This product is part of the RAND Corporation technical report series. Reports may include research findings on a specific topic that is limited in scope; present discussions of the methodology employed in research; provide literature reviews, survey instruments, modeling exercises, guidelines for practitioners and research professionals, and supporting documentation; or deliver preliminary findings. All RAND reports undergo rigorous peer review to ensure that they meet high standards for research quality and objectivity.

REPORT

Facilitating Information Sharing Across the International Space Community

Lessons from Behavioral Science

Kirsten M. Keller • Douglas Yeung • Dave Baiocchi • William Welser IV

RAND PROJECT AIR FORCE

REPORT

Facilitating Information Sharing Across the International Space Community

Lessons from Behavioral Science

Kirsten M. Keller • Douglas Yeung • Dave Baiocchi • William Welser IV

Prepared for the United States Air Force
Approved for public release; distribution unlimited

PROJECT AIR FORCE

The research described in this report was sponsored by the United States Air Force under Contract FA7014-06-C-0001. Further information may be obtained from the Strategic Planning Division, Directorate of Plans, Hq USAF.

Library of Congress Cataloging-in-Publication Data

Keller, Kirsten M.
Facilitating information sharing across the international space community : lessons from behavioral sciences / Kirsten M. Keller, Douglas Yeung, Dave Baiocchi, William Welser IV.
pages cm
Includes bibliographical references.
ISBN 978-0-8330-7694-6 (pbk. : alk. paper)
1. Space debris—International cooperation. 2. United States. Strategic Command (2002-)
3. Communication—International cooperation. I. Yeung, Douglas. II. Baiocchi, Dave. III. Welser, William. IV. Title.

TL1499.K45 2013
363.12'472—dc233

2013012884

Published 2013 by the RAND Corporation
1776 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138
1200 South Hayes Street, Arlington, VA 22202-5050
4570 Fifth Avenue, Suite 600, Pittsburgh, PA 15213-2665
RAND URL: http://www.rand.org
To order RAND documents or to obtain additional information, contact
Distribution Services: Telephone: (310) 451-7002;
Fax: (310) 451-6915; Email: order@rand.org

Preface

Space debris—the man-made orbital junk that represents a collision risk to operational satellites—is a growing threat that will increasingly affect future space-related mission designs and operations. This increase in debris has renewed interest among entities such as the U.S. military and private spaceflight companies in reducing future debris populations using political and technical means.

The 2010 U.S. National Space Policy makes several policy recommendations for addressing the space congestion problem. One of the policy's key suggestions instructs U.S. government agencies to promote the sharing of satellite positional data because they can be used to predict (and avoid) potential collisions. This type of information is referred to as space situational awareness data. The organizations that keep track of such information have traditionally treated it as proprietary or sensitive.

This document seeks to facilitate the data-sharing process by examining some of the behavioral and psychological barriers that may prevent diverse entities from sharing data and processes more freely. Specifically, this document addresses the following questions: What are key psychological and motivational barriers to information sharing? What steps can the U.S. Air Force take to facilitate improved information sharing among space-faring entities?

This report is written for those who are familiar with the technical concepts of space situational awareness but have little experience with the behavioral motivations behind information sharing. Understanding the psychology behind sharing information may help senior decisionmakers and policy experts make more-effective choices when considering future agreements with private industry or foreign nations. The work should be of interest to public and private sector individuals who are working on the technical and policy-oriented aspects of space situational awareness, the legislative and executive branches of the U.S. government, and the U.S. Air Force.

This document is the latest RAND research on space debris. The initial monograph, *Confronting Space Debris: Strategies and Warnings from Comparable Examples Including Deepwater Horizon* (Baiocchi and Welser, 2010), was sponsored by the Defense Advanced Research Projects Agency. The monograph addresses the debris problem by looking for applicable lessons from outside the aerospace industry. While *Confronting Space Debris* took a broad look at the debris problem, this document takes a detailed look at what steps the Air Force and other spacefaring organizations can do to promote better situational awareness through increased data sharing.

This research was sponsored by Maj Gen John Hyten, Director, Space Programs, Office of the Assistant Secretary of the Air Force (Acquisition) (SAF/AQS); and Gen C. Robert Kehler (AFSPC/CC). The project was conducted within the Force Modernization and Employment

Program of RAND Project AIR FORCE as part of a fiscal year 2011 study, "Space Situational Awareness and Maintaining Access and Use of Space."

RAND Project AIR FORCE

RAND Project AIR FORCE (PAF), a division of the RAND Corporation, is the U.S. Air Force's federally funded research and development center for studies and analyses. PAF provides the Air Force with independent analyses of policy alternatives affecting the development, employment, combat readiness, and support of current and future air, space, and cyber forces. Research is conducted in four programs: Force Modernization and Employment; Manpower, Personnel, and Training; Resource Management; and Strategy and Doctrine.

Additional information about PAF is available on our website:
http://www.rand.org/paf/

Contents

Summary

Over the past 60 years, an increasing number of countries and organizations have realized the advantages that space-based assets can provide. Currently, a handful of countries have the independent ability to launch unmanned orbital missions. Many more have also built what are known as *hosted payloads* for launch via partnerships with other countries. Hosted payloads use excess capacity on spacecraft or rockets that are already scheduled for launch. In addition, private companies, such as Arianespace, Orbital Sciences, and SpaceX, have started to develop capabilities that will provide the public and private sectors with additional spacelift capacity.

Along with the increase in spacefaring activity, there has been a commensurate increase in the number of operational satellites and an even greater increase in space debris. As a result, there is renewed interest among such entities as the U.S. military and private spaceflight companies in reducing future debris populations using political and technical means.

The 2010 U.S. Space Policy (White House, 2010) makes several policy recommendations for addressing the space congestion problem. One of the policy's key suggestions instructs U.S. government agencies to promote the sharing of satellite positional data, which can be used to predict (and avoid) potential collisions. This type of information is referred to as *space situational awareness* (SSA) *data*. The organizations that keep track of such information have traditionally treated it as proprietary or sensitive because it can reveal information about a satellite operator's intent or vulnerability.

This document seeks to facilitate the data-sharing process by highlighting a few of the key behavioral and psychological barriers that may prevent diverse entities from sharing data and their processes more freely. Specifically, this document addresses the following questions: What are key psychological and motivational barriers to information sharing? What steps can the U.S. Air Force (USAF) take to facilitate improved information sharing among spacefaring entities?

To address these questions, we primarily drew on literature focused on information sharing at the individual level to examine potential psychological and motivational factors that may influence decisionmakers to create certain policies on information sharing. This work, therefore, provides a complementary perspective to such fields as political science, which often takes a broader view to explore relations at the nation-state level. However, it is important to note that, in the context of the space community, more macro-level factors and organizational dynamics, including legal, security, and political concerns that are beyond the scope of this review, will also play a role in how these psychological and motivational barriers ultimately manifest and influence policy decisions. Furthermore, this review focuses predominantly on empirical psychological and organizational behavior literature. Other disciplines, such as economics, political science, and sociology, may provide additional perspectives on the issue of

information sharing among members of the space community that are beyond the scope of the current review.

Barriers to Information Sharing

There are several key barriers to information sharing that may be particularly relevant to space community decisionmakers. First, one of the primary barriers to information sharing is the extent to which relationships with others are viewed as competitive or cooperative. Rivalries likely exist within the space community, such as between the United States and other nation-states or between private companies competing for the same business. Therefore, the more that space community members view each other as competitors and perceive that providing information is a detriment to achieving their individual goals (i.e., incentives to not share information exist), the less likely they will be to share information.

Similarly, given that possessing information is viewed as a competitive advantage and provides a source of power, research finds that sharing information with others, particularly others that may be viewed as competitors, requires a considerable amount of trust. It may not be possible to develop completely trusting relationships among members of the space community, given the existence of defense and intelligence satellites, which require a certain degree of secrecy and security. However, without any level of trust among members of the space community, there is little motivation to share information and believe that information others share is accurate.

Attitudes and beliefs can also play a role in information sharing, such as perceptions of information ownership. For example, research in online communities has found that members are more likely to share information that is perceived as belonging to the community—that is, information they consider to be a "public good." Therefore, to the extent that members of a community view themselves as belonging to that community and information as benefiting the whole community, they are more likely to share information. Likewise, when individuals do not view themselves as part of a larger community, they will be less likely to share information.

