preference and resources, as discussed in detail above. Preference usually plays the same role as resources (i.e., preference \propto resources) since access to resources will become higher and the opposite is possible; therefore, we will consider both preference and resource, as they both can be applied similarly. The capability of agent i , denoted (Ψ_i), is the sum of a set of different capabilities $\{\psi_1, \psi_2, \dots, \psi_n\}$ for different tasks (n). To measure the activeness (β) of agent i , we propose Equation 1.1 depending on the role assigned ξ .

Equation 1.1

$$\beta_i = \sum_i \xi_i (\text{preference}_i \times \Psi_i)$$

The utility of individual agent x_i is measured through Equation 1.2.

Equation 1.2

$$\begin{aligned} \varphi(x_i, \xi_i) &= \beta_i + \frac{1}{\lambda} \sum_i^j \delta(i, j) \\ \lambda &= \sum_i (\Psi_i | \Psi_i \in \xi_i) \end{aligned}$$

The average global utility (U_G) of such a network organization is measured through Equation 1.3.

Equation 1.3

$$U_G = \sum_i^j \frac{\varphi(x_i, \xi_i)}{\mu}$$

Where μ is the total number of agents (i.e., $\mu = \sum_i x_i$). This shows the average satisfaction with respect to the role assigned for the majority of a NO. Using these equations, the formula for finding the relative utility has been implemented to depict the case of Aum in order to discover

who has the highest utility among Aum's members. Specifically, Equation 1.2 was used in the NetLogo implementation of this study to find the expected utility for each agent. Developed by Uri Wilensky in 1999, NetLogo is a programmable modeling environment used to simulate natural and social phenomena (i.e. agents) and runs on the Java virtual machine. The NetLogo programming environment allows the programmer to give instructions to a limitless number of independently operating agents as a means to model complex systems over time. Moreover, NetLogo provides programmers with the capability to explore the connections and patterns between (1) individual level behaviors (i.e., interactions between agents), and/or (2) individual agents and their environments (Wilensky 1999).

The simulation in this study presents each leader's utility through random connections. This is based on the type of ties that link them in order to show the hierarchical structure of this organization and how Asahara has the highest utility in Aum. Furthermore, the simulation shows that the size of an agent changes based on the number of ties for each member within the organization, and upon it he or she will be assigned a title. The supreme leader (SL) Asahara is the main character in forming this organization, thus his rank was the highest as he was in control of this hierarchical structure. His leaders (L)—which include ministry heads, senior advisors, and inner circle members—are in the second stage of this hierarchy since they helped in forming, evaluating and changing this organization based on the SL's needs while followers (F) had ties that were generally not noticeable in comparison with others.

