Leadership in SCIENCE and TECHNOLOGY

A REFERENCE HANDBOOK

1

General Principles

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CONTROVERSIES

BRIAN MARTIN

Leaders in science and technology sometimes emerge through controversies, taking one side or another in a major debate, and all science and technology leaders must deal with controversy at one time or another, so understanding the dynamics of controversy is highly valuable. Consider the following examples.

George Waldbott was a doctor and medical researcher based in Wisconsin who was noted for a few scientific discoveries. He came to public prominence in the mid-1950s when he joined the debate over adding fluoride to public water supplies. From then until his death in 1982, he was the de facto leader of the U.S. anti-fluoridation movement.

In 1976, three nuclear engineers—Dale Bridenbaugh, Richard Hubbard, and Gregory Minor—resigned from their jobs with nuclear power plant manufacturer General Electric and publicly criticized nuclear power. At the time, nearly all nuclear scientists and engineers supported nuclear power, or said nothing about it. Bridenbaugh, Hubbard, and Minor became celebrities within the anti-nuclear-power movement.

James Hansen is a climate scientist who for many years has been warning about global warming. In the early 2000s, as climate change became the most prominent environmental issue, Hansen became a high-profile figure in the climate debate with his warnings that global warming may be happening more quickly than normally acknowledged.

Waldbott, Bridenbaugh, Hubbard, Minor, and Hansen are examples of leaders in scientific and technological controversies. How can we understand their roles? Controversies over issues such as fluoridation, nuclear power, climate change, stem cells, pesticides, nuclear weapons, and antidepressants are extremely complex: there is more than enough material to write a book about any one of them, and indeed books have been written about each of these. Just as the controversies are complex, so is the role of leadership.

The next section outlines typical features of scientific and technological controversies (referred to here, for convenience, as scientific controversies) especially relevant to understanding leaders and their roles. Afterward, several types of controversy leaders will be described, then some consequences of being a leader are outlined, and finally some issues for leaders in controversies are spelled out.

An established body of social-science research is available about the dynamics of scientific controversies, but little systematic study of leadership in controversies has taken place. The description of leadership roles and consequences given here is based on observations of a range of controversies. The examples provided are meant to illustrate the points made rather than to serve as the foundation for them. The topic of controversy leadership needs much more research to develop sound generalizations across a diversity of controversies.

Features of Public Controversies

Some scientific controversies are just among scientists, with few others involved or even interested. An example is the controversy over waves thought to propagate gravity, involving a small number of physicists who debate theory and observations (Collins 1985, 2004). There is much to learn from such controversies about the nature of science, but the focus here is on controversies that are called scientific or technological but actually involve significant social dimensions. These can be called public controversies: people outside specialist fields become interested because they—or something they care about, like the environment—are potentially affected.

The debate over global warming—its existence, cause, extent, and what to do about it—is ostensibly about climate science. But the science is mixed in with economic and political arguments concerning the appropriate response to global warming and with moral arguments about the responsibility of rich and poor countries for the problem and questions about planetary survival. In such cases, it is possible to say that there are two separate controversies occurring, a scientific controversy and a social controversy (Engelhardt and Caplan 1987), but this is too simple because these two facets interact: the debate over scientific matters is strongly influenced by the social debate, and vice versa. So it is often better to look at a controversy as a package.

Many people imagine that a scientific controversy can be resolved by obtaining more evidence. Strangely enough, this seldom makes very much difference. Because partisans see the world through their own sets of assumptions about what is important, the same evidence can be assessed quite differently. Even when controversies do not have obvious social dimensions, scientists can continue debating over whether new evidence is credible and what it actually implies.

The fluoridation controversy has been raging for more than half a century. There has been plenty of new evidence, but the debate continues, in part because one of the key issues is whether adding fluoride to public water supplies is ethical: opponents say fluoridation is mass medication with an uncontrolled dose, whereas proponents say fluoridation is especially beneficial to lower socioeconomic groups. As well, the two sides in the debate interpret scientific findings differently. For example, studies show that fluoride operates mainly on the surfaces of teeth rather than through the body after being ingested. Opponents say this means water fluoridation should be ended, whereas proponents say ingesting fluoride is harmless and the mechanism by which fluoride operates is irrelevant.