A final potential barrier to information sharing is cross-cultural differences. In particular, differences in individualism-collectivism, a dimension that measures the degree to which a society reinforces individual or collective achievement and interpersonal relationships, may influence information sharing. Research studies have found that collectivist cultures make a sharp distinction between in-group and out-group members.[1] This distinction then influences information-sharing behaviors, with individuals more likely to share information with members of their in-group and less likely to share information with members of an out-group.

Recommendations

We found several key factors that may affect the motivations of decisionmakers to allow information sharing with others in the space community. Again, it is important to note that more

[1] *In-groups* may be defined by relationships to family, friends, or coworkers, and in a broader context, even by national identity. Collectivists have strong loyalty to in-group members, while disliking and distrusting out-group members (Triandis, 1989).

macro-level factors and organizational dynamics that are beyond the scope of this review will also play a role in final policy decisions. However, these psychological and motivational factors highlight several key barriers the Air Force may wish to consider as it works to facilitate information sharing within the space community. Based on our review, we developed the following four recommendations for promoting greater collaboration across the space community:

Recommendation 1: Show Each Organization That the Benefits of Information Sharing Outweigh the Perceived Risks. Members of the space community may perceive inherent risks in sharing information with potential rivals, particularly when defense and intelligence satellites may be involved. Therefore, a key first step is to show each organization that the benefits of information sharing outweigh the perceived risks, or similarly, that the risks of *not sharing* information are greater than the risks *of sharing* information with others. USAF can help in this effort by (1) quantifying the explicit costs of not sharing information and (2) demonstrating that information sharing will result in more good than harm.

Recommendation 2: Encourage Organizations to See Themselves as Members of a Broader Group: The Space Community. The more members of the space community see themselves as competitors, the less likely they will be to openly share information. Therefore, encouraging these diverse organizations to see themselves as belonging to a single community with a common goal can help facilitate information sharing. Examples of ways USAF might be able to help build this broader community identity are by (1) communicating the importance of preventing collisions due to space debris and that this issue affects all members of the space community (i.e., a common goal), (2) showing that the United States wants to be a collaborative partner by demonstrating a willingness to share technical information and pool resources across the space community, (3) having senior military leadership encourage all military members representing the United States at conferences and public forums to treat others as equal members of the space community, encouraging collaboration instead of competition, and (4) encouraging adherence to existing international guidelines or agreements for space activities to illustrate that all members are part of a single community governed by similar guidelines.

Recommendation 3: Establish SSA Data as a Public Good That Benefits the Entire Space Community. Information is most likely to be shared when it is viewed as belonging to everyone, for use as a public good. USAF can help establish key types of information as public goods that should be shared within the entire space community by designating specific information types as public. It is important to note that not all information can be made public; organizations will not share everything. Therefore, members of the space community will need to attempt to explicitly agree on which information can be made public, providing mutual benefit without harming individual members.

Recommendation 4: Build Trust Among Members Through Successful Information Transactions over Time and Transparency of Processes and Systems. Given that many of the organizations and international agencies within the space community are likely to see themselves as potential rivals, there may be an initial lack of trust between many members of the space community. Trust will need to be built over time and can develop through continued successful transactions between space community members. Providing transparency regarding the processes and systems used to share information can also help reassure organizations that the information they share is secure and will not be used against them. USAF can help establish this sense of trust by (1) increasing its own sharing of information, starting with its closest

allies; (2) disseminating related U.S. policies and procedures to promote increased transparency; and (3) disseminating information on proposed mechanisms for sharing data.

Additional Considerations

As noted earlier, additional factors are likely to be important in making decisions to share information within the space community. First, many members of the space community, particularly nations and their militaries, may have security concerns regarding information dissemination, such as with classified or otherwise sensitive information. Such information may need to be declassified or deidentified before sharing is possible. There may be legal barriers to information sharing as well. Export control regulations or antitrust laws may preclude sharing certain types of information, either outright or with particular countries or corporations. Finally, a shifting landscape in how space operations are funded and conducted may affect information sharing in unknown ways. The space community has become increasingly commercialized as government agencies, such as the National Aeronautics and Space Administration (NASA), have refocused efforts toward funding private firms. Whereas national space programs could easily engender cooperative motives, such as by appealing to national pride, private firms competing for market share may be less likely to trust and cooperate with one another.

Acknowledgments

We are very grateful for our U.S. Air Force sponsors, Maj Gen John Hyten, Director, Space Programs, Office of the Assistant Secretary of the Air Force (Acquisition) (SAF/AQS), and Gen C. Robert Kehler (AFSPC/CC), who have been abundantly helpful and supportive of this work from the start. Col (ret) Michael Taylor was also very helpful in getting this project under way and started down the right path. Finally, we would also like to thank Christopher Paul and Laura Miller for their reviews. Their comments greatly improved the quality of this work.

We have taken extra care to make sure that the results of this research are accessible and intuitive. The observations and conclusions made within this document are those of the authors and do not represent the official views or policies of the U.S. Air Force.

Abbreviations

PAF	Project AIR FORCE
RVC	relational virtual community
SSA	space situational awareness
TVC	transactional virtual community
USAF	U.S. Air Force
USSTRATCOM	U.S. Strategic Command

CHAPTER ONE

Introduction

Over the past 60 years, an increasing number of countries and organizations have realized the advantages that space-based assets can provide. As of March 2012, ten countries had the independent ability to launch unmanned orbital missions.[1] Many more have also built what is known as *hosted payloads* for launch via partnerships with other countries. Hosted payloads use available capacity on spacecraft or rockets already scheduled to be launched into space. In addition, private companies, such as Arianespace, Orbital Sciences, and SpaceX, have started to develop capabilities that will provide the public and private sectors with additional spacelift capacity. This large number of stakeholders means that the space community is a diverse group that uses space as a resource for a variety of reasons: Nation-states enhance national security and protect economic interests; private companies generate revenue and provide broader access to space; and the scientific community pursues scholarly research using space-based resources (Baiocchi and Welser, 2011).

While the motivations for using space differ among stakeholders, most would agree that space must be preserved by properly managing the congestion problem. Currently, the largest congestion threat comes from the risk that two operational (or formerly operational) satellites will collide, creating a debris field that threatens other operational satellites (e.g., Iridium-Cosmos collision in 2009). To manage this problem, the community needs to make effective use of space situational awareness (SSA) assets, such as catalogs that track space objects.

Currently, a number of organizations maintain catalogs (or partial catalogs) to track the man-made objects in orbit. At the time of this writing, one of these, Space-Track.org, listed 3,603 active payloads across all countries, or 16,276, if including rocket bodies and debris. These catalogs are considered proprietary to each catalog owner, but as orbital regimes continue to grow more crowded with more diverse interests, the catalog owners will feel increased pressure to share the details of their catalogs with the rest of the space community.

As the 2010 U.S. National Space Policy suggests, information sharing within the space community is currently insufficient and needs to be improved (White House, 2010). Therefore, one of the policy's key suggestions is that U.S. government agencies promote the sharing of satellite positional data because this information can be used to predict (and avoid) potential collisions. More recently, at the 2011 U.S. Strategic Command (USSTRATCOM) Cyber and Space Symposium, Gen Robert Kehler noted that the United States needs to work together "to build coalitions of like-minded spacefaring nations, and explore development of such things as combined space doctrine, combined space operations, and combined space activities that enable sharing of space capabilities in crisis and conflict" (Kehler, 2011). Although addressing

[1] These countries were the United States, China, France, Japan, United Kingdom, India, Israel, Russia, Ukraine, and Iran.

challenges to information sharing involves many aspects of national and international policy, we believe there is an opportunity for the U.S. Air Force (USAF) to take a leadership role and help facilitate information sharing within the space community.

Objective and Methodology

This document is intended as an exploratory examination of some of the key behavioral and psychological barriers that may inhibit information sharing and may prevent the space community from sharing their SSA data and processes more freely. Specifically, it addresses the following questions: What are the key psychological and motivational barriers to information sharing? What steps can USAF take to facilitate improved information sharing among spacefaring entities?

