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From Backstage to Center Stage

An exploration of Hannes Alfvén's role(s) as an expert advisor

1945-1980

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ABSTRACT

Hannes Alfvén is an all-important figure in the history of Swedish science for both his scientific discoveries and his contributions to developing Swedish research policy. He is also a controversial figure who would anger many in the government and the scientific community in Sweden when he openly expressed his opposition to their efforts. During his time as an expert advisor, he transformed from being pro-nuclear energy to opposing it, moving from developing Sweden's nuclear energy program in concert with the ruling government to offering his expertise to the social movements fighting against the nuclear society. At all times, however, Alfvén needed to construct and maintain his identity as an expert, a process which is revealed by viewing Alfvén's actions across these 35 years as a series of performances. Looking at Alfvén's performances over such a long period of time and across different contexts exposes the disruptions and continuities in his larger beliefs about the role of science in society, resulting in a cohesive narrative that captures the complexity of his character. The narrative presented here also shows inherent contradiction in the hope for a pure, objective form of scientific advising that is free from involvement in politics, as Alfvén evolves from holding this position to realizing that it is too important to him to leave the products of scientific knowledge production in the hands of big industry and governments.

Through his performances, Alfvén altered the way expertise was recognized in Sweden by expanding the role of the expert advisor from one who claims objectivity and stays out of politics to one who engages openly with political issues, advocating for specific uses of science and technology in the betterment of humanity.

Keywords: expert, expertise, Hannes Alfvén, nuclear power, performance, science and technology, techno-science idealism, history of science, performativity, technocracy, science and democracy, anti-nuclear movements

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1. Introduction

In 1966, a science fiction book hit the shelves of Swedish book stores entitled *Sagan om den stora datamaskinen: en vision* by author Olof Johannesson. Set far into the future, it tells the history of society's evolution on Earth where the ultimate evolutionary actors are not humans but computers. (B.C. refers to the time Before Computers.) In this history, humanity is merely a stepping stone to the ultimate creation of super computers, which are better suited for organizing and running society. Humanity failed at this task due to its inability to keep up with a rapidly changing, technologically complex society along with its inability to behave morally. The most immoral persons to be found in this history are the politicians, who organized mass murder with their new weapons, and who gained their positions in society not due to superior intelligence but merely through a lust for power. The incompetence of politicians is a major theme of the book, and it would not be long before it was revealed that author Olof Johannesson was actually a pseudonym for the well-known Swedish physicist, Hannes Alfvén. At the time of the book's publication, Alfvén was nearing the end of his 20-year career as an expert advisor to the Swedish government where he had worked intimately with various government ministers, including Prime Minister Tage Erlander the entire time. Upon the revelation of Alfvén as the true author of the book, Erlander asked him for a copy. Alfvén included a personal note along with the copy to Erlander which read, "thanks for the inspiration!"¹

Alfvén's career as an expert advisor began officially in 1945 and in his more than twenty years in that role he helped shape Sweden's overall science policy in addition to being an advisor in the country's atomic research program. As such, he is both a key player in two major reforms of Swedish research policy and one of the government's key experts in its most expensive research project to date. Later in his career, Alfvén would leave his posts as an official advisor to the Swedish government and lend his expertise to the anti-nuclear movement, with many historians identifying him as a decisive influence in the Swedish nuclear debates in the 1970s. However, despite his ubiquitous presence in some of the country's most important scientific events, as well as being arguably Sweden's most well-known physicist, a thorough history of Hannes Alfvén's life has yet to be written.

This thesis will stimulate research on this important subject as it (un)covers previously unexplored areas in the expert career of Hannes Alfvén. One such area is his activities in the

¹ Carl-Gunnar Fälthammar, "Plasma Physics from Laboratory to Cosmos--The Life and Achievements of Hannes Alfvén," *IEEE Transactions on Plasma Science* 25, no. 3 (June 1997): 413.

early years of the Swedish atomic program, as his specific role during this time has not been thoroughly examined previously. The second unexamined area of his career that I cover is his key role in an international group of socially concerned scientists in the 1970s, an experience that has a significant impact on Alfvén's views on science. In total, this examination covers working career of Alfvén between 1945-1980 with a specific focus on his role as an expert advisor. As such, it traces his journey from pro- to anti-nuclear by examining his changing views on the role of science in society, the relationship between science and the state, and the proper role of experts in scientific advising. Along the way, Alfvén also altered his views on how scientific knowledge is produced, starting with a strong belief in the sanctity of basic research and ending with a view that is more complex. During the investigation I locate the major turning points and influences on Alfvén that account for his transformation and connect these to the changes in his self-understanding of the role of science and the scientist in shaping a better world.

Along with identifying the changes in his views on science, I also display their impact on his *performance* as an expert. Using a theory of expertise as performance from Science and Technology Studies scholar Stephen Hilgartner, combined with a set of ideal expert advising types presented by Roger Pielke, Jr., I demonstrate the ways Alfvén constructed and defended his scientific authority as well as enacted his advising in forms that Pielke names Pure Scientist, Issue Advocate and others. Further, I employ Thomas Gieryn's concept of boundary work to analyze some of Alfvén's actions. Last, I utilize a concept of techno-scientific idealism in order to situate Alfvén's actions that set him apart from many of his contemporaries. By using these models, I present an historical interpretation of Alfvén that captures his intellectual scope as well as demonstrates the theoretical usefulness of the STS concepts that I am employing with regards to historical scientific research. In order to contextualize Alfvén's work, I also highlight the larger national and international contexts in which he performed.

1.1 Background

As detailed historical background information is provided with each empirical section, I provide only a brief summary of the overall story, here, primarily to introduce relevant details that assist in the reading of the remainder of this introduction. In short, Sweden began work on its nuclear program (atomic program in the language of the time) shortly after the explosion of two atomic bombs by the USA over Japan in WWII in 1945. Like in many

countries in the world, this event led to a concentrated effort to exploit these new discoveries in atomic physics, both for military and civilian uses. Eventually, Sweden would abandon their efforts to build an atomic weapon, officially in 1968, and focus only on the production of atomic energy. Atomic energy was viewed around the world as the energy source that would power nations into the future, which was part of a larger belief in science and technology to lead the way into a new, modern society. This faith in science and technology was particularly strong in Sweden, and scientists and engineers were largely viewed as the supermen who would lead this effort and their authority was largely unquestioned.

This faith in science and technology, and its experts, started to be questioned in the late 1960s and throughout the 70s, particularly with respect to nuclear energy. Dissident scientists began to sound the alarm on the unsolved problems associated with nuclear energy, and citizens around the world started demanding a say in the policies of their governments with respect to new developments in science and technology. These controversies resulted in the necessity for governments and their scientists to justify their policies based upon science, or science policy, and the authority of science and scientists had to be repeatedly constructed in a contested environment. In Sweden, these controversies would ultimately lead to two significant events that round out my story: the election of the first non-socialist government in 40 years in 1976 largely because of the nuclear issue; and the popular referendum on the future of Sweden's nuclear program in 1980.

Hannes Alfvén was an important figure in Sweden during this entire period between 1945-1980, primarily as an expert advisor in developing (and opposing) Sweden's science policy. Alfvén was actively involved in a major reform of Swedish science policy in the mid-1940s with the introduction of the research advisory system (*forskningsrådssystemet*), and he was one of the original members of the advisory body on atomic energy that follows, the Atomic Committee (*Atomkommittén*). Further, he served as a government expert on the board of the half state-owned company largely responsible for developing Sweden's atomic energy program, Atomic Energy Incorporated (*AB Atomenergi*). Later, Alfvén, along with his colleagues, would help to instigate a second important reform to Swedish science policy by lobbying Prime Minister Tage Erlander to establish an Advisory Board on Science (*Forskningsberedning*), which would oversee the majority of research projects funded by the government. From the beginning in 1945, Alfvén was decidedly pro-nuclear, believing like so many at the time that it was the energy source of the future. Concomitant with this belief, he is a fierce proponent of free, basic research in all fields, including atomic science, which eventually placed him in conflict with the government and industry who have already

committed to specific type of atomic energy production and are generally more interested in the practical applications of scientific discovery. This conflict would ultimately reach a crescendo in 1967 and Alfvén left Sweden in protest to continue his work in the USA.

Once in the USA at the University of California San Diego, Alfvén was exposed to new information and arguments that depicted atomic energy as dangerous and irresponsible. He was persuaded by these arguments and followed the nuclear debate in the USA closely, at times becoming directly involved on the anti-nuclear side. In addition, he became active in an international group of peace-oriented scientists named Pugwash, and he was the organization's president between 1971-1974. This experience had a significant impact on his views on the role of science in society and the responsibility of scientists for the application of their discoveries. He demonstrated these new understandings in the Swedish nuclear debates of the 1970s, culminating in his role as an unofficial scientific advisor to the Center Party, which succeeded in becoming the ruling party after the 1976 election by running on an anti-nuclear platform. Alfvén's role in this course of events is considered by many as decisive. His activities as an anti-nuclear scientist continued up to the popular referendum on nuclear power in Sweden in 1980, the results of which (theoretically) made the final determination of Sweden's nuclear policy, which is where I stop my analysis.

1.2 Theory and Research Questions

The theoretical approach that I employ in this thesis provides some coherence to the fluctuating story of Hannes Alfvén's views and activities as a scientific expert advisor over the course of thirty-five years. I achieve this coherence by applying a set of theories taken from the field of Science and Technology Studies (also Science, Technology and Society; hereafter STS), which allows me to trace the dynamic career of Alfvén with a focus on his *performance* as an expert, uncovering his shifting views on the relationships between science, politics and society along the way. I have chosen to apply STS theory to this historical research as it makes visible that which is often hidden by the assumption that certain phenomena are natural or inevitable, such as the authority of science or the development of technology. From an STS perspective, rather than accept these assumptions, it is necessary to uncover how such authority is constructed and maintained in order to better understand the way science operates in society. As it relates specifically to my focus on scientific experts, such an examination adds explanatory power to the actions of an individual expert like Hannes Alfvén. Closely related to this effort is marking the changing public perceptions on

the role of science in society; thus, it is useful to chart these changes and their effects on the performance of experts like Alfvén. I clarify and expand on these ideas, below, but first it is helpful to provide a brief overview of the field of STS and some of its general areas of study, which provides the foundation to my specific theoretical choices.

According to Sheila Jasanoff, one of the best-known theorists within STS, the current discipline “can be described as a merger of two broad, mid-twentieth century streams of scholarship” that focused on science and technology (S&T).² The first of these dealt with the *nature and practices* of S&T as social institutions with their own norms that change over time and in different contexts. This research focused on the social means of production of scientific claims, the ethnographic study of scientists in the lab and the interplay between scientific knowledge production and the wider culture.³ The second stream focused on the *impacts and control* of S&T, focusing on concerns to health and safety by developments like atomic weapons and pesticides, as well as looking at issues of power and governance regarding the application of new developments in S&T, which tended to marginalize weaker groups in society. The combination of these fields in the USA in the late 1980s, according to Jasanoff, resulted in an innovative view, which she succinctly states here: “the power of S&T was no longer seen as wholly separable from other kinds of power. Nor were the formation and application of knowledge considered entirely distinct from their eventual uses and impacts.”⁴

The investigation into the interaction between scientific authority and other forms of power has led to a lot of work that focus on the relationship between science and democracy and specifically on the role of experts therein. Jasanoff has been writing on this subject for over twenty-five years, so a short review of her work will help to introduce the main tenets to the STS approach to these questions. Her insights illuminate a relationship that is far more nuanced than the common, or idealized, understanding of the role of science in politics i.e. in the creation of public policy that is dependent on scientific information. The idealized understanding is that there is a clear difference between the fields of science and politics, and, moreover, science is meant to provide clear, objective information to political decision makers who, on behalf of the citizenry, can then make the obvious right choice on a given issue based upon the science. Research on these types of interactions between science and

² Sheila Jasanoff, “A Field of Its Own: The Emergence of Science and Technology Studies,” in *The Oxford Handbook of Interdisciplinarity*, ed. Robert Frodeman (Oxford: Oxford University Press, 2010), 192.

³ Here, Jasanoff is referring broadly to schools of thought such as the sociology of scientific knowledge (SSK)/social construction of technological systems (SCOT); actor-network theory (ANT); and work that focused on the meaning people attached to the products of S&T, often with regards to issues of identity.

⁴ Jasanoff, “A Field of Its Own: The Emergence of Science and Technology Studies,” 197.

politics reveal several shortcomings: first, scientists can rarely separate their findings from their implications to policy, or in other words, their facts from their values; and second, the problem is further complicated when one considers that the production of the scientific knowledge, itself, is a social process, thus the knowledge itself is not entirely independent of social norms and values. As a result of both factors, it becomes apparent that the hope of a clear policy choice, based purely on the best science, will often be out of reach. In addition to these considerations, there is also often the desire of the public to participate directly in scientific policy decisions, and here a question arises of the general public's ability to adequately understand an already imperfect science. In the end, a conflict emerges between the public's right to decide its own future versus the need to rely on expertise in complex, scientific issues.

These subjects make up the core of one of Jasanoff's earliest works in this area, which, despite its age, is of great relevance to my thesis, as it covers specifically the role of experts in the creation of science policy. The book, *The Fifth Branch: Science Advisors as Policymakers*, aims to apply the awareness of the socially constructed nature of scientific reality to the realm of science policy.⁵ Using the USA as her site of study, Jasanoff examines the usage of science by regulatory agencies, such as the Environmental Protection Agency (EPA), and critiques the dominant two paradigms that are often cited for how this process should occur: the technocratic model and the democratic model. Briefly, the technocratic model suggests that scientists should be the main validators of policy while the democratic model invites broad public participation into process. Jasanoff deems both paradigms insufficient as they do not fully reflect the complex, socially constructed nature of either science or politics. In the process of developing an alternative paradigm, she touches upon themes such as the processes of legitimization of expert claims and the intermingling of facts and values in expert advising, which are cornerstones of the theoretical lenses that I will adopt.

More should be said, however, about Jasanoff's contributions to the study of science and democracy, as she developed her theories further after the publication of *The Fifth Branch*, which have become foundational in the field of STS and relevant to my topic. In *States of Knowledge*, she outlines what has become a staple of STS theory: the framework

⁵ Sheila Jasanoff, *The Fifth Branch: Science Advisers as Policymakers* (Cambridge, Mass: Harvard University Press, 1990).

of co-production.⁶ Co-production is a concept that shows that both science and the social order are mutually constitutive. In other words, scientific knowledge both *produces* and is a *product of* social norms, and the concept of co-production works to explain the mutual reinforcement of both. When applied to state power and governance, or more specifically to the relationship between science and democracy, several interesting areas of inquiry emerge. Following the co-production model, it surfaces that governing bodies "construct the very sciences that they claim to rely on, while invoking objective science to legitimize their actions....and that the practices of science, politics and technology work together to produce effects of naturalness...objectivity, and inevitability..." in order to depoliticize issues and policies.⁷ Examples of this occur in my text with the creation of the scientific advisory system in Sweden in the mid-1940s, when the government and scientists created the very research bodies that they would then rely upon to decide policy. As STS scholars view neither epistemic nor political authority as a given, they explore how legitimacy is constructed in scientific thought, technological choices and political action. As such, specific attention is also paid to how expert authority is either accepted or rejected in hotly contested political debates.

While all of the above themes in Sheila Jasanoff's are relevant to my thesis, I do not emphasize all of them. My goal in providing this overview of STS is to highlight some of the primary themes that are taken up by this research, namely the relationship between science and government in technically advanced societies. Also, the extensive work from Jasanoff and others to establish the field of STS has laid the foundation for further inquiries into the role of science in a democracy, specifically on the study of the role of experts. Below I introduce the major theoretical lenses from this work that I use to analyze the empirical information in order to provide coherence to the story of Hannes Alfvén and to use his story as a case-study in analyzing the role of experts. My primary theoretical lens is to view expertise as performance. Within this, I compliment the theory with a set of four different "ideal types" of scientific advisor, which I use to label different types of performances, based largely on the expert performer's beliefs on the role of science in society. Last, I test a theory of technoscientific idealism to explain events outside of the performance analysis in order to discover its possible relevance to the actions of Alfvén.

⁶ Sheila Jasanoff, ed., *States of Knowledge: The Co-Production of Science and Social Order* (London: Routledge, 2004).

⁷ Jasanoff, 266.

EXPERTISE AS PERFORMANCE

Since the publication of Jasanoff's *The Fifth Branch: Science Advisors as Policymakers*, STS scholars have added to the theories outlined in this foundational text regarding the functioning of experts in society. For example, scholars have observed the unstable, socially constructed nature of experts' authority as they seek to establish their scientific authority within their respective fields and with the state and society. This instability of expertise has led to a reformulation of the concept that views expertise as something that primarily materializes through the *performance* of experts as they seek to construct, maintain and defend their authority in a series of *encounters* with various audiences. One of the first works in STS to adopt this approach is Stephen Hilgartner's, *Science on Stage: Expert Advice as Public Drama*. Hilgartner utilizes sociologist Erving Goffman's metaphor of the theater to describe social interactions between individuals. Goffman observes that individuals (the performers) in society possess a consciousness of the images they create of themselves when interacting with others (the audience), in order to manage favorable impressions and present different "selves" (characters) depending on the circumstances. Hilgartner applies this metaphor to the scientific advising, using expert advisory bodies as the performers, as it "offers a means to examine how credibility is produced in social action, rather than treating it as a preexisting property of an advisory body."⁸ He looks at the ways that scientific advisors construct their confidence and credibility and present themselves as knowledgeable and trustworthy, while also demonstrating integrity and good judgement. The audience is equally important in this drama of scientific credibility, and a performance can vary whether the audience is an administrative state, a group of fellow scientists or the public at large.

Using Goffman's metaphor of theater, or "dramaturgical analysis," Hilgartner identifies the "techniques, props and procedures" that advisors deploy to build credibility, "paying special attention to self-presentation and information control."⁹ Specifically, he identifies four categories of techniques: persuasive rhetoric; stage management; identity and interests; and information control and written documents. Part of persuasive rhetoric is convincing an audience not only of an advisory body's knowledge claims and recommendations but also of its interpretation of what is "science" and what is "policy," thus determining who should ultimately resolve a particular issue: the scientist or the politician. As Jasanoff pointed out in the *Fifth Branch*, this is a process of "boundary work," (see sub-

⁸ Stephen Hilgartner, *Science on Stage: Expert Advice as Public Drama* (Stanford, Calif: Stanford University Press, 2000), 7.

⁹ Hilgartner, 9.

section below) and Hilgartner analyzes the rhetorical devices used to this end. For stage management, it is relevant to note how impressions are managed by the performers on stage, which is often in stark contrast to the chaotic scenes occurring back stage. Science advisors make choices about what they present publicly and what they relegate to the back stage. By hiding the messiness of the ‘behind the scenes’ negotiations between experts in the construction of a scientific report, for example, the final recommendations that appear in the report appear more authoritative and objective. Further, stage management refers to the collective efforts of many individuals often associated with a production, such as the number of different scientific advisors involved in the preparation of an advisory report.

Identity and interest involves the way an expert body presents itself as a character that embodies trustworthiness and knowledgeability, of which the analysis of performance can tease apart to reveal the techniques. It is important to note that this type of character presentation does not necessarily involve an intentional deception on the part of the actors, it is more often an attempt to portray that part of the self, or enact that part of one’s identity, which is relevant for the situation i.e. a good scientist. One of the central features, here, is the self-presentation by a scientific advisor of their objectivity in order to separate themselves from the charge of being influenced by vested interests. This charge is often levelled by those seeking to criticize an expert report, thus the perceived morality of the expert and expert institutions are key factors in a scientific dispute. The final category of Hilgartner’s “dramaturgical analysis” involves the information control in written documents. As Goffman’s original theory of performance applied to face-to-face interactions between individuals, Hilgartner must transfer this approach to the written documents of advisory reports. Here, it is the written document that is used as a means of self-presentation, impression management and of controlling information. Techniques of control here include what information to include in, and leave out of, a report as well as restricting who has access to a report’s contents. This issue of access is further complicated when restricted documents are leaked beyond their initial audiences, weakening the attempted efforts of information management. All of these efforts comprise the techniques that expert advisors and bodies use to manage impressions and shape the perceptions of their audiences in order to establish, maintain and defend their credibility.

Hilgartner also describes the necessary qualities of someone who wishes to critique the statements of an expert panel, in an official report for example, and he describes the most common techniques employed to this end. First, he says that the critic must be a credible figure, such as Hannes Alfvén. The critic must also convince their audience that the report is

deficient in a consequential way. Finally, the critic must meet these requirements on a stage already occupied by other performers. Of the most common techniques for delegitimizing an expert scientific body, Hilgartner says revealing the ‘backstage’ is one of the most effective. Here, someone with inside knowledge of the inner workings of a group of experts can disclose that the work done prior to a particular recommendation was not so unified or even controlled by authoritative members thus discrediting the final result. Another tactic is to attack the composition of a particular expert committee, claiming that it does represent a sufficiently diverse number of viewpoints. Along with this critique, the opponent can also question a report’s representation of scientific knowledge, suggesting that it is incorrect or insufficient. Finally, critics of an expert report can add new characters to the story by suggesting that there are vested interests such as large industry actors who are affecting a committee’s recommendations.

Since the publication of Hilgartner’s work in 2000, several scholars have added to this field of viewing expert advising as a performance, including the original inspiration for my own work, an edited volume entitled, *Scientists’ Expertise as Performance: Between State and Society, 1860-1960*. The theoretical approach taken in this volume adds to Hilgarnter’s in a number of ways. First, this volume includes the analysis of individual expert advisors and their performances, while Hilgartner emphasized the actions of advisory bodies. Further the authors emphasize they are not only looking at the *performance* of the expert as a set of techniques, but also the *performativity* of such techniques i.e. their “resorting of external effects.”¹⁰ In other words, in the act of performing, these expert advisors are effecting changes in the outside world as in deciding a nation’s future energy policy. A key area of analysis, here, then is how effective a particular scientific expert is in bringing about change. Along with this notion of the performativity, the expert is viewed as the embodiment of a specialist role with a set of social and scientific ideals connected to it. Experts both reflect and shape these ideals, thus this analysis pays attention to how experts navigate the changing boundaries of state and society while actively negotiating between the realms of state power, the public sphere and academic authority that result in their legitimacy and influence. Charting these changes over the course of 35 years provides some explanatory power to the activities of my subject, Hannes Alfvén.

¹⁰ Joris Vandendriessche, Evert Peeters, and Kaat Wils, eds., *Scientists’ Expertise as Performance: Between State and Society, 1860 - 1960*, History and Philosophy of Technoscience 6 (London: Pickering & Chatto Ltd, 2015), 4.

The contributors to *Scientists' Expertise as Performance* look at three fundamental features of technoscientific expertise in the late-modern era, which distinguish the role of expertise from previous eras and feature prominently in the career of Hannes Alfvén. The first distinction is scientific grounding of expertise via institutional affiliation, professional organizations and membership on government commissions. That is, in the late-modern era scientists receive their credibility based upon their connections to existing reputable institutions. The second feature of expertise identified is the political and institutional embeddedness of experts with some experts becoming fixed actors within government structures, which gave them enormous influence on policy while also causing problems around questions of neutrality. Thus, in the late-modern era, experts become not only more influential in creating policy with their close ties to government, they also benefit themselves from their recommendations in the forms of funding allocation and prestige. The final aspect of late-modern expertise identified is the growing entanglement of expertise and political ideologies, as the belief in science and technology to carry out social improvements results in many experts carrying out the plans of politically inspired social reform movements, while at the same time maintaining scientific objectivity. Here, experts are so heavily relied upon for their important contributions to the larger government efforts towards society, it proves difficult for them not to be involved in the larger political aims associated with such efforts.

I will use a combination of Hillgartner's original analysis combined with these more recent innovations to analyze the performance of Hannes Alfvén between 1945-1980. Applying the tools of dramaturgical analysis, I ask: How does Hannes Alfvén construct and reproduce his identity and authority as an expert in the period covered? Under this main question, I further inquire: how does Alfvén's performance differ when appearing as a supporter of nuclear energy versus an opponent? How did Hannes Alfvén's expert performance change along with the changing relationships between the state, science and society? How does his performance change in front of different audiences? How did he embody his role and how effective was he to bring about change? In order to explore these questions, I also rely on Pielke's typology of expert roles, which I discuss in the following sub-section.

Four Ideal Types

Within my analysis of Alfvén's performance, I will combine this focus on performativity with the work of Roger Pielke, Jr. who has also worked to theorize the role of experts, primarily in his text written for active scientific advisors, *The Honest Broker: Making Sense of Science in*

Policy and Politics.¹¹ While the aim of the book is to provoke current scientific advisors to (re)consider how they approach the world of policymaking, Pielke offers a few original theoretical frameworks resulting from his own engagement with STS literature that I will apply to the historical context. The most central of these theories are his four ideal types of expert: the *Pure Scientist*, the *Science Arbiter*, the *Issue Advocate* and the *Honest Broker of Policy Alternatives*. Each of the types has a time/place where it is the most suitable option but only if the individual expert holds an awareness of the complex (or social) nature of establishing science policy. These types are also intertwined with different views on the role of science in society, which he distinguishes into the “linear model” and the “stakeholder model.” In short, I employ these four ideal types to label the type of ‘character’ Alfvén presents at different times in his career and demonstrate his changing views on the role of science in society as well as what the role of experts should be in a democracy, as each type is associated with a combination of these variables. By combining these labels with the dramaturgical analysis, I provide a means of charting changes in his outlook and his performance as a scientific expert.

As I introduce the four ideal types, it is important to remember that these are only ideal types, thus not meant to be rigid categories in which to neatly place random scientists. Nevertheless, they provide a framework for understanding the different forms that scientific advising can take. Pielke presents the Pure Scientist as the stereotypical scientist who focuses on research without regard to its usage and thus stays above the fray when it comes to politics. This person simply provides the information and allows others to act on it. The ideal of the Pure Scientist is someone who believes strongly in the value of basic research and who sees themselves as politically neutral. The Pure Scientist seeks knowledge for its own sake, purportedly without concern for its application. Pielke observes that this ideal type is probably the most difficult find in reality, as it is difficult for a scientist to maintain such a neutral stance. Next, the Science Arbiter also does not seek to align with a particular course of action but merely acts as a resource for the decision-maker by answering questions as they arise. Science Arbiters would like to stay away from specific political issues and policy matters, like the Pure Scientists, but do make themselves available to answer questions that arise in policy debates in their role as experts. Ideally, the Science Arbiters only try to answer positive questions from decision-makers that can be resolved through science, thus attempting to stay

¹¹ Roger A. Pielke, *The Honest Broker: Making Sense of Science in Policy and Politics* (Cambridge: Cambridge University Press, 2007).

above the messiness of politics. Science Arbiters often appear in the form of advisory committees, but, like the Pure Scientist, maintaining an entirely policy neutral position is difficult to sustain.

The third role is that of the Issue Advocate who, like the name suggests, does advocate for one position over another based upon his or her interpretation of the science and engages with the decision-makers in the process. Issue Advocates align with a deliberate choice of faction in a policy issue, which they seek to support with their science. Issue Advocates believe that scientists need to interact with decision-makers and participate in policy making. They also often use their status as scientists (or experts) to lend credibility to their political positions. While Pielke mostly considers Issue Advocates in their roles in advising governments, the same notion can be applied to those scientific experts that choose to align with a social movement, such as the anti-nuclear movements. And, finally, the Honest Broker of Policy Alternatives seeks to expand the range of choices for decision-makers by connecting the science to a “smorgasbord of policy options.”¹² This is accomplished, for example, by committees where a diversity of viewpoints is held and can be put forward for the decision-makers to choose from based upon the values of the decision-makers. The Honest Brokers not only consider the diversity of opinions among scientists but are also interested in the views of the users of S&T i.e. the general public.