In the nuclear power debate, the risk of a nuclear accident is a key point of debate. For many years, proponents of nuclear power commonly pointed out that no member of the public had died as a result of an accident at a civilian nuclear power plant. The 1979 accident at Three Mile Island did not change this argument. The 1986 Chernobyl accident was harder to dismiss, but even so most of those who died immediately were workers. Opponents, prior to 1979, pointed to many accidents that showed the risk of a core meltdown, including ones at military installations and in which workers died. Opponents treated the Three Mile Island and Chernobyl accidents as demonstrating the dangers of nuclear facilities. Proponents said the number of civilians who died at Chernobyl was small compared with the death toll from coal-burning power plants, and they blamed the accident on operator error and inadequate safety systems in Soviet plants. Opponents referred to the high figures for possible cancer deaths from Chernobyl and said the accident vividly demonstrated the hazards that inevitably accompany nuclear power. This is only the beginning: the arguments pro and con for nuclear power plant accident risks go on and on. And this is just one of many points of contention in the nuclear power debate.

Partisans see the world so much through their own frameworks that in some controversies it can be said that each side subscribes to a paradigm, namely a set of assumptions and practices that structures the way people see the world and interact with it. In the pesticide paradigm, for example, the solution to the problem of pests is pesticides: the key questions are which pesticides to use, when to use them, how much, and so forth. Organic farming is off the agenda.

The usual image of scientists and engineers is that they are rational and objective, so the expectation is that they will debate issues calmly, sensibly, and dispassionately. Anyone who knows scientists and engineers and talks to them about sensitive topics—or, even better, who challenges their most precious beliefs—soon learns that they can be just as emotional and dogmatic as anyone else. Ian Mitroff (1974) interviewed leading scientists involved in debates about interpretation of rocks from the moon; one of his most striking findings was that prestigious scientists displayed dismissive attitudes and abusive language toward those with different ideas.

In many controversies, attitudes become polarized. If you are engaging in the debate, to be effective you need to support one side or the other. In the fluoridation debate, there are four main issues: benefits, risks, ethics, and decision-making processes. Leading partisans line up on one side or the other, either in favor of or opposed to fluoridation on all four issues (Martin 1991). There is no one who says the benefits are minimal but there are no risks either. What this means is that to be a leader in a controversy, it is essential to support a side fully. There is very little room for someone who says there are valuable ideas to be gained from both sides of the debate.

Another key element in controversies is interests, especially what are called vested interests. An interest means a stake—something to gain or lose. A scientist has a stake in gaining recognition from peers for a discovery or in obtaining a research grant, consultancy, job, promotion, or award. Groups of scientists can have collective interests. For example, nuclear scientists would benefit from the expansion of nuclear power insofar as this would produce more jobs and status for them and their students.

Other interests are economic, political, or professional. Fossil fuel companies have an interest in climate change skepticism—indeed, some of them fund skeptic campaigners. Militaries have an interest in opposing claims about the damaging health effects of Agent Orange (a defoliant used in the Vietnam War) and depleted uranium (nonradioactive uranium used in some bullets because it is denser than lead).

A professional group, such as doctors, dentists, or researchers in a particular discipline, can become committed to a position in a controversy. Evolutionary theory underpins much biological research and is an emblem of a scientific approach, so most biologists have a stake in supporting evolution in the debate with creationism. The dental profession receives no financial benefit from fluoridation—if anything, reduced tooth decay means less business—but because the profession in some countries has been so committed to fluoridation, it would be hard to change positions.

Psychologically, partisans become highly committed to positions they have publicly supported. The commitment of controversy leaders often helps maintain support by colleagues and larger groups.

Controversies vary enormously in scale and duration. Some are prominent, whereas others are low key; some are global, whereas others are localized; and some are long lasting, whereas others are brief. Climate change was a low-key controversy in the 1980s; it developed to become highly prominent in the 2000s. The fluoridation controversy flares up periodically, usually in local areas where decisions are on the agenda, and it has persisted since the 1950s. The controversy over nuclear winter—the climatic consequences of nuclear war—burst on the scene in the 1980s and then faded into obscurity.