In exploring these questions, we primarily drew on literature focused on information sharing at the individual level to examine potential psychological and motivational factors found in empirical research that may also influence decisionmakers to create certain policies on information sharing. This provides a complementary perspective to such fields as political science, which often takes a broader view to explore relations at the nation-state level. However, it is important to note that, in the context of the space community, more macro-level factors and organizational dynamics, including legal, security, and political concerns that are beyond the scope of this review, will also play a role in how these psychological and motivational barriers ultimately manifest and influence policy decisions.[2] Similarly, the extent to which decisions are made by a single leader or a committee will also have an effect.

In the following sections, we provide an overview of several key psychological and behavioral factors that have been identified in the empirical literature as influencing information sharing and then present recommendations for specific actions USAF can take to address these barriers. A greater understanding of these factors may help the space community better facilitate information sharing among its members. In particular, the recommendations we present here should be useful to policymakers as they look to implement the 2010 U.S. National Space Policy, which encourages sharing and international collaboration.

---

[2] This review focuses predominantly on the empirical psychological and organizational behavior literature. However, other disciplines, such as economics, political science, and sociology, may provide additional perspectives on the issue of information sharing among members of the space community.

CHAPTER TWO

Barriers to Information Sharing

Our review of the literature identified several key psychological and motivational barriers to information sharing that may be particularly relevant to decisionmakers in the context of the space community. We discuss each of these in the following sections.

Cooperative Motives in a Competitive Environment

One of the primary barriers to information sharing often cited in the literature is the extent to which relationships with others are viewed as competitive or cooperative. For example, organizational structures themselves are frequently devised such that individuals are competing against one another for resources, promotions, raises, etc. (Hinds and Pfeffer, 2003). As a result, individuals often view their relationships with others in terms of a competitive zero-sum game: What one gains, another loses. In fact, power is often defined as access to and control over resources, such as information (e.g., Galinsky, Gruenfeld, and Magee, 2003; Pettigrew, 1972; Pfeffer and Salancik, 1978; Yukl and Falbe, 1991). Thus, collaborating and sharing unique information, even when it is toward a mutually beneficial goal, may be perceived as leading to the potential loss of competitive advantage and power.

Research shows that when individuals or groups do choose to enter into cooperative relationships, they are often put into mixed-motive interdependence, meaning that they are simultaneously competing and cooperating with one another (Tsai, 2002). For example, in the context of group decisionmaking, members often have competing cooperative and competitive goals or incentives (De Dreu, Nijstad, and van Knippenberg, 2008; Wittenbaum, Hollingshead, and Botero, 2004). The group as a whole may be more likely to reach an optimal or mutually beneficial decision when individual group members cooperate and openly share information with one another. However, individual group members also have their own incentives to be the first to reach a decision. For example, an experiment by Toma and Butera (2009) found that the perception of a decisionmaking task as being either cooperative or competitive influenced the extent to which group members shared information. A decisionmaking task was designed so that group members held different pieces of information and so that the group would reach the correct decision only if all the members cooperated and openly shared their pieces of information. However, individual group members were then put into either a cooperative or a competitive situation. In the cooperative situation, participants were told that their goal was to jointly decide the best solution. In the competitive situation, participants were told that, although groups usually make a joint decision, their goal was to be the first person in the group to offer the best solution. Thus, individuals in the competitive condition faced

both cooperative and competitive incentives. The experiment revealed that individuals who had cooperative incentives were significantly more likely to share information with other team members than were individuals with competitive incentives. Group members with competitive incentives actually withheld unique information from other group members in an effort to be the first team member to come up with the solution.

Additionally, other research has found that, when information sharing is required, but the individuals engaged do not hold cooperative motives, the individuals are more likely to lie or to distort the information. For example, in a similar decisionmaking study to the one described above, Steinel, Utz, and Koning (2010) examined the information-sharing behaviors of individuals that had either cooperative or competitive motives. Individuals who were cooperatively motivated were given an incentive based on group performance; they were focused on the cooperative goal of reaching a high-quality group decision. Individuals who were competitively motivated were given an incentive based on their individual performance; they were focused on outperforming the other group members. Study results indicated that cooperatively motivated individuals were more likely to share information with other group members, including information that was important and was known only to them. In contrast, competitively motivated individuals strategically withheld information, particularly important information, and even distorted the information that they chose to share with others. Steinel and De Dreu (2004) had similar results in a series of decisionmaking experiments between dyads. They found that individuals provided more-accurate information when they believed their counterpart was a cooperative partner. In contrast, individuals who believed their counterpart to be a competitor were more likely to withhold accurate information and to engage in deception. The withholding of accurate information was due to fears of exploitation and greed. Thus, just having an agreement to share information is not enough; actors must also be motivated to share information.

Research on organizations similarly highlights the importance of access to unique resources, including information, as being a firm's competitive advantage over others (Barney, 1991). Competitive rivalries likely exist within the space community, such as between the United States and other nation-states, or between private companies, such as SpaceX and Orbital Sciences Corporation. Therefore, even though sharing information would result in some mutually beneficial outcomes, the more leaders of the space community view each other as competitors and perceive that providing information is a detriment to achieving their goals (i.e., incentives to not share information exist), the less likely they will be to allow their organizations to share information.

Trust

Given that possessing information is viewed as a competitive advantage and provides a source of power, sharing information, particularly with others that may be viewed as competitors, requires a considerable amount of trust. At the interpersonal level, trust has been defined as a "psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another" (Rousseau et al., 1998, p. 395). In the context of organizational partnerships, trust has similarly been defined as "the degree of confidence the individual partners have in the reliability and integrity of each other" (Aulakh, Kotabe, and Sahay, 1996, p. 1008). Thus, scholars have cited trust as an important factor in

information and knowledge sharing (Dirks and Ferrin, 2001; Hinds and Pfeffer, 2003; Panteli and Sockalingam, 2005; Zand, 1972).

When a situation involves some inherent risk, such as sharing private information, it is critical to be able to expect that the other parties involved have positive intentions and that the shared information will not be used in a negative way. For example, research at the individual level has found that trust is a critical aspect of information sharing. In a simulated decision-making task, O'Reilly (1978) found that subordinates shared more information with a supervisor when he or she was perceived as trustworthy, even if the information was important but reflected unfavorably on the subordinate. Similarly, in a study examining negotiation behaviors, Butler (1999) found that expectations of trust led to greater information exchange among negotiation partners. Furthermore, the amount of information exchanged between parties played a partial role in helping to develop a broader climate of trust among negotiators. That is, the more information was exchanged, the more trust increased between the negotiators.

The importance of having a climate of trust in facilitating information exchange among organizational members has also been highlighted in other research. For example, individuals are less likely to share information when there is a low climate of trust and when they do not understand how the information they share might be used or believe that the information may be used against them in some manner (e.g., Bock et al., 2005; Buckman, 1998; Orlikowski, 1993; Pan and Scarbrough, 1999). In the context of the space community, this may also be especially important, considering that data and satellite locations could be used for defense or intelligence purposes.

In addition, members may not trust the information they receive from others. As described previously, individuals who view the context as competitive are more likely to distort and lie about the information they share with others (Steinel and De Dreu, 2004; Steinel, Utz, and Koning, 2010). Consistent with these potential concerns, research has shown that individuals are more likely to perceive the information they receive as being accurate when it comes from someone they initially believe to be trustworthy (Benton et al., 1969; Roberts and O'Reilly, 1974).

Similarly, research finds that trust is an important factor in information sharing when people are communicating electronically, such as in online communities that may resemble how members of the space community communicate. For example, the head of a corporation in one country and a military leader in another country may not have met in person and would likely communicate about issues relating to space by using email or something similar. "Virtual communities of practice" consist of groups of people who come together online to exchange knowledge about a topic of common interest (Ridings, Gefen, and Arinze, 2002). Such communities are defined not only by the passion and expertise of their members but also by the concept of membership, whether formal or informal (Ardichvili, Page, and Wentling, 2003), which suggests the existence of accountability to the community (e.g., through group norms or more-explicit rules).