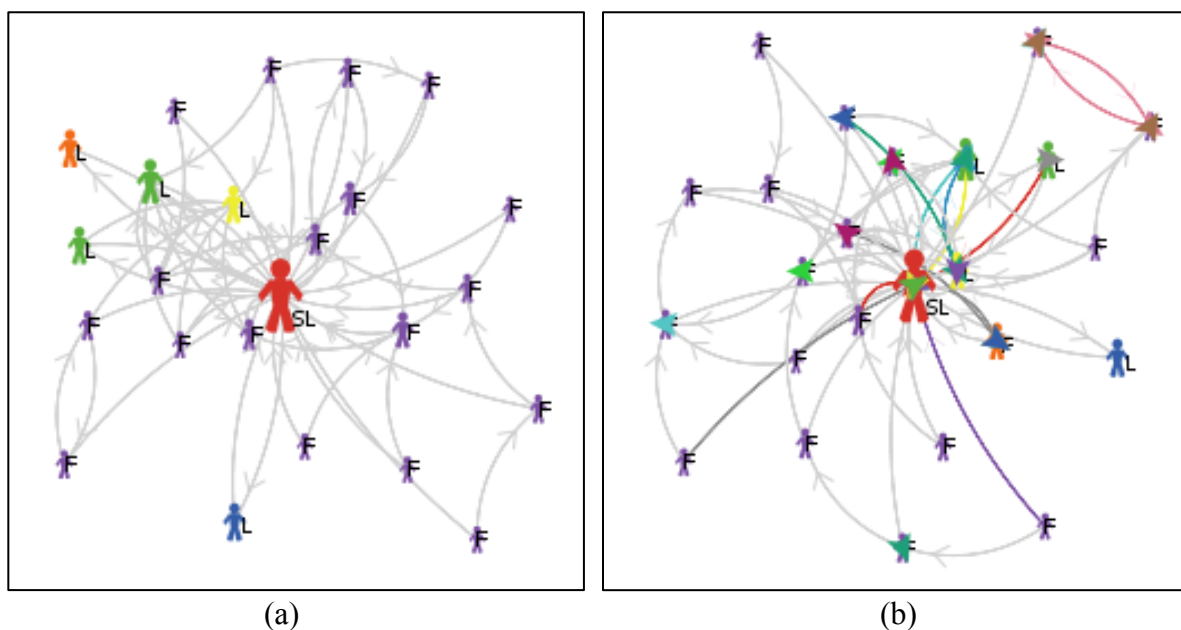


Figure 1.3
Simulation of member classifications based on the utility function.

The preceding simulation output represents the rate in which Aum leaders gained utility where Figure 1.3a shows the member classifications based on the diffusion of one idea, and Figure 1.3b shows the member classifications based on a continuous set of actions assigned randomly. Throughout the simulation Asahara maintained the highest utility, qualifying him as the supreme leader of Aum, while the 23 leaders in the hierarchy below him had fewer utilities than Asahara, but more than the remaining 50,000 plus followers. Additionally, the simulation shows which of the 23 leaders under Asahara had the most utility among them, qualifying the

leader with the most utility to become the supreme leader should something become of Asahara (e.g., death or imprisonment). For simplicity, the assumption in the simulation was based on those agents to have random capabilities, resources, and preferences, which allow them to have different volumes of excessive interaction and different ranking in the hierarchical structure.

1.5. CONCLUSION AND FUTURE WORK

In summary, this chapter presented the case study of a terrorist organization known as Aum. This organization has caused a lot of damage inside Japan with many of their activities, which resulted in many deaths and injuries. An evaluation of such a network organization using multi-agent systems was presented. This section showed the impact of norms on the society with other important factors (i.e., roles, capabilities, preferences and resources), and how Aum has benefited from it. The chapter progressed to cover the role of social capital in this organization and how it helped in maintaining the organization over time. The method of finding the global utility was proposed and implemented for validation using the Aum network. Additionally, this study shows not only how dependence on hierarchical structure can affect organizational performance, but also how the types of ties, norms, roles, capabilities, resources and preferences play an important role in forming the NO.

As our study only looked at the creation of NO ties within Aum, future research will include analysis of various tie disseminations and forms of negative social capital. These disseminations can be seen through the change of Aum's organizational goals (a reaction to outside forces that were not acceptable in Asahara's view), while negative social capital was the use of Aum's social capital for harmful purposes against other organizations (i.e., Japanese government). For instance, Asahara began triggering negative social capital from the sociality that existed in order to protect his organization, resulting in several terrorist attacks. Subsequently, the attacks led to the dissemination of their NO and the arrest of Asahara as well as several of the 23 leaders. Additionally, Aum leaders did not allow ties between followers to diminish due to the negative effect on the other members (i.e., followers who attempted to leave were viewed as a threat since they knew too much). As a result, when any member tried to leave Aum's NO, the individual was tracked down and brought back to be tortured, humiliated or even killed. This has reflected on the dynamic organizational roles (i.e., the role is updated dynamically for every member over time) pointing to the awareness that leaving the group is impossible. By analyzing these aspects of Aum's NO dissemination, we will be able to see how broken ties affected the utility of Aum and led to its fragmentation into small splinter groups with Asahara no longer the supreme leader.

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