Few people have heard about the controversy over how bees find their way to pollen. The usual view is that bees give directions by communicating using a dance, but there is an alternative theory based on searching for odor (Wenner and Wells 1990). Most members of the public learn of controversies through the mass media, and only in some cases are journalists likely to present views challenging orthodoxy.

When vested interests are involved, controversies may be created or prolonged. The tobacco industry, by providing funding to researchers, prolonged the argument that cigarette smoking was not linked with lung cancer far longer than would have occurred otherwise. However, there are few vested interests to push the argument that marijuana is less harmful than many legal drugs.

Types of Controversy Leaders

In some controversies, the struggle is led by large organizations, so you might expect that the office-bearers in the organizations would be the leaders. Seldom do actual controversies fit such a neat model. The reality is usually complex and messy. Leaders in public controversies come in all shapes and sizes.

To make some sense out of leadership roles, it is useful to distinguish four types: cognitive, formal, operational, and symbolic.

Cognitive leaders have some claim to credibility through their own intellectual contributions to the issues being debated. We are talking about scientific and technological issues, so being a trained scientist or engineer is usually required, plus some accomplishments in the field. Edward Teller made pioneering contributions to the development of nuclear weapons; this gave him credibility for his later support for both nuclear weapons and nuclear power. Waldbott's studies on allergies resulting from fluoride gave him greater credibility as an opponent of fluoridation.

To be a cognitive leader, having done *some* research in the field may be sufficient. Only occasionally are the very top researchers long-term leaders in public controversies, simply because keeping up with a raging debate takes a lot of time away from research.

The key point here is that cognitive leaders are able to convert some of their credibility as contributors to the field in question into credibility in the debate. Whether their specialist knowledge is actually relevant to the issues being debated is another question.

Formal leaders have executive positions in organizations that have a stake in or are relevant to the controversy. Their positions give them credibility, especially with the media—an example is Chauncey Starr, former head of the Electric Power Research Institute, in relation to the debate about the health effects of electromagnetic radiation. In some cases, organizations are set up around key partisans.

Operational leaders are the workers who keep a campaign going through organizing public meetings, arranging interviews, encouraging participation, as well as maintaining membership lists and a host of behind-the-scenes activities. An example is Edith Waldbott, George Waldbott's wife, who edited and published *National Fluoridation News* in the 1950s and 1960s, which served to tie together anti-fluoridation campaigners. Whether to call such individuals leaders is an interesting question. They are sometimes called *organizers* and may see their key role as helping others to develop skills and take action. They are absolutely essential to the success of many movements; yet they may have little or no public visibility. It could be said that they are leaders of the work done out of the public spotlight.

Figurehead leaders are those with a public profile, often for activities in another arena, who contribute to a debate with credibility because they are well known. For example, William Shockley, a Nobel Prize–winning physicist, joined the debate about the influence of race on IQ, with a position supportive of eugenics, although he did not conduct any research in the area.

These four types of leaders often overlap. A cognitive leader may be chosen as an executive in a relevant organization, becoming a formal leader, and might perform some of the networking and promotional work characteristic of operational leaders.

The resources available to leaders depend a lot on their relationship to interests as well as on personal circumstances. When powerful and wealthy interests support a position in a controversy, they may provide ample resources, such as research funding and secretarial assistance. Consider, for example, scientists who testify in court cases about the health effects of electromagnetic radiation, such as from power lines or mobile phones.

Those who support the industry position, namely that there is little or no hazard, can receive generous funding, for example, appearance fees and travel expenses, and possibly covert assistance in preparing publications. Chauncey Starr was, as a result of his publications, a cognitive leader in the field of risk assessment and, as the head of the Electric Power Research Institute, a formal leader. He had enormous resources available to carry out his role as leader.