According to this research, trust in online communication is built from two primary factors: identity presentation (e.g., providing personal information) and perceived responsiveness (e.g., responding quickly to electronic messages). People may be more likely to trust others about whom they know something. Accordingly, people who feel like their identity is salient to others may be more inclined to engage and interact in the community. For instance, Ma and Agarwal (2007) found that design factors in online information-sharing systems that increased individuals' visibility also had the effect of increasing the quantity of information they shared.

This may be because trust is extremely important in virtual communities, where members have often never met and know little about each other outside of what is shared in the community. In a survey of 36 virtual communities, trust level significantly predicted members' "desire to exchange information, and especially to get information" (Ridings, Gefen, and Arinze, 2002). Trust itself was predicted by members' responsiveness and willingness to confide in others.

Consequently, if there is a lack of trust between members of the space community regarding how the information they provide will be used and on the extent to which the information they receive is accurate, they may be less likely to wait to engage in a cooperative relationship. This concern is likely to be further amplified when contemplating entering into an information-exchange relationship with a potential rival, such as for many members within the space community.

Consistent with this, scholars have highlighted the importance of trust in interorganizational relationships and alliances (e.g., Aulakh, Kotabe, and Sahay, 1996; Cullen, Johnson, and Sakano, 2000; Das and Teng, 1998; Ring and van de Ven, 1992) and have argued that "no matter how mutually beneficial and logical the venture may seem at its start, without trust and commitment, the alliance will fail entirely or, at the very least, it will fail to reach its strategic potential" (Cullen, Johnson, and Sakano, 2000, p. 224). This includes what they term *credibility trust,* or the confidence that the partner has the "intent and ability to meet their obligations" (p. 225), and *benevolent trust,* which is the "belief that an alliance partner will behave with good will toward the alliance and the partner" (p. 225).

Ultimately, it may not be possible to develop completely trusting relationships among members of the space community, given the existence of defense and intelligence satellites, which require a certain degree of secrecy and security. However, if trust among members of the space community is lacking entirely, there is little motivation to share information and believe that the information others share is accurate.

Research in this area suggests, however, that trust can be developed over time. Specifically, trust can be built through continued successful transactions between parties (see Butler, 1999; Cullen, Johnson, and Sakano, 2000; Ring and van de Ven, 1992). As Zand (1972) notes, when information is exchanged successfully, a climate of trust can develop that will further facilitate future information sharing. This leads to what he calls a spiral reinforcement model of trust. Thus, over time, members of the space community may also be able to develop a shared climate of trust to help facilitate information sharing among members.

Knowledge as a Public Good

The attitudes and beliefs decisionmakers hold about the information itself may also play a role in whether they choose to share information. For example, at the individual level, some research shows that perceptions about information ownership are important influences on information-sharing attitudes. In a study by Constant, Kiesler, and Sproull (1994), participants were asked to read several vignettes describing an encounter with a coworker who was requesting help. They found that, when there was a belief that the information being requested belonged to the organization, not the individual, participants were more likely to share the information with others. Consequently, encouraging the perception that information belongs to an entire community may enhance information sharing.

Similarly, research in online communities has found that members are more likely to share information that is perceived as belonging to the community—that is, information they consider to be a public good. When the perception of information as a public good exists, "knowledge exchange is motivated by moral obligation and community interest, not by a narrow self-interest" (Ardichvili, Page, and Wentling, 2003). As with trust, the structure of the community may influence such individual perceptions. Sun et al. (2010) draw a distinction between relational virtual communities (RVCs), "where knowledge sharing is regarded as a social exchange behavior, heavily depending on the social concerns such as reciprocity, identification, and norms," and transactional virtual communities (TVCs), "where knowledge sharing is mainly guided under the principle of economic exchange, and cost-benefit tradeoff is the primary motive for knowledge sharing." These divergent motives for sharing knowledge result from the ways in which these virtual communities form. RVCs are formed primarily to share knowledge that increases socialization and builds relationships between members. In TVCs, the economic value of the shared information is increasingly perceived and subsequently emphasized. Noting that most knowledge-sharing research has been conducted on RVCs, the authors point out that information is generally perceived as a public good in RVCs but as a private good in TVCs.

For example, one study investigated online communities within a large, multinational corporation that were formed primarily by employees for the purpose of sharing business knowledge. Results from a survey administered to participants in these communities showed that knowledge "flowed easily" when employees viewed knowledge as a public good belonging to the entire organization (Ardichvili, Page, and Wentling, 2003).

Although these findings are focused on information sharing among individuals, similar motivations may also exist for information sharing between organizations. That is, to the extent that organizational leaders or decisionmakers view their organization as belonging to a larger community and the data their organization holds as benefiting that community, they may be more likely to share information.

Cross-Cultural Differences

Another potential barrier to information sharing is cross-cultural differences. Culture can be defined as "shared elements that provide the standards for perceiving, believing, evaluating, communicating, and acting among those who share a language, a historic period, and a geographic location" (Triandis, 1996, p. 408). Culture is usually examined based on national or regional differences, such as looking at cultural differences between the United States and Japan. The cross-cultural dimension most relevant to the formation of interorganizational relationships and alliances is likely the individualism-collectivism dimension, which measures the degree to which the society reinforces individual or collective achievement and interpersonal relationships.[1] On one end of the continuum is individualism, in which the focus is on indi-

[1] Although we focus only on individualism-collectivism as relevant to this discussion, additional cross-cultural dimensions include power distance, uncertainty avoidance, and masculinity-femininity (Hofstede, 1980). *Power distance* is the degree of equality, or inequality, between people in the country's society. *Uncertainty avoidance* is the level of tolerance for uncertainty and ambiguity within the society (i.e., unstructured situations). Finally, *masculinity-femininity* is the degree to which the society reinforces the traditional masculine work role model of male achievement, control, and power. Since their initial identification, these dimensions have been further refined and utilized in a wide array of research to examine how

viduality and individual rights. Individualistic cultures tend to focus on each individual taking care of him or herself and only his or her immediate family. There is a focus on achievement and independence or autonomy. In contrast, collectivist cultures tend to focus on the group and promoting the goals of the group over those of the individual. There is a strong distinction made between in-groups and out-groups with the goal to maintain interpersonal relationships and in-group harmony. An *in-group* is a social group with which someone identifies and in which he or she feels some sort of membership. An *out-group* is a social group with which someone feels no similarity and in which he or she feels no sense of membership (Hofstede, 1980; Triandis, 1989; Triandis, 1995; Triandis, Bontempo, and Villareal, 1988).

Scholars argue that the difference between collectivist and individualistic cultures, in terms of the distinction made between in-groups and out-groups, is likely to influence information-sharing behaviors (Ardichvili et al., 2006; Chow, Deng, and Ho, 2000; Hutchings and Michailova, 2004; Michailova and Hutchings, 2006). Overall, members of collectivist cultures are more likely to cooperate and share information with others than are members of individualistic cultures. However, in collectivist cultures, there is also a strong distinction made between in-group members, or the individuals having a close relationship, and out-group members. In-groups may be defined by relationships with family, friends, or coworkers and, in a broader context, even by national identity. Collectivists have strong loyalty to in-group members, while disliking and distrusting out-group members (Triandis, 1989). Therefore, individuals are likely to share information with other members of their in-group but are less likely to share information with members of an out-group. Individualistic cultures do not make the same sharp distinction between in-group and out-group members; instead, they should be just as likely to share information with an in-group member as with an out-group member, particularly when it is serves their individual goals.

Although limited, there has been some research examining the influence of individualism-collectivism on the likelihood of sharing information with others. For example, Chow, Deng, and Ho (2000) examined information sharing differences in a business scenario between participants in the United States (an individualistic culture) and China (a collectivist culture). In their study, participants were given a series of scenarios to read that described a business situation in which a fellow colleague asked for help in obtaining sales contacts in a particular industry. The colleague was described as being either an in-group member with whom they had a close relationship or an out-group member. Participants were then asked a series of questions concerning how typical employees in their organization would behave. Consistent with the sharper in-group versus out-group distinction made in collectivist culture, Chinese participants reported being significantly less willing to share information files with out-group members (individuals in the same organization, but with whom they had no prior relationship) than were U.S. participants.