A final category that is not officially listed among the four but which Pielke suggests is extremely common is the Stealth Issue Advocate. This type appears when the Pure Scientist or the Science Arbiter slips into advocating for a particular side, either consciously or unconsciously, through either hiding their political values or being unaware of their influence on themselves. Pielke argues that values and science can rarely be wholly separated; however, the myth of the objective scientist persists, in part, because of the dominant narrative regarding the role of science in society, which is the linear model.

As stated previously, a full understanding of Pielke’s four ideal types of expert cannot be achieved without also understanding the type of scientific and democratic models with which they are associated. Concerning the scientific model, Pielke maintains that the “linear model” is still the dominant way to position the role of science in society, both *descriptively* and *normatively*. At the base of the linear model, and the scientific enterprise in general, is that scientific discovery should lead to the betterment of the world and its inhabitants. (This

¹² Pielke, 17.

presentation of the role of science is traced back to Vannevar Bush's 1945 influential report to US President Truman, *Science – The Endless Frontier*.) The flow of knowledge goes from basic to applied research, then to development and societal benefits.¹³ Basic research is viewed, at its core, as the realm of the freely inquiring scientist who is only interested in objective truth and is untainted from political concerns. As it relates to specific policy decisions, the linear model suggests that the answers to a problem lie in the basic research and agreement on the science is required before political consensus and subsequent policy choices can occur. This can obviously lead to the belief that all political debate can simply be resolved through some objective, scientific criteria otherwise known as technocracy or scientization.¹⁴ Pielke argues that it is here that the existence of values is concealed in the very framework meant to keep science objective. Further, Pielke asserts that the linear model "creates incentives for scientists to present themselves as Pure Scientists or Science Arbiters when in fact they are acting as Stealth Issue Advocates."¹⁵ This phenomenon occurs largely due to the long-standing belief among scientists that scientific research can and should be separated from both politics and from its applications. The micro-level conclusions from the linear model imply that if one can get the science right at the "basic level" then the subsequent policies for its application will become clearer. Thus, the linear model prioritizes the science, which is presented as neutral, in a policy debate and, as a result, "encourages the mapping of political agendas onto scientific findings."¹⁶ And when it concerns policy *for* science, because all societal benefits emerge from the initial basic research, this sort of research should be generously funded by governments. One can easily see here the temptation for a scientist to insist that his or her science is sound to continue receiving support and funding. So, while arguing often from a position of pure science, science advisors who are either unaware of their subjective values or purposely concealing them, end up acting as Stealth Issue Advocates.

The connection, here, to Jasanoff's work on the role of science in society is clear. Pielke, like Jasanoff, maintain that it is not possible to separate science and values, thus the ideal known today as the "linear model" is difficult to achieve in practice. Pielke offers a short description of alternatives to this view of science that he generally describes as "stakeholder models." As the name implies, these models involve the end users of science

¹³ Pielke, 80.

¹⁴ Pielke, 34.

¹⁵ Pielke, 76.

¹⁶ Pielke, 125.

being involved in its production with a two-way conversation between scientists and those best suited to understand society's needs such as laypersons, politicians, and the general public. Incorporating these views and "values" will make the application of science and technology more democratic, rather than solely relying on the values of the expert advisors, hidden in their presentation of unbiased scientific information. At a minimum, an expert could at least be open about his or her values in the stakeholder models by advising as an Issue Advocate.

In this thesis, I examine the extent to which Pielke's ideal types are helpful in analyzing the career of Hannes Alfvén. Towards this end, I use these types to identify and label the performance of Alfvén at different points in his career and illustrate the times. So, the relevant questions, here, with respect to my work are: how do the ideal types of Pielke affect performance? How do they reveal an expert's views on the role of science in society? As with the ideal types, I employ another theory under the larger analysis of performance, which is the concept of boundary work discussed next.

Boundary Work

As mentioned in the section on expertise as performance, the concept of boundary work is useful to analyze certain actions by expert advisors in their attempts to establish their scientific authority. The theory of boundary work within the scientific enterprise is largely associated with the name of Thomas Gieryn, who first wrote an article on the subject in 1983, which he later developed into a book. Boundary work examines the social processes by which scientists seek to legitimate their work at the expense of competing narratives, either scientific or non-scientific, thereby securing intellectual authority over a subject area, while also maintaining the authority of science itself. Additional aims of such efforts include scientists' ability to secure career opportunities for themselves as well as protect their research from the interference of political actors.¹⁷ Gieryn demonstrates through several historical examples how this process is usually carried out through the consistent redrawing of the boundaries of what science is, or what makes for good science. Gieryn analyzes the representation of science in the boundary drawing process rhetorically, where the particularities of the presentation depend largely on the nature of the Other with whom the science (or scientists) opposes itself.

¹⁷ Thomas F. Gieryn, "Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists," *American Sociological Review* 48, no. 6 (December 1983): 781.

To this end, Gieryn identifies three genres of boundary work: expulsion, expansion and protection of autonomy. Expulsion is a battle between two competing sciences where there can be but one winner. Expansion occurs when two or more rival representations of reality struggle for control of an "ontological domain."¹⁸ The third category, protection of autonomy, is most relevant for my analysis, as I do not look specifically at Alfvén's scientific knowledge production as much as his actions as an expert advisor. Boundary work in the protection of autonomy occurs when actors outside of science seek to exploit it for their own purposes with the possible effect of compromising the material and symbolic resources of scientists on the inside. Gieryn gives the example of when science is used by political or corporate actors to pursue their interests, then scientists seek to erect interpretive walls to maintain control over the selection of research domains or the standards used to judge knowledge claims.

Finally, Gieryn makes a few general observations about the nature of boundary work. One of the most important is that science receives its credibility "downstream" in its public uptake, not in its creation. So, it is not in the laboratory where authority is conferred, but later when science must be represented to the public in the media, courtrooms or legislatures. This means that the epistemic authority of science is created "time and time again in a diverse array of settings," thus demonstrating the flexibility of science and its concurrent success as the ultimate authority about the nature of reality.¹⁹ This clearly connects to the analysis of expertise as performance since expert scientists must continually reconstruct their authority.

As it relates to the creation of science, Gieryn also notes that science is always produced in a context where attention must be paid to the "players and stakeholders, their goals and interests, and the arenas in which they operate."²⁰ Despite all of the attention paid to these motives and influences that affect scientific production, Gieryn also emphasizes that it is too simple to simply reduce all efforts of scientists to their selfish pursuit of resources, employment or status. First, interests are not always fixed and cannot be said to solely drive an entire process and, further, it is often the case that the scientists involved fully believe in the work they are pursuing. As stated previously, they may simply be unaware of the subjective nature of their own work and the role that norms and values play on their knowledge production. Pielke makes a similar observation when he discusses the actions of a

¹⁸ Thomas F. Gieryn, *Cultural Boundaries of Science: Credibility on the Line* (Chicago: University of Chicago Press, 1999), 16.

¹⁹ Gieryn, *Cultural Boundaries of Science*, xi.

²⁰ Gieryn, *Cultural Boundaries of Science*, 21.

Stealth Issue Advocate, who engage in political activities while maintaining the position that they are merely objective, neutral scientists.

With these connections to my larger theoretical models regarding performance, I apply the concept of boundary work to show how experts attempt to construct, maintain and defend their authority. I examine the activities of Alfvén as an expert to identify when he engages in activity that can be labelled as such.

SCIENTIFIC IDEALISM

The theoretical lenses covered above, focusing mainly on the performance of expertise, are still insufficient to tell the entire story of Hannes Alfvén. A reason for this is the previously mentioned focus of STS research that seeks to disclose the relationships between scientific authority and other forms of power. In these cases, the scientists who are highlighted are usually proponents, or at least apologists, for technoscience while the history of those scientists who have been critical of it is rarely written. This argument is made in a journal article by philosopher of science Carl Mitcham entitled, “Professional Idealism among Scientists and Engineers: A Neglected Tradition in STS Studies.”²¹ To begin the rectification of this problem, he offers short histories of five different scientific organizations, including Pugwash, who have engaged in a “scientific criticism of science.” He coins the term “technoscience idealism” to describe the motivations behind these critical scientific voices. Although this article was written 15 years ago, I believe that this deficit in research still exists in STS studies. Particularly as it applies to research on the performance of scientific experts, most case studies focus on the actions of those scientists aligned with government planning, as they seek to maintain their authority in the face of challenges by the public. My research intends to add to the limited body of work that Mitcham calls for in this article, as I look for those encounters that are explained, in part, by the notion of techno-scientific idealism. Unlike Mitcham, however, I intend to extend the application of this term to not only describe my subject’s action when he is critical of science and technology, but also when he is a proponent of it. A couple of questions arising from this is: how does Hannes Alfvén reflect a belief in techno-science idealism? Can this concept be applied to those periods when Alfvén is a proponent of nuclear energy, or is it only applicable when he is critical it, as Mitcham’s original theory states?

²¹ Carl Mitcham, “Professional Idealism among Scientists and Engineers: A Neglected Tradition in STS Studies,” *Studies in Science, Technology, and Society (STS) North and South* 25, no. 2 (April 1, 2003): 249–62.

1.3 Previous Research

Despite an internationally successful career including a Nobel Prize, there exists very little direct research written about the career of Hannes Alfvén, which makes this essay a rather unique and significant contribution to the subject. As this work of mine is part-biographical and part STS-case study, I believe that it makes contributions to both research areas, thus previous relevant research in these areas will be discussed, here. The few instances of historical research that focus exclusively on Hannes Alfvén come from the esteemed science historian, Svante Lindqvist, who announced twenty years ago that he was writing a book on him. This book has not yet been completed; however, in the process Lindqvist has published a handful of journal articles and book chapters on Alfvén, which I will discuss below. With regards to STS based historical research that focuses particularly on Swedish research politics and the role of experts, there are a number of works that apply a similar theoretical approach to my own in which I will place my study. First, however, I will situate my research with respect to the only substantial material directly about the subject, which is the previously mentioned efforts of Svante Lindqvist.

Lindqvist has written about his intended book on Alfvén in two separate places, both of which include a sampling of his research on the subject at the time they were written. The first work is a book chapter entitled, “*La lagom longue durée: Tidsanda och struktur i en studie kring Hannes Alfvén*” (italics in original) published in 1998.²² The second is a journal article entitled, “*Symbolernas arkeologi: Teman i en studie kring Hannes Alfvén*.”²³ Lindqvist states in both chapters that the main subject of his research is actually the history of scientific and technical research in Sweden, in general, after WWII; however, he uses Alfvén as a figure, as “to study how images of Alfvén are formed and changed is therefore the same as studying the view of Swedish science and technology during the post-war period.” As the previous quote implies, Lindqvist is most interested not in the history of Alfvén, *per se*, but rather how Alfvén is presented as a symbol in the Swedish press of the hopeful future promised by Swedish scientific development and then, later, as a critic of the technical society.²⁴ In analyzing hundreds of newspaper pictures and articles, Lindqvist writes,

²² Svante Lindqvist, “*La lagom longue durée: Tidsanda och struktur i en studie kring Hannes Alfvén*,” in *Forskarbiografin: föredrag vid ett symposium i Stockholm 12-13 maj 1997*, ed. Evert Baudou, Konferenser 41 (Stockholm: Kungl. Vitterhets-, historie och antikvitets akademien, 1998).

²³ Svante Lindqvist, “*Symbolernas arkeologi : Teman i en studie kring Hannes Alfvén*,” *Nordisk Museologi* 2003, no. 2 (2003): 27–50.

²⁴ See also...Svante Lindqvist, “*De motstridiga bilderna av Hannes Alfvén*,” *Forskning & Framsteg*, accessed April 24, 2017, <http://fof.se/tidning/2008/4/de-motstridiga-bilderna-av-hannes-alfven>.

specifically, that Alfvén's image as a working scientist is used to reflect the strong belief in the linear model at the time, as it is the applications of his basic research in electronics and fusion research that will lead to a prosperous Sweden, as well as establish Sweden as a major player in the international scientific community. By employing a broad range of images, Lindqvist places Alfvén several different contexts, from the international down to the institutional level, while also using the image as a reflection of those contexts. I also place Alfvén in these contexts and show how he reflects many of the dominant thought paradigms of the places and times; however, I utilize these observations to different ends, namely to show how he performs as a scientific expert at these different points. Further, by analyzing Alfvén's own texts and utterances, I am looking at how he presents and hence constructs his self-identity as a scientific expert. Of course, the self-formation is done in contextual interaction and these relevant parts are included in my text.

Another book chapter from Svante Lindqvist, entitled “Om konsten att ligga lågt, inte sticka upp och sitta ner i båten,” offers insights into Alfvén's time as an anti-nuclear activist, highlighting specifically the hostile, personal antagonisms that emerged between Alfvén and his fellow Swedish scientists during the nuclear debates in the 60s and 70s.²⁵ Once again, Lindqvist uses Alfvén as a catalyst for a larger discussion on Swedish scientific culture, including the differences between the Royal Swedish Academy of Engineering (*Kungl. Ingenjörsvetenskapsakademien*, or IVA) and the Royal Swedish Academy of Sciences (*Vetenskapsakademien*, or KVA). In 1980, Alfvén resigned his membership from IVA in protest of their pro-nuclear stance, but not from KVA, which never clearly formulated a stance on nuclear energy. Lindqvist concludes that Alfvén's choice to remain in KVA was a function of the difference in cultures between the two organizations, with the former being more about applied science while the latter represented the ideals of basic research. As with the previous works, Lindqvist's focus is on revealing the larger, institutional structures that influence individuals such as Alfvén, and he is interested in highlighting the professional norms of the scientific-technical community in Sweden. He does so by pointing out how and when Alfvén broke these norms, and the hostile response this generated in return. From the beginning, Lindqvist argues that Alfvén was always slightly outside the most elite circle of those researchers with the closest ties to industry. He was there because his basic research was of interest to industry, and, in the end, he chose his own conscience over loyalty to the

²⁵ Svante Lindqvist, “Om konsten att ligga lågt, inte sticka upp och sitta ner i båten,” in *Till en konstnärssjäl: En vänbok till Stig Ramel* (Stockholm: Atlantis, 2002).

industrial-scientific apparatus. Lindqvist also provides some examples of the rhetorical strategies used by Alfvén, saying that he liked to speak in anecdotes, which can later turn out to be oversimplifications or not entirely true. This fact, however, is useful in analyzing Alfvén's expert performances, as it provides insight into some of his techniques and strategies when creating his opposition to nuclear energy. In total, Lindqvist's research gives an overview of the history of Swedish research politics and culture, and Alfvén's place within it. Lindqvist is able to employ a diverse array of theoretical and methodological tools for analyzing his subject. However, his focus is more on the internal workings of scientific research societies, while I focus on the relations between scientists like Alfvén and the larger society. As such, I draw upon a different set of theoretical lenses, borrowed from STS, and apply them to mostly different source material in order to construct my narrative.

It is also necessary to place my thesis within the body of research that has been conducted on Swedish research politics, the nuclear program and the role of experts that generally uses a STS paradigm as a theoretical entry-point. Of special interest in this regard are two edited volumes, *Vetenskapens sociala strukturer* and *Det forskningspolitiska laboratoriet*, both of which use case-studies to demonstrate the interplay between science, politics and society. Of special relevance to my own work are Anna Tunlid's chapters in both volumes about Swedish biochemist Arne Tiselius and his efforts to establish the Advisory Board on Science and to institutionalize the field of molecular biology within Sweden.²⁶ Tunlid applies two of the bedrock STS concepts, co-production and boundary work, to explain Tiselius' actions as he attempted to influence the direction of Swedish 'policy for science' towards his particular research interests. Both Alfvén and Tiselius lobbied to establish FB, using boundary work in the process, and they both sought to direct resources to their own particular areas of research. What distinguishes the two, however, is their degree of internal boundary drawing within the scientific disciplines, themselves. Tunlid reports that Tiselius regularly argued for a careful consideration of which natural science fields deserved the limited research money that was available, of which molecular biology was one such field, while Alfvén rarely or never makes similar demands. Rather, Alfvén is consistently on the record as arguing for more money to all forms of basic research, arguing that there is enough

²⁶ Anna Tunlid, "Forskningspolitisk aktör och vetenskaplig institutionsbyggare. Arne Tiselius och etableringen av molekylärbiologin i Sverige," in *Det forskningspolitiska laboratoriet: Förväntningar på vetenskapen 1900-2010*, ed. Anna Tunlid and Sven Widmalm (Lund: Nordic Academic Press, 2016); Anna Tunlid, "Den nya biologin," in *Vetenskapens sociala strukturer: Sju historiska fallstudier om konflikt, samverkan och makt*, ed. Sven Widmalm (Lund: Nordic Academic Press, 2008).

money to go around. I offer my explanation for Alfvén's view on this a little further down, but first I provide another related example via another set of relevant STS-inspired studies.

An explicitly STS-inspired study that focuses on the nuclear program in Sweden is Göran Sundqvist's, *The Bedrock of Opinion: Science, Technology and Society in the Siting of High-level Nuclear Waste*.²⁷ As the title implies, Sundqvist focuses in this text on one of the most important factors in the nuclear debate in Sweden in the 70s, the safe storage of high-level nuclear waste (HLNW), a technical process that involves geological and technical barriers to establish a safe storage facility. To this, Sundqvist adds a third “social” barrier, which is public opinion and the political decision-making process, which is also a key component for any successful siting operation. Using the concept of co-production, Sundqvist analyzes “how the interplay between science (geology), technology (engineered barriers-cannisters) and society are established and used in the plans presented by the utilities and authorities in Sweden for constructing a safe final repository for HLNW.”²⁸ In addition to co-production, the text refers to several other well-known STS related concepts that I also employ, such as boundary work, and, naturally, the role of experts features prominently. A few pages are devoted to Hannes Alfvén, whom Sundqvist notes, “for a short time was the only prestigious Swedish expert to warn of the dangers of a society based on nuclear power.”²⁹ While I focus on much of the same history and, like Sundqvist, employ a STS analysis to it, my focus on the construction of expert authority via the performative aspect of experts distinguishes my approach from this excellent study completed by Sundqvist.

Two further book chapters dealing with the dominant role of experts in Swedish research policy in decades after WWII, with one of them focusing on the Swedish atomic research program, are of key relevance to my study. These works emphasize the role of experts in creating, directing and controlling Swedish research in order to fulfill their own visions for the future of the Swedish welfare state. The first of these chapters, by Maja Fjæstad and Thomas Jonter, appears in *Science for Welfare and Warfare*, and focuses specifically on the atomic program and its scientists' vision for a nuclear fueled Sweden.³⁰ The second chapter summarizes the larger story of expert influence in the establishment of

²⁷ Göran Sundqvist, *The Bedrock of Opinion: Science, Technology and Society in the Siting of High-Level Nuclear Waste* (Dordrecht: Springer Netherlands, 2002).

²⁸ Sundqvist, 16.

²⁹ Sundqvist, 103.

³⁰ Maja Fjæstad and Thomas Jonter, “Between Welfare and Warfare: The Rise and Fall of the ‘Swedish Line’ in Nuclear Engineering,” in *Science for Welfare and Warfare: Technology and State Initiative in Cold War Sweden*, ed. Per Lundin, Niklas Stenlås, and Johan Gribbe (Science History Publications, 2010).

Swedish society after WWII, written by Per Lundin and Niklas Stenlås, and appears in *Scientists' Expertise as Performance*.³¹ These two chapters show that these networks of experts acted as social planners with a strong faith in science and technology, and they are labeled in these texts as “reform technocrats,” which would be considered quintessential Stealth Issue Advocates in Pielke’s terms. Hannes Alfvén is one of these social planners, and he shared the enormous conviction that science would pave the way to prosperity; however, unlike many of these experts, I view him as less scheming when it comes to the experts’ role in distributing research money. As in the example above with Tunlid’s work, my analysis shows that Alfvén acts more out his commitment to improving Swedish society than to simply alter the direction of research funding to support his own career ambitions.

A final group of texts that requires attention are the numerous works that focus on longer or shorter periods of nuclear energy development and the resistance to it in both Sweden and the world. These are texts that I use to provide the historical context at the beginning of each empirical section for Alfvén’s activities, and many write about Alfvén as part of their larger narratives. The first of these is a work written by Annki Schagerhölm in 1993 entitled, “För het att hantera: kärnkraftfrågan i svensk politik 1945-1980.”³² This work is noteworthy because it is so often cited in the many texts about Sweden’s nuclear history which followed it. It focuses on the relationship between technology and politics, investigating how governments steer large technical projects and asks how the public can influence the process. The investigation touches on the role of experts in a democracy, as do I, and both Shagerhölm and I use some of the same archival material. She notes in her introduction, however, that not all archival material was accessible to her as much of it is not publicly available, and she suggests that further research would benefit from finding personal archives that contain information on the inner workings of certain atomic energy organizations, such as Atomic Energy Inc. I build upon Schagerholm’s suggestion to extend the research area, which is made possible by using the Atomic Energy Corporation’s board meeting minutes from the personal archive of board member, Elam Tunhammar. By doing so, my examination of this relatively unused archival material extends our understanding of Sweden’s nuclear program in general and the role Alfvén played as an expert in connection to it.

³¹ Per Lundin and Niklas Stenlås, “The Reform Technocrats: The Strategists of the Swedish Welfare State, 1930-1960,” in *Scientists' Expertise as Performance: Between State and Society, 1860-1960*, ed. Joris Vandendriessche, Evert Peeters, and Kaat Wils (Pickering & Chatto, 2015), 135–46.

³² Annki Schagerholm, ‘För het att hantera: Kärnkraftfrågan i svensk politik 1945-1980” (Historiska Institutionen Göteborg, 1993).

Other works about the development of Sweden's nuclear program include three publications from Stefan Lindström: *Hela nationens tacksamhet*, which covers the earlier years of Sweden's atomic program between 1945-1956; *De stora programmens tid*, written with Björn Wittrock; and a book chapter entitled, "Implementing the Welfare State: The Emergence of Swedish Atomic Energy Research."³³ Lindström places the atomic program within the larger social ideals of the time and analyzes the motivations behind the early decisions in the development of Sweden's program. Finally, James M. Jasper's, *Nuclear Politics: Energy and the State in the United States, Sweden, and France* is a useful English language source for an overview of Sweden's nuclear program and the politics surrounding it.³⁴ As the title infers, Jasper uses a comparative analysis to show how different norms of conducting politics in the three countries affects the course of the nuclear programs and debates.

From a history of ideas perspective, it is Jonas Anshelm's *Mellan frälsning och domedag* which is often cited in historical works regarding Sweden's nuclear program.³⁵ This far-reaching work covers the period between 1945-1999 focusing mainly on newspaper articles in order to follow the discourse on nuclear energy in Sweden. Anshelm, of course, places these discourses in their larger social context i.e. the faith in science and technology in the early years followed by a more skeptical view. Alfvén makes a significant appearance in this book, and Anshelm identifies him as a primary actor in Sweden's anti-nuclear campaign; however, Alfvén is not mentioned in the earlier years when he was working to build Sweden's nuclear program. Similar to Anshelm's work is Per Lindqvist's doctoral thesis, *Det klyvbara ämnet*.³⁶ Although officially a history of sociology rather than history of ideas thesis, the analysis is also a discursive one, focusing specifically on the Swedish nuclear debates between 1972-1980. Unlike Anshelm, Lindqvist analyzes documents from the Swedish parliament during the time period. The book does include a substantial review of Sweden's nuclear program between 1945-1980, and Alfvén features here much in the same way as

³³ Stefan Lindström, "Hela nationens tacksamhet: Svensk forskningspolitik på atomenergiområdet: 1945-1956" (Stockholm University, 1991); Björn Wittrock and Stefan Lindström, *De stora programmens tid: Forskning och energi i svensk politik* (Akademilitteratur, 1984); Stefan Lindström, "Implementing the Welfare State: The Emergence of Swedish Atomic Research Policy," in *Center of the Periphery: Historical Aspects of 20th-Century Swedish Physics*, ed. Svante Lindqvist (Science History Publications, 1993), 179–95.

³⁴ James M. Jasper, *Nuclear Politics: Energy and the State in the United States, Sweden, and France* (Princeton, N.J: Princeton University Press, 1990).

³⁵ Jonas Anshelm, *Mellan frälsning och domedag: Om kärnkraftens politiska idéhistoria i Sverige 1945-1999* (Stockholm: Brutus Östlings Bokförlag Symposion, 2000).

³⁶ Per Lindqvist, "Det klyvbara ämnet: Diskursiva ordningar i svensk kärnkraftspolitik 1972-1980" (Lunds universitet, 1997).

Anshelm's book, though primarily only through his influential cooperation with the Center Party, as Lindqvist's book focuses on government actors.

For the history of global anti-nuclear movements, Lawrence Wittner's monumental three volume history entitled, *The Struggle Against the Bomb*, is decisive. The three volumes different time periods in the history, and I rely primarily on volumes two and three.³⁷ It is a thoroughly researched series with details on a variety of social movements that mobilized against the nuclear project. For a history of anti-nuclear scientists, I have primarily referred to Wolfgang Rüdig's, *Anti-Nuclear Movements: A World Survey of Opposition to Nuclear Energy*.³⁸ Rüdig applies social movement theory to the history of the global anti-nuclear struggle, paying special attention to the role of scientists in their interactions with grass-roots organizations.

1.4 Research Limits and Source Material

The time period covered in this work is 1945-1980 and focuses on the activities of Hannes Alfvén as an expert advisor in the Swedish context. The time period is chosen to demonstrate the changes in his expert performance over the period starting with his first position as an expert advisor in Sweden's research policy reforms and atomic program in 1945 and ending with the public referendum on nuclear power in Sweden in 1980. This period is broken down into two main stages, each with its own type of performance, with a short epilogue to complete the story. As this work covers a relatively long period of time, and touches on number of subjects, it must be an investigation that is carried out more broadly than deeply. It is a multifaceted story that includes the histories of nuclear energy and weapons, research politics, anti-nuclear movements, and environmental movements, often in both the USA and Sweden. As such, the historical summaries that are provided as background information for each period are necessarily brief.

The primary source material for this project comes from archival documents, periodical sources, and scientific conference proceedings. In addition to this, I complement the research with a popular science book by Alfvén, an autobiography of Birgitta Hamraeus and even a few quotes from Tage Erlander's memoirs. For my first section covering the years

³⁷ Lawrence S. Wittner, *The Struggle Against the Bomb: A History of the World Nuclear Disarmament Movement, 1954-1970*, vol. 2, Stanford Nuclear Age Series (Stanford, Calif: Stanford University Press, 1993); Lawrence S. Wittner, *The Struggle Against the Bomb: A History of the World Nuclear Disarmament Movement, 1971 to the Present*, vol. 3, Stanford Nuclear Age Series (Stanford, Calif: Stanford University Press, 1993).