However, some leaders are in precarious financial and career positions and receive little or no assistance in their roles. For example, Andrew Marino (2011), a researcher into the health effects of electromagnetic radiation, had difficulties pursuing research in the area because of opposition from funders. His career in the field was insecure and testifying at court cases was an optional extra rather than a lucrative source of income. Waldbott (1965:312) never obtained any payment for testifying, thereby avoiding any appearance of conflict of interest.

Demographics

Most controversy leaders are men, just like the majority of scientists. Prominent women, such as Vandana Shiva, a critic of genetic engineering, are noteworthy by their rarity.

Although, on the one hand, there have been no surveys of controversy leaders, it is plausible that they are even more likely to be men than scientists in general because of the need to debate issues, often in an adversarial way, which is a characteristically masculine approach. On the other hand, the predominance of men may simply reflect the fact that most leaders in science and technology are men. The exception would be operational leaders, like Edith Waldbott, who need people skills to be effective but do not need to enter the public debate.

Because science itself is international—scientific facts and laws are assumed to be the same in any country—many scientific controversies are international in scope, although there can be regional or country-specific variations. For example, nuclear power has been debated in nearly every country where it has been introduced or proposed, the only exceptions being where governments suppress dissent on the issue. Although there are some variations in the technology, for example different reactor designs in Canada, Britain, the Soviet Union, and the United States, pretty much the same issues arise, including reactor accidents and long-lived radioactive waste.

When controversies take place in different parts of the world, partisans on each side support each other, sharing information, strategies—and leaders. It is common for controversy leaders to travel, providing support for campaigns in other countries. Leaders are often brought into local debates as authorities whose stature is all the greater for being a foreign expert.

When controversies are waged internationally, it is common for leaders to be from the United States, in part because of U.S. leadership in science and technology generally and in part because English is the most widely used language. Controversy leaders in Japan or Russia can be influential locally but are unlikely to be key players in many other countries unless they can speak or write a relevant language, usually English.

Consequences of Being a Leader

Becoming prominent in a controversy commonly brings in train a set of consequences. Suppose you speak out about a topic—anything from abortion to biodiversity—in which there are members of the public concerned about related issues. If you demonstrate some special attributes or skills—scientific credentials, knowledge of relevant research, ability to speak or write well, or organizing skills—then you may be recruited to support one side in the controversy, or perhaps even sought out by both sides. This can start small, for example, by publishing your research findings, giving a media interview, commenting at a public meeting, or simply talking with friends. A partisan in the controversy may spot you and encourage you to do more, perhaps give a talk or write an article for a newsletter. Little by little you are drawn into the arena.

Campaigners in controversies are always on the lookout for support and, even better, champions: individuals with knowledge and communication skills, even charisma, who can powerfully advocate the case. A few individuals have everything required to burst onto the scene fully knowledgeable and skilled. Most, though, take time to learn what is needed to be an effective leader.

One of the crucial skills of a leader is to be able to present arguments in a persuasive and defensible way. It is not good enough to respond to a questioner by saying, "I don't know" or, even worse, "Your criticisms are sound." A leader is expected to support the cause on all fronts. Because public controversies involve a variety of scientific and social dimensions, it is essential for leaders to be able to address arguments in all the dimensions. An antismoking campaigner needs to know the research on the health effects of smoking and on the effects of secondhand smoke—the scientific dimensions—and answer objections relating to economics ("Aren't smokers paying more than their fair share of taxes?") and freedom of choice ("This is a free country").

It is difficult to avoid confronting the full gamut of issues in the controversy. In writing an article, the author has more control over the agenda, but when giving a public lecture, the speaker needs to develop responses to common questions. A writer or speaker soon learns the trigger points in the debate and how to deal with the most common types of questions and challenges. A budding leader learns from others by scouring texts for answers to research questions and by talking with others who have been through the fray. Campaigning groups prepare leaflets and websites, often with answers to common questions. Leaders draw on these resources.

The test of a set of positions in a debate depends on what goes down well with audiences, both scientific and popular, and this in part depends on the tactics of the opponents. A leader can seldom sit down, carefully assess the arguments, and prepare a nuanced position because that may not work well in the hurly burly of debate. For example, a public promoter of fluoridation cannot say that fluoridation is valuable, but as a result of fluoride in the food chain, it might be worth considering lowering the standard fluoride concentration from 1 part per million to 0.5 parts per million, because opponents will seize on this as a sign of weakness. In a polarized debate, figures who make such "concessions" or "admissions" are unlikely to remain in leadership positions. Those who promote the standard package of arguments are more likely to be accepted by other leaders—especially operational leaders—and promoted by campaigners.