In another study, Ardichvili et al. (2006) conducted a qualitative examination of the influence of cross-cultural differences on knowledge sharing in online communities of practice. They interviewed employees from three different locations (China, Brazil, and Russia) of a single multinational company concerning their knowledge-sharing behaviors with other employees and work units in the organization. All three of these cultures are collectivist, but to different degrees. As expected, they heard sharp distinctions from Chinese employees regard-

---

cultural differences affect behaviors, cognitive processing, social interactions, etc. (see Berry, Segall, and Kagitcibasi, 1997; Bond and Smith, 1996).

ing in-group versus out-group members. Similarly, Russian employees described being open to sharing information with their local office (immediate in-group) but also described being willing to share information within the broader organization because they "felt equally proud and fond of their membership in the organization as a whole" (p. 103). On the other hand, Brazilians described themselves as open to sharing information with others in the larger organization but, at the same time, made a distinction labeling both local dealers and U.S. expatriates as being out-group members. They described not being comfortable with either local dealers or U.S. expatriates managing the local knowledge-sharing community, even though the U.S. expatriates were part of the same organization.

Thus, again, although these findings focus on information sharing among individuals, cross-cultural differences, particularly individualism-collectivism, may also influence whether organizational leaders or decisionmakers allow information sharing with another organization. Specifically, collectivist cultures make a sharp distinction between in-group and out-group members. This distinction then influences information-sharing behaviors, with individuals more likely to share information with members perceived as being part of their in-group and less likely to share information with members perceived as being part of an out-group.

The Role of Individual Perceptions

Finally, research focused on information sharing among individuals has found that certain individual beliefs may affect personal willingness to share. These findings tend to focus on beliefs specifically regarding individuals, however, and are less likely to be applicable to motivations for information sharing at an organizational or nation-state level. Nevertheless, we discuss the findings here to illustrate additional psychological factors that have been found to be important influences on information sharing. For example, He and Wei (2009) argue that user beliefs are paramount in maintaining knowledge-sharing systems and communities. Ardichvili, Page, and Wentling (2003) note that some barriers to knowledge contribution may not be selfishly motivated. Rather, people may wish to act in the community's interests but hesitate to do so, believing themselves unable to uphold community standards of usefulness. For instance, members of one professional virtual community appeared to be reluctant to post information that they personally considered unimportant, irrelevant, or inaccurate. Newer members also indicated that they felt intimidated by not having "earned the right" to contribute knowledge. Such self-perceptions of status may hinder information sharing. People with low status may be less willing to share information (Hinds and Pfeffer, 2003). People may also feel they need to establish themselves as experts (i.e., of higher status) before contributing (Ardichvili, Page, and Wentling, 2003) and may not share if they do not feel they are qualified or have sufficient status.[2] This may lead to people not sharing information because they are not sure it is of high quality and are afraid of "losing face."

These individual beliefs and motivations toward information sharing may be influenced by social factors, such as the constraints the structure of a community or organization imposes.

---

[2] Another important motivator for information sharing in online communities is associating information with one's identity (Ma and Agarwal, 2007; Raban and Rafaeli, 2007). Successfully presenting one's identity to others—especially in an online forum—may be a key part of building mutual understanding and successful relationships. However, the extent to which identity may play a role in information sharing when interactions are between organizations or nation-states is less clear.

For example, social cognitive theory (Bandura, 1986) has been proposed to help explain how social factors, such as community norms, may influence information sharing in virtual communities (Hsu et al., 2007). Social self-efficacy and outcome expectations, the two key components of social cognitive theory, are thought to drive such behaviors. First, *self-efficacy* is an individual's belief that he or she will be able to execute a given behavior (such as providing useful information). Hsu and colleagues point to knowledge-sharing studies showing that, in virtual communities, people will be more likely to share information if they perceive their contribution to be valuable. Second, *outcome expectations* are the predicted effects of people's behaviors. People generally act in a way that elicits the rewards that they expect within a given community. For instance, in TVCs, people would expect explicit economic rewards; in RVCs, people might derive intrinsic rewards from contributing to the community at large, such as elevated status.

A Web-based survey of individual members of various virtual communities (Lin, Hung, and Chen, 2009) found that self-efficacy predicted knowledge-sharing behavior and that people who believed that knowledge sharing would lead to positive experiences (e.g., improved personal relationships) were more likely to share knowledge. Consequently, it is important to design and implement incentive structures specifically tailored to a particular community (e.g., the space community). For example, if an individual receives positive feedback after sharing information, he or she will feel valued and will be more likely to share again in the future.

Social cognitive theory has also been used in combination with other theoretical models to explain social influences on online knowledge-sharing attitudes and behaviors. Lin, Hung, and Chen (2009) used social cognitive theory as a basis for an integrative research model of knowledge sharing. This model states that contextual factors affect individual attitudes and motivations, which in turn influence the individual community member's behavior. Surveying three professional virtual communities, the authors found that "personal perceptions of knowledge sharing (knowledge sharing self-efficacy, perceived relative advantage, and compatibility)" significantly and positively influenced knowledge sharing. The survey results also showed that individualized reciprocity did not directly affect knowledge sharing but did help build trust. Lin et al. argued that, in contrast to individualized reciprocity, generalized reciprocity (in which sharing is not necessarily reciprocated by the recipient but may be by a third party) is seen more often in professional virtual communities. This is because online communities more commonly involve generalized, rather than one-to-one, interactions. Thus, people tend to share freely, expecting that someone in the community will at some time return the favor. In this manner, the concept of generalized reciprocity helps explain how prosocial motivations in online communities are formed and how they may lead to increased information sharing. Again, however, the factors discussed in this section may be less likely to play a role in leader or decisionmaker choices regarding information sharing between organizations or nation-states.

CHAPTER THREE

Conclusions and Recommendations

USSTRATCOM recognizes that supporting cooperative information sharing can help foster safe space operations (McLeod, 2012). As the provider of space and cyberspace forces for USSTRATCOM, Air Force Space Command is among the major organizations within the space community that could benefit from information sharing.

Examples of interorganizational collaborations or alliances are not uncommon. Although organizations may wish to be independent entities, it is often necessary to collaborate or engage with other organizations to obtain necessary resources or information to which the organization itself does not have access (Galaskiewicz, 1985). Additionally, with increasing economic globalization, alliances between commercial organizations, as well as between international government agencies, now abound (Dyer, Kale, and Singh, 2001; Hamel, Doz, and Prahalad, 1989; Ring and van de Ven, 1994).

Our review of the relevant empirical literature found several key factors at the individual level that may also be relevant in affecting the motivations and choices of leaders or decisionmakers to allow information sharing with others in the space community. These include cooperative versus competitive social motives, trust, attitudes toward information sharing (e.g., information as a public or private good), and cross-cultural differences. Again, broader factors and organizational dynamics that are beyond the scope of this review will also play a role in policy decisions. However, these psychological and motivational factors highlight several potential key barriers the Air Force may wish to consider as it works to facilitate information sharing within the space community.

Recommendations

Below, we provide four recommendations for actions USAF can take to address these potential barriers and help facilitate information sharing within the space community.

Recommendation 1: Show Each Organization That the Benefits of Information Sharing Outweigh the Perceived Risks

Members of the space community may perceive inherent risks in sharing information with potential rivals, particularly when defense and intelligence satellites may be involved. Therefore, a key first step is to show each organization that the benefits of information sharing outweigh the perceived risks or, similarly, that the risks of *not sharing* information are greater than the risks of *sharing* information. Thus, it is important for members of the space community to understand how they could benefit from sharing their information and that the risks to shar-

ing information are minimal. Ultimately, this can help curb fears of losing one's competitive advantage or worries over security and loss of sensitive information.

Examples of specific actions the Air Force could take to help illustrate the long-term advantages of information sharing to members of the space community include:

1. Quantify explicit benefits of sharing information.
2. Demonstrate that information sharing will not be harmful.

Recommendation 2: Encourage Organizations to See Themselves as Members of a Broader Group, the Space Community

As we identified in our review, an important potential barrier to information sharing is that members of the space community may see themselves as competitors. Accordingly, they may perceive the information they possess to be economically valuable or proprietary. As a result, they may be less likely to openly share information because of the perception that they could lose their competitive advantage. Similarly, research on cross-cultural differences has found that, in collectivist societies that make sharp distinctions between in-group and out-group membership, individuals are less likely to share information with members of a perceived out-group. Therefore, to the extent that other organizations and international agencies within the space community are seen as out-group members, organizations in collectivist cultures may also be less willing to share information.