³⁸ Wolfgang Rüdig, *Anti-Nuclear Movements: A World Survey of Opposition to Nuclear Energy* (Harlow, Essex: Longman Current Affairs, 1990).

between 1945-1967, I rely mostly on archival documents in the form of meeting minutes (*protokoll*) of the two main advisory bodies on which Alfvén sat, the Atomic Committee and the governing board of Atomic Energy Incorporated. It is interesting to note that these minutes from Atomic Energy Inc are rarely viewed, as they were initially classified and now sit within the corporate archives of power producer Studsvik AB, viewable only with special permission (a permission which I was denied).³⁹ However, I was able to locate copies of them, along with other internal documents of the corporation, in the personal archive of a board member, Elam Tunhammar, in the Swedish National Archives (*Riksarkivet*) in Stockholm. In addition to this archive, the personal archive of Lund physicist Torsten Gustafson located at Lund University is also key to my research in this period. Within this archive are the minutes from the Atomic Committee, the Advisory Board on Science and personal correspondence between Gustafson and Alfvén. These two worked on the Atomic Committee at the same time and shared many of the same views regarding Swedish research politics, as reflected in the correspondence, and worked together on the creation of the Advisory Board on Science. These internal documents offer a view into the ‘backstage’ of Swedish research, which can be contrasted to the public image presented to the public via the press. Together, these internal documents from the main bodies overseeing Sweden’s research policies and atomic program provide substantial insight into the beliefs and activities of Hannes Alfvén as an expert during this time. Although meeting minutes often present a summarized, and even sanitized, version of events, the views held by Alfvén are still well represented.

Periodicals are another important source that I use in the period between 1945-1967. Often, these are newspaper articles written by Hannes Alfvén which are critical of the state’s approach to research funding, and these articles are illuminating with regards to Alfvén’s beliefs at the time about the role of science in society as well the relationship between science and the state. Further, it is in these articles that one can find Alfvén trying to apply pressure on the government, often through boundary work and by revealing the ‘backstage’, to alter its approach to its policy for science. Other articles which I make use of are written by journalists about Alfvén or the Swedish nuclear program. These often help to provide details of events

³⁹ None of the works that I reviewed on the history of Sweden’s nuclear program contain references to the internal documents of Atomenergi AB. The only exception is the work of Dr. Thomas Jonter, who wrote several reports on behalf of the Swedish Nuclear Power Inspectorate (SKI). See...Thomas Jonter, “Sweden and the Bomb: The Swedish Plans to Acquire Nuclear Weapons, 1945-1972,” SKI Report 01:33 (Stockholm: SKI, September 2001); Thomas Jonter, “Nuclear Weapons Research in Sweden: The Co-Operation between Civilian and Military Research, 1947-1972,” SKI Report 02:18 (Stockholm: SKI, May 2002).

occurring within the Swedish atomic program that are not reflected fully in the meeting minutes. Last, I employ the newspaper articles to help tell the dramatic tale of Alfvén's departure from Sweden, which played out spectacularly in the pages of the Swedish press in early 1967.

The second main empirical section covers 1967-1976 and is divided into two sub-sections. The material for the first sub-section consists largely of published conference proceedings of the Pugwash International Conferences on Science and World Affairs. These were annual, closed meetings (i.e. no journalists) of international, socially concerned scientists, and the proceedings of the conferences were distributed strictly to members several months after the conference was held. Alfvén's speeches and presentations appear in many of these publications, particularly when he was president of the organization, and the time he spent in Pugwash was decisive regarding his views specifically on experts and on the role of science, in general. Nevertheless, a close examination of Alfvén's time in Pugwash has never been published, which also makes this section of the thesis particularly significant for understanding Alfvén's views on role of science in society. Other sources in this sub-section include a lecture by Alfvén to the Academic Society (*Akademiska Föreningen*) in Lund and a newspaper interview, both regarding the Pugwash movement. Finally, I briefly make use of some archival documents from Torsten Gustafson's archive regarding the Swedish Pugwash group and a letter from Alfvén to a fellow Pugwashite that came from the Hannes Alfvén Papers housed at UC San Diego. All combined, I use these materials tell a previously untold story in the career of Hannes Alfvén. In addition, I use the material to illuminate his markedly new beliefs on the role of science, and scientists, in society. Finally, the material serves as an example of Alfvén's performance as an expert when he is addressing his fellow scientists.

The second sub-section in the period between 1967-1976 covers Alfvén in action as an expert in the Swedish nuclear debates of the 1970s. The source materials, here, are newspaper articles featuring Alfvén as well as a popular science book he released in 1975 entitled, *Kärnkraft och atombomber*. These print materials display Alfvén as an expert to the people, as he attempts to influence the results of the 1976 Parliamentary elections towards a party with an anti-nuclear platform. His interactions with the Center Party's leadership also comprise a major element of this part of the story, and this is told through a series of letter exchanges between Alfvén and Center Party member of Parliament Birgitta Hamraeus, which I have collected from both the Alfvén Papers in San Diego and Hamraeus' archive in Stockholm. Further, as Hamraeus was the key figure driving the anti-nuclear platform within the party, I utilize her autobiography in order to recount the details of this event. Together,

these materials demonstrate Alfvén's performance as an expert in a completely new way vis à vis his previous role as an official government advisor in the previous period.

Last, for the entire period between 1967-1976, I utilize a book of photocopied writings authored by Alfvén on issues of politics and science from a now defunct Alfvén archive at KTH. The book, entitled *Hannes Alfvén: Politiska och etiska inlägg*, consists of completed written works by Alfvén such as journal articles and conference papers covering the years 1967-1986.⁴⁰ With Alfvén's approval these documents were organized in to a book by Thommas Carlsson in 1986 and can be found in the main library of KTH as well as the National Library of Sweden in Stockholm.

The epilogue, which covers 1976-1980, is written primarily from periodical articles in which Alfvén warns about the dangers of nuclear energy. These sources show Alfvén as an expert to the larger public who would ultimately vote in a national referendum on the future of nuclear power in Sweden. Last, a final note on the material used throughout the thesis: the background and contextual histories offered at the beginning of each section are largely based upon secondary literature.

1.5 Disposition

While the previous section has pointed to the general organization of the thesis, it is necessary to expand on its disposition, here. As already mentioned, the thesis is largely organized chronologically, which provides the best format for tracking changes within the beliefs and performances of Hannes Alfvén over time. Naturally, the chronological approach is also fitting when it comes to answering the question about how did Alfvén change from being a pro-nuclear scientist to an anti-nuclear activist, as the answer to this question depends a lot on the larger historical and spatial contexts in which he found himself; therefore, it is beneficial to tell this story in a chronological, diachronic manner. There are, however, a few disadvantages to the chronological order, primarily in that there is a level of repetition in some of the material that I present from Alfvén over the years, as he often repeats the same arguments in different settings.

Also, while the material is organized chronologically, there is an element of thematic organization, as well, which makes the chronological distinctions malleable rather fixed. For example, the distinction between the two major sections reflects a shift in the type of expert

⁴⁰ Thommas Carlsson and Hannes Alfvén, *Hannes Alfvén: Politiska och etiska inlägg 1967-1986* (Stockholm: Pilgrim Press, 2002).

that Alfvén represents, which is both a chronological and thematic separation. As such, the year 1967 is included in both sections 3 and 4, as I separate the material from that year based upon the theme of the sections. Further, section 4 which covers 1967-1976, begins with a background section which starts in 1954, as this is necessary to provide the context for the role of experts in the anti-nuclear movement. Last, section 4 is divided between his activities in Pugwash and his activities during the Swedish nuclear debates although these two sets of events largely overlap chronologically. Because actual reality is never as straightforward as a chronological narrative would imply, this mix of chronological and thematic organization provides a good structure for telling the story of Hannes Alfvén's expert performance.

Following this introductory section, the thesis continues with a short biography of Hannes Alfvén. This biography focuses on details that are not a part of the larger text, mainly his scientific production, which helps to establish the credibility of Alfvén as an expert both via his larger intellectual achievement and his specific knowledge of nuclear science. After the short biography comes the first main empirical section, Section 3, where Alfvén is a main actor in Sweden's plans to further modernize the country via science and technology. After a history of Swedish research policy and its atomic program, I present his expert performances in three parts. The first represents the early years on the Atomic Committee and the governing board of Atomic Energy Inc., where things go smoothly in large part. The second performance occurs outside the confines of the atomic program when Alfvén and his colleagues convince the government to establish a central research oversight body, the Advisory Board on Science. The third section returns to his activities at AK and AE and ends in his dramatic departure from Sweden.

Next is section 4 which describes his turn into an active, anti-nuclear campaigner while displaying a different type of expert performance. This section begins with a history of the role of experts in the anti-nuclear movement, with a special focus on the group in which Alfvén would be most involved, Pugwash. I use the material from Pugwash mostly to demonstrate his changing beliefs regarding the role of experts, the role of science in society, the relationship between science and the state. I follow this with a two-part section demonstrating his performance as an expert in the Swedish nuclear debates in the 1970s, first as an expert directly to the people via the press and other publications and then via his unofficial advisory role to the Center Party.

Section 5 is an epilogue, which ends with the Swedish referendum on nuclear power in 1980. This referendum is the last major activity in the history of Sweden's nuclear program and offers a clear end point for the story. Alfvén is active as an expert in the years leading up

to the referendum, and he demonstrates an even further evolution of his beliefs about science and society. His involvement as an expert occurs largely outside of the government arena offering an additional, unique encounter to analyze for its performance. Following the epilogue comes my final analysis and conclusions in section 6.

1.6 Note on Language

All of the source material covered in my research is originally in Swedish or English. When referring to the Swedish sources, I have translated shorter citations myself and provided the original Swedish in a footnote in order to provide a continuity in the reading of the text. Exceptions are made, however, with respect to the titles of publications as well as longer quotations from primary source material, which are left in the original Swedish to maintain the original emphasis, as it assumed that the current readers of this work are fluent in both English and Swedish. I have left a few short quotes by Alfvén in their original Swedish because it better captures his remarkable wit.

Also, in order to reduce the presence of gender bias, I use a plural pronoun to refer to a singular person whose gender is unimportant. So, for example, I could write “An expert can employ a range of techniques to legitimize *their* position.” This is a both my personal preference and the recommended approach in the latest *University of Oxford Style Guide*, as it replaces the cumbersomeness associated with writing, ‘he or she,’ ‘s/he,’ or ‘his or her.’

Last, the history of Sweden’s nuclear program involves a complex mix of governmental organizations, often with the same organization changing names over the course of time. Below I offer a short list of those organizations that I refer to often with their official English names, original Swedish titles and their abbreviations in order to aid the reader.

ORGANIZATIONAL TITLES

Advisory Board on Science	Forskningsberedning	FB
Atomic Committee	Atomkommittén	AK
Atomic Energy Delegation	Delegationen för atomenergifrågor	DFA
Atomic Energy Incorporated	AB Atomenergi	AE
Natural Science Research Council	Naturvetenskapliga forskningsrådet	NFR
Swedish Atomic Research Council	Statens råd för atomforskning	AFR

2. Scientific career of Hannes Alfvén

Because the primary content of this thesis only covers a particular aspect of Alfvén's career, namely his role as an expert advisor, here I provide a more general account of his professional life as it applies to his work as a scientist. In addition to adding to the overall picture of Dr. Alfvén, this short history also helps to establish the importance of his scientific achievements and his contributions to Swedish higher education, both of which serve to enhance his position as an expert in Swedish research politics. In short, Hannes Alfvén built a successful, internationally recognized career for himself out of novel discoveries in his fields, and the respect he ultimately received for this helped to establish his credibility and authority as a scientist.

Hannes Alfvén was born on 30 May 1908 in Norrköping to a family with some notable members, including his mother Anna-Clara Romanus, one of the first female doctors in Sweden, and his famous uncle Hugo Alfvén, the classical music composer. By his own account, it was two childhood interests that ended up shaping his scientific pursuits later in life, astronomy and radio technology, which would possibly explain his later approach to astrophysical problems from an electromagnetic perspective. He conducted all of his higher education at the University of Uppsala, initially focusing on math and experimental and theoretical physics, with a focus on nuclear physics and electronics. He received his doctorate at the age of 26 under the supervision of the 1924 Nobel prize winner Manne Siegbahn, with whom Alfvén continued to work for many years. Shortly after receiving his doctorate, however, Alfvén decided to shift away from nuclear physics at a time when it was becoming the trendy science and returned to his passions for electronics and astronomy, reflecting his independence rather than simply following the spirit of the times.⁴¹ He continued to work on issues related to electronic measurements of small atomic particles as well studying cosmic rays plus the magnetic storms associated with the aurora borealis. He conducted this work as a researcher at Uppsala between 1934-1938 and then at the Royal Swedish Academy of Science's Research Institute for Experimental Physics⁴² in Stockholm between 1938-1940. This institute was run by Manne Siegbahn, who invited the 30-year old Alfvén to work there, and it became home to the country's first particle accelerator (*cyklotron*) in 1938 and played a major role in the basic research for Sweden's atomic program.

⁴¹ Carl-Gunne Fälthammar and Alexander J. Dessler, "Hannes Alfvén, 30 May 1908 · 2 April 1995," *Proceedings of the American Philosophical Society* 150, no. 4 (December 2006): 649–62.

⁴² In Swedish, *Vetenskapsakademiens forskningsinstitut för experimentell fysik*, which would later be called The Nobel Institute of Experimental Physics (*Nobelinstitut för fysik*).

Alfvén's most well-known scientific contribution, and that for which he received the Nobel Prize in 1970, is his discovery of what are now appropriately called "Alfvén waves," which led to an entirely new field within physics, magnetohydrodynamics. Prior to his discovery, the fields of electromagnetic theory and hydrodynamics had been two separate fields, but Alfvén's discovery brought them together, as he theorized the existence of a wave within the sunspot cycle created via an interaction between electromagnetic fields and fluid motion. His theory, published in a simple letter to the journal *Nature* in 1942, was initially rejected by most of his colleagues in the field, and it would be six years before the notion was taken seriously, and then only because the famed nuclear physicist Enrico Fermi acknowledged that such waves could exist after listening to a presentation by Alfvén at the University of Chicago. The existence of the waves was conclusively demonstrated in a laboratory setting several years later, which proved Alfvén's theory undoubtedly correct. Alfvén presented his understandings of these phenomena in his "classic monograph" *Cosmical Electrodynamics* in 1950. His former student and colleague Carl-Gunne Fälthammar says that Alfvén's discovery of the Alfvén waves is a perfect example of his "profound physical insight and intuition that allowed him to derive results of great generality from specific problems,"⁴³ and this is a "defining characteristic of Hannes Alfvén's work."⁴⁴

The new field of magnetohydrodynamics would come to play a fundamental role in the study of plasma physics in general and space plasma physics in particular. Although no specific applications were identified in the beginning, by the 1950s it became a key component in thermonuclear research, or fusion energy. In short, fusion energy is a way of producing nuclear energy as it done in stars, like the sun, when two heavier atoms smash together to form a lighter element, releasing enormous amounts of energy in the process. The new field of magnetohydrodynamics played an essential role in the generation of high-temperature plasmas in laboratories on Earth, a prerequisite for reproducing the fusion reaction, and Alfvén began work in this area at KTH in the late 1950s.⁴⁵ As I elaborate further in this thesis, Alfvén's advocacy for fusion research came to play a significant role in his expert advisory career.

⁴³ Carl-Gunne Fälthammar, "The Scientific Legacy of Hannes Alfvén," *Eos, Transactions American Geophysical Union* 93, no. 21 (2012): 202.

⁴⁴ Carl-Gunne Fälthammar and Alexander J. Dessler, "Hannes Alfvén, 30 May 1908 · 2 April 1995," 653.

⁴⁵ R. S. Pease and S. Lindqvist, "Hannes Olof Gösta Alfvén. 30 May 1908-2 April 1995," *Biographical Memoirs of Fellows of the Royal Society* 44 (1998): 10.

When Alfvén submitted his now famous paper to *Nature* in 1942, it had been two years since he received his first professorship at KTH in the department of Electromagnetic Theory and Electrical Measurements (*Teoretisk elektroteknik med mätteknik*) at the age of 32. Although his appointment to the position was unanimous, there was a slight hesitation due to his research interests in cosmic radiation, which could cause him to move his chair to another department.⁴⁶ This concern seemed well-founded, as Alfvén's ambitious efforts expanded the work of the department into different activities related to electronics, plasma physics, magnetohydrodynamics, fusion plasma physics and accelerator technology, which eventually created new departments within KTH to which he moved his chair.⁴⁷ Thus, first he moved to the chair of Electronics in 1945 and then to the Institute for Plasma Physics in 1963.

Ultimately, these new schools later formed the core of the School of Electrical Engineering, and three of these institutions (plasma physics, fusion plasma physics, and accelerator technology) were combined in 1990 to form the Alfvén Laboratory at KTH in recognition of his efforts at the university.⁴⁸ It should be noted that much of Alfvén's early work at KTH often involved close association with Swedish industry, which also provided funding for the research. For example, in the late 40s and early 50s, Alfvén's department worked to develop a new technology for use in telephones and computers on behalf of Ericsson; in addition, he and his colleagues also worked during this time on solving a problem for the large electrical equipment company, ASEA. This close relationship between science and Swedish industry was typical of the time and later played a large role in Hannes Alfvén's work and views on the role of science in society.⁴⁹

Some of Alfvén's early successful work, including the work that benefitted Ericsson, made it to the pages of the Swedish press, which emphasized the relationship between basic research and industrial applications, creating a hopeful picture for more instances of this type of development, or in other words, for the linear model.⁵⁰ As we will see, Alfvén was a fierce advocate for basic research for much of his career, but this cozy relationship with industry would eventually sour. After over 25 years at KTH with a career that established new departments at the university and after educating several of Sweden's future, well-known

⁴⁶ Ulf Larsson, "Physics in a Stronghold of Engineering: Professorial Appointments at the Royal Institute of Technology, 1922-1985," in *Center on the Periphery: Historical Aspects of 20th-Century Swedish Physics*, ed. Svante Lindqvist (Canton, MA: Science History Publications, 1993), 64–65.

⁴⁷ Pease and Lindqvist, "Hannes Olof Gösta Alfvén. 30 May 1908-2 April 1995," 8.

⁴⁸ Carl-Gunne Fälthammar, *Hannes Alfvén: En pionjärs liv och verk* (Stockholm, 1998).

⁴⁹ Lindqvist, "La lagom longue durée: Tidsanda och struktur i en studie kring Hannes Alfvén," 145.

⁵⁰ Lindqvist, "Symbolernas arkeologi : Teman i en studie kring Hannes Alfvén," 33–34.

scientists, Hannes Alfvén left his appointment in Stockholm for a position at the University of California at San Diego, where he spent 6-9 months out of every year and returned Sweden for the remainder, often in the summer. He continued this pattern beyond his formal retirement in 1973 until 1988 when he permanently resettled in Sweden.

The importance of his scientific work can be summarized in the number of terms that bear his name: Alfvén waves, Alfvén velocity, Alfvén number and Alfvén layer. Further, he developed concepts that are now indispensable to the field of plasma physics including *guiding center* and *frozen-in magnetic flux*. He received the Nobel Prize in 1970 for “his contributions and fundamental discoveries in magnetohydrodynamics and their fruitful applications in different areas of plasma physics,” which is right around the time he began his advocacy against atomic energy and the bomb.⁵¹ This story, along with his role in transforming Swedish research policies, comprises the body of my thesis, to which I now turn.

⁵¹ Fälthammar, *Hannes Alfvén*.

3. Planning the future society: Hannes Alfvén and research politics in Sweden 1945-1967

Hannes Alfvén started performing as an expert advisor not long after receiving his doctorate in 1940. As I elaborate later, by way of his education and connections from the physics department at Uppsala, he was part of a relatively small number of scientists who set out to transform Swedish society via the application of new discoveries within science and technology. Certainly, the largest of these projects was the nuclear program, which was to provide both a powerful military weapon and the possibility of nearly unlimited, “clean” energy. Alfvén was present at the very beginning of this program as a scientific advisor, so it is here that the analysis of his expert performance begins. I start this period in 1945 when Sweden entered the nuclear arena and end it in the early part of 1967, when Alfvén left Sweden to work in the USA.

During the 22 years covered in this section, Sweden underwent two reforms with regards to its funding of scientific research, and Alfvén was a key person in both reforms. The first occurred during and right after WWII, when many countries in Europe and North America embarked upon large-scale, government funded scientific projects. Sweden was no exception to this trend, and the government put relatively large amounts of funding towards scientific research and development in the immediate years after the war. These efforts required the expertise of scientists for the purpose of advising political decision makers in the arena of policy making regarding their research and regulation, or science *in* policy, also science policy. In addition, expert scientists were relied upon in this period to create the policies that organized a country's educational and scientific enterprises, or policy *for* science. Hannes Alfvén functioned in both of these capacities: he was an expert as a member of one of the newly created research councils (*forskningsråd*) during this period, and he participated in the two major organizational reforms to Swedish research. The second reform occurred at the end of 1962 when the government created a new central body to direct all research funding in Sweden, the Advisory Board on Science, in which Alfvén was also member of the influential working group (*arbetsutskott*) within the body. In one sense, Alfvén performed during this entire period as a Pure Scientist, embracing the linear model and appealing consistently for more money for basic research, all the while claiming the mantle of scientific objectivity and political disinterestedness. He and his colleagues operationalized their identities as leading Swedish scientists to persuade their government audience on the necessity of their proposed reforms and programs. However, as I illustrate in this section, Alfvén and his colleagues

functioned much more as Stealth Issue Advocates, as they mapped their social ideals and visions for the state onto their projects and onto their reforms of Swedish research policies. What distinguishes Alfvén, however, from most of his colleagues is the degree to which he committed to the ideal of basic research leading to positive results for Swedish society, and his strong affirmation on the role of science in a democracy. In both committee meetings and in the Swedish press, I show that he is one of the loudest and most frequently heard voices arguing for more money to basic research, eventually accusing those in power of neglecting their obligations to the Swedish people due to the insufficient amount of money spent towards it. As he started to critique the direction of the Swedish scientific research, he revealed part of the ‘backstage’ to the public and added new characters to the plot. Ultimately, it was his uncompromising stance on these beliefs regarding free, basic research as well as the role of science in a democracy that caused him to leave Sweden and look for better research conditions abroad.

To demonstrate Alfvén’s performance as an expert during this time, I will focus on three decision making bodies that he sat on: the Atomic Committee; the Advisory Board on Science; and the corporate board of Atomic Energy Inc, which was the largest recipient of state research money outside of the military. It is noteworthy that Alfvén held positions in all three of these organizations, often within the bodies’ inner working groups, which reflects the importance he held as a scientific advisor to the Swedish government. I will primarily use archival material, consisting largely of meeting minutes (*protokoll*) from the organizations as well as correspondence between Alfvén and other members. To repeat, these internal documents provide a look into the ‘backstage’ of the Swedish atomic program and show how Alfvén performed his role as a ‘stage manager’ and how he did not. I will also refer to newspaper articles by and about Alfvén and the Swedish nuclear program and the personal memoirs of Tage Erlander, which offer a contrasting ‘front-stage’ performance, although a critical one, as Alfvén began his dissent towards the program(s). In order to provide some context to the material, I will begin with a condensed version of the history of Sweden’s modern research politics with a focus the atomic energy program between 1945-1967. This is followed with a closer look at Alfvén’s performances in three parts.

3.1. Research Politics and Atomic Energy 1945-1967

Like many countries around the world, Sweden was both horrified and amazed at the atomic bombs which were dropped over Nagasaki and Hiroshima towards the end of WWII. The

bombs not only displayed a mighty destructive ability but also revealed the enormous amount of energy that could be released through the nuclear fission process, which could hopefully be harnessed for the production of electricity. During the war years, the Swedish government began investigating alternative solutions to meet the country's energy needs after suffering shortages of petroleum imports, so the possibility of a new technological solution to the country's energy needs was appealing. The dropping of the bombs also awoke the desires of the military to acquire such a weapon, which it saw as a necessity in this new age of warfare and, politically, as a way to guarantee national independence. Thus, as a result of these new possibilities, both civilian and military, that the explosion of the bombs revealed, the Swedish government accelerated its existing plans to increase funding to technical and natural science research.

This marks the beginning of the modern Swedish approach to science policy (*forskningspolitik*) with the introduction of the research advisory system (*forskningsrådssystemet*),⁵² which will play a significant role in my analysis of the performance of experts and the relationship between science, politics and society. Already in 1942, a new advisory body had been created around stimulating technical research, the Swedish Council for Technical Research (*Statens Tekniska forsknings råd*), and several other areas received research councils in the immediate years following, including the natural sciences (*naturvetenskapliga forskningsråd*), medicine (*medicinska forskningsråd*) and agriculture (*jordbruksforskningsråd*). The research councils, populated by experts in their various fields, did carry out any scientific research, themselves, but were charged with having a good overview of the current research in their disciplines, and they were to direct state funding to the areas that they deemed important. In short, their purpose was to “strengthen, stimulate and contribute to Swedish research.”⁵³ While the technical and medical councils were more interested in goal-oriented research, it was the natural science research council that had as its stated task to focus on unconditional, non-applied basic research.⁵⁴ The advisory body for atomic research, which eventually became the Atomic Committee, was also initiated during this time though not originally as an official research council like the others; it also had basic research as its focus. Coinciding with the creation of the research councils, the

⁵² Lindström, “Hela nationens tacksamhet: Svensk forskningspolitik på atomenergiområdet: 1945-1956,” 52.

⁵³ Henrik Brissman, *Mellan nation och omvärld: Debatt i Sverige om vetenskapens organisering och finansiering samt dess internationella och nationella aspekter under 1900-talets första hälft* (Lund: Lunds universitet, 2010), 18.

⁵⁴ Peter Stevrin, *Den samhällsstyrda forskningen: En samhällsorganisatorisk studie av den sektoriella forskningspolitikens framväxt och tillämpning i Sverige* (Stockholm: LiberFörlag, 1978), 88.

government allocated previously unheard-of sums of money for research in an attempt to quickly jumpstart the country's scientific and technical programs.

It is important to understand both the larger motivations behind the desire to ramp up Sweden's research programs and the prevailing attitude towards how scientific research should be carried out. As mentioned previously, it was the enormous contribution of science and technology to the war efforts, ultimately represented in the atomic bomb, that awoke national governments to the importance of this work. It is no accident, then, that the first official research council was for technical development, which had as its main focus "goal-oriented" research (*målsforskning*). This type of research also appealed to major industrial actors who saw its relevance for their own agendas, which quickly resulted in close cooperation between the state and industry in areas of scientific and technical development. As the research councils were dominated by representatives of science, however, it was not long until they were arguing for the importance of free, basic research. Anna Tunlid summarizes the spirit underpinning the new approach to science policy as:

Man betonade... att en fri och självständig grundforskning var det som i längden bäst tjänade samhällets intressen. Staten skulle bidra med ekonomiskt stöd men i övrigt inte styra forskningen. Det var istället den kollegiala granskningen som utgjorde grunden för fördelningen av forskningsmedlen. Denna uppfattning var i sin tur väl förankrad i de akademiska normerna om forskarnas opartiskhet, oegennytta och kritiska förhållningssätt till forskningsresultaten.⁵⁵

She emphasizes, too, that the newly organized and relatively well-funded research councils reflected a strong belief in the ability of science to develop society. This belief was also reflected in an overall optimism regarding the future, a belief that was shared in most parts of the industrialized world.