The media often contribute to polarization. A figure is more newsworthy when perceived as promoting an identifiable position on one of the standard sides to a debate. Someone with an original, idiosyncratic viewpoint is less likely to be supported by campaigners or recognized by the media.

It is safe to say that nearly all controversy leaders sincerely believe in the cause they support. They sometimes adapt their viewpoints, or what they say in public, to fit the standard line; this can be considered an adaptation to the debate, for the greater cause, rather than a deliberate deception. Studies of psychology show that when people continually say something, they often end up believing it. The beliefs of controversy campaigners are forged or fortified through debate.

The conventional public belief about scientists is that they are objective: they judge the evidence on its merits, not on the basis of personal values or prejudices. As noted earlier, actual scientists seldom conform to this stereotype, but they are instead just as opinionated and extraneously motivated as anyone else. However, scientists are very well informed about their specialties. Controversy leaders are, by necessity, well informed about issues being debated. Leaders, in their own beliefs, have some room to maneuver because any movement contains a variety of perspectives. For example, climate change scientists differ concerning the likely extent of current and future global warming and when it is likely to occur. But too much deviation from the standard view puts a leader in possible conflict with followers. However, sometimes it is possible to pull others toward one's own view. James Hansen, who thinks global warming is more urgent and serious than many other scientists in the field, no doubt pulls some controversy participants in his direction.

Although many controversy leaders are committed to a standard line, some are continually monitoring the evidence and reassessing their positions. What happens if a leader rethinks entirely and comes to a different conclusion? The most likely scenario is dropping out of the debate. There are hardly any examples of leading figures who change their views so drastically that they become partisans on the opposite side.

One of the rare exceptions is John Colquhoun, a dentist and dental officer in New Zealand. Colquhoun had long supported fluoridation when he went on a world tour to learn about the latest research on the issue. He ended up changing his views and subsequently became a key leader in the worldwide anti-fluoridation movement. However, Colquhoun was not all that prominent as a pro-fluoridationist prior to his conversion.

Scientists who become active in public controversies do so at risk to their reputations as scientists. There are several reasons for this. Some are so active in public debates that they have little time for research—their actual performance as scientists declines, which can affect their reputation. However, even those who continue to be active researchers may pay a reputation penalty for becoming active on a public issue.

In general, scientists respect peers who focus their activities in professional domains, such as publishing in refereed journals and giving talks at professional conferences. A bit of promotional activity is acceptable, such as media releases about scientific discoveries, as long as it is oriented to professional activities with the goal of building support for science. A lot of activity beyond this, for example giving interviews on controversial issues, is suspect in the eyes of many scientists. Being perceived as a campaigner or partisan debases the currency of professional knowledge. Communicating to nonscientists potentially puts scientific knowledge on the same level as other facets of issues, such as ethics and politics, and this is threatening to many scientists' self-image, based on the assumption that they are involved in a superior calling. Being a popularizer of science, for example, writing popular texts or appearing as a television commentator, is similarly suspect. Astronomer Carl Sagan was productive as a researcher, but his media profile meant that his research was overshadowed and downgraded.

The result of the widespread disdain or distaste for public engagement is that those few scientists who become highly active in public debates become typecast as partisans. They use their status as scientists to gain credibility in public forums, ironically often losing status among colleagues.

The effect of entering a public debate depends quite a bit on the controversy and one's role in it. Joining on the side of the dominant view is usually far safer for one's career and reputation, especially when the dominant view is backed by government, corporate, or professional interests. For a dentist in a country like the United States, becoming, on the one hand, an activist for fluoridation can be compatible with respectability among dentists and much of the community. On the other hand, joining the contrary side, an embattled minority, is far riskier. U.S. dentists who speak out against fluoridation put their reputations at risk, professionally at least. A biologist who publicly supports intelligent design or a physicist who supports cold fusion would lose peer respect.