Encouraging diverse organizations to see themselves as members of the same in-group—the space community—with a common goal may help surmount these barriers. As described previously, when individuals see themselves as members of the same group instead of as competitors, more information is shared among group members (e.g., Steinel, Utz, and Koning, 2010; Toma and Butera, 2009). Similarly, research on online communities of practice found that, when members felt an obligation to the wider community and that the information would benefit the broader community, they were more likely to share the information (Ardichvili, Page, and Wentling, 2003). Because many such online communities are emergent (Ridings, Gefen, and Arinze, 2002)—meaning that their growth is organic rather than organized externally—it is important to consider not only how to facilitate information sharing within what is presumed to be the existing space community but also how to build and then sustain the community in the first place. Fostering a group identity is therefore crucial to creating the community itself.

In psychology, a long line of research focuses on the role of group identity in intergroup bias (e.g., Gaertner and Dovidio, 2000; Sherif, 1966; Tajfel and Turner, 1986; Turner, 1987). The extent to which individuals are able to see themselves as members of the same in-group who must cooperate for a common goal, the less likely intergroup bias and competition will exist (Gaertner and Dovidio, 2000; Sherif, 1966). Consistent with this, Hinds and Pfeffer (2003) highlight the importance of encouraging individuals to see themselves as part of a single organization as one way to reduce intergroup competition and increase knowledge sharing within organizations. Finally, greater social identification with the global community leads to greater contributions to global public goods, regardless of how much one expects others to contribute (Buchan et al., 2011). Therefore, the importance of identifying with a broader group may also be important at higher levels or in the context of the space community.

Here are some examples of ways USAF might be able to help build this broader community identity, which in turn could help facilitate information sharing:

1. Communicate the importance of preventing collisions due to space debris and that this issue affects all members of the space community (i.e., a common goal).
2. Show that the United States wants to be a collaborative partner by demonstrating a willingness to share technical information and pool resources across the space community.
3. Have senior military leadership encourage all military members representing the United States at conferences and public forums to treat others as equal members of the space community, encouraging collaboration instead of competition.
4. Encourage adherence to existing international guidelines or agreements for space activities to illustrate that all members are part of a single community governed by similar guidelines.

The goal of these actions is to begin building a sense of a broader group identity—that of the space community—with the same common goal. This may help encourage cooperation and information sharing and help discourage competition and distrust.

Recommendation 3: Establish Situational Awareness Information as a "Public Good" That Benefits the Entire Space Community

Another potential barrier to information sharing is the extent to which members of the space community view the information and data they hold either as private or as a public good owned by the broader community. Information that is perceived to be of communal benefit is more likely to be shared (Ardichvili, Page, and Wentling, 2003). Furthermore, communities organized around cooperation and that incentivize generalized reciprocity facilitate perceptions of information as a public good (Sun et al., 2010). The development of these communities is the intended purpose of Recommendation 2. However, it would also be beneficial to specifically designate specific information types as public.

It is important to note that not all information can be made public; organizations will not share everything. Therefore, members of the space community will need to attempt to explicitly agree upon which information can be made public and provide mutual benefit without harming individual members. It is also important to consider whether organizations share the most pertinent technical information or whether shared information is reliable, timely, and complete. Finally, technologies and protocols that enable secure processing of private information exist and should be investigated for use by the space community.

Recommendation 4: Build Trust Among Members Through Successful Information Transactions over Time and Transparency of Processes and Systems

Trust has been identified as critical to information sharing across a variety of contexts, including negotiation, decisionmaking, online communities of practice, and the formation of organizational alliances (e.g., Aulakh, Kotabe, and Sahay, 1996; Bock et al., 2005; Buckman, 1998; Cullen, Johnson, and Sakano, 2000; Das and Teng, 1998; Dirks and Ferrin, 2001; Hinds and Pfeffer, 2003; Orlikowski, 1993; Pan and Scarbrough, 1999; Panteli and Sockalingam, 2005; Ridings, Gefen, and Arinze, 2002; Ring and van de Ven, 1992; Zand, 1972). Specifically, the extent to which there is trust that the other parties have positive intentions and that the shared information will not be used in a negative or harmful way influences the willingness to share information.

Two key ways to help build trust among members of the space community are successful information transactions over time and transparency of the processes and systems used to

share information. Given that many of the organizations and international agencies within the space community are likely to see themselves as potential rivals, there may be an initial lack of trust between many members of the space community. Therefore, this trust will need to be built over time and can develop through continued successful transactions between space community members (see Butler, 1999; Cullen, Johnson, and Sakano, 2000; Ring and van de Ven, 1992). As Zand (1972) notes, when information is exchanged successfully, a climate of trust can develop that will further facilitate future information sharing. This leads to what he calls a spiral reinforcement model of trust. In addition to successful transactions over time, providing transparency on the processes and systems used to share information can help reassure organizations that the information they share is secure and will not be used against them. Additionally, improving people's confidence in their knowledge-sharing abilities—such as by providing guidelines and training—has been shown to be a motivator to share information (Lin, Hung, and Chen, 2009).

Examples of specific actions the Air Force could take to build trust among members of the space community include the following:

1. Increase U.S. sharing of information, starting with its closest allies.
2. Disseminate U.S. policies and procedures on information sharing.
3. Disseminate information on proposed mechanisms for sharing data, communicating among members of the community, and protecting sensitive data.

Consistent with these recommendations, recent U.S. military leadership appears to implicitly understand the importance of steadily building both trust and transparency. Admiral Michael Mullen (ret), former Chairman of the Joint Chiefs of Staff, wrote in *The New York Times* calling for greater transparency in the military relationship between the United States and China. He advocated more frequent talks, military exercises, and personnel exchanges among senior leadership, as well as younger officers, about whom he concludes: "[U]pon their shoulders rests the best hope for deeper, more meaningful trust" (Mullen, 2011).

Additional Considerations

Based on our literature review, we have offered several recommendations to enhance information sharing in the space community from a psychological and organizational behavior perspective. As noted earlier, additional factors are likely to be important in decisions to share information within the space community. First, many members of the space community, particularly nations and their militaries, may have security concerns about information dissemination, such as with classified or otherwise sensitive information. Such information may need to be declassified or deidentified before sharing is possible. Pressures to keep information safe or confidential—particularly within military or intelligence communities—may also dissuade the sharing of information. For instance, while organizations would presumably want to withhold information regarding their defense or intelligence satellites, they could also benefit from shared information about others' satellites. Future research could use a public good or free rider typology to portray and better understand such dilemmas. For example, individual organizations may perceive information sharing to be beneficial enough that they will do so without

regard to free riders (who cannot be prevented from reaping the benefits of information as a public good) or in spite of a desire to keep certain information secret.

There may be legal barriers to information sharing as well. Export control regulations or antitrust laws may preclude sharing certain types of information, either outright or with particular countries or corporations. Plans to increase information sharing may look to other forms of international cooperation to allay these concerns.

Finally, a shifting landscape in how space operations are funded and conducted may affect information sharing in unknown ways. The space community has become increasingly commercialized as government agencies, such as the National Aeronautics and Space Administration (NASA), have refocused efforts toward funding private firms, which envision vast market opportunities in space. Whereas national space programs could easily engender cooperative motives, such as by appealing to national pride, private firms competing for market share may be less likely to trust and cooperate with one another. Increasingly competitive funding structures may only exacerbate this issue. Entrepreneurial space competitions, such as the Lunar X Prize, would also appear to discourage cooperation because they offer large prizes to only a few winners. Successful information sharing among members of the space community may depend on the extent to which it can address potential barriers to cooperation, including those we have identified in the psychological and organizational behavior research literature and those that materialize from future trends in the conduct of space operations.