It is also important to place this new approach to Swedish research policy in its international context. Specifically, the idea of the research councils can be traced to examples from other countries, primarily the USA, Great Britain, and Germany. More importantly, the general belief in the ability of scientific research for developing society was also an international phenomenon, and the special status attached to unobstructed, basic research as the basis for this development was widely shared. As I mention in the section on theory in this thesis, Vannevar Bush's influential essay, *Science – The Endless Frontier*, released in 1945 is the exemplar in arguing for basic research to ultimately resolve society's challenges. Less obvious, perhaps, are the political connotations embedded into Bush's, and others', ideas regarding the role of science in society. For example, Bush believed that the broad

⁵⁵ Tunlid, "Den nya biologin," 104.

advancement of scientific knowledge would serve as a barrier to authoritarianism, as dictators would no longer be able to feed on the ignorance of their populations.⁵⁶ Bush, however, believed in a particular version of a free society, a liberal one, and he was against the use of science in a type of state-led social planning often associated with socialist government. This socialist approach was already present in, for example, Great Britain in the 1930s with its most famous proponent being the Marxist oriented, Cambridge physicist John Desmond Bernal, who thought that scientific research should focus on improving the real-life conditions of humanity, and the government should engage with this type of scientific research in order to plan and develop society. In Sweden, "the belief in and blessings of planning was not restricted to the Social Democratic Party or to a few representatives of the political left: it became just as prevalent in important industrial and engineering circles."⁵⁷ Thus, the general new belief in the importance of science and technology was shared across the political spectrum in Sweden, with some differences, which also accounts for the close relationship between government and industry that played a key role in the development of the welfare state over the next few decades.

The emerging faith in science and technology, exemplified in the reforms of the mid-1940s, also initiated a change in the relationship between the state and society as it related to scientific advancements, and the role of the experts, therein. Beginning in 1945 and continuing for the next 30 years, the state "assumed a markedly more active role in Swedish society than ever before."⁵⁸ The new, large research initiatives were aimed at the development of the welfare state, and, less overtly, the strength of the military. Beginning with the introduction of the advisory system, the government employed a mix of scientists, engineers, industrialists, economists as well as high-ranking bureaucrats and politicians to implement these visions, and these actors played a decisive role in how these visions would ultimately manifest. Per Lundin and Niklas Stenlås refer to these experts as Reform Technocrats and point out they "were not only an instrument of the strong, active state, but also the primary actors, initiators and architects of many state initiatives."⁵⁹ They all shared a belief in the role

⁵⁶ Brissman, *Mellan nation och omvärld*, 111.

⁵⁷ Thorsten Nybom, "The Socialization of Science: Technical Research and the Natural Sciences in Swedish Research Policy in the 1930s and 1940s," in *Center of the Periphery: Historical Aspects of 20th-Century Swedish Physics*, ed. Svante Lindqvist (Canton, MA: Science History Publications, 1993), 164–66.

⁵⁸ Per Lundin and Niklas Stenlås, "Technology, State Initiative and National Myths in Cold War Sweden: An Introduction," in *Science for Welfare and Warfare: Technology and State Initiative in Cold War Sweden*, ed. Per Lundin, Niklas Stenlås, and Johan Gribbe (Sagamore Beach, MA: Science History Publications, 2010), 3.

⁵⁹ Lundin and Stenlås, "The Reform Technocrats: The Strategists of the Swedish Welfare State, 1930-1960," 136.

of the state for developing society and saw themselves as society's planners. Reform Technocrats acted as quintessential Stealth Issue Advocates in the sense that they "were seemingly apolitical professionals possessing, or claiming to possess, administrative, technological and/or scientific expertise, and who sought to overcome political or social conflicts of interests by means of scientific methods."⁶⁰ In other words, they used their claims to scientific objectivity and political disinterest to implement a decisively political vision for the Swedish state and Swedish society. Lundin and Stenlås explain that these experts operated mainly within the three decades between 1945-1975, which was a time of Social Democratic dominance in the political arena coupled with a period of economic expansion and was characterized by a belief in a state led development of society based upon principles of scientific rationality and the benefits of modern technology.

The structure of the Swedish state, itself, also resulted in these experts acquiring extraordinary influence. The state was organized largely into small ministries who, having no internal expertise, would delegate tasks to agencies and committees, usually to the research councils.⁶¹ The research councils acted largely without interference from above, thus allowing them to become powerful and independent actors in the decades after WWII. This entire system of mostly independent activity based upon the views of experts gave them a strong position charting the government reforms during the Social Democratic era. Thus, these government committees provided the "institutional space to shape government policy."⁶² And, while the government worked to maintain public support through appeals to national independence and the creation of a strong public welfare, these technocrats went on to construct the very institutions through which they could carry out their plans, or, alternatively, they directed funding to their existing institutions to conduct research, as was the case with Hannes Alfvén. Atomic energy research was one of the first such efforts and one of the first large state funded projects that thought sought to rely heavily on basic research to develop a technology for the development and welfare of society.

Sweden's first civil nuclear research body was established on November 23, 1945 by then Minister for Ecclesiastical Affairs, Tage Erlander, as part of the introduction of the new research councils. The immediate goals of the committee were to make suggestions for

⁶⁰ Lundin and Stenlås, 138.

⁶¹ Fjæstad and Jonter, "Between Welfare and Warfare: The Rise and Fall of the 'Swedish Line' in Nuclear Engineering," 15.

⁶² Lundin and Stenlås, "The Reform Technocrats: The Strategists of the Swedish Welfare State, 1930-1960," 146.

research efforts as well as to act as an advisory body in questions relating to nuclear research.⁶³ The original composition of the committee consisted of five professors: Hannes Alfvén; his mentor and colleague Manne Siegbahn; Bo Kalling, a former professor of Metallurgy at KTH; Lund physics professor Torsten Gustafson; and Uppsala professor and later Nobel Laureate in Chemistry (1948) Arne Willhelm Tiselius. In addition to the five professors, Erlander appointed: Albert Björkeson, who was also the head of the Swedish National Defense Research Agency (*Försvarets forskningsanstalt*); electrical engineer and technical director at ASEA Ragnar Liljeblad; county governor (*landshövdingen*) Malte Jacobsson; Torsten Schmidt, also from the Swedish National Defense Research Agency; and generaldirektör for Telegrafverket Håkan Sterky. Noticeably, there was a heavy reliance on trained scientists and the academic community, and it was not only the five professors who had scientific training but many in the second group were also former professors in the sciences or highly educated, therein. Another interesting connection among the members is to the military, as Björkeson, Schmidt, Tiselius and Kalling sat on the board of the Defense Research Agency with Sterky as the chairperson.⁶⁴ These two observations about the ten members reveal a couple of interesting attributes of the time: there was an intimate coupling of civil and military interests from the beginning of the Swedish nuclear program; and, the government relied heavily on scientific experts to carry out these large projects. Politicians and industry leaders possessed very limited knowledge on nuclear science, thus the early efforts were left to the elite group of scientists and experts to act largely unimpeded, which in turn led to a creation of initiatives largely aimed at increasing basic research on the subject.⁶⁵

The Atom Committee held their first meeting on December 13th, 1945 and within four months issued their first summary report (*betänkande*). Among the strongest recommendations was a significant increase in funding of universities, technical colleges (*tekniska högskolor*) and research institutes to carry out basic research in nuclear related fields, particularly physics and chemistry. If necessary, new departments within universities would need to be created and a number of new nuclear scientists would need to be trained. This approach was also reflected in the directive document which had accompanied the creation of the committee, which stressed the importance of basic research without specifically naming any applications, such as nuclear energy.⁶⁶ This is not surprising,

⁶³ Lindström, “Hela nationens tacksamhet: Svensk forskningspolitik på atomenergiområdet: 1945-1956,” 17.

⁶⁴ Lindström, 60.

⁶⁵ Anshelm, *Mellan frälsning och domedag*, 23.

⁶⁶ Lindström, “Hela nationens tacksamhet: Svensk forskningspolitik på atomenergiområdet: 1945-1956,” 57–58.

however given two factors: first, it was still unknown if nuclear research could ultimately result in the creation of a new energy source and openly referring to the nuclear bomb was not considered prudent; and, more importantly, the seeming omission reflected the language of basic research as the wellspring of all future societal benefits, which is another example of the commitment to the linear model of science at the time and the experts performing as pure scientists. The committee also identified the main areas for further research, which included the construction of a first reactor for research purposes, the production of uranium and an investigation into which moderator to use to help sustain a nuclear reaction. Through these recommendations in the first summary report, the scientist experts successfully "...portrayed themselves as a vital link between the present position and the desired goal, and they had succeeded by this means in procuring a considerable increase in the resources for pure research."⁶⁷ This was one of the first of many successful performances on the part of the members of the Atomic Committee, including Alfvén, as they used their authority as experts to easily persuade their audience of government ministers to follow their recommendations with little resistance.

While the government was convinced of the importance of basic research, it was also eager to see some of it applied towards its social and military ends. The members of the atom committee were aware that eventually such applications, such as the construction of nuclear reactors or the processing of large quantities of uranium, were too large to be carried out within a university or research institution's laboratories and that private industry would be brought into development process. Coinciding with a time when certain private industry actors were already expressing an interest in some of these aspects i.e. uranium production, the atom committee suggested the creation of a new organization, a half-state and half-private owned company, which was named Atomic Energy Incorporated. A major factor for suggesting the state-owned company was the enormous investment that was required, which only an actor as large as the state could provide. The members of the Atomic Committee, however, were also careful to explain that the state should maintain majority control, in part, in order to be able to control the direction of research.⁶⁸

Atomic Energy Incorporated was officially founded via the approval of the Swedish Parliament in 1947 with a total 3,5 million kronor investment, of which 2,0 million came from the state and 1,5 came from private industry. Further, the state held four board seats out of

⁶⁷ Lindström, "Implementing the Welfare State: The Emergence of Swedish Atomic Research Policy," 185.

⁶⁸ Lindström, "Hela nationens tacksamhet: Svensk forskningspolitik på atomenergiområdet: 1945-1956," 75.

seven and appointed the chairman, who was also to be the chairman of the Atomic Committee. The representatives from industry, then, had three seats on the board and appointed the vice-chairman. The primary tasks of the company were:

att efterforska och utvinna för atomenergins utnyttjande nödvändiga grundmaterial, att bygga experimentstaplar för atomenergins utnyttjande, att senare i större skala bygga staplar för utnyttjande av atomenergi i forskningens och näringslivets tjänst samt att driva i samband med förutnämnda verksamhetstående forskning även som industriell och kommersiell rörelse.”⁶⁹

The company's early activities focused on basic research within chemistry and physics as well as uranium production. The recommendation by the Atomic Committee to create Atomic Energy Inc, however, should not be regarded as a ringing endorsement of the idea by the scientists of the committee. The scientists sought to delay changes to the work of the Atomic Committee for as long as possible out of fear of losing influence in the nuclear arena and particularly in losing the government funding that came along with it.⁷⁰ They were initially successful in delaying the reorganization by arguing that it was more of a priority to focus on strengthening the scientific bases at the universities and technical colleges. Hannes Alfvén was one of the scientists who objected to the changes, arguing both that it was too soon to be building reactors and that uranium production was better handled within the existing framework.⁷¹ But, ultimately the government's call for applied research had to be answered, so they came up with the solution of Atomic Energy Inc.

Although not official Swedish policy until 1956, it is important to point out at this point that the early research being conducted at Atomic Energy Inc was largely directed towards what would be known as the ‘Swedish line’ of atomic energy production. The Swedish line, which I will discuss in detail further down, was a strategy of achieving energy independence for Sweden, as it relied on sources of uranium from within Swedish borders, thus eliminating the need for importing it and being dependent on a foreign source of energy. Due to the nature of Swedish uranium sources, this strategy also required the choice of a particular type of nuclear reactor, a so-called heavy water reactor, to the exclusion of other reactor types available or being developed internationally at the time. The heavy water reactor also left the door open to constructing an atomic weapon, something the government was still

⁶⁹ “Svensk atomenergipolitik: Motiv och riktlinjer för statens insatser på atomenergiområdet 1947-1970” (Industridepartementet, 1970), 17.

⁷⁰ Lindström, “Hela nationens tacksamhet: Svensk forskningspolitik på atomenergiområdet: 1945-1956,” 75.

⁷¹ Protokoll för Atomkommittén 20/12 1946, Box 28, Torsten Gustafsons efterlämnade papper, Lund University Library.

considering at the time. As we will see, this strategy became a major point of contention within the Swedish atomic program and specifically for Hannes Alfvén.

Overall, the early years of the Swedish atomic program (1945-1955) progressed according to plan and without much controversy until the mid-1950s. Recommendations by the Atomic Committee were usually approved by the relevant government ministries with little to no questioning. The level of trust from politicians towards scientists at that time exemplifies Hilgartner's observation about the effectiveness that the myth of pure science, and the authority offered by membership in an advisory group, provides. Research continued through large project initiatives at the universities, research institutes and Atomic Energy Inc, and these efforts resulted in a solution to extract uranium from Swedish culm and shale as well as the building of the program's first (research) reactor known as R1, which they located underground in central Stockholm at KTH in 1954. Further, Atomic Energy Inc was planning a materials-testing reactor, R2, to be located in Studsvik where the company would eventually build its own research station. Up to this point, nuclear research was still almost entirely a state-driven enterprise with most large private energy actors still unsure about the feasibility and profitability of nuclear energy; however, this all changed with the 1955 UN-sponsored Geneva Conference, which came about as a result of the Eisenhower administration in the USA announcing an 'Atoms for Peace' program in 1953. This program allowed other countries access to nuclear reactor technology and low cost, refined uranium in order to build their own nuclear energy programs in exchange for open inspections and a commitment not to pursue nuclear weapons. Following the Geneva Conference, large private actors in Sweden awakened their interest in being involved in the nuclear project, and this interest would eventually put them in conflict with the state's monopoly over the nuclear energy program, and the state's commitment to the heavy water reactor as part of the 'Swedish line'. For example, Sweden's largest producer of electrical equipment and main builder of Sweden's existing hydroelectric power plants, the private firm ASEA (*Allmänna Svenska Elektriska Aktiebolaget*), had already initiated a long-term strategy for nuclear power in 1954 following the announcement of the Atoms for Peace program, and the company's belief in the feasibility and profitability of nuclear power only strengthened after the Geneva conference. It envisioned a future in which it not only built Sweden's nuclear reactors but also sold their own reactors on the international market; however, it was not convinced that heavy water reactors were the optimal choice. Another actor, Vattenfall, the Swedish State Power Board, was interested in producing atomic energy, but it too was not committed to the heavy water

type of reactor. The Geneva conference also furthered the government's desire for the development of nuclear energy, and the state began investing more heavily in its own program beginning in the budget year 56/57.⁷²

By 1956, the Social Democratic government had cemented its view on the ability of developments in science and technology to build the modern Swedish state, and they began to more publicly promote this strategy as a means of increasing their political capital. At the end of 1955, the Social Democratic Party and The Swedish Trade Union Confederation (*Landsorganisationen i Sverige*, or LO) organized a conference entitled Technology and the Society of Tomorrow (*Tekniken och morgondagans samhälle*) where scientists, economists, engineers, among others, spoke to the public about the ability of scientific advancement to create the successful welfare state. The atomic project was presented as an exemplar of the role of science in the modern society, and the government could boast that it intended to produce its nuclear energy entirely 'in-house,' that is to say with reactors built in Sweden that ran on local uranium sources, thus eliminating dependence on foreign countries for energy (and avoiding the nuclear inspections that accompanied buying enriched uranium.)

In late 1955, the government established a commission to outline the options for deploying the nuclear program. The Atomic Energy Committee (*Atomenergiutredningen*) released their report (*1955 års atomenergiutredning*) in 1956, recommending the construction of 5-6 new nuclear reactors by 1965, a suggestion that Hannes Alfvén later criticized as unfeasible. Consistent with the strategy of the 'Swedish line,' the committee recommended that all of the new reactors be of the previously mentioned heavy water type, which refers to the type of moderator used. The report also recommended a centralization of nuclear authority under one body, as was done in the USA with the Atomic Energy Commission, which was an attempt by the scientists and the government to reassert control over the area against the previously mentioned increased interest in nuclear development coming from private industry. Despite some criticism by the non-socialist parties regarding the state's concentration of resources on Atomic Energy Inc at the exclusion of private industry, all of the political parties in parliament approved the committee's recommendations with a bill in the spring of 1956 to regulate atomic energy and officially launched the 'Swedish-line,' which offered Sweden energy independence plus the means for possibly creating a weapon.⁷³ Moreover, the bill established the Atomic Energy Delegation (*Delegationen för*

⁷² Schagerholm, "För het att Hantera: Kärnkraftfrågan i svensk politik 1945-1980," 23.

⁷³ Schagerholm, 18–21.

atomenergifrågor, or DFA), which strengthened the hand of the government on nuclear matters and helped to reestablish control over the area, thereby reinforcing the power of the expert scientists, like Hannes Alfvén, at the Atomic Committee and Atomic Energy Inc.⁷⁴

The competition over the direction of Sweden's nuclear program, however, continued. The private industry resented the state's monopoly on nuclear production, but they were dependent on the state's investments for their own work in the nuclear arena. ASEA opposed the heavy water reactor choice based upon the costs of construction and operation, while simultaneously holding the contract to build one at Marviken. And Vattenfall, in a cooperation with a consortium of smaller, private energy producers, tried to order a light water reactor from outside of Sweden in 1959, but the effort failed due to a lack of resources. ASEA and Vattenfall, who were initially both critical of heavy water reactors, eventually went different ways on the Marviken project, as ASEA was forced to support it due to the funding it supplied the company while Vattenfall remained critical.⁷⁵

Worldwide, several reactor types were being tested during this time, and it was only Sweden and Canada who committed to the heavy water system. In late 1963, the American company General Electric released its first commercial reactor that could be sold on the market, and it was fueled by enriched uranium and moderated by light water, known as light water reactors, which sat in direct opposition to the Swedish line. This marked a significant turning point in the international nuclear arena, as several countries soon committed to this type of reactor, as it was considered more efficient and cost-effective. ASEA was also excited by this development and hoped to be able to produce its own light water reactor that could be sold both within and outside of Sweden. The Swedish government and AE, however, continued with their commitment to heavy water, in part because it still offered the chance for producing a weapon but primarily because it had already invested so much into the program, and it would look bad politically to be seen as having wasted so much money. This commitment to heavy water was tested when it was time to build Sweden's largest reactor to-date and second non-research reactor, R4/Eva at Marviken. Swedish experts, particularly Alfvén, were not united in their support for the project at Marviken, and he and others began to criticize it, especially as the project experienced delays, technical complications and rising costs. And, in the mid-1960s, private industry in Sweden committed fully to the light water reactor. In 1965, a consortium of private power producers owned by several municipalities,

⁷⁴ DFA's primary efforts were to oversee issues of regulation such as the granting of licenses though it also participated in general advising regarding the program. It became *Statens kärnkraftinspektion*, or SKI, in 1974.

⁷⁵ Schagerholm, "För het att hantera: Kärnkraftfrågan i svensk politik 1945-1980," 28.

Oskarshamnsverkets Kraftgrupp AB, ordered a light water reactor from ASEA, and other orders soon followed, including one from Vattenfall. With these orders, the heavy water program was essentially dead, and the reactor at Marviken was never realized despite the enormous expenditure already spent towards its development.⁷⁶

During the period just described, Swedish research politics also underwent its second major reform during this period with the creation of an oversight body for all state-funded research, The Advisory Board on Science, in 1962. As with the previous reforms of the mid-40s, the idea for such a body was inspired from abroad with similar organizations in the USA, France and England. Since those initial reforms, the size and cost of Swedish research efforts had grown, which led to a desire for more oversight. More importantly to the researchers, they felt their freedom and influence was waning due to the governments' increased involvement in science and technology to advance political goals. The researchers at this time began clamoring for better lines of communication between politicians and scientists, and Prime Minister Tage Erlander agreed that such a body was necessary, particularly as he considered Sweden a small country with limited resources to put towards research, and the creation of an oversight body could focus the country's efforts in a more systematic way. The creation of the Advisory Board reflected, once again, the importance of science in the development of Swedish society, and, once again, Hannes Alfvén was a key participant during its creation.⁷⁷ This story will be told a little further down, as I examine specifically his performance as an expert within the Advisory Board.

3.2. Hannes Alfvén as Expert

Having very briefly reviewed the history of Sweden's research politics and its nuclear program between 1945-1967, I now focus on the activities of Hannes Alfvén as an expert during this period with a focus on the second half between 1955-1967, as it captures Alfvén as a full supporter of Sweden's atomic program along with an increasing level of criticism. I use this time to demonstrate his fervent allegiance to basic research, as he reflected the characteristics of both a Pure Scientist and Stealth Issue Advocate. This period further allows for an analysis of his performance using the dramaturgical tools of Hilgartner, as he attempted to draw boundaries between science and politics in order to remain the expert in the former, while involving himself indirectly in the latter. In addition, he engaged with the 'front stage'

⁷⁶ Arne Kaijser, "Redirecting Power: Swedish Nuclear Power Policies in Historical Perspective," *Annual Review of Energy and the Environment* 17 (1992): 446.

⁷⁷ Tunlid, "Den nya biologin," 105–7.

and ‘backstage’ activities of Swedish research politics, at times maintaining appearances and at other times revealing the inner workings in order to strengthen his own argument(s). Last, I show how Alfvén’s actions in this period reflect his idealism regarding the role of science in society, as his frustrations with the lack of support towards, free basic research ultimately led to his professional departure from Sweden. Before getting into the details, I will offer a short overview of his expert activities, here.

The same year that the Parliament created Sweden's official nuclear policy, 1956, Alfvén was appointed as one of the government's four representatives to the board of Atomic Energy Inc, and he remained a member until 1968. He also maintained his position as a member of the Atomic Committee, which became a permanent advisory organ via a transformation into the Swedish Atomic Research Council (*Statens råd för atomforskning*) in 1959. In addition to these two bodies that dealt specifically with the atomic program, another important site in which I examine Alfvén’s role as an expert in this section is the Advisory Board on Science, which he played a key role in creating. The story of this body’s creation as well as Alfvén’s activities within it exemplify well his beliefs on the role of science in society as well as show him performing to the Swedish public as he attempts to make reforms to Swedish policy for science. In this period we find that Alfvén regularly argued for more money to basic research not just in the atomic arena but across disciplines, including the humanities and social sciences. However, it is in the field of basic atomic research (about which he was most passionate) where he expressed doubts about the ‘Swedish line’ and wanted to keep the door open for other atomic energy options, which could only come from basic research.

One such very promising area of atomic research that he supported and which intersected with his own research on plasma physics was nuclear fusion, also known as thermonuclear energy, which is theoretically a way to produce nuclear energy without the harmful waste by-product by smashing together light elements, such as hydrogen, to form heavier elements, such as helium, and releasing enormous amounts of energy in the process. This process occurs naturally in stars, and the means to recreate the phenomenon on earth involves directly the fields of research in which Alfvén made his career: magnetohydrodynamics and plasma physics. Producing energy from nuclear fusion was an internationally pursued project in the early years of atomic science, and Alfvén was a recognized researcher in the field. There were, and still are, technical issues that prevent the reproduction of a fusion reaction in a stable manner, referred to as a “controlled” fusion

reaction, which is a prerequisite for building a fusion energy reactor. While the solution to achieving a “controlled” thermonuclear reaction is still unsolved to this day, the hope of producing energy from fusion reaction was shared among a number of nuclear scientists around the world in Alfvén’s time. Sweden’s contribution to these international research efforts was carried out by a small number of researchers at KTH under Alfvén’s supervision, which is a contributing factor in his insistence on putting more money towards basic research.

In the following section I will use board meeting minutes and other documents that I collected from the archives as well as newspaper articles from the Swedish press to demonstrate Alfvén’s performance as an expert during this period. I present the material chronologically, dividing it into three sections, beginning with meeting minutes from the Atomic Committee/Research Council and Atomic Energy Inc starting in 1958. Then, I provide the story of the creation of the Advisory Board on Science starting in 1961, which is told via a mix of archival material and newspaper articles. Last, I return to the politics at Atomic Energy Inc, as the story culminates in Hannes Alfvén leaving Sweden in protest over its research policies, a story that played out in both meeting minutes and, more spectacularly, in the press.

3.2.1. Expert Performance – Act I: the early years in the atomic program

The first several years of this period, when Alfvén worked as an expert both within the Atomic Committee/Research Council and Atomic Energy Inc, were fairly harmonious. Alfvén supported most decisions made by the two bodies, and he was content with the funding he is receiving. The vast majority of government money spent on researching civilian uses of the atom went to the research council and the energy company, both of which distributed the funds as they saw fit. Within the research council, Alfvén and his colleagues directed funding to each other’s research sites, with the largest annual grants typically going to Siegbahn’s Institute for experimental physics and the Gustafson’s physics institution in Lund. The grants awarded towards fusion research went first to Alfvén’s Institution of Electronics at KTH and then to the Institute for Plasma Physics in 1963 when his professorship changed.⁷⁸ Within the council, Alfvén was the head of the physics delegation, which along with chemistry and radiation biology, represented the three primary subject areas that the work of the council covered. At Atomic Energy Inc, Alfvén was an ordinary board member, and, although he later

⁷⁸ These observations about the directing of funding are supported by a review of the Atomic Committee’s (also Atomic Research Council’s) meeting minutes over several years. See boxes 28-40, Torsten Gustafsons efterlämnade papper, Lund University Library.

complained that the board lacked influence over the company's direction, his years on the board show that he argued for, and received, money for fusion research.

While the Atomic research council was a key organization for directing basic research in Sweden's nuclear program, Atomic Energy Inc was by far the primary recipient of government funding for the civilian nuclear program and was largely responsible for developing the Swedish line. And, while the company's primary tasks involved carrying out applied research in the atomic arena, it also maintained activities more rooted in basic research. It was these activities that Alfvén later argued needed substantially more funding, though the company was also the primary funding source for Alfvén's own fusion research. An analysis of the minutes from the board meetings highlights Alfvén's efforts to this end and demonstrates both his strong belief in basic research at this time and his desires to see this research lead to a particular vision of Sweden's future with regards to its nuclear program.

The minutes from an Atomic Energy Inc board on 12 May 1958 give an indication of Alfvén's satisfaction regarding his institution's funding and indirectly show the influence of the research councils on directing research.⁷⁹ During the meeting, Alfvén submitted a report on the latest developments in producing a "controlled" fusion reaction, which is a prerequisite for producing thermonuclear energy, with the conclusion that the large financial contributions around the world to this area would probably result in a solution to this problem in the not too distant future. Excited by this news, a fellow board member asked CEO Henry Brynielsson what AE has been doing in this area. The CEO replied that the company was funding the salaries for two researchers at KTH, and he added that additional researchers could be on the horizon. The inquisitive board member asked Alfvén if he felt that the resources to fusion research were sufficient, and he answered positively noting that he had also received money from the natural science and technical research councils, as well. Here, Alfvén was referring to a grant for 750.000 kr that he received for experiments in strong magnetic fields (*starka magnetfält*) in budget year 1958/59, and the cost of funding the grant was shared among AK (200.000), the Natural Science Advisory Board (200.000) and the Swedish Council for Technical Research (350.000).⁸⁰ In total, this was a considerable amount of money, especially for an emerging field of research. More important, it demonstrates the substantial influence that a relatively small group of scientific experts within the research councils had at the time

⁷⁹ Protokoll nr. 85 for board meeting of AB Atomenergi 12/5 1958, Box 80, Elam Tunhammar's archive, Riksarkivet.