Another factor is the number of scientists who join a debate: the more who take a stand publicly, the safer it is for themselves and others. In the controversy about whether HIV causes AIDS, it was safe to sign a petition in support—this is the scientific consensus and the position of most governments. Challengers to powerful interests also gain safety in numbers. During the struggle in the 1980s over a proposed U.S. space-based anti-missile system—commonly known as Star Wars—many computer scientists and other scientists spoke out, although there was some risk to their careers because government grants could have been at stake. This was the period of the huge social movement against nuclear weapons, so taking a stand was less risky than at other times.

The more scientists who join a public movement, the safer it is to be a leader, and often the more respectable it becomes. In terms of the above examples, the reputation and career risks of becoming a leader are less if you are a U.S. dentist promoting fluoridation or a biologist supporting evolution or the view that HIV causes AIDS. Becoming a leader on the opposite sides is far riskier (Martin 2004).

Controversy leaders are prime targets for attack, including personal criticism, verbal abuse, legal threats, complaints to bosses, and potentially loss of a job or career. Those on the weaker side of a debate are especially vulnerable. An effective leader has to be able to withstand attacks, for example, to respond effectively to stinging attacks in the media or threats to sue. Being a controversy leader can be emotionally wearing, especially for those in minority positions without powerful backers.

Issues for Leaders in Controversies

Many leaders in scientific controversies focus on being effective, supporting the cause in which they deeply believe. That means they want to use powerful arguments to convince relevant people, win allies to their side, mobilize their supporters, counter the opponents, and maintain or bring about changes in policies or practices that they believe are beneficial. In pursuing these sorts of aims, several issues can arise for which there are no easy or automatic answers.

A first set of issues involves *ethics*. Is it acceptable to present evidence in a way that is not perfectly balanced? Outside observers would probably judge that both sides in any controversy present one-sided perspectives, omitting unfavorable evidence, presenting some weak arguments and appealing to emotions rather than to strictly logical matters. After all, partisans are trying to win the debate, not give a neutral assessment of the issues.

Beyond this, some leaders become excessively one-sided, for example, by using widely discredited information or deceptive arguments. Unsurprisingly, partisans commonly say this is exactly what the *opponents* do. It is far harder to assess these sorts of shortcomings in one's own advocacy. This is where ethics comes in: a leader has to make a judgment about the appropriate balance between making a powerful case by any means possible (including examples that might be perceived as misrepresentations) and presenting a case that is scientifically credible.

In many controversies, the limits of using arguments and evidence are set not by leaders' personal ethics but by the debate itself: using a discredited piece of evidence is risky because astute campaigners on the other side will attack this as a weakness; furthermore, using a faulty line of argument may alienate some supporters. Even so, leaders may differ in their willingness to pursue arguments that push the boundaries of evidence and logic. Some leaders are mostly concerned about appearing scientific or objective to informed observers, whereas others are mostly concerned about being persuasive even at the risk of appearing biased.

A second set of issues involves *compromise*. Should a leader make concessions to the other side's position in order to gain something in return? Might critics of vaccination admit that some vaccines are safe, or some advocates of vaccination admit that side effects can be highly damaging, in an attempt to gain credibility as being reasonable? Might opponents and supporters of fluoridation agree on ways to get fluoride to nearly everyone's teeth on a voluntary basis, for example, through fluoride in table salt (as in Switzerland)?

In vehement controversies, compromises and concessions are rare. One explanation for this is that leaders gain their self-image and status more through their role within a partisan position than through negotiating with opponents. Another explanation is that leaders are so committed to their positions that they think the opponents are wrong—so opponents should be the ones to compromise.

A third set of issues involves *style*. Should a leader establish a lofty tone, sticking to scientific data and logical argumentation—in what might be called a dry-science style—or be tough and earthy, using striking metaphors, vivid illustrations, and *ad hominem* arguments? For example, a critic of pesticides using a dry-science style might provide data about costs and consequences of pesticide use and parallel data about alternatives. A critic using a more dramatic or personal style might tell about a child poisoned by pesticides or about how a farmer was able to switch to organic farming and increase profits or, in an attacking mode, accuse proponents of being funded by pesticide companies.