USAF or others seeking to address these challenges may look to both the public and private sectors for examples of otherwise competing organizations successfully cooperating toward a common goal. In the private sector, the Open Handset Alliance is a consortium for mobile device standards that includes major technology companies, such as Google, Dell, Intel, and Samsung. The alliance's major accomplishment is Android, the widely used mobile phone platform. More directly relevant for SSA, the International Charter on Space and Major Disasters aims to provide satellite data from various private companies and government space agencies to respond to major disasters. Most recently, this charter was used to support relief efforts in Haiti, New Zealand, and Japan. These examples of both international and public-private cooperation may suggest lessons for facilitating cultural and behavioral shifts in the space community.

Bibliography

Ardichvili, Alexander, Vaughn Page, and Tim Wentling, "Motivation and Barriers to Participation in Virtual Knowledge-Sharing Communities of Practice," *Journal of Knowledge Management*, Vol. 7, No. 1, 2003, p. 64.

Ardichvili, Alexandre, Martin Maurer, Wei Li, Tim Wentling, and Reed Stuedemann, "Cultural Influences on Knowledge Sharing Through Online Communities of Practice," *Journal of Knowledge Management*, Vol. 10, No. 1, 2006, pp. 94–107.

Aulakh, Preet S., Masaaki Kotabe, and Arvind Sahay, "Trust and Performance in Cross-Border Marketing Partnerships: A Behavioral Approach," *Journal of International Business Studies*, Vol. 27, No. 5, 1996, pp. 1005–1032.

Baiocchi, Dave, and William Welser IV, *Confronting Space Debris: Strategies and Warnings from Comparable Examples Including Deepwater Horizon*, Santa Monica, Calif.: RAND Corporation, MG-1042-DARPA, 2010. As of October 3, 2012:
http://www.rand.org/pubs/monographs/MG1042.html

Baiocchi, Dave, William Welser IV, and Kenneth Grosselin III, "Cleaning Up Space: A Framework for Characterizing the Stakeholder Community," unpublished RAND research, July 2011.

Bandura, Albert, *Social Foundations of Thought and Action: A Social Cognitive Theory*, Englewood Cliffs, N.J.: Prentice-Hall, 1986.

Barney, Jay, "Firm Resources and Sustained Competitive Advantage," *Journal of Management*, Vol. 17, No. 1, March 1991, pp. 99–120.

Benton, Alan A., Eric R. Gelber, Harold H. Kelley, and Barry A. Liebling, "Reactions to Various Degrees of Deceit in a Mixed-Motive Relationship," *Journal of Personality and Social Psychology*, Vol. 12, No. 2, June 1969, pp. 170–180.

Berry, John W., Marshall H. Segall, and Cigdem Kagitcibasi, *Handbook of Cross-Cultural Psychology*, Vol. 3: *Social Behavior and Applications*, Needham Heights, Mass.: Allyn & Bacon, 1997.

Bock, Gee-Woo, Robert W. Zmud, Young-Gul Kim, and Jae-Nam Lee, "Behavioral Intention Formation in Knowledge Sharing: Examining the Roles of Extrinsic Motivators, Social-Psychological Forces, and Organizational Climate," *MIS Quarterly*, Vol. 29, No. 1, March 2005, pp. 87–111.

Bond, Michael Harris, and Peter B. Smith, "Cross-Cultural Social and Organizational Psychology," *Annual Review of Psychology*, Vol. 47, 1996, pp. 205–235.

Buchan, Nancy R., Marilynn B. Brewer, Gianluca Grimalda, Rick K. Wilson, Enrique Fatas, and Margaret Foddy, "Global Social Identity and Global Cooperation," *Psychological Science*, Vol. 22, May 2011, pp. 821–828.

Buckman, Robert H., "Knowledge Sharing at Buckman Labs," *Journal of Business Strategy*, Vol. 19, 1998, pp. 11–15.

Butler, John K., "Trust Expectations, Information Sharing, Climate of Trust, and Negotiation Effectiveness and Efficiency," *Group & Organization Management*, Vol. 24, No. 2, June 1999, pp. 217–238.

Carmeli, Abraham, Leanne Atwater, and Avi Levi, "How Leadership Enhances Employees' Knowledge Sharing: The Intervening Roles of Relational and Organizational Identification," *The Journal of Technology Transfer*, Vol. 36, No. 3, June 2011, pp. 257–274.

Chow, Chee W., F. Johnny Deng, and Joanna L. Ho, "The Openness of Knowledge Sharing Within Organizations: A Comparative Study of the United States and the People's Republic of China," *Journal of Management Accounting Research*, Vol. 12, January 2000, pp. 65–95.

Constant, David, Sara Kiesler, and Lee Sproull, "What's Mine Is Ours, or Is It? A Study of Attitudes About Information Sharing," *Information Systems Research*, Vol. 5, No. 4, December 1994, pp. 400–421.

Cullen, John B., Jean L. Johnson, and Tomoaki Sakano, "Success Through Commitment and Trust: The Soft Side of Strategic Alliance Management," *Journal of World Business*, Vol. 35, No. 3, 2000, pp. 223–240.

Das, T. K., and Bing-Sheng Teng, "Between Trust and Control: Developing Confidence in Partner Cooperation in Alliances," *Academy of Management Review*, Vol. 23, No. 3, July 1998, pp. 491–512.

De Dreu, Carsten K. W., Bernard A. Nijstad, and Daan van Knippenberg, "Motivated Information Processing in Group Judgment and Decision Making," *Personality and Social Psychology Review*, Vol. 12, No. 1, February 2008, pp. 22–49.

Dirks, Kurt T., and Donald L. Ferrin, "The Role of Trust in Organizational Settings," *Organization Science*, Vol. 12, No. 4, July/August 2001, pp. 450–467.

Dyer, Jeffrey H., Prashant Kale, and Harbir Singh, "How to Make Strategic Alliances Work," *MIT Sloan Management Review*, Summer 2001, pp. 37–43.

Dyer, Jeffrey H., and Harbir Singh, "The Relational View: Cooperative Strategy and Sources of Interorganizational Competitive Advantage," *Academy of Management Review*, Vol. 23, No. 4, October 1998, pp. 660–679.

Gaertner, Samuel L., and John F. Dovidio, *Reducing Intergroup Bias: The Common Ingroup Identity Model*, Philadelphia, Pa.: Psychology Press, 2000.

Galaskiewicz, Joseph, "Interorganizational Relations," *Annual Review of Sociology*, Vol. 11, August 1985, pp. 281–304.

Galinsky, Adam, Debra Gruenfeld, and Joe Magee, "From Power to Action," *Journal of Personality and Social Psychology*, Vol. 85, September 2003, pp. 453–466.

Hamel, Gary, Yves L. Doz, and C. K. Prahalad, "Collaborate with Your Competitors and Win," *Harvard Business Review*, January/February 1989, pp. 133–139.

He, Wei, and Kwok-Kee Wei, "What Drives Continued Knowledge Sharing? An Investigation of Knowledge-Contribution and -Seeking Beliefs," *Decision Support Systems,* Vol. 46, No. 4, March 2009, pp. 826–838.

Hinds, Pamela J., and Jeffrey Pfeffer, "Why Organizations Don't 'Know What They Know': Cognitive and Motivational Factors Affecting the Transfer of Expertise," in Mark Ackerman, Volkmar Pipek, and Volker Wulf, eds., *Sharing Expertise: Beyond Knowledge Management*, Cambridge, Mass.: MIT Press, 2003, pp. 3–26.

Hofstede, Geert, *Culture's Consequences: Comparing Values, Behaviors, Institutions and Organizations Across Nations*, Beverly Hills, Calif.: Sage, 1980.

Hsu, Meng-Hsiang, Teresa L. Ju, Chia-Hui Yen, and Chun-Ming Chang, "Knowledge Sharing Behavior in Virtual Communities: The Relationship Between Trust, Self-Efficacy, and Outcome Expectations," *International Journal of Human-Computer Studies,* Vol. 65, No. 2, February 2007, pp. 153–169.

Hutchings, Kate, and Snejina Michailova, "Facilitating Knowledge Sharing in Russian and Chinese Subsidiaries: The Role of Personal Networks and Group Membership," *Journal of Knowledge Management*, Vol. 8, No. 2, 2004, pp. 84–94.