⁸⁰ Protokoll nr. 80 of Atomkommittén 20/9 1957, Box 29, Torsten Gustafsons efterlämnade papper, Lund University Library.

with their ability to allocate such a sum to Alfvén's institution, which he received in addition to the money from the company that year. (See Table 1 for overview of Alfvén's research funding from Statens råd för atomforskning.)

Budget Year	58/59	59/60	60/61	61/62	62/63	63/64	64/65
AFR							
–annual to HA/fusion	200 000 kr	322 360 kr	358 076 kr	442 880 kr	486 088 kr	485 996 kr	504 228 kr
–additional grants	550 000 kr	55 000 kr					

Table 1 – Grant allocations to fusion research from Atomic Research Council 1958-1965 Source: Torsten Gustafsons efterlämnade papper, LUB

Despite his satisfaction for the situation with regards to his own institution's funding, Alfvén had reservations about another issue, namely the commitment to the 'Swedish line.' In a series of company board meetings in 1959, he slowly started expressing these doubts, which he coupled with arguing for more basic research in other areas. For example, in the meeting on 13 January 1959, the members learned that the government was not likely to approve enough money for budget year 59/60 to develop the uranium plant in Ranstad; Alfvén responded that if the "blue-yellow line" was dropped, then it would be fine to simply buy enriched uranium.⁸¹ In other words, abandon the goal of producing nuclear energy with Swedish uranium sources and buy enriched uranium from abroad, which would also involve committing to a different reactor type. The conversation about the Swedish line continued during the year, and at a board meeting on 23 October 1959, Director of the board Elam Tunhammar put the question directly to the board if it still supported the idea of using unenriched uranium as fuel and heavy water as a moderator, the two essential elements of the Swedish line. After discussion, it was decided that the board was united in its support for this approach; however, "Professor Alfvén emphasized that this line of development should not prohibit basic research regarding alternative systems."⁸² This is the first of many comments made by Alfvén where he emphasized the importance of basic research as well as his willingness to go along with the Swedish line approach, despite his doubts. This can be read as Alfvén doing his part in 'stage management' in that while he does not really support the 'Swedish line,' he allowed the board to communicate that the decision to pursue it was unanimous at this time.

⁸¹ Protokoll nr. 90 for board meeting of AB Atomenergi 13/1 1959, Box 81, Elam Tunhammar's archive, RA.

⁸² In Swedish: "Professor Alfvén betonade att denna utvecklingslinje ej får utesluta grundläggande forskning avseende andra system." Protokoll nr. 96 for board meeting of AB Atomenergi 23/10 1959, Box 81, Elam Tunhammar's archive, RA.

Another example of Alfvén's concerns about the research within AE can be found in the board meeting of 10 May 1961 when the company was considering a reorganization of research within the company. Alfvén worried that the new organizational plan would constrict free, basic research in areas outside of the 'Swedish line.' Reminding the board of what he considered AE's main responsibilities, he emphasized:

Den skall verksamt bidra till att kontinuerligt hålla en översikt över hela atomenergiområdet. Detta innefattar bl a att den skall studera alternativt till den svenska tung-vatten-linjen och ge material till bedömning, huruvida landets intressen bäst främjas av ett fortsatt arbete på denna linje eller om någan annan linje skulle visa sig fördelaktigare.⁸³

This quote displays Alfvén's belief in the importance of basic research, as he was arguing that the best way forward for Sweden's nuclear program is undetermined; therefore, all options regarding the production of nuclear energy must be considered, which also involved monitoring and conducting basic research in these areas, including his own fusion energy. To label his performance here in Pielke's terms, he is displaying the attributes of a Stealth Issue Advocate, as he argued that all options must remain open because it is ultimately the science that will determine the best form of nuclear energy production to pursue. This is an argument sounds objective until one considers that it is also an argument that will lead to more funding for basic research, including towards his own institution.

In general, it seems Alfvén's fusion research was being positively received within AE. At a board meeting on 8 May 1963, the CEO expressed his satisfaction regarding the company's relationship with Alfvén's institution and noted that Alfvén's work in fusion research was internationally known. "It is important that the company follows what is done within this area," he underscored, and the chairman of the board agreed.⁸⁴ In the same meeting, they discussed the company's five-year plan, particularly with the direction of research. Alfvén's comments were noted as:

Professor Alfvén betonade att bolaget måste skaffa sig hög kompetens inom ett vidsträckt område för att kunna följa utvecklingen beträffande atomenergin. Den eventualiteten kan inträffa att den svenska linjen i längden ej blir konkurrenskraftig. Bolagets personal bör då kunna ha möjlighet att slå in på andra vägar.⁸⁵

As in the above-mentioned board meeting, he is again presenting as a Pure Scientist with the argument that more basic research would ultimately reveal the optimal choice for producing

⁸³ Protokoll nr. 106 for board meeting of AB Atomenergi 10/5 1961, Box 81, Elam Tunhammar's archive, RA.

⁸⁴ In Swedish: "Det är angeläget att bolaget följer upp vad som görs inom detta område;" Protokoll nr. 118 for board meeting of AB Atomenergi 8/5 1963, Box 81, Elam Tunhammar's archive, RA. In Swedish."

⁸⁵ Ibid.

nuclear energy. This prodding for basic research was eventually rewarded in the company's five-year budget plan in a section entitled "Long-term research" (*Det långsiktiga forskningsarbetet*) which supported the idea of increasing funding to the theoretical and experimental work in thermonuclear reactions done at Alfvén's institution at KTH.⁸⁶

A final example shows Alfvén in his best diplomatic performance when arguing for more money to basic research. In a board meeting on 22 August 1963, Alfvén responded to CEO Brynielsson's announcement that the nuclear plant in Ågesta (the third reactor in Sweden and the first non-research reactor) had reached capacity, although "unfortunately the total cost of the project rose 7 million crowns over what was stated the previous year." Alfvén said nothing about the cost overrun (which he did do in public a short time later); rather, in his first comment, Alfvén pointed out that the magazine *Vi* recently ran a "very misleading" article regarding pollution into Lake Magelungen from the Ågesta nuclear plant. Next, he expressed satisfaction that the reactor in Ågesta had reached full capacity, and that the project in Marviken was progressing.⁸⁷ (Again, these statements are also notable, as it is his harsh critique of these two projects in only a year's time that would form the basis of Alfvén's accusations of retaliation by the Swedish government and leadership at the company.) After praising these accomplishments of the company, he then moved directly to lobbying for more money to basic research and long-term planning. Now that these two large projects were done or progressing, he argued, the company needed to focus on developing the research center at Studsvik into a world class facility for high level research. The only way to do this, according to Alfvén, was through a large increase of funding, there. It is possible that Alfvén's initial positive comments towards Ågesta and Marviken were a type of rhetorical maneuver, presenting his united stance with the other board members on these projects and praising the efforts, which put him in a better position to make his argument for more basic research funding within the company. It seems unlikely that the numerous criticisms he soon unleashed in about a year's time, including specifically the projects at Ågesta and Marviken, would have quickly developed in such a relatively short period. I will discuss this critique in a subsequent section, but first we will look at Alfvén perform in a different setting when playing a key role in shaping Sweden's overall policy for science.

⁸⁶ Styrelsen PM 85, 'Femårsplan för budgetåren 1963/64 – 1967/68' 8/5 1963, Box 81, Elam Tunhammar's archive, RA.

⁸⁷ Protokoll nr. 120 for board meeting of AB Atomenergi 22/8 1963, Box 81, Elam Tunhammar's archive, RA.

3.2.2. Expert Performance – Act II: The Advisory Body on Science

Although Alfvén was fairly satisfied up to this point with the support his institution was receiving for fusion research, it soon became apparent that he, and several of his colleagues, had been quite frustrated in regard to the larger state of affairs regarding Swedish research policies. Concomitant with his work on the boards of AFR and AE, Alfvén was having discussions with several colleagues to affect the direction of Sweden's policy for science on a larger scale with the suggestion of creating an advisory body that could better facilitate the communication between scientists and politicians. In February of 1961, Alfvén drafted a memorandum to Swedish Prime Minister Tage Erlander entitled, "P.M. angående kontakt mellan regering och forskningsrepresentanter," which he sent to his colleagues Torsten Gustafson and Göste Funke for review. In the P.M. he stated:

Den nuvarande kontakten mellan statsmakterna och forskarna fungerar otillfredsställande. Med den stora betydelse som den vetenskapliga forskningen och den därmed sammanhängande tekniska utvecklingen har i varje progressivt land, är det nödvändigt att en långsiktig planering av forskningen äger rum i vårt land. Detta kan endast ske genom att ett kontaktorgan mellan regering och forskningsrepresentanter skapas.⁸⁸

Gustafson's replied to Alfvén that he supported the idea, and the two sent a different jointly authored letter to Erlander on 19 May 1961 calling for the creation of such a body, citing the examples of England and the USA who had similar organizations.⁸⁹ They further suggested a structure for the body, with the Prime Minister as its head and representatives from all of the research councils plus the National Defense Research Agency, the Atomic Energy Delegation and the universities. As in the establishment and early days of work with the research councils, Alfvén, Gustafson and others using their positions as elite researchers as well as their personal relationship with Erlander to institute a change in Swedish policy for science.

The state of Sweden's research policies was also a topic that appeared regularly in the press at this time, particularly in *Dagens Nyheter*. In early 1962 the paper ran a series of articles written by scientific researchers from around the country who provided their viewpoints on research conditions in Sweden. Often, the scientists engaged in a dialogue by responding to each other's articles, either agreeing or disagreeing about a particular issue. These articles appeared nearly weekly, and, as an example from February, three articles

⁸⁸ P.M. angående kontakt mellan regering och forskningsrepresentanter 24/2 1961, Box 57, Torsten Gustafsons Efterlämnade papper, LUB.

⁸⁹ Letter Hannes Alfvén and Torsten Gustafson to Tage Erlander 19/5 1961, Box 57, Torsten Gustafsons efterlämnade papper, LUB.

appeared with titles such as “AB Sverige och forskningen”⁹⁰ by Lund university organic chemistry professor Lennart Eberson, “Varför forskar vi?”⁹¹ by Royal Academy of Engineering member Sven Malmström, and an interview with Nobel prize winning chemist Arne Tiselius where he lamented the need to rely on international funding at his own institution.⁹² The climax of the discussion must be said to one of the last articles in the series, written by Hannes Alfvén and entitled, “Vår svälftödda vetenskap,” which was published on 2 March 1962.

The article was an appeal for the recognition of the value of basic, natural science research and a demand for the amount of funding that it deserved. This was Alfvén performing to a public audience, and it contains examples of his sharp wit when it came to blaming politicians. Reflecting the needs of his audience who might not be entirely informed about science and/or research politics, he was pedagogical in his writing style as he laid out the history of Swedish government funding to the sciences, beginning with the reforms in the mid-1940s. Although the great increase in funding towards basic research at that time was commendable, he lamented that the increases to funding since had been relatively negligible. He also explained the goals of research and the questions explored by the natural sciences, technical research and the humanities. He said that there is no sharp boundary between technical research and pure natural science research, making the argument that basic natural science research is as important as the technical, applied type. Referring to the importance of basic natural science research and research in the humanities, he said, “The shared goal of the humanities and natural sciences is to clarify our place in the world: from where do we come and to where are we going?”⁹³ He pointed out that such questions should naturally be considered so important that they should receive great financial support to research, but this was not the case.

The reason for this lack of financial support, Alfvén explained to the reader, is that too much of the funding towards research in Sweden was geared towards short-sighted, technical developments that could quickly increase profits for industry. “Furthermore can one sometimes meet a direct, hostile attitude to basic, natural science research when it is

⁹⁰ Lennart Eberson, “AB Sverige och forskningen,” *Dagens Nyheter* 2/2 1962.

⁹¹ Sven Malström, “Varför forskar vi?,” *Dagens Nyheter* 20/2 1962.

⁹² “Staten finanserar inte mer än 50 proc av svensk forskning,” *Dagens Nyheter* 8/2 1962.

⁹³ In Swedish: ”Det gemensamma målet för humaniora och naturvetenskap är att klarrätta vår ställning i världen: varifrån kommer vi och var är vi på väg?” Hannes Alfvén, “Vår svälftödda vetenskap,” *Dagens Nyheter* 2/3 1962, 6.

considered to be a competitor to the technical...which all men of industry prefer to be used for short-sighted, lucrative aims.”⁹⁴ The only wise and viable solution was to put substantially more money towards basic research in the natural sciences, which he stated are responsible for nearly all major breakthroughs in technical development and were responsible for Sweden’s development from a poor country to its current wealth. “Natural science’s significance for our country’s prosperity seems completely unknown, at least among those who steer our country’s fate.”⁹⁵ Even if one was only thinking in pure economical terms, he pointed out, as was the case “in today’s brutally commercialized Sweden” then basic research should be supported as it leads to the desired economic and societal benefits. All of the above was a reflection of his strong, core beliefs in the importance of basic research and the linear model. At the same time, it also pointed to an inherent contradiction in his argument, of which Alfvén might have been unaware. As the argument for basic research states that research is to be undertaken for its own sake, without concern for application, Alfvén was clearly arguing here that it should be undertaken because it would lead to applications that will benefit society. This is also an example of Stealth Issue Advocacy, as he presented himself as a Pure Scientist, while still clearly engaging in issues of politics i.e. the distribution of tax money in trying to direct funding that would support his and his colleagues’ visions for what was best for Sweden.

In the article, Alfvén also explained where to lay the blame for Sweden’s research problems, which was with the political decision makers, and he provided a solution, which was to be found in the scientific experts. Given that the short-sighted approach was not sustainable and would leave Sweden unprepared for the quickly evolving, technical world, he said that there are two ways to react: “The first is that of the ostrich, also the politicians’ method: hide your eyes for as long as possible to that which is coming, and when it comes meet it with improvised and poorly planned measures.”⁹⁶ The second approach was to prepare in advance for the upcoming changes, and it was here that science could play a large role. He identified scientists, who were experts in their respective fields and who were familiar with

⁹⁴ In Swedish: “Dessutom kan ibland möta en direkt fientlig inställning till den grundläggande naturvetenskapliga forskningen, då den tros vara en konkurrent om den tekniskt...som somliga industrimän anser hellre bör användas på kortsiktigt lukrativa uppgifter.” Ibid.

⁹⁵ In Swedish: ”Naturvetenskapens betydelse för vårt välbstånd tycks vara fullkomligt okänd, åtminstone för dem som leder vårt lands öden.” Ibid.

⁹⁶ In Swedish: ”Det första är strutsens, och de svenska statsmäkternas metod: man blundar så länge man kan för vad som komma skall, och när det sedan kommer möter man det med improviserade och illa planerade åtgärder.” Ibid.

the international developments in science and technology, as those best suited to prepare Sweden for the evolving world. The best way for these scientists to have an impact was to create an advisory body that can improve the relationship between researchers and politicians. He cited the success of such bodies in the USA and USSR, where, as a result of the positive opinion of politicians towards scientific research, “well equipped laboratories grow like mushrooms from the black soil.”⁹⁷

Here, Alfvén seeks to return influence back to the representatives of science, which he felt had decreased since the early days of the research advisory system, when scientists were largely left alone to pursue their activities without government interference. He tried to distinguish between what was considered politics and what fell under science thus allowing the scientists to claim authority over their own domain. One can view this as an example of Gieryn’s notion of boundary work for the protection of autonomy, also cited by Hilgartner as a function of persuasive rhetoric. Alfvén argued that scientists were the most qualified to handle scientific matters, and they merely needed better contact with the political decision makers to inform them on the best way forward regarding Sweden’s policy for science. In countries where this approach had been adopted, the results were clear, according to Alfvén. He depicted politicians as seemingly incapable of understanding the obvious importance of basic research, as it should be clear to anyone that much more money should be placed there. Even worse, he accused politicians of simply ignoring predictable problems until it was too late, a clear sign of their incompetence to handle these matters. Alfvén’s arguments were not missed by Tage Erlander, who reflected on the article years later: “Then Hannes Alfvén wrote a widely discussed article in *Dagens Nyheter*...One can still read it and admire his ability to express his indignation over politicians’ indifference towards research.”⁹⁸

Ultimately, Alfvén and his fellow scientists were successful in their efforts, as the government announced the formation of the Advisory Board on Science on 16 December 1962. The new organization would consist of the Prime minister, five ministers, six representatives from industry and 15 representatives from the scientific community. Erlander announced to the press that the new organ would be a forum for consultation on the long-term

⁹⁷ In Swedish: ”välutrustade laboratorier växer upp som svampar ur den svarta jorden.” Ibid.

⁹⁸ In Swedish: ”Då skrev Hannes Alfvén en mycket uppmärksammad artikel i *Dagens Nyheter*...Man kan fortfarande läsa den och beundra hans förmåga att uttrycka sin indignation över politikernas oförstående inför forskningen.” Tage Erlander and Arvid Lagercrantz, *Tage Erlander. 1960-talet: Samtal med Arvid Lagercrantz* (Stockholm: Tidens Förlag, 1982), 91.

planning of Swedish research.⁹⁹ It would deliberate on the general areas of scientific research that should be focused upon with regards to funding, and the body was to function as an information channel between scientists and the government. The government emphasized in its announcement of the new body that it would in no way act as an attempt to direct or constrict free, basic scientific research.

The Advisory Board on Science held its first meeting on 27 June 1963 at Harpsund, the Prime Minister's vacation home that had been the site of several research policy meetings in the past. They planned out the meetings for the next two years, in which they would meet twice per year. Perhaps most importantly, the Prime Minister officially assigned the members of the influential working group that he would lead, which consisted of Alfvén along with Sven Brohult, Arne Tiselius, Bror Rexed and economist Ingvar Svennilson plus government representatives Sven Moberg from the education department (*ecklesiastikdepartement*) and Hans Håkansson from the department of commerce (*handelsdepartement*). The primary task of the working group was to ultimately prepare in advance the material that would be taken up by the larger body by deciding on which issues and areas of importance were most relevant for the determination of Sweden's research policies. As such, they had significant influence over what would be deliberated upon within this newly formed, influential body that would ultimately seek to direct the future of Sweden's research politics.

It would not be long, however, before Alfvén registered his first disappointments with the new body. After the first meeting of FB at Harpsund, Alfvén drafted a document summarizing his criticisms of the gathering and the current state of affairs of the Swedish research politics. The document, found in Torsten Gustafson's archive (it is unclear whether it is a letter or a draft of a committee document) is an insightful summary of Alfvén's views on research politics, the role of experts in a democracy and his potential solution to the problems. He began his analysis of the problem by worrying about the current state of affairs under Erlander:

Erlander har en stor akning för sin egen grupp av människor, alltså de som sitter I administrationen, eller som från andra vägar än expertisen kommit fram... Av en utomordentlig fara är regerings bedömning att administrationen är klokare än de verkliga experterna.¹⁰⁰

He contended that decisions were made within the administration and government departments without input from the experts, and he further worried of an uncontrolled

⁹⁹ "Regeringen skapar nyt forskningsråd," *Dagens Nyheter* 16/12 1962, 1.

¹⁰⁰ Draft, Hannes Alfvén to Torsten Gustafson, date missing, Box 1, Torsten Gustafsons efterlämnade papper, LUB.

concentration of power from within the government offices when it came to the handling of research policy. He also asserted that a joke made by Erlander at the end of the first FB meeting, “First, all the experts should be thrown out before deciding on a matter,” should be taken seriously. Next, he accused the governing party, the Social Democrats, of violating democratic principles by winning elections based upon their presentation of a political platform that receives broad public support, including from Alfvén, and then used this support to consolidate their power:

Jag anser att själva den principiella och låt oss saga demokratiska situationen är helt otillfredsställande...Makten som de får...användes till ett av den allmänna opinionen fullkomligt okontrollerat maktutövande. Jag anser att man inte har någon positive möjlighet att påverka regeringen enligt den politik, som vetenskapsmännen hittills följt.¹⁰¹

This quote, and the document in general, represents a clear example of Hannes Alfvén’s idea on the role of experts in a democracy. Their declining influence in the halls of government represented for him a violation of democratic principles. The government was elected by the people to act in their best interests, not simply as a means of achieving power, and not allowing experts to decide the direction of research in the country is a betrayal. This exemplifies Alfvén as overtly political, as he was obviously engaging in issues of politics while his official representation of himself is as an independent, Pure Scientist, whose main concern was the advancement of knowledge. In an even more political move, Alfvén suggested at the end of the document that scientists should go public with their criticisms of the government, thus appealing to the public to pressure government officials to change their approach to scientific research. Here, Alfvén was threatening to reveal to the public the ‘backstage’ of Swedish research politics.

It seems that Alfvén was serious in this last suggestion as he penned an article that appeared in *Dagens Nyheter* entitled, as before, “Vår svältfödda vetenskap,” which ran on 26 November 1963. Here, he argued, again, for the importance of basic research and its direct connection to societal benefits. The article appeared to be written in support of an upcoming budget request, where the research councils asked for a near 100% increase, or 50 million kronor, from the previous year. He made the argument to support this request by providing recently published numbers on the total amount of government money put towards research, 420 million, and notes that this is only 0.5% of the national income (GDP). This number was well behind the averages of other countries like the England, USA and USSR who spend 2.6%, 3.4% and 4.3% of GDP, respectively. As the atomic and natural science research

¹⁰¹ Ibid.

councils dealt exclusively with basic research, he reminded the reader, “...the pure science, which primarily works to discover nature, our society and human relations...is possibly the most important factor in development.”¹⁰² He also continued his attacks on the political decision makers, saying that those in the Parliament who approved the budgets did not understand scientific research’s importance to society, and he warned that the situation is precarious:

Alltmer börjar den åsikten tränga igenom även i Sverige att ett lands framtid i hög grad avgörs av hur stark dess forskning är. Men ingen av dem som har ansvaret för hur våra ekonomiska resurser utnyttjas tycks vara villig att dra konsekvenserna och ge den svenska forskningen den upprustning de är i trängande behöv av.¹⁰³

He ended the article by suggesting to the reader that not much has changed since he wrote similar words nearly two years ago. This article also marked the beginning of a much more public presence for Alfvén in the Swedish press, as he began to publicly discuss his criticisms of the nuclear energy program and its commitment to the ‘Swedish line’ as represented in the Marviken project.

3.2.3. Expert Performance – the final Act

Returning now, specifically, to the nuclear program and Alfvén’s activities on the board at the Atomic Energy Corporation, the records show Alfvén increasingly unsatisfied with the company’s activities regarding long term research, and his criticism would soon reach the public via the press. As mentioned previously, in mid-1963 he began to insist that the focus must now go to Studsvik and the company’s research facility there, which must be made into a “superior” research facility through greater investment, and that the amount requested in the next year’s budget was 20% too low.¹⁰⁴ He made a similar point in the board meeting of 6 October 1964:

Professor Alfvén underströk att Atombolaget är ett uttryckt för Sveriges reaktion inför atomåldern. Bolaget har att överväga även andra synpunkter än dem som i första hand framförs av den tillverkande industrin och kraftindustrin. Bolaget måste beakta hela den nya teknik, som har sitt ursprung i atomenergienspekten. Det finns en dualism i bolaget mellan projektarbete och forskningsarbete. Bolaget måste stimulera utvecklingen av nya idéer på forskningsområdet. 1970-talet kommer inte att präglas av de idéer som nu är förhärskande.¹⁰⁵

¹⁰² In Swedish: ”den rena vetenskapen, som primärt arbetar för att utforska naturen, vårt samhälle och de mänskliga förhållandena...är den kanske allra viktigaste faktorn i utvecklingen.” Hannes Alfvén, “Vår svältfödda vetenskap,” *Dagens Nyheter* 26/11 1963, 7.

¹⁰³ Ibid.

¹⁰⁴ Protokoll nr. 120 for board meeting of AB Atomenergi 22/8 1963, Box 81, Elam Tunhammar’s archive, RA.

¹⁰⁵ Protokoll nr. 125 for board meeting of AB Atomenergi 6/10 1963, Box 81, Elam Tunhammar’s archive, RA.

This quote, like the previous ones, demonstrates his adamant belief in basic research, which according to him was always producing “new ideas,” and his worry that the company, and Sweden, would be left behind if they did not make basic research a priority. In the next board meeting he reiterated, again, that the money to Studsvik should be increased, and further stated more or less decisively that the heavy water project at Marviken was a lost cause. He noted that the large, private industrial actors no longer saw the Swedish line as desirable, and it was clear that reactors could be purchased from abroad that were much cheaper than the cost of Marviken. After years of questioning the Swedish line in board meetings, he finally made his most condemning remark when he said, “This project has lost so much current interest that one should now consider discarding it.”¹⁰⁶

Despite the board meetings of the Atomic Energy Corporation being classified and details not available to the public, what Hilgartner refers to as information control, news of this statement reached the Swedish press because Alfvén asked that his concerns about Marviken, as he expressed them in the board meeting, be sent officially to the Atomic Energy Delegation, which made them open to the public. An article in *Svenska Dagbladet* on 13 November 1964 reported on his dissent in the board meeting on 21 August 1964 over the further completion of the Marviken project and the pursuit of reactors of this type i.e. heavy water reactors. The article quotes his reasons as: the fact that Sweden’s power industry did not see Marviken as important for Sweden’s energy needs; that Swedish industry felt that the atomic program could be developed in another direction; that the atomic industry had changed with new types of reactors now available; and that the costs for continuing with the Marviken project and Swedish line could increase dramatically. And, most importantly to Alfvén, he said:

För närvarande befinner sig många andra forskningsområden, särskilt grundforskning, i en ekonomiskt utomordentligt prekär situation. Det synes nödvändigt med en prioriteringsdiskussion, där utgifter för Marviken ställs i relation till övriga statsutgifter för forskning och utveckling.¹⁰⁷

Alfvén did not miss an opportunity to argue for more money to basic research, and this move to make public his disapproval of the Marviken project demonstrates the lengths to which he will go to pursue his cause. He lifted the curtain to reveal the ‘backstage’ and revealed to the public the dysfunction within the country’s most expensive research project and energy hope

¹⁰⁶ In Swedish: “Detta projekt har förlorat så mycken aktualitet att man nu bör överväga att slopa det.” Protokoll nr. 126 for board meeting of AB Atomenergi 21/8 1964, Box 81, Elam Tunhammar’s archive, RA.

¹⁰⁷ “Reservation i Atombolaget,” *Svenska Dagbladet* 13/11 1964, sec. A, 20.

for the future while maintaining his expert performance as he spoke with authority and confidence about the action needed by the government.