Style involves several elements, including language, content, and tone of voice. Leaders, by their behavior in a debate, often provide a model for their followers and occasionally for opponents. Style can be influenced by the opportunities for debate. A talk in dry-science style can be effective at a scientific conference, and this might be reported in the media, but a media release or newspaper feature story in dry-science style might fall flat.

A fourth set of issues involves *participation*. Some leaders take on much of the campaigning themselves, whereas others foster involvement by others in the campaigning. The dynamics of many public debates discourage greater participation. Journalists usually like to talk to prominent figures—prominence is a key value for assessing newsworthiness—and so keep coming back to the same individuals, especially heads of organizations, well-credentialed individuals, and those able to provide a timely sound bite. So it is easier for prominent campaigners to do interviews with the media than to encourage others to handle some of the load—after all, the others might not be as capable and will not have as much impact because their profile is not as high.

The same dynamic applies for other key tasks in campaigning, including giving talks, writing articles, and testifying in hearings and court cases. A local group wants a speaker for a debate and, naturally enough, invites someone with a high profile. In the short term, it is far easier for a campaigner to accept the invitation than to spend time nurturing others who can, after study and practice, take on some of these tasks that are both difficult and crucial to the campaign.

For leaders who take on a heavy load, the risk is being overburdened. On the one hand, if the campaign is long-running or becomes a major social issue, a few high-profile campaigners cannot cope and others will need to fill the gap, with varying capabilities. On the other hand, if the controversy dies down, painstaking efforts to broaden participation might be considered in retrospect as a waste of time.

A fifth set of issues involves *debate*. In some controversies, everyone involved accepts that there are issues that need to be debated. In others, though, campaigners on one side believe that the other side has so little credibility that there is nothing to debate. In the fluoridation controversy, some proponents have argued against participating in public debates because it gives credibility to the opponents. Likewise, some supporters of evolution do not want to debate with creationists and some who believe climate change is real do not want to debate with skeptics. Those on the side with less scientific support usually welcome debate.

For a dominant side, refusing to debate is a tactic because usually campaigners are more than willing to present their ideas to audiences, for example, in talks and interviews—they just refuse to do this when opponents are given equal billing. However, there is a potential negative consequence of refusing to debate: it may be perceived as arrogant and, hence, alienate some observers. If one position on an issue is very widely accepted by people who are informed—for example, the issue of whether the moon landings actually occurred—then refusing-to-debate critics will not be perceived as a problem. But when critics of orthodoxy have some following, refusing to debate may leave the arena open to them.

Conclusion

Leaders in scientific and technological controversies have much in common with other leaders in science and technology: they need to command authority, through accomplishments, skills, or personality, and to have an opportunity to lead symbolically or practically. Leaders in controversies differ from other leaders because of one key factor: the existence of controversy itself, which involves the existence of a competing position.

In public controversies, scientific matters are more obviously mixed with political, economic, ethical, and other matters. Leaders need to be highly competent both with scientific arguments and with other domains relevant to public debate. Many scientists and engineers prefer to concentrate on their research; they avoid and sometimes despise public campaigning because it so often fails to conform to the sober style and measured pace of scientific journals and conferences.

Controversy leaders believe they need to participate in a public debate in order to achieve a worthy end concerning science and public policy. Skills in speaking and writing for a nonscientific audience are crucial. In addition, organizational and strategic skills are essential and are similar to those needed by military commanders—understanding of how to deploy resources to achieve goals—except that the troops in controversies can be more difficult to control than soldiers.

Science and engineering are sometimes perceived as campaigns to understand or conquer nature, as in the race to the moon, so leaders need strategic skills. In controversies, the key difference is that the opponent is not nature but instead another group of campaigners, with a different set of values and objectives. For many scientists, public debates are highly frustrating because the rules are not well defined and there are no authoritative referees to enforce proper behavior. To lead in such struggles requires skills in operating in unfamiliar terrain—skills best learned through the struggle itself.

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