Kehler, C. Robert, "Opening Remarks," 2011 USSTRATCOM Cyber and Space Symposium, Omaha, Neb., November 15, 2011. As of June 18, 2012:
http://www.stratcom.mil/speeches/2011/77/2011_USSTRATCOM_Cyber_and_Space_Symposium_-_Opening_Remarks/

Lin, Ming-Ji James, Shiu-Wan Hung, and Chih-Jou Chen, "Fostering the Determinants of Knowledge Sharing in Professional Virtual Communities," *Computers in Human Behavior*, Vol. 25, July 2009, pp. 929–939.

Ma, Meng, and Ritu Agarwal, "Through a Glass Darkly: Information Technology Design, Identity Verification, and Knowledge Contribution in Online Communities," *Information Systems Research*, Vol. 18, No. 1, March 2007, pp. 42–67.

McLeod, Courtland B., "Space Situational Awareness (SSA) Sharing," briefing slides, Offutt Air Force Base, Neb.: U.S. Strategic Command, Space Policy, 2012.

Michailova, Snejina, and Kate Hutchings, "National Cultural Influences on Knowledge Sharing: A Comparison of China and Russia," *Journal of Management Studies*, Vol. 43, May 2006, pp. 383–405.

Mullen, Mike, "A Step Toward Trust with China," *The New York Times*, July 25, 2011.

O'Reilly, Charles A., "The Intentional Distortion of Information in Organizational Communication: A Laboratory and Field Investigation," *Human Relations*, Vol. 31, No. 2, February 1978, pp. 173–193.

Orlikowski, Wanda J., "Learning from Notes: Organizational Issues in Groupware Implementation," *The Information Society*, Vol. 9, 1993, pp. 237–250.

Pan, Shan L., and Harry Scarbrough, "Knowledge Management in Practice: An Exploratory Case Study," *Technology Analysis & Strategic Management*, Vol. 11, No. 3, 1999, pp. 359–374.

Panteli, Niki, and Siva Sockalingam, "Trust and Conflict Within Virtual Inter-Organizational Alliances: A Framework for Facilitating Knowledge Sharing," *Decision Support Systems*, Vol. 39, June 2005, pp. 599–617.

Pettigrew, Andrew M., "Information Control as a Power Resource," *Sociology*, Vol. 6, No. 2, May 1972, pp. 187–204.

Pfeffer, Jeffrey, and Gerald Salancik, *The External Control of Organizations: A Resource Dependence Perspective*, New York: Harper & Row, 1978.

Raban, Daphne R., and Sheizaf Rafaeli, "Investigating Ownership and the Willingness to Share Information Online," *Computers in Human Behavior*, Vol. 23, September 2007, pp. 2367–2382.

Ridings, Catherine M., David Gefen, and Bay Arinze, "Some Antecedents and Effects of Trust in Virtual Communities," *Journal of Strategic Information Systems*, Vol. 11, 2002, pp. 271–295.

Ring, Peter Smith, and Andrew H. van de Ven, "Structuring Cooperative Relationships Between Organizations," *Strategic Management Journal*, Vol. 13, No. 7, October 1992, pp. 483–498.

———, "Developmental Processes of Cooperative Interorganizational Relationships," *The Academy of Management Review*, Vol. 19, No. 1, January 1994, pp. 90–118.

Roberts, Karlene H., and Charles A. O'Reilly, "Failures in Upward Communication in Organizations: Three Possible Culprits," *Academy of Management Journal*, Vol. 17, No. 2, June 1974, pp. 205–215.

Rousseau, Denise M., Sim B. Sitkin, Ronald S. Burt, and Colin Camerer, "Not So Different After All: A Cross-Discipline View of Trust," *Academy of Management Review*, Vol. 23, No. 3, July 1998, pp. 393–404.

Sherif, Muzafer, *Group Conflict and Co-Operation: Their Social Psychology*, London: Routledge and Kegan Paul, 1966.

Shweder, Richard A., and Robert A. LeVine, *Culture Theory: Essays on Mind, Self, and Emotion*, Cambridge, England: Cambridge University Press, 1984.

Steinel, Wolfgang, and Carsten K. W. De Dreu, "Social Motives and Strategic Misrepresentation in Social Decision Making," *Journal of Personality and Social Psychology*, Vol. 86, No. 3, March 2004, pp. 419–434.

Steinel, Wolfgang, Sonja Utz, and Lukas Koning, "The Good, the Bad, the Ugly Thing to Do When Sharing Information: Revealing, Concealing and Lying Depend on Social Motivation, Distribution and Importance of Information," *Organizational Behavior and Human Decision Processes*, Vol. 113, November 2010, pp. 85–96.

Sun, Yongqiang, Yulin Fang, Kai H. Lim, and Xiaojian Chen, "Understanding Satisfaction of Knowledge Contributors in Transactional Virtual Communities from a Cost-Benefit Tradeoff Perspective," *PACIS 2010 Proceedings*, Taipei, Taiwan: Pacific Asia Conference on Information Systems (PACIS), January 1, 2010.

Tajfel, Henri, and John C. Turner, "The Social Identity Theory of Intergroup Behavior," in S. Worchel and W. G. Austin, eds., *Psychology of Intergroup Relations*, Chicago: Nelson-Hall, 1986, pp. 7–24.

Toma, Claudia, and Fabrizio Butera, "Hidden Profiles and Concealed Information: Strategic Information Sharing and Use in Group Decision Making," *Personality and Social Psychology Bulletin*, Vol. 35, June 2009, pp. 793–806.

Triandis, Harry C., "The Self and Social Behaviors in Differing Cultural Contexts," *Psychological Review*, Vol. 96, July 1989, pp. 506–520.

———, *Individualism and Collectivism*, Boulder, Colo.: Westview Press, 1995.

———, "The Psychological Measurement of Cultural Syndromes," *American Psychologist*, Vol. 51, No. 4, April 1996, pp. 407–415.

Triandis, Harry C., Robert Bontempo, and Marcelo J. Villareal, "Individualism and Collectivism: Cross-Cultural Perspectives on Self-Ingroup Relationships," *Journal of Personality and Social Psychology*, Vol. 54, No. 2, February 1988, pp. 323–338.

Tsai, Wenpin, "Social Structure of 'Coopetition' Within a Multiunit Organization: Coordination, Competition, and Intraorganizational Knowledge Sharing," *Organization Science*, Vol. 13, No. 2, March–April 2002, pp. 179–190.

Turner, John C., *Rediscovering the Social Group: A Self-Categorization Theory*, Oxford, England: Basil Blackwell, 1987.

The White House, *National Space Policy of the United States of America*, Washington, D.C., June 28, 2010. As of June 18, 2012:
http://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf

Wittenbaum, Gwen, M., Andrea B. Hollingshead, and Isabel C. Botero, "From Cooperative to Motivated Information Sharing in Groups: Moving Beyond the Hidden Profile Paradigm," *Communication Monographs*, Vol. 71, No. 3, September 2004, pp. 286–310.

Yukl, Gary, and Cecilia M. Falbe, "Importance of Different Power Sources in Downward and Lateral Relations," *Journal of Applied Psychology*, Vol. 76, No. 3, June 1991, pp. 416–423.

Zand, Dale E., "Trust and Managerial Problem Solving," *Administrative Science Quarterly*, Vol. 17, No. 2, June 1972, pp. 229–239.

RAND

HEADQUARTERS CAMPUS
1776 MAIN STREET, P.O. BOX 2138
SANTA MONICA, CA 90407-2138

OFFICES
SANTA MONICA, CA
WASHINGTON, DC
PITTSBURGH, PA
NEW ORLEANS, LA
JACKSON, MS
BOSTON, MA

DOHA, QA

CAMBRIDGE, UK
BRUSSELS, BE

www.rand.org

OBJECTIVE ANALYSIS.
EFFECTIVE SOLUTIONS.

RAND publications are available at www.rand.org

This product is part of the RAND Corporation report series. RAND reports are used to communicate research findings and policy recommendations on a specific topic for a targeted audience. All RAND reports undergo rigorous peer review to ensure high standards for research quality and objectivity.

$19.95

TR-1255-AF