Alfvén later claimed that it was immediately after making these criticisms of Marviken that his allocation of fusion research money from the energy company's annual budget began to be reduced. At that time research allocation was distributed within the company and not listed as a separate line-item in the overall budget request sent to the government.¹⁰⁸ Rather, it was part of a larger budget item called "Other basic and applied research in physics." Thus, when the overall budget was approved by the government, the amount allocated to Alfvén's institution was determined primarily by the CEO with the approval of the board, and this was the case when Alfvén received his first alleged reduction in funding. This occurred when the 65/66 budget was announced right before Christmas of 1964, when Alfvén expected to receive something near 1 000 000 kr based upon his internal conversations within the company. Not only did he not receive the 1 million, but he did not even receive his usual amount of 800 000; rather his institute was given 600 000 kr.¹⁰⁹ Alfvén responded with a letter in January 1965 to the board regarding the company's activities around fusion research. He complained that while it had been discussed frequently during board meetings, the company has not done enough particularly compared with the large investments made in other countries, and moreover, certain actions by the company's leadership have placed the work on fusion in a "precarious situation."¹¹⁰ Thus, Alfvén insisted that it was necessary for the board to immediately assign a committee to look at the issue. The board agreed to create the committee with the observation that all money spent towards fusion research should be analyzed and not just those contributions made from the Atomic Energy Corporation. The committee returned with its report in May of 1965, which included money allocation suggestions for the next three budget years. Following the special fusion committee's report, the company asked the government for 1 000 000 towards fusion research for 66/67 with the note that it would request 1 500 000 kr and 2 000 000 kr in the following two years, respectively. It seemed the company even supported the fight for resources, writing in the budget request:

¹⁰⁸ This changes with the 66/67 budget request when research on fusion energy gets its own line-item.

¹⁰⁹ Dag Lindberg, "Delar sin tid mellan USA och Sovjet," Vi, March 25, 1967, 22.; AB Atomenergi angående anslag till bolagets verksamhet för budgetåren 1966/67, 31/8 1965, 79, Elam Tunhammars archive, RA.

¹¹⁰ Protokoll nr. 128 for board meeting of AB Atomenergi 20/1 1965, Box 81, Elam Tunhammar's archive, RA.

Den vetenskapliga insatsen inom fusionsforskningen i Sverige är av hög internationell klass, men den ekonomiska insatsen för denna forskning kan inte ses betydande... Bolaget anser det värdefullt om fusionsforskningen kan fortsätta enligt de riktlinjer som föreslagits av institutionen för plasmatfysik vid överläggningar med bolaget.¹¹¹

Despite these steps from within the corporation to show support for his own fusion research in the upcoming budget request, Alfvén still engaged in a highly confrontational strategy to affect the overall direction of the company with the hope of altering its continued focus on heavy water reactors and the Swedish line. Alfvén boldly attached a “special statement” (*särskilt yttrande*) to the company’s 66/67 budget request to the government which called for a change of direction in the country’s efforts in the atomic arena.¹¹² He insisted that a complete, unconditional investigation into Sweden’s nuclear program was necessary in light of recent developments i.e. Sweden’s power producers want light water reactors and ASEA now had the ability to manufacture them. The statement continued:

Vid denna utredning bör även hansyn tagas till den kritik som från många håll framförs mot AB Atomenergi. Vissa av de kritiska synpunkterna avser jag att inom den närmaste tiden återkomma till i en särskild promemoria benämnd ”PM betr. AB Atomenergi och dess organisation”.¹¹³

Once again, he threatened to reveal the ‘backstage’ of the Atomic Energy Corporation’s inner workings, but this time the audience was the government rather than the public. Alfvén was ready to make these revelations, but first he gave the leaders at the company a chance to reconsider their plans. Alfvén’s call for an investigation was supported by the Atomic Energy Delegation, the Royal Swedish Academy of Engineering Sciences (*Kungl. Ingenjörsvetenskapsakademien*) and even the board of AE.

Before submitting his memorandum to the government, Alfvén sent a copy of it to all of the corporation’s board members in July of 1965. The memorandum also included an attachment entitled, “Kritiskt översikt över AE:s verksamhet.”¹¹⁴ The two documents are a scathing account of how the company was run including criticisms over the design of research and the lack of power invested in the board. Alfvén also made a review of the company’s major activities, primarily the four reactor projects to date, and suggested incompetence and lack of vision on the part of the company. Alfvén directed his strongest accusations to the leadership of the half-state owned corporation, suggesting that the CEO held all of the power

¹¹¹ AB Atomenergi angående anslag till bolagets verksamhet för budgetåren 1966/67, 31/8 1965, 79, Elam Tunhammars archive, RA.

¹¹² Särskilt yttrande till av professor H. Alfvén, bilaga till AB Atomenergis anslagsskrivelse för budgetåret 1966/67, Box 79, Elam Tunhammar’s archive, RA.

¹¹³ PM beträffande AB Atomenergi och dess organization 14/7 1965, Box 81, Elam Tunhammar’s archive, RA.

¹¹⁴ Kritiskt översikt över AE:s verksamhet, bilaga till PM beträffande AB Atomenergi och dess organization 14/7 1965, Box 81, Elam Tunhammar’s archive, RA.

and made decisions with no accountability. He said that the company was a corporation in name only, as it was completely dependent on state funding, and the CEO spent it as he saw fit. Moreover, there was no other area of government funding that received so much money with so little oversight; Atomic Energy Inc had not had a thorough review of its expenditures for over fifteen years, and the word of the CEO was simply taken as truth. According to Alfvén, the CEO also prevented complaints from employees/researchers from reaching the board, and the confidentiality agreements of employees made it impossible for them to speak with anyone else about their criticisms. He also noted fear among researchers from speaking up, as their livelihoods depended on the company. In one of the most serious of Alfvén's accusations, he claimed that researchers had been told of consequences for their careers if they criticized the company, and he asserted that one researcher had his funding pulled after officially criticizing the company during an internal review process. It is unclear whether these claims of retaliation were ultimately true, but Alfvén maintained this position throughout his life.

The reactions to Alfvén's accusations were intense. Within two months, CEO Brynielsson wrote a letter saying that he would resign if there was any other board member who also held the same views, thus demonstrating that he had lost the confidence of the board. Two other executives also submitted their conditional resignations if Brynielsson stepped down. Written responses were also made to Alfvén's statements by fellow board members, noting that Alfvén himself had gone along with nearly every decision taken by the company to that point and that these decisions were taken with the scientific information available at the time. The dispute was resolved, however, when the board requested, along with Atomic Energy Delegation and the Royal Swedish Academy of Engineering Sciences (*Kungl. Ingenjörsvetenskapsakademien*), that the Commerce Department initiate the public investigation that Alfvén wanted, which became the 1966 års atomenergiutredning. On the same day the board made this request, Alfvén wrote to the government that he would not be submitting his "PM betr. AB Atomenergi och dess organisation."¹¹⁵ The next day he wrote to CEO Harry Brynielson saying that he recalled the two documents that he had submitted asked him to simply destroy them."¹¹⁶ The whole episode is remarkable, as it seems that Alfvén attempted to force the hand of the board of AE to support the call for a reassessment of

¹¹⁵ Untitled document 16/9 1965, Box 81, Elam Tunhammar's archive, RA.

¹¹⁶ "Jag får harmed återkalla den promemoria med bilaga som jag den 14 juli 1965 under hand överlämnade. Jag ber Dig därför ha godheten att makulera den." Letter to CEO Harry Brynielson 17/9 1965 Box 81, Elam Tunhammar's archive, RA.

Sweden's nuclear energy program by threatening to expose inadequacies and near corruption within the company. It is a key example of threatening to expose the 'backstage' of AE to the government audience. On the other hand, it could be that Alfvén believed every word of what he wrote, and it was not only him that supported the idea of changing directions in the nuclear arena.

Despite the dramatic events behind the scenes at the Atomic Energy Corporation, the frontstage appearance was maintained via multiple front-page articles in *Svenska Dagbladet* on 2 September 1965 in which the broader topic was the upcoming 66/67 budget request from the company, which totaled 101 000 000 kr.¹¹⁷ The headline for the day read, "AB Atomoenergi satsar på ny reaktortyp" with the by-line reading "Vätekraftämjare skall få ökad stöd," hydrogen power being another name for fusion energy. The article reads in the beginning like a press release for AE, highlighting the promising future of its work, and its new focus on long-term research, including fusion energy. The same page features a smaller article entitled, "De arbetar för våra barnbarns skull" featuring pictures of Sweden's three researchers in fusion energy, Hannes Alfvén, Bo Lehnert and Nicolai Herlofson. They were presented as the pioneers who are working diligently to develop the technology that would provide the final solution to a clean, reliable source of energy that would be realized for another generation or two. With the positive report from the fusion committee, the requested review of the atomic energy program and newspaper coverage his fusion research, Alfvén's efforts seemed to have been successful. He got the board to request the money he wanted through internal negotiations and managed to build a positive image of himself as one of Sweden's most important scientists in the press, thereby successfully negotiating his position in society, politics and science. In the end, however, Alfvén may have harmed his own cause, as the request for 1 000 000 kr for budget year 66/67 was reduced to the current year's level of 600 000 with the explanation that the government was waiting on the results of the 1966 investigation.¹¹⁸ This was the second year in a row that Alfvén's institution received decreased funding, which, again, he would attribute to his internal and public criticisms of the company and Sweden's overall atomic energy program.

Ever determined, Alfvén returned to the pages of *Dagens Nyheter* to fire what would turn out to be a crucial shot in his war of words with the leadership of AE and the government

¹¹⁷ "AB Atomenergi satsar på ny reaktortyp," *Svenska Dagbladet* 2/9 1965, sec. A, 1; "De arbetar för våra barnbarns skull," *Svenska Dagbladet* 2/9 1965, sec. A, 1.

¹¹⁸ AB Atomenergi angående anslag till bolagets verksamhet för budgetåren 1967/68, 31/8 1966, 79, Elam Tunhammars archive, RA.

in an article entitled, “Forskningspolitik i baklås,” which ran on 23 February 1966. On the stage this time in front of the general public, he used rhetorical devices to establish his credibility, demonstrating insider knowledge and supporting his arguments with statistics. In the text, he slowly built to his main argument, which is that politicians were still not listening to the scientific experts regarding the direction of research funding. First, he analyzed the progress made since the establishment of the Advisory Board on Science, through which certain areas of research improved via increased funding, but the overall picture was still unsatisfactory. Using a table to help explain his argument, Alfvén noted that Sweden was still behind the major, industrialized countries when it came to research money relative to GDP. Countering the often-heard argument that a small country like Sweden could not spend on the same level as the superpowers, he argued the exact opposite: a small country like Sweden that was so dependent on the quality of its scientific and technological development should put a greater amount of its available resources towards research. Returning to the work of the Advisory Board, he reminded the reader that a primary task of the body was to prioritize research areas where funding was needed. This work was ongoing; however, the problem was that the Board only had influence over the funding that was allocated to the research councils, which is about 70-80 million kr, while the country’s total expenditure towards research was 1.4 billion kr, when counting both state and industry backed projects. These projects were of the type operated by AE, and it is here where Alfvén laid out his sharpest criticism:

De sammanlagda forskningsanslagen till de medicinska, naturvetenskapliga och tekniska
forskningsråden under de senaste tio åren uppgår till 209 miljoner, vilket är ungefärligt mycket
som enbart Ågesta atomanläggning uppges kosta och mindre än hälften av vad som skall läggas
ned på det omdiskuterade Marviken (över 500 miljoner).¹¹⁹

He accused the research conducted in the areas outside of the Advisory Board’s oversight of being poorly organized and in desperate need of planning. He ended the article by complaining that politicians simply do not listen to their scientific advisors; therefore, Swedish research policies are stagnant. Once again, Alfvén was arguing for increased control by scientists over research funding, this time going after the big money that was spent outside of the research councils. Given the timing, this should also be read in the context of Alfvén’s reduced funding over the last two years, the most recent having occurred only 2-3 months before that article was published.

Towards the end of the same year, Alfvén received his third setback regarding fusion research funding from the Atomic Energy Corporation. He soon found out that the entire

¹¹⁹ Hannes Alfvén, “Forskningspolitik i baklås,” *Dagens Nyheter* 23/2 1966, sec. A, 4.

budget request of 1,5 million kr for fusion research was eliminated from the 67/68 budget for the company. Instead, the government decided that the money for fusion research should come out of the budget of the Atomic Research Council, which was supposedly given an increased amount of money to cover the cost of Alfvén's research. Torsten Gustafson reacted to this move by writing an article in *Dagens Nyheter* demonstrating that the Council had not, in fact, received a higher amount of money (relative to increasing costs), and he noted that Alfvén did not want to take money away from other, well-deserving research grants from within the Atomic Council's budget.¹²⁰ This left Alfvén with the only interpretation that he could make: "my activities are not considered desirable by those who decide the country's research policies."¹²¹

His interpretation went farther than this, however, as he saw this move surrounding his funding as a form of payback for his internal and public criticisms of the Marviken and Ågesta projects, and he decided that he had enough of Swedish research politics. Despite speculation in the press that he was going to leave Sweden, it was not until an interview in the consumer magazine, *Vi*, on 25 March 1967 that he confirmed his plans to continue his work abroad, splitting his time between the USA and USSR. (Half of this plan would never be realized, as he ends up only working in the USA.) The journalist, Margareta Hall, after having interviewed Alfvén stated that the primary issue forcing him to leave Sweden was not a disagreement over scientific matters, but an issue of democracy and the ability to sustain a hard critique against authorities without punishment. In other words, Alfvén's principles regarding the role of science in society and the right of free researchers to openly critique those in power were essential rights for him, and he would not stand for their violation. In the interview, Alfvén recounted in his own words how his relationship within Atomic Energy Inc was completely satisfactory until 1964, when he criticized the newly proposed Marviken both within the company and in the press. He also said that he carried out this critique at the request of several researchers from within the company who were afraid to speak up, fearing reprisals. He said, "I saw no reason to withhold this critique...it was a lot of money."¹²² Here

¹²⁰ Torsten Gustafsson, "Ett anslag mot forskningen," *Dagens Nyheter* 22/2 1967, sec. A, 4.

¹²¹ In Swedish: "det kan endast tolkas så att min verksamhet inte anses önskvärd av dem som bestämmer landets forskningspolitik." Arne Karsberg, "Alfvén hotar flytta: 'Är inte önskvärd,'" *Dagens Nyheter* 11/2 1967, sec. A, 1.

¹²² In Swedish: "Jag såg inget skäl att hålla inne med denna kritik...det handlade om väldiga belopp." Lindberg, "Delar sin tid mellan USA och Sovjet," 22.

is how he recounted the story several years later in an article in the journal *Impact of Science on Society*:

The group running the Marviken project made it clear that if I made public my critical stand on the project, I could expect reprisals in the form of cuts in certain research grants to my institution which were under its control. Since I did not submit to this kind of pressure, the research grants were reduced and my institution found itself in a disastrous position. An unpleasant quarrel followed, with the result that I felt obliged to leave the country.”¹²³

Again, this shows Alfvén’s extraordinary adherence to his ideals, as he claimed that he, too, was threatened with reprisals if he spoke up, yet he chose to act anyway. It should be noted that Alfvén initially stated that his leaving Sweden was not a form of protest, but it was a direct result of the loss of financing, which would simply not allow for work to continue on fusion energy at KTH. If true, this also demonstrates a significant commitment to his scientific research, as he left the institution(s) that he had built over a 25-year career at KTH, and he ended his time as an official expert advisor to the Swedish government, which covered almost the exact same time period.

Reflecting on Alfvén’s entire time as an expert advisor to the government, Tage Erlander wrote the following revealing words:

Alfvén var en utomordentligt intressant bekantskap att göra. Att det blev en del slitningar ska jag inte gå in på här. Men jag tror att han kunnat spela en ännu större roll för vår forskningspolitik om han hade kunnat överse med en del mänskliga svagheter och kanske också lite oförståelse från vissa tjänstemän inom ecklesiastikdepartementet.¹²⁴

I read this paragraph as indicating that Alfvén was indeed inflexible regarding his moral positions and that he did, in fact, receive some poor treatment at the hands of civil servants/ministers. This paragraph about Alfvén was found in a draft of Erlander’s “Conversation with Arvid Lagercrantz” that he sent to Torsten Gustafson for review before publication. Interestingly, these words were deleted from the final, printed version of his diaries.

3.3. Performance Summary 1945-1966

Hannes Alfvén’s role as an expert government advisor began with the Atomic Committee in 1945 and largely ended in 1967, when he abruptly left Sweden and all of his official advising duties. The Atomic Committee was one of the earliest councils created in the new research advisory system created under Education Minister Tage Erlander, but it should be

¹²³ Hannes Alfvén, “Science, Technocracy and the Politico-Economic Power,” *Impact of Science on Society* 22, no. 1/2 (June 1972): 90.

¹²⁴ Draft of *Tage Erlander. 1960-talet: samtal med Arvid Lagercrantz*; Box 1, Torsten Gustafsons efterlämnade papper, LUB.

remembered that it was not Erlander who initiated these reforms but the scientists themselves, like Alfvén, Tiselius and Siegbahn, who lobbied for their creation. These scientists constructed and performed their identities as elite, trustworthy and objective scientists, or Pure Scientists in Pielke's description, in order to reform Swedish research policy in their own image. The creation of the research councils and the advisory system reflected a new understanding in the relationships between science, the state and society; science and technology were seen as the key to creating a prosperous future, and the state took the initiative by funding and directing research to this end. It was also a time with a dominant view among scientists about how research should be conducted and knowledge produced, as unrestricted basic research was considered sacred by many, not least by Hannes Alfvén.

Although Alfvén was more politically active later in his career, this period is also political but less overtly, performing in a manner more consistent with Pielke's description of a Stealth Issue Advocate. Alfvén and his cohorts believed strongly in the power of science, coupled with the state, to create a better society. And in this historical period of growing technological complexity, and in a subject as complex as nuclear physics, these experts were able to establish themselves as powerful actors in an area where few government representatives could participate. Nevertheless, as the Social Democratic governments increasingly sought to implement their own visions of a future Sweden, Alfvén felt himself in conflict with these decision-makers whom he accused of seeking power and influence at the expense of the Swedish people. His self-identity as a Pure Scientist, with its belief in the benefits of basic research, compelled him to be involved in politics. He tried to draw boundaries between the political and the scientific, hoping to retain expert influence over the realm of research, but these attempts ultimately fail. It is possible that Alfvén did not realize the impossibility of separating out these areas of politics, industry and scientific research. Because they are all intricately linked, particularly in the Swedish context where the state and industry are closely aligned, it would be a futile effort to argue for research conditions that were entirely free of these influences. It was his idealism regarding basic research coupled with his idealism about the role of science in a democracy that led to his high level of frustration with Swedish research politics.

It is important to realize the significance of Alfvén as a representative of science in Sweden, which is reflected in his innovative scientific contributions, as well as the number of high profile, expert advisory positions that he received. Alfvén embodied the role of the scientific expert as a part of the Uppsala educated physicists who, like Manne Siegbahn, were undisputedly competent and able to represent Sweden's foremost thinkers on topics related to

theoretical physics. Alfvén's early successes in his field and appointment as a professor at KTH further cemented his reputation. Alfvén and his colleagues' effectiveness as experts, i.e. the ability to bring about change and/or influence government actors, is reflected in the fact that they succeeded in carrying out two major reforms within Swedish research policies with the introduction of the advisory system and the creation of the Advisory Board in Science, and they succeeded in establishing committees and organizations that would last for decades and distribute billions of kronor in resources.

Although Alfvén maintained his identity as what Pielke would call a Pure Scientist throughout this period, there is a change in his performance as he grows increasingly frustrated with the government's approach to research. For example, in his initial career as an expert within the Atomic Committee/Research Council and Atomic Energy Inc, Alfvén acted in concert with his fellow committee/board members to maintain a united front on the presentation of scientific information, which Hilgartner refers to as 'stage management.' He first deviated from this approach in the creation of the Advisory Board on Science, when he and his colleagues published newspaper articles revealing the difficulties they face when working with the government. Here, the language of Alfvén's writings, directed to the public, display the persuasive rhetoric identified by Hilgartner as typical of a scientist constructing their credibility in order to persuade their audience. When Alfvén maneuvered to get his criticisms of the Marviken project, expressed confidentially in a corporate board meeting, sent to a public agency and thus to the press, he was engaging in one of Hilgartner's recognized techniques of a critic: revealing the backstage in order to delegitimize an opponent. And, in an extraordinary move, he further uses the threat of revealing the 'backstage' of Atomic Energy Inc to the government to push for a review of Sweden's nuclear program.

Despite moving from an initial supporter to a growing critic, Alfvén maintained his view on the role of science in society, throughout. Alfvén argued fervently in the meeting notes and in the press about the importance of basic research and the need to keep the country's options open when it came to its nuclear future. While it may be assumed that all scientists of this period shared in a belief in the importance of basic research, it is usually only Alfvén driving the point in the board meetings of Atomic Energy Inc, suggesting that it should be prioritized to a much greater degree. Alfvén's passionate belief in free and unfettered research would eventually lead to his dramatic critique of the government's nuclear policy as being too narrowly tied to one goal i.e. the Swedish line as represented in the Marviken project. In the end, Alfvén's commitment to free and basic research and his

frustrations of needing to be involved in politics led him to leave Sweden and take a job at the University of California in San Diego in the USA, which is where the story continues in the next section.

4. Stopping the Nuclear Society: 1967-1976

The years between 1967 and 1976 represent the second major period that I distinguish in the career of Hannes Alfvén as it relates to his changing views on science in society and his role as an expert while he still maintained his belief in the responsibility of science to propel society forward. It is in this time that he left Sweden and began his half-year working assignments in the applied physics department at the University of California in San Diego. In the USA, he was exposed to the anti-nuclear arguments being made by fellow scientists along with new research that demonstrated potential dangers associated with nuclear power. As a result, his approach to expert advising took a distinguishable turn moving from his earlier presentations as a Pure Scientist (and Stealth Issue Advocate) to performing as an Issue Advocate, as he also tweaked some of his views regarding the relationship between science, state and society. He was inspired by the Pugwash movement, which I present in section 4.1.1, and he devoted a lot of his energy to spreading its message, which advocated an explicit view on the responsibility of scientists as well as a commitment to finding solutions to humanity's biggest threats. He served as the organization's President from 1971-1974, but I trace the beginning of his serious involvement to 1967, when the organization held its annual conference in Sweden. In perhaps his most well-known performance as an expert, I end this period with his historic persuasion of the Center Party leadership to take up the anti-nuclear cause, which ultimately resulted in a non-socialist government in Sweden for the first time in 40 years in 1976.

I divide this section into two main parts in order to show both Alfvén's evolving views on the role of science in society and the resulting changes in his performance as an expert during this period. The first section focuses on his work within Pugwash where there is a lot of material in which Alfvén specifically expressed his views on the responsibility of scientists, the role of experts and the relationship between the state, science and society. For material, I use the official proceedings from Pugwash conferences between 1964-1974, which were published and distributed exclusively to members. In addition to the published conference material, I also look at archival material and newspaper articles by or regarding Alfvén in the period 1967-1976. The second part shows Alfvén in action as an expert during the nuclear debates in Sweden in the 1970s with a particular focus on his cooperation with the Center Party in Sweden during that time period. Here, he used his position as an expert to persuade a main opposition party to adopt the anti-nuclear view, and he was wildly successful in this endeavor. For material, I include archival records and letters, biographical and

historical accounts and newspaper articles. Finally, I frame his actions with the Center Party and the 1976 elections as being consistent with the views he held while in Pugwash such as using his expertise to advise governments. Before getting to the main material of this section, however, I first provide some historical details on the growth of the anti-nuclear movement and the role of scientists therein.

4.1. Background to the Anti-Nuclear Movement

Before discussing the material for the years between 1967-1976, in this section, I provide a brief history on the role of scientists in the anti-nuclear movement, which began largely in the decade before. This history is important to understand the early development of resistance to the nuclear project to see how it led to the forms of opposition in the following decade in which I focus regarding the efforts of Hannes Alfvén. Many of the concerns raised by scientists, specifically about the dangers of nuclear energy, emerged during the 1950s primarily in the USA, so it is there where I begin this background section. Next, I cover the larger international context, primarily as I discuss the development of the previously mentioned Pugwash movement of concerned scientists. I begin the story in 1954, when the dangers of atom-splitting reached the popular conscience in the USA and the world thus creating an opportunity for concerned scientists to join with popular movements and mount a credible opposition to the nuclear program.¹²⁵

4.1.1 Scientists and the Anti-Nuclear Movement in the USA

On March 1, 1954 the US government via the Atomic Energy Commission (AEC) tested a hydrogen bomb at Bikini Atoll in the Marshall Islands, located in the Pacific Ocean. This event had reverberations beyond those created by the explosion, as it represents a “turning point” in public consciousness about the dangers of the bomb its testing. This occurred due to the radioactive fallout radius being much larger than was predicted by the AEC scientists resulting in the radioactive poisoning of not only Marshall Islanders who were thought to be outside of the danger zone but also of 350 sailors aboard a Japanese fishing vessel which was eighty-five miles from the test site. Further investigations into hydrogen bomb testing revealed that fallout could enter the earth’s stratosphere and thus spread all over the planet, increasing fears among the public about the dangers of nuclear testing. As a result, opposition

¹²⁵ Naturally there was opposition to the bomb prior to 1954 by both scientific and citizen groups, but these were largely subsumed by Cold War politics and the prioritization of national defense.

among scientists to the nuclear bomb broadens and influential actors such as Nobel laureate chemist Linus Pauling, who became a leading figure in the anti-nuclear movement, joined the efforts.¹²⁶

The entry of leading scientific experts into the anti-nuclear marks a significant turn in the movement. Because nuclear technology was such a complicated science, and only fully understood by a small group of scientists, there credible opposition to the nuclear programs was dependent on their supportive critique. While it was not uncommon in the 1970s to see environmental groups enlisting researchers to provide scientific support to their causes, it was in this period of the mid-20th century when such arrangements were formed for the first time. Beginning with the issue of radioactive fallout, it was the involvement of experts which breathed life back into the fledgling peace movement, whose calls for the abolition of atomic weapons were being subsumed by Cold War politics.¹²⁷ For scientists, who had previously attempted to scale back military involvement in nuclear research immediately after the horrors of Hiroshima and Nagasaki, the connection to broader social movements allowed their concerns to be spread to a wider audience and exert more pressure on governments. Thus, the combination of scientists and social movements allowed both groups to amplify their existing messages.

It was also during this time that key issues relating to the nuclear energy debate of the 1970s were raised. A key issue, still of concern today, was the storage of nuclear waste, which was raised in 1952 by a former chemist from the Manhattan Project and stated by the National Academy of Science in 1957 as the biggest hindrance to the nuclear industry. In 1961, an article was published in the Proceedings of the American Society of Engineers which layed out a comprehensive critique of nuclear energy including the warning that all new technologies come with failure and in this case failure can be catastrophic. The article aslo questioned if nuclear energy really was cost beneficial. And in 1963 a former head of the AEC, David Lilienthal, published a book entitled *Change, Hope and the Bomb*, which given the authority of the author on nuclear issues, had to be taken seriously. The book's arguments reflected what became the cornerstone of the anti-nuclear campaign in the 70s, namely that nuclear energy should not be developed until the waste issue was solved along with the other potential health hazards.¹²⁸

¹²⁶ Rüdig, *Anti-Nuclear Movements*, 55.

¹²⁷ Rüdig, 55.

¹²⁸ Rüdig, 61.

Although the fears of radioactive fallout from nuclear testing abated after the 1963 Atmospheric Test Ban Treaty, which prohibited the above ground testing of nuclear devices, the table was already set to transfer this concern to radioactive leakage coming from nuclear energy facilities. Beginning in 1969, a number of scientific challenges to civil nuclear technology emerge which have a greater impact than the earlier, more isolated cases of expert dissent.¹²⁹ Surprisingly, it was the issue of atmospheric testing, which was largely a settled issue, that brought in some big names into the anti-nuclear camp. It started with a University of Pittsburgh researcher, Ernest Stenglass, who released a report linking infant mortality to low level radiation from nuclear testing. The AEC quickly wanted to challenge these findings and asked one of its own scientists, Dr. Arthur Tamplin, to review Stenglass' report. While Tamplin reduced the number infant mortality cases by a factor of 100, he confirmed that low level radiation has negative health effects. (Pro nuclear scientists had long argued that effects of low level radiation from testing and/or power plants were negligible.) Tamplin's findings were supported by the director of his laboratory, Dr. John Gofman who was an AEC authority on radiation effects. Both Goffman and Tamplin refused to comply with AEC requests to eliminate certain elements from their published findings, and they were convinced that the AEC was withholding relevant information on low level radiation and did not acknowledge the danger. So, they went public with their concerns by presenting a report to a US senate committee suggesting that the current standards were insufficient and that they should be reduced. Specifically, Stenglass, Tamplin and Gofman called for a reduction of radiation output from power plants by a factor of ten. Tamplin and Goffman would later become key expert figures in the anti-nuclear movements and both of them would even have a presence in the Swedish debates of the 1970s. According to Rüdig, their significance is great:

It was Gofman and Tamplin's action which made all the difference. Here were two distinguished AEC scientists publicly criticizing AEC policy on low level radiation and the Commission's general approach to nuclear safety...Henceforth, concern over nuclear safety could no longer be easily dismissed as irrational and lacking any scientific base...Gofman and Tamplin had given the anti-nuclear movement scientific legitimacy.¹³⁰

Gofman and Tamplin can also be placed within the larger mobilization of certain social groups that were galvanized by the nuclear disarmament issue. While scientists played a central role due to their familiarity with the subject as well as their feelings of responsibility for having created the problem, other intellectuals and educated members of the middle class became more involved as agents of social change. Rüdig observes that this occurs in the USA

¹²⁹ Rüdig, 65.

¹³⁰ Rüdig, 66.

at a time when working class politics is on the decline due to an acquiescence to the mainstream narrative on the need for nuclear weapons and the promise of middle class prosperity.¹³¹

During this earlier period of scientific dissent towards nuclear energy, several of the most credible voices came from the USA thus its focus, here. Moreover, it was the nuclear debates in the USA in the late 60s and early 70s to which Hannes Alfvén was exposed during the beginning of his work at UC San Diego in 1967, and he credited these debates for providing him with the arguments regarding the dangers of nuclear energy. Finally, it was the US's status as a world leader both politically and in nuclear science that made the debates there relevant to the entire world. Rüdig confirms this when he writes, "US expert dissent exerted a crucial influence without which anti-nuclear movements elsewhere would not have emerged in the strength in which they did."¹³²

4.1.2 International scientists and the anti-nuclear movement: the history of Pugwash

It was not only in the USA, however, that the fallout from the Bikini Atoll test in 1954 would awaken the movements against nuclear testing and the bomb among both scientists and the public. In Sweden, which had now publicly revealed its intent to pursue a nuclear weapon, a split occurred with the ruling Social Democratic party when labor organizations began taking up the question and, in 1956, the women's organization (*kvinnoförbundet*) within the Social Democrats passed a resolution against nuclear weapons.¹³³ Internationally, a movement of concerned scientists, which would come to have a substantial impact on nuclear politics, began taking shape with some of the largest names in science and philosophy, including Albert Einstein and Bertrand Russell, on board. This peace-oriented movement of scientists from all over the world, is known as Pugwash due to the site of its first meeting in Pugwash, Nova Scotia. Because of the importance of Pugwash to the expert career of Hannes Alfvén, I provide a brief history of the organization before examining his specific activities within the group.

On December 23, 1954 Bertrand Russell, whose existing concern over the danger of nuclear weapons was increasing due to the advances of the hydrogen bomb, took to the airwaves of the BBC to warn humanity of its possible end. He asked if the human race was

¹³¹ Wittner, *The Struggle Against the Bomb: A History of the World Nuclear Disarmament Movement, 1954-1970*, 2:464.

¹³² Rüdig, *Anti-Nuclear Movements*, 68.

¹³³ Anna Rudling, *Kampen mot atomvapen* (Stockholm: Tidens forlag, 1975).

"so destitute of wisdom...that the last proof of its silly cleverness is to be extermination of all life on our planet."¹³⁴ The speech was reproduced in publications around the world and struck a chord with scientists who shared such concerns, including the Polish-born physicist Joseph Rotblat who worked at Oxford at the time and who had previously had discussions with Russell on such matters. Joseph Rotblat, who ultimately founded and led Pugwash for many years, holds the distinction of being the only scientist to quit the Manhattan Project on moral grounds once he learned that Nazi Germany would not be acquiring a nuclear weapon. At the time of Russell's speech, Rotblat was already working on organizing a conference of concerned scientists within the British Atomic Scientists Association (ASA) to specifically address the threat of nuclear weapons.¹³⁵ After his BBC speech, Russell was soon contacted by a number of concerned scientists, and together they decided that a letter signed by eminent researchers urging world leaders to halt their march towards destruction could have a positive effect. Russell decided to focus primarily on Nobel Prize winning scientists as signatories in order to have the greatest impact. Eventually Albert Einstein was invited to sign the letter, which by now not only included the appeal to world leaders but also a call for scientists to meet in a conference setting to discuss possible actions to stop nuclear annihilation.¹³⁶

The result of these efforts ultimately became known as the Russell-Einstein Manifesto, which would serve as the foundation of the forthcoming transnational organization named the Pugwash Conferences on Science and World Affairs. The manifesto was presented to the world at a well-attended press conference on July 9, 1955 with Russell and Rotblat as the spokespersons. Russell emphasized that they spoke "not as members of this or that nation, continent or creed but as human beings, member of the species of Man..." Sensitive to the hostile climate of the Cold War, the message was to be non-partisan with a focus on the risk for all of humanity to be exterminated in a conflict that used atomic weapons. In his most famous line from the event, Russell appealed to everyone to "remember your humanity and

¹³⁴ Andrew Brown, *Keeper of the Nuclear Conscience: The Life and Work of Joseph Rotblat* (Oxford : New York: Oxford University Press, 2012), 119.

¹³⁵ Wittner, *The Struggle Against the Bomb: A History of the World Nuclear Disarmament Movement, 1954-1970*, 2:33.

¹³⁶ In a dramatic set of events, Einstein signed the letter only days before his death and sent the document back to Russell, who was travelling at the time. Russell learned of Einstein's death during a flight from Rome to Paris and was disappointed that the chance to include Einstein as a supporter had passed. Russell was shocked, however, when he arrived at his hotel to find the signed letter waiting for him. Brown, *Keeper of the Nuclear Conscience*, 124.

forget the rest.” The statement included a call for a conference of scientists to analyze the perils of weapons of mass destruction and to discuss a solution to them.¹³⁷

The actual resolution to which the signatories agreed stated the following:

In view of the fact that in any future world war nuclear weapons will certainly be employed, and that such weapons threaten the continued existence of mankind, we urge the governments of the world to realize, and to acknowledge publicly, that their purpose cannot be furthered by a world war, and we urge them, consequently, to find peaceful means for the settlement of all matters of dispute between them.¹³⁸

All but two of the signatories had received Nobel prizes and included, besides Einstein, Rotblat and Russell, Max Born, Percy W. Bridgman (USA, Nobel Prize in Physics), Frédéric Joliot-Curie (France, Nobel prize in Chemistry), Linus Pauling (USA, Nobel Prize in Chemistry), Leopold Warsaw (Poland) and Hideki Yukawa (Japan, Nobel Prize in Physics). Russell referred to all of the signatories as being “exceedingly eminent in the scientific world.”¹³⁹ Although no Russian scientists were a part of the initial signatories, it is significant that Infeld from communist Poland and Joliot-Curie, who worked with the communist supported World Peace Council and World Federation of Scientific Workers, were included. The East-West divide would be further bridged once the actual Pugwash conferences began with scientists from all over the world, including the USA and USSR, meeting each other to openly discuss solutions to nuclear annihilation.

The first conference of scientists responding to the Manifesto’s call took place in July 1957 in Pugwash, Nova Scotia, Canada. It was a small group of 22, but the participants came from ten different countries, including the USSR, the USA, United Kingdom, France, China and Poland.¹⁴⁰ Pugwash organizers felt that ideological differences i.e. communism and anti-communism were at the heart of the threat of catastrophic war and went to special lengths to see that no bias would be exerted towards anyone based upon their country’s ideology. Accordingly, debates were to be conducted in the “scientific spirit” without devolving into propaganda for one side or another.¹⁴¹ Member scientists were to meet as individuals to speak freely regarding their views about the dangers of nuclear war and other issues threatening the global population. The work of the first conference was divided into committees, a pattern

¹³⁷ Sandra Bruno, “The Origins of the Russel-Einstein Manifesto,” History Series (Council of Pugwash Conferences on Science and World Affairs, May 2005), 5.

¹³⁸ Joseph Rotblat, *Scientists in the Quest for Peace; a History of the Pugwash Conferences* (Cambridge, Mass: MIT Press, 1972), 138–41.

¹³⁹ Bruno, “The Origins of the Russel-Einstein Manifesto,” 19.

¹⁴⁰ Joseph Rotblat, ed., *Scientists, the Arms Race, and Disarmament: A Unesco/Pugwash Symposium* (London: Taylor & Francis, 1982), 134.

¹⁴¹ Rotblat, 136.

which would continue in all future conferences, whose topics were: 1) hazards arising from the use of atomic energy in peace and war; 2) control of nuclear weapons; 3) the social responsibility of scientists. As the organization took form in subsequent years, it was decided that these types of closed meetings among scientists (the press was forbidden) would best facilitate the in-depth discussion of problems and solutions aimed at influencing decision-makers.¹⁴² The task of educating and organizing the public at large was best left to mass-movements such as the Campaign for Nuclear Disarmament. Pugwash scientists would meet annually for their main conferences and in smaller symposia throughout the year. All conference proceedings were kept private and only distributed to the fellow members.

The Pugwash movement represented a specific approach to how science and scientists could influence the world. It was quite effective in its aims to influence decision-makers in government, particularly of the super powers. For example, a top science adviser within the British Defense Ministry, Sir Solly Zuckerman, credited Pugwash with playing a key role in pushing government leaders to concluding the Partial Test Ban Treaty in 1963.¹⁴³ It was at a series of Pugwash meetings including American and Soviet scientists that technical solutions were put forth and discussed that would ultimately satisfy government parties and lead to the ban. Other successes to which Pugwash is given (partial) credit are the Non-Proliferation Treaty of 1970 and to the limited gains from the Strategic Arms Limitation Talks (SALT I & II) in the late 60's and 70's.¹⁴⁴

It is worth noting how Pugwash functioned in order to uncover the larger themes that are relevant to my analysis. Pugwash worked primarily as a forum for discussion among scientists from “enemy” countries, where they could speak as individuals concerned about the future of the world. Then, these same scientists could take their conclusions back to their respective governments, and, in this way, function as a communication channel between governments who were not speaking about these issues directly. From a theoretical point of view, these scientists functioned as “scientist diplomats,” navigating both the scientific and political worlds. Pugwash scientists’ views on the role of science in society can also be observed: on one hand they reflect the dominant belief that science is in a unique position to solve the problems of the day, and they believed that their status as respected scientists gave more authenticity to their anti-nuclear arguments; while on the other hand they very much

¹⁴² Rotblat, 135.

¹⁴³ Wittner, *The Struggle Against the Bomb: A History of the World Nuclear Disarmament Movement, 1954-1970*, 2:467.

¹⁴⁴ Rotblat, *Scientists, the Arms Race, and Disarmament*, 140–42.

believe that scientists must take responsibility for the consequences of their work and can no longer leave it to someone else to decide its application.

4.2 Hannes Alfvén and Pugwash

The story on Hannes Alfvén's involvement with Pugwash begins with the establishment of the Swedish national group. The first official meeting of Swedish scientists to discuss the formation of this group occurred on March 2, 1964.¹⁴⁵ Alfvén was not present at this meeting, but he was included on the original list of invitees. Initial discussion around the formation of the group included a note that there was strong interest from the international Pugwash movement to have a Swedish group due to the country's neutral political status.¹⁴⁶ The group's main activity in the beginning was to prepare arrangements for the 17th annual Pugwash conference in 1967, which was to be held in Ronneby. A few years after this conference, the group initiated some of its own projects including researching the global and long-term supply of energy, alternative methods of measuring development, and pollution of the Baltic Sea as a source of international conflict. Internationally, Alfvén attended nearly every annual Pugwash conference between 1964-1974, and he was the president of the international organization between 1971-1974.¹⁴⁷ In Pugwash, he is surrounded by several other scientists who held a view of 'techno-science idealism,' in Mitcham's terms. He attended his first Pugwash conference in the same year that the Swedish group was formed, 1964, which was held in Karlovy Vary, Czechoslovakia (now Czech Republic).

4.2.1 Planting of the seed: Alfvén's early years in Pugwash

While Alfvén did not give any presentations during his first conference, he did participate in a working group entitled, "Aims and Methods for Peaceful Collaboration among Nations," and a summary of the group's discussions are provided in a report in the conference proceedings. Although I cannot provide any specific quotes from him in the report, I believe that there is value in a brief look at its contents because, at a minimum, it serves as an introduction to the intellectual environment in which Alfvén was beginning to operate. The group was tasked with addressing issues within two main subject areas: the role of science and scientists in advancing the cause of peace; and, the long-term consequences of disarmament in the

¹⁴⁵ Bilaga 3 to protokoll för forskningsberedning working group 9/4 1964, A 2:1, 1962 Års forskningsberedning, RA.

¹⁴⁶ Protokoll för forskningsberedning working group 9/4 1964, A 2:1, 1962 Års forskningsberedning, RA.

¹⁴⁷ "List of Pugwash Meetings, 1957-2007," *Pugwash Newsletter* 44, no. 2 (October 2007): 26–155.

development of science and technology. In addressing the first issue, the report states, “scientists have personal and professional responsibility...to finding ways towards disarmament,” particularly given their intimate knowledge of the destructiveness of existing and developing weapons and the scientific issues involved. Further, “The increasing role and importance of science in a contemporary society inevitably results in a growing influence and responsibility of scientists in the economic, cultural and political developments of nations.”¹⁴⁸

To address the second question, the group offers a few short comments, including a call to support fundamental (basic) research and “not to see the function of basic research too narrowly and to restrict it unduly in the desire to secure early economic returns, a tendency which is observed.”¹⁴⁹ These ideas would have resonated with Alfvén who already had been criticizing the short-sighted nature of research planning in Sweden; however, the idea of advancing the cause of peace and disarmament is not something Alfvén had advocated for at this point, at least not publicly. In fact, Sweden’s atomic program at this point still included the possibility of pursuing an atomic bomb, something Alfvén has not objected to, yet.

Alfvén attended the following year’s conference in Venice, and he skipped the 1966 conference. Beginning with the 1967 conference in Ronneby entitled, “Scientists and World Affairs,” held between 3-8 September, his activity within the group increases, which provides the basis for a wealth of material to analyze regarding his evolving views on the role of science. Alfvén prepared a speech for the conference where he covers the functions of experts, the role of science in society and the relationship between science and the state. Although it is not reflected in the official conference proceedings, there is copy of the speech in the archives dated 15 June 1967 that is entitled, “Professional and Amateur Politicians.” In this prepared speech, Alfvén suggested a role for science (and scientists) in creating a habitable world for all, while at the same time derided politicians for their (inherent) inability to solve the world’s most pressing problems.¹⁵⁰ The title refers to the fact that a scientist who is concerned about how their results will be used by governments must involve themselves in political issues, and, in these cases, they are amateurs in the political arena compared to the professional politicians. Further, Alfvén explained that scientists make contributions to

¹⁴⁸ Pugwash Conference on Science and World Affairs, *Disarmament and Peaceful Collaboration among Nations: Proceedings of the Thirteenth Pugwash Conference on Science and World Affairs, Karlovy Vary, Czechoslovakia, September 13-19, 1964* (London: Pugwash Cont. Comm., 1964), 45–46.

¹⁴⁹ Pugwash Conference on Science and World Affairs, 54.

¹⁵⁰ Referring to rhetorical practices of politicians, he says, “If the peace problem could be solved by eloquence and by moral maxims, it would have been solved many thousand years ago.” Hannes Alfvén, “Professional and Amateur Politicians,” in *Hannes Alfvén: Politiska och etiska inlägg 1967-1986*, ed. Hannes Alfvén and Thomas Carlsson (Stockholm: Pilgrim Press, 2002), 2.

solving political problems “when acting as experts,” but they must use their knowledge appropriately. He suggested that instead of scientific experts only coming to the aid of governments when requested, they should seek to “speak also without being asked by the politicians and produce plans for the solutions of problems.” These comments reflect perhaps a recognition that it was not possible to keep the worlds of politics and science separate, as he did previously. He acknowledged that scientists were directly involved in policy making processes when giving expert advice, going as far as to describe scientists as ‘amateur politicians.’ Here, we can see the beginnings of a shift in what Pielke describes as a Pure Scientist or Science Arbiter to an Issue Advocate.

Alfvén’s recommendations in the speech to scientists did not stop there, however. The problem with only changing how scientists function as experts is that it only makes improvements within the existing world order, rather than changing that order fundamentally, which may be required. Revealing his strong belief regarding the role of science in society, he envisioned a larger function for science, which would diagnose the root causes to the world’s great problems and solve them through scientific means; because “as scientists we must question everything, including the fundamental rules of handling the great international problems.” He stated that current developments in science and technology were sufficient to provide every human being with a decent standard of living (providing that population is controlled, which science and technology could also accomplish). The problem lied with politicians, not because they were stupid or even exceptionally immoral, but because their training made them “not very well suited” for solving the problems of the world. In short, he argued that politicians were more interested in obtaining and maintaining power over all other considerations. Alfvén exclaimed that, “The properties which are necessary in order to become a political leader do not at all guarantee that the man in question has any ability to organize the world for the whole of mankind.”¹⁵¹ In his views, famine and inequality persisted because resources were considered instruments of money and power, which politicians sought to maintain above all. These comments reveal his changing attitude about the relationship between science and the state: the state could no longer be trusted to advance the causes of science, which were, in turn, the causes of developing society. Because society’s problems could be solved through scientific inquiry, while those in power were more interested in getting and holding power, there was a fundamental defect in the process for advancing society.

¹⁵¹ Alfvén, 5.

Following that logic, Alfvén suggested that, perhaps, another group should seek to lead the way. Scientists, for example, were by default more honest than politicians because if they made a mistake or cheated in their work i.e. by falsifying results, then their careers would be ruined, which was not the case for politicians. Also, the scientific project already operated successfully on an international level while politicians were a “relic of the time of the national states.” Should scientists rule the world, he asked. Probably not, as they were not skilled in the art of sophistry. They should focus on their roles as experts. “I do not think that scientists should look for power but for influence. It is as advisors to the executives that they are of importance.”¹⁵² It was not enough, however, to merely advise their governments to be more moral, he said. Scientists needed to dedicate their efforts in systematic and technological ways to address the great international problems like world hunger and security against war. They should not, however, limit themselves to the restraints offered by the current political and economic systems because “it is more important to solve these problems than to preserve a certain system.”¹⁵³ This statement elucidates his idealism for the world and the place for science within it. Science could solve the biggest challenges facing humanity, and he believed that these solutions could even lead the way to a new political and social order, if that was what is required for their realization.

During the Ronneby conference, Alfvén participated in a working group entitled, “The Special Responsibility of Scientists” along with Tiselius and Joseph Rotblat. The report from the group offers many insights into relevant topics of this thesis with sections specifically on the role of scientists in advising governments and in influencing public opinion. In a section entitled, “Ethical Problems” the report stated that scientists should “accept a collective responsibility for what they do” and “generally should be more ‘socially accountable’” for the consequences of their acts, both in the immediate and by anticipating the effects and potential applications of their discoveries. It continued, interestingly, with this:

To carry out these tasks, it was believed that closer communication between politicians and scientists needed to be developed. Attention was drawn, however, to a possible danger as scientists become more active politically. While on the one hand...they are too often merely used and are...mercenaries; on the other hand, they might, conceivably in the future...become a technical elite, divorced from society...”¹⁵⁴

¹⁵² Alfvén, 8.

¹⁵³ Alfvén, 10.

¹⁵⁴ Pugwash Conference on Science and World Affairs, *Scientists and World Affairs: Proceedings of the Seventeenth Pugwash Conference on Science and World Affairs, Ronneby, Sweden, September 3-8, 1967* (London: Pugwash Cont. Comm., 1967), 66.

While this passage comes from a general report of the working group, it reads as if Alfvén himself could have written it. The dynamics discussed here between politicians and scientists are similar to those raised by Alfvén during his criticisms of the Marviken project, when he accused the non-critical scientists of this project of being paid mouthpieces for the government.

The timing and location of these statements at the 1967 Ronneby conference are extremely notable, as it was only six months since Alfvén announced his departure from Sweden. Now, in a speech to be delivered in Sweden, he conveyed a strong condemnation of politicians' general motives and abilities to solve the largest problems facing humanity. He spoke directly regarding the role of experts in advising governments and suggested they must do more than simply respond to questions when asked, thus encouraging scientists to be more directly involved in making policy. The working group report in which he participated included a warning about being "mercenary" scientist who merely advocated for the government line. Finally, he presented a much larger role for science, that of diagnosing and solving the world's greatest challenges, even if that means a different social, political and economic order.

After the Pugwash conference in Ronneby, Alfvén did not attend any international Pugwash meetings until 1970, when a conference was held in Fontana, California, only a two-hour drive from his new (part-time) home in San Diego. In a letter dated May 28, 1970 to Pugwash Continuing Committee member M.D. Millionshchikov, who was also the head of the Soviet Pugwash delegation, Alfvén mentioned that he hesitated to collaborate with the USA Pugwash group due to "internal conditions in Sweden." However, after discussing the matter with the Swedish Pugwash group, he decided "that there are no serious difficulties." He continued, "[i]n case the Pugwash movement should decide to follow the plans you indicate I shall be glad to accept the position you suggested, provided that in this way I can be useful to the movement."¹⁵⁵ Alfvén was named president of Pugwash shortly thereafter, in 1971, succeeding Eugene Rabinowitch, and the movement started to occupy an even larger part of his activities. Between 1971 and 1975, Alfvén attended 10 Pugwash conferences and smaller "symposia" with titles/topics such as: "Social Aspects of Technological Change;" "Problems of World Security, Environment and Development;" "Scientists and World Affairs;" and "Public Opinion and European Cooperation."¹⁵⁶ As President, Alfvén presided

¹⁵⁵ Letter Hannes Alfvén to M.D. Millionshchikov 28/5 1970, Box 19 Folder 27, Hannes Alfvén Papers, Mandeville Special Collections Library UCSD.

¹⁵⁶ "List of Pugwash Meetings, 1957-2007."

over each of the annual, international conferences, and the proceedings of these are rich in material for which to analyze his views on the relationship between science and society.

Alfvén's activities as Pugwash president went beyond organizing and attending conferences. Over the next several years, he also gave public talks and press interviews touting the organization. One such talk was given to the Akademiska Förening in Lund on 14 May 1971, which was entitled, "Vetenskap och politik." The talk is insightful into his views on the role of science in society, as well as the relationship between science and the state. His main point in that talk was that science must be used to make fundamental changes to society's basic values (*grundvärderingar*), as it had during other periods in history. Alfvén recounted the history of scientific advancement, beginning with Tycho Brahe and the birth of natural science, pointing out that in all major periods of change i.e. the Renaissance or the Enlightenment, scientists challenged the existing world view of the time. He identified the main causes of the changing relationship between science and the state as WWI, with the use of poisonous gas weaponry, and WWII and the use of atomic bombs, as politicians, economists, and military leaders all discovered a new source of power. Reflecting on the relationship which prevailed at the time, he suggested that scientific initiative was in the hands of politicians and industry, and research had become a commodity that could be ordered on demand. Moreover, he claimed that a large and powerful group of "forskningspolitiker" existed at the time who determined what should be researched and how it should be applied along with what scientists could and could not think. In his characteristic wit, Alfvén said of Tycho Brahe, "Vi måste allvarligt klandra mannen på Ven, för att han byggde sitt observatorium utan att först göra en marknadsundersökning—snarare riktade den sig mot de bestående samhällsdoktrinerna." And in reference to his own "exile" from Sweden, he continued, "Det måste således anses fullkomligt riktigt att det kungliga forskningsanslaget drogs in och att han förpassades ur riket."¹⁵⁷ He concluded the story remarkably by comparing the politicians of the day to the Catholic Church during the Inquisition and suggested that they reevaluate their thinking if they did not want to make the same mistakes. In addition to demonstrating his sharp wit, these conclusions reflect, once again, his lost trust in politicians and the state to handle scientific affairs. Further, he implied the necessity for a re-evaluation of the relationship between science, society and the state, as politicians were more concerned

¹⁵⁷ Hannes Alfvén, "Vetenskap Och Politik," in *Hannes Alfvén: Politiska Och Etiska Inlägg 1967-1986*, ed. Hannes Alfvén and Thomas Carlsson (Stockholm: Pilgrim Press, 2002), 2–3.

about their own power or survival, which impacted the ability of science to contribute positively to the state of the world.

Following this narrative, Alfvén made the point that just as the revelations of Brahe and Galileo challenged the dominant world view of their time, so must science lead the way for a new set of “basic values.” Those basic values that must be challenged included the desire for constant growth as championed by the economists, the political approach which saw the competition for resources and power as a “zero sum game,” and the narrow focus upon one’s own nation or group, rather than seeing humanity’s connection to the environment and the planet’s place in the cosmos. He noted that this work was partly sociological but that it must go deeper as the sociologist often took the basic values as “self-evident.” Thus, the onus fell once again on science to play the role that it had played throughout history. The first step was to convince scientists of their responsibility for international scientific development and the political consequences of their work, as was the aim of Pugwash. These comments show a change in his beliefs in how scientific knowledge should be produced with a new focus on the responsibility of scientists for the applications of their work. Advocating for scientists to take responsibility for their discoveries was a contradiction of the widely held view at the time regarding the flow of scientific knowledge, or in other words, the linear model. Alfvén’s comments reflect, once again, his growing shift from acting as a Pure Scientist to an Issue Advocate. This lecture is also a good example of his “techno-science idealism,” as he expected science to be used in the service of creating a better world for all. Alfvén expanded upon these views during his time as Pugwash president, which I will now review.

4.2.2 The Presidential Years

Hannes Alfvén gave his first presidential address to the 21st Pugwash conference held in Sinaia, Romania between August 26-31, 1971. The address reveals a good deal regarding his thinking regarding the roles of scientists, specifically as experts, in society. Additionally, it serves as an encounter between Alfvén and his fellow scientists that can be analyzed for its performance. It may be useful to remember that while many scientists who attended Pugwash conferences were largely in agreement on the broad goal of nuclear disarmament, it was not true that all were so committed to this over, for example, national interest. Thus, there was room to convert them to the cause and return to their governments with a different point of view. Further, they did not all agree on the methods or the related issues such as nuclear energy. Last, Pugwash was undergoing an internal debate over the direction of the

organization around this time. So, in his presidential address, Alfvén hoped to persuade those in the audience of his point of view on this as well.

Alfvén opened his remarks by focusing on nuclear warfare, presenting an apocalyptic picture regarding the state of atomic weapons. He referenced a report from fellow Pugwash member Bernard Feld, a physicist who worked on the first atomic bomb, which concluded that nuclear war would kill “everybody of us now,” and this was inevitable on the current course. Thus, Alfvén argued, nuclear armaments needed to remain the focus for Pugwash. When discussing the peaceful use of atomic energy, however, he struck a much more balanced tone. Here, he recommended two further essays, which he said, together, provided an equitable view of the issue, as claims from both pro- and anti- nuclear energy advocates were exaggerated. As a concession to the pro-nuclear side, he even said, “one cannot help but admire all the precautions that the atomic energy people have made in order to prevent possible harm from...radioactive materials,” but, he added, “it seems far from certain that they...will ever succeed.”¹⁵⁸ Again, these comments are notable due to their softness, as Alfvén had been more critical of nuclear energy in other statements. On the one hand, this could be in deference to his audience, which consisted of scientists who were still supportive of or undecided about nuclear energy, and Alfvén might not have wanted to offend them if he was going to attempt to broaden their views on its dangers. On the other hand, he was also officially undecided fully on the issue of nuclear energy at this time, and, he was waiting for the science to provide the answer as to its safe usage (or lack thereof). Bringing together the issues of atomic weapons and atomic energy, he continued that the reactor industry claimed their uranium-plutonium nucleus could be separated from “its militant twin brother,” but that was being questioned.¹⁵⁹ Ultimately, he exhorted that it was the duty of Pugwash to discuss whether development of nuclear energy could really lead humanity to a state that was tolerable and suggested that perhaps all fissionable material needed to be done away with.

Alfvén also directly addressed the role of experts in the speech and even commented on the way scientific knowledge was produced, both of which “depend on the relations between science and society.” He held that in society, broadly speaking, scientists played the role of problem-solvers.” In a bit of sarcasm he noted that scientists built bigger and better bombs and then figured out how to provide protection from the bombs of others. And,

¹⁵⁸ Pugwash Conference on Science and World Affairs, *Problems of World Security, Environment, and Development : Proceedings of the Twenty-First Pugwash Conference on Science and World Affairs, Sinaia, Romania, August 26th - 31st, 1971* (London: Pugwash Cont. Comm., 1971), 71.

¹⁵⁹ The fission process used in nuclear plants results in the production of plutonium as a byproduct, which can then be used for making a bomb. This would increasingly become an argument for the anti-nuclear energy camp.

scientists made products that gave profits to companies and then provided protections from the pollutions that these products caused. More specifically, “scientists do their best to clarify the questions they get and leave the results of their investigations to their bosses.” The bosses, who could be industrial or governmental, took out of the reports what was beneficial to them and ignored the rest. In many cases, he noted, that what was good for the boss/organization was also good for humanity as a whole, so in these cases, “science is contributing to the progress of mankind.” Here, he summarized the basic linear model, which he supported adamantly for most of his career, as seen in the section covering 1945-1967.¹⁶⁰

He described other cases, however, where what was good for the organization was harmful to humanity as a whole as with pollution or nuclear weapons. In these cases, the scientist had a moral duty to protest the usage of his knowledge in such a way, although Alfvén noted that this was not always allowed. Once again, these passages reflect a change in Alfvén’s own approach to science during his time as a government expert in Sweden. Rather than leaving the application of one’s discoveries to someone else, he suggested that the scientist be involved in this as well. Further, the scientist should openly protest applications which are harmful. Although Alfvén and his fellow Pugwash scientists are not alone within the profession in advocating for a socially responsible science, speaking up in the way Alfvén described here was not consistent with the identity of an objective, politically disinterested scientist who gave their unbiased knowledge to others for its application.

Another revealing text by Alfvén at this time shows his awareness of the concern about the role of experts in a democracy. He released a paper in 1972 that focused this relationship entitled, in Swedish as “Vetenskap och Samhälle” and in English as, “Science, Technocracy and the Politico-Economic Power.”¹⁶¹ Here, he addressed the rising concern in the public sphere about the power of scientific experts, or technocrats, who some were beginning to see as a threat to the democratic process, as they were tasked with making decisions on issues that were considered too advanced for the general public to understand. He noted that an increasing technologically complex society required the input of experts in the democratic process, but he disagreed that these ‘technocrats’ were the real power brokers. He drew on his own experience in Sweden’s nuclear project to argue that power did not, in fact, lie with the scientists. First, he noted that the “exploitation of new scientific and

¹⁶⁰ Pugwash Conference on Science and World Affairs, *Problems of World Security, Environment, and Development : Proceedings of the Twenty-First Pugwash Conference on Science and World Affairs, Sinaia, Romania, August 26th - 31st, 1971*, 72–74.

¹⁶¹ Alfvén, “Science, Technocracy and the Politico-Economic Power.”

technical ideas” was controlled by the boards of the various companies, either private or state owned. Decisions were taken for economic, militaristic and political reasons above all else. Politicians often failed in their duties to represent the public, and the public themselves were often deceived by very slick propaganda from industry and government when it came to deciding on complex, technical issues. It was these decision makers who were the real threat to democracy, not the scientists who worked on their behest. Here, Alfvén introduced a new ‘character’ to the drama, those with vested interests in industry and government who acted for reasons other than the common good. This was an accusation that he repeated often in the Swedish nuclear debates, which I cover separately in the next section.

Alfvén’s second annual conference as president was the 22nd Pugwash Conference for Science and World Affairs, held in Oxford, England between September 7-12, 1972. Part of the agenda was to decide on the main activities for the organization over the next five years. After the six days of meetings, the group decided that they would continue to meet in order to discuss those problems of world affairs “to which scientific study and analysis may be expected to contribute constructively.”¹⁶² The ultimate goal of the organization continued to be the establishment of a lasting world peace based upon principles of justice, and the activities of the group fell under three main categories: influencing governments, which would remain the top priority; pinpointing within the scientific community the consequences, good or bad, of new discoveries and their applications; and to inform the general public, when possible, about the solutions provided by science to world problems.

As President, Hannes Alfvén offered his own vision of Pugwash’s next five years during his speech on the first day of the conference. As in the previous year, he began by discussing the madness of the nuclear arms race with both superpowers possessing far more weapons than necessary to completely destroy each other, yet they still built more. He pointed out the faulty logic of more weapons equaling more security, while at the same time placing a lot of blame on the military industrial complex. He argued that these actors drove the arms race for profit, but “not because they are evil, but ignorant; not corrupt but parochial in their interests.” He asserted further that the arms race was as much a conspiracy as it was an enormous machinery set into motion during WWII and the Cold War that now suffered from

¹⁶² Pugwash Conference on Science and World Affairs, *Scientists and World Affairs : Proceedings of the Twenty-Second Pugwash Conference on Science and World Affairs, Oxford, England, September 7th - 12th, 1972* (London: Pugwash Cont. Comm., 1972), 29.

extreme inertia. As such, laboratories continued to manufacture new weapons, not out of need, but out of tradition and to continue to justify their existence.¹⁶³

Alfvén then went on to discuss the question of atomic energy. Here, he was a little firmer than in the previous year that it would be impossible to safely produce electricity on a global scale by means of fission energy without opening the door for producing bombs with the leftover plutonium. He summarized the sides of the energy debate as being between two camps: the pro-nuclear advocates, backed up by “very powerful economic interests” and governments, who said that nuclear energy is needed to meet the demand; and the anti-nuclear side, supported by ecologists and an “increasingly alarmed public,” who claimed atomic energy was not needed nor a suitable answer. Setting aside the plutonium byproduct, Alfvén conceded that it might be possible to create a safe nuclear energy, but it had not happened, yet, and, more importantly, objections were not taken seriously by government representatives or their scientists. Alfvén asserted that governments and the nuclear industry regularly shut down debates on the issue and harassed scientists that raise objections. He suggested that if only a small amount of the money put towards fission energy were allocated to alternative sources, then the energy problem could be solved. In that speech, Alfvén was less patient with the pro-nuclear side than in the one from the previous year. He did not attack their science; however, he associated everyone on that side with repression and suggested they might have had motives that were beyond simply providing a solution to the need for energy.

He stressed this accusation further by stating that the prevailing view at the time of the world’s energy needs as presented by governments obscured the real picture, as these governments and other vested interests sidetracked the conversation to their own ends. “Power and power are brothers,” he noted incisively. He asked, however, what would a “purely scientific-technological solution” that was de-politicized and de-commercialized look like? Admitting that this would be a utopian vision, he suggested it was still worth pursuing, because if such a solution were put forward by “scientists and technologists with established integrity and competence,” then it could have an impact. This statement is interesting for a couple of reasons. First, it can be considered an example of his ‘techno-science idealism,’ as he once again believes in the ability of science to create a significantly better world. Second, it displays an awareness by Alfvén regarding the importance of the public perception of scientists as credible and trustworthy, thus it is important that this image be constructed, maintained and reproduced. As examples of other science and technology fields that operated

¹⁶³ Pugwash Conference on Science and World Affairs, 184.

generally outside the realm of politics, he lists international postal delivery, telephone and telegraph exchange and the assignment of radio frequencies and argued that energy production and distribution could be organized into a similar arrangement. Alfvén was arguing for a new relationship between science, the state and society, and he his ideal view of this relationship did not include the interference of national governments.

After the 22nd conference in Oxford, Alfvén continued to oversee the next two meetings as president in 1973 and 1974. His presidential address to the 23rd conference was rather short, ending with the hope that Pugwash could bring “unbiased scientific clarity into the thinking that is now going on” regarding the world’s problems.¹⁶⁴ This statement is telling in that reveals his continued belief in objective science despite his own experiences with the contested science around the dangers of nuclear energy. Further, it shows a conviction that political problems could be more easily solved with the “clarity” of scientific information, reflecting again his belief in pure science to provide the information needed to make the best political choice. I interpret this as demonstrating, again, his reluctance to have scientists behave as political actors, as he wanted to keep science above the pettiness of politics, but this view became increasingly harder to maintain.

More illuminating into his views on role of science in society are contained in his presidential address at the 24th conference, held in Baden, Austria in August 1974. The first section of the speech, in its written form, is entitled 'The end of an epoch.' Referring again to the popular means of measuring the state of human affairs in numbers such as population, GNP, and energy consumption, Alfvén suggested that advances in science and technology have reduced the 'doubling' time of such numbers by one magnitude. Meaning that, for example, what used to take centuries now takes only a decade. Such growth has typically been considered positive, but he insisted that science must be used to change the view of these “basic values” of measuring progress. "We are now entering a new phase in the evolution of mankind," he continued, which is one where this runaway increase cannot be sustained, and, in order to reach "a new state in the evolution," growth must be managed into a slow and stable pace. In a remarkable statement, he characterized this transition to a slower pace as the

¹⁶⁴ Pugwash Conference on Science and World Affairs, *European Security, Disarmament and Other Problems: Proceedings of the Twenty-Third Pugwash Conference on Science and World Affairs, Aulanko, Finland, 30th August - 4th September, 1973* (London: Pugwash Cont. Comm., 1974), 83.

"main scientific-technical-economic-political problem" of his time.¹⁶⁵ He said that governments seemed clueless on these matters while the environmentalists seemed to understand.¹⁶⁶

Alfvén was now ready more than in any previous speech to call for an end to the pursuit of fission energy. Addressing the issue of nuclear reactors and the environment, he referred to a number of scientific articles which appeared in the *Bulletin of Atomic Scientists* and *Science* written by competent scientists who made serious objections to nuclear energy. He then quoted two official statements from the previous Pugwash conference questioning the wisdom of developing widespread nuclear energy programs globally. Of these statements, he noted, "...this discussion shows how well the Pugwash way of discussing problems works. Although several of the participants were affiliated with atomic energy establishments, which under other conditions would have made it difficult for them to accept conclusions critical of these establishments, their role in Pugwash as independent scientists made the discussion purely scientific without damaging influence of the affiliations."¹⁶⁷ By referring to the works of fellow scientists, he appealed to his scientific audience in the language of science to persuade them to his anti-nuclear energy point of view.

Next, he argued that the opposition to nuclear energy had "avalanched" and provided three national contexts where this opposition expressed itself with some success. In the USA, he identified a number of concerned scientists as well as consumer advocate Ralph Nader, who had started a nation-wide campaign against nuclear energy. In the UK, the government had reduced its nuclear program by two-thirds due in part to the influence of environmentalists. And, in Sweden, he highlighted that the government program to build 25 reactors was defeated in Parliament, which only authorized the 10 that were already under construction.¹⁶⁸ He noted that nuclear energy was one of the major political issues in Sweden, with "Labour and Conservatives for nuclear energy, and the Center (main opposition party) and the Communists against it."

¹⁶⁵ Pugwash Conference on Science and World Affairs, *Disarmament, Energy Problems and International Collaboration: Proceedings of the Twenty-Fourth Pugwash Conference on Science and World Affairs, Baden, Austria, 28th August - 2nd September 1974* (London: Pugwash Cont. Comm., 1974), 79.

¹⁶⁶ The emerging international environmental movements were key actors in the campaigns against nuclear energy, focusing on the potential environmental damage caused by nuclear waste and radiation.

¹⁶⁷ Pugwash Conference on Science and World Affairs, *Disarmament, Energy Problems and International Collaboration: Proceedings of the Twenty-Fourth Pugwash Conference on Science and World Affairs, Baden, Austria, 28th August - 2nd September 1974*, 81–82.

¹⁶⁸ This is not entirely accurate. It was 11 reactors out of a possible 24 that were allowed to continue production/development after a vote in the Swedish Parliament in May 1973. This is discussed in detail in the following section.

Alfvén reached the crescendo of his speech when he returned to his argument regarding the relationship between the peaceful atom and its "militant twin brother," or in other words, the possibility to manufacture a bomb from the leftover plutonium from an atomic reactor. By that point, he insisted that it was impossible to separate the two, thus by increasing the number of reactors around the world, the number of states and other rogue actors would have the ability to make nuclear bombs. The next war, he dramatized, might only take a matter of hours or minutes to reach the "complete genocide which took years for Hitler." Further, Europe was currently the home to 10,000 nuclear bombs, enough to destroy 10,000 European cities, "if there were so many." Because politicians of the world had "so clearly demonstrated their incompetence to handle the most important problems of the world, a popular movement...seems the only new factor which has a fair chance of stopping the flood of fissionable material." He hoped the environmentalists, who were raising the concerns of nuclear energy, would soon realize that the threat from nuclear bombs was even more serious and would focus more of their efforts against this threat. Knowing that his audience was comprised of representatives of the USA and USSR, the two countries which posed the greatest threat of starting a nuclear war, he ended his speech with the following bold claim: "The decisive conflict of today is not between capitalists and communists, not between rich and poor, but between the mass producers of plutonium and us who merely wish to survive."¹⁶⁹ With these comments, Alfvén showed he was now a completely against the production of fission energy, and he cemented his role as an anti-nuclear scientist.¹⁷⁰

After the 24th conference Alfvén stopped his intensive activities within Pugwash. He only attended one smaller symposium in 1975 and then one more annual conference in 1984, which was held in Sweden. Nevertheless, his time in the organization played a decisive role in shaping his outlook on, among other subjects, the responsibility of scientists. The analysis of his speeches and writings during his time in Pugwash reveals his views on three important themes relevant to my thesis: the role of experts; the role of science in society; and the relationship between science and the state.

To summarize, Alfvén demonstrates a vastly new approach from the previous period to the role of science in society and the participation of experts in it. His years working in Pugwash have had a transformative effect on his outlook. While still ardent supporter of

¹⁶⁹ Pugwash Conference on Science and World Affairs, *Disarmament, Energy Problems and International Collaboration: Proceedings of the Twenty-Fourth Pugwash Conference on Science and World Affairs, Baden, Austria, 28th August - 2nd September 1974*, 85.

¹⁷⁰ These comments are also interesting given their location in Austria, which was about to embark on the construction of its first nuclear reactor, only to be stopped within a few years by a national referendum.

basic research, he abandoned the traditional approach, known today as the linear model, with regards to the application of new discoveries and implored scientists to be openly involved in the application of new science. He also believed expert scientists should no longer merely wait to be asked by decision-makers for their advice on specific questions, but they should engage themselves with finding scientific solutions to the world's greatest problems along with challenging the dominant world view of the growth paradigm. He also lambasted politicians for inhibiting the proper use of science in order to maintain their power and influence at the expense of the greater good. Using the theoretical models of this thesis, we can say he now performs as an Issue Advocate. The significance of this new outlook on the role of science and experts should not be missed. Alfvén was at that point calling for scientists to actively engage with decision makers on one side of a political debate, at time when a core tenet of scientific practice was that it should be neutral, objective and above political matters. This new outlook alone, however, is not enough to explain Alfvén's actions. His idealism also caused him to often go further and higher in advocating for the anti-nuclear position. He had an extraordinary belief in the power of science, and he had high expectations for the type of world that can be achieved through it. In the next section, I illustrate how Alfvén put these views to work in the Swedish nuclear debate as he performed his new role as an Issue Advocate, targeting his message to both the general public and, more importantly, advising an opposition political party on energy issues.

4.3. The Expert Returns: Alfvén and the Nuclear Debate in Sweden

For much of the same time that Alfvén was actively engaged with Pugwash movement, he was also participating in the nuclear debate in Sweden (and the USA). The nuclear debate in Sweden ignited in the early 1970s and can largely be placed within the wider international debate on nuclear energy occurring at the time in which the dangers of radiation, the storage of nuclear waste and the possibility of a catastrophic meltdown were increasingly being raised. Hannes Alfvén often complained that Swedish politicians were ignoring the concerns being raised by scientists in the USA, and he is often credited with bringing these arguments to the shores of Sweden from the US. Opposition to nuclear energy in Sweden is also considered as part of the larger environmental movements that were growing around the world, which had added nuclear energy to their list of concerns. This movement, as it concerned nuclear energy, took its own shape in Sweden which combined ecological concern with a strong moral argument about the state of the world that was being left behind for future

generations to deal with, particularly with respect to nuclear waste.¹⁷¹ This emphasis on morality would be important, as it opened the door for a more general participation in the debate by the public rather than leaving it to the technical experts.

The first published criticisms of Sweden's nuclear project appeared in the late 1960s primarily in *Dagens Nyheter*, and the debate saw its first full exchange between pro- and anti-sides in 1970.¹⁷² Anshelm identifies the early 1970s as “the critical questioning (*det kritiska ifrågasättandets*)” phase where the issues that would shape the debate are founded. He observes, “The previously united nuclear power discourse splits now, and an influential and well-organized counter discourse is established.”¹⁷³ The opposition would come to reinterpret technology’s cultural, environmental, social and political meaning, and the pro-nuclear interests were forced to re-strategize to meet these criticisms. Furthermore, the nuclear lobby lost their claim to a utopian future powered by nuclear energy, where it supplied a clean and limitless source of power, and this vision was replaced by an alternative utopian picture provided by the opposition.

And, although opposition to nuclear energy existed in Sweden during the 50s and 60s, these efforts were largely local, as it related to the proposed locations of nuclear reactors. It was not until the 70s, with the growth of the environmental movement, that the opposition becomes national. The debate in Sweden for much of the 70s focused on the issues concerned with nuclear waste, as it was considered irresponsible by many to produce a dangerous radioactive substance that would have to be safely stored for hundreds or even thousands of years. With the meltdown at Three Mile Island in the USA in 1979,¹⁷⁴ concerns about a catastrophic nuclear reactor event were added, which ultimately made a nuclear referendum in Sweden possible.¹⁷⁵ Last, these debates highlighted two larger social/political concerns that emerged during this time: the domination of experts and politicians in decision making, which left out the general public in a democracy and the questioning of the dominant growth

¹⁷¹ Jasper, *Nuclear Politics*, 129.

¹⁷² Anshelm, *Mellan frälsning och domedag*, 106–10.

¹⁷³ ”Den tidigare så sammanhållna kärnkraftsdiskursen splittrades nu och in inflytelserik och välorganiserad motdiskurs etablerades.” In Anshelm, 114–15.

¹⁷⁴ The Three Mile Island Nuclear Generating Station in Harrisburg, Pennsylvania experienced an accident on March 28, 1979 which was rated a five on the seven-point International Nuclear Event Scale: accident with wider consequences. Described as ‘a partial meltdown’ the accident resulted in the release of radioactive gases into the environment, increasing worries among anti-nuclear activists and the general public. According to J. Samuel Walker (2004), the Three Mile Island accident was “the single most important event in the fifty-year history of nuclear power regulation in the United States.” Samuel J. Walker, *Three Mile Island: A Nuclear Crisis in Historical Perspective* (Berkeley: University of California Press, 2004) pp. ix-x.

¹⁷⁵ Schagerholm, “För het att hantera: Kärnkraftfrågan i svensk politik 1945–1980,” 102.

paradigm, which Alfvén addressed in many of his remarks as illustrated in the section on Pugwash.

Consistent with the priorities set by the 22nd Pugwash Conference, influencing governments and informing the general public, Alfvén involved himself in the nuclear debate in Sweden in the 1970s through expert advising to an opposition political party and public debating in the press and other publications. In what follows, I analyze some of the material relevant to this history to demonstrate Hannes Alfvén's performance as an expert in this period, which is, once again, can summarized with the label of Issue Advocate as he directed his activities towards political leaders, despite his general mistrust of politicians, and directly to the public. Alfvén's activities during this period are also very well suited for examination through the lens of Hilgartner's "dramaturgical analysis" as Alfvén constructed and reproduced his expert authority to persuade his audiences, though now in the full service of the critical side in the debate. For sources, I mainly use archival material such as letters and speech copies as well as periodicals and biographical materials. Organizationally, I divide his performance here in two sections. The first shows Alfvén informing the public on the dangers of nuclear energy via the press and a popular science book he authored. The second section shows Alfvén as an unofficial advisor on nuclear issues to the leadership and members of the Center Party leading up to the 1976 elections.

4.3.1. An Expert to the People

Alfvén made one of his last direct attempts to persuade the sitting Social Democratic government to re-evaluate its energy program with a letter to the Minister of Industry, Kerstin Wickman, dated 27 August 1970. In his seven-page letter, Alfvén stated, "The aim with this writing is to point out that the conditions regarding the Swedish energy policy now seem to have changed."¹⁷⁶ He argued that: the discovery of new oil deposits had made the rush to atomic energy less acute; mass production of plutonium around the world was dangerous; and advances in plasma physics, Alfvén's own field, had made the realization of fusion energy probable in the near future. Further, he explained the safety and environmental benefits of fusion energy vs. fission, discussed other possible energy sources, and emphasized the relation between nuclear energy and nuclear bombs. In the end, he called for a change of direction in Sweden's energy project. Wickman responded to Alfvén largely dismissing his

¹⁷⁶ In Swedish: "Ändamålet med denna skrivelse är att påpeka att förutsättningarna för den svenska energipolitiken nu synes ha ändrats." Hannes Alfvén, 'Beträffande det svenska atomenergiprogrammet' 27/8/1970, F 2:1, Birgitta Hamraeus archive, RA.

concerns; however, the letter had an important effect on the public discourse about nuclear power. Jonas Anshelm, in *Mellan frälsning och domedag*, identifies this letter from Alfvén as a key early moment in the Swedish debate, which revealed Alfvén as a “svuren motsåndare” to fission energy. Anshelm notes:

Att en professor i fysik, därtill nobelpristagare, på detta sätt offentligt kunde ifrågasätta fissionsenergin i allmänhet och de svenska kärnkraftsprogrammet i synnerhet bidrog till att ge legitimitet åt en kärnkraftskritisk opinion i Sverige.¹⁷⁷

The letter to Wickman, and the support of a respected scientist who was knowledgeable of the issues, opened the door for a public debate in the pages of the Swedish press. Remarkably, Alfvén and his letter to Wickman were referred to so much in the contributions from the anti-nuclear side that they appear in nearly every other article in these publications during 1972.¹⁷⁸

In his analysis of the discourse of the anti-nuclear side, Anshelm further identifies six categories of critique: technical; security (*säkerhetspolitiska*); ecological; democratic; moral; and the call for a low energy society.¹⁷⁹ In addition, Jamison, et.al, in their history of the Swedish environmental movements, distinguish between opposition strategies that are “success oriented” and “value oriented,” with the success model focused on achieving political results and the value model seeking to change ideological and lifestyle habits of Sweden’s inhabitants.¹⁸⁰ While some critics from the anti-nuclear side confined their arguments to one or two of these areas, Alfvén’s public expressions at the time covered the criticisms in all six categories and across both strategies. That is, Alfvén did not confine himself to the technical critique, as might be expected, nor did he only focus on achieving political results (although I would argue these were more important to him.) As already seen from his work around the Pugwash conferences, Alfvén addressed issues such as questioning the pro-growth paradigm, called for a re-evaluation of the relationship between science and society, warned of the power of politicians and the threat to democracy, among other things. These themes appear across different articles by or about Alfvén in various publications in the Swedish press during the entire nuclear debate in the 70s and particularly during the build-up to the parliamentary election in 1976.¹⁸¹ Hannes Alfvén also appeared in several newspaper

¹⁷⁷ Anshelm, *Mellan frälsning och domedag*, 118.

¹⁷⁸ Ibid.

¹⁷⁹ Anshelm, *Mellan frälsning och domedag*, 120.

¹⁸⁰ Andrew Jamison, Ron Eyerman, and Jacqueline Cramer, *The Making of the New Environmental Consciousness: A Comparative Study of the Environmental Movements in Sweden, Denmark, and the Netherlands*, Environment, Politics, and Society Series, vol. 1 (Edinburgh: Edinburgh University Press, 1990), 145.

¹⁸¹ Anshelm, *Mellan frälsning och domedag*, 120–51.

articles/interviews in 1976 announcing that he was joining the Center party. "One must vote for the party whose politics lay closest to him,"¹⁸² said Alfvén in a newspaper article from 29 April 1976. He also said that he has returned to Sweden in the summer of 1976, in part, to campaign for the Center party.

Alfvén often repeated the same arguments against nuclear energy in his press appearances while varying them according to the context or whether it was in response to a specific argument from the pro-industry side. However, he gathered all of these arguments into one popular science book, *Kärnkraft och atombomber*, which was published in 1975. The book shows Alfvén performing with the general public as his audience and demonstrates his arguments that cover the six themes mentioned above.

In the introduction, Alfvén establishes himself as an expert, referring to the number of articles he has published on the relationship between science and politics. He also makes note of the "*adult education (vuxenundervisning)*" in research politics he received in two different periods of his life: one as a member of the Advisory Board for Science and the second as president of Pugwash. The book covers an explanation of what energy is, alternative energy sources, the dangers of nuclear fission, the relationship between science and society, the relationship between nuclear energy and nuclear bombs, and the burgeoning environmental movement. The book is short (88 pages) and written in simple language yet includes enough technical details to make the case with the help of diagrams and tables. It includes the history of nuclear energy and how its dangers became known in the scientific community around 1968/69.

In general, the book serves as a counter argument to what he calls the "propaganda" from the "nuclear establishment (*kärnkraftsetablissemanget*)."¹⁸³ Countering some of these arguments, he asserts:

"Det är inte korrekt att påstå att reaktorerna är absolut säkra...det är inte rätt att påstå att reaktorolyckor skall accepteras på samma sätt som tåg- och flygolyckor...det är inte korrekt att påstå att långvarig lagring av radioaktivt avfall inte är något allvarligt problem..."¹⁸³

He further asks if there really is an energy crisis or just a research crisis led by politicians who do not understand what thermodynamics are or what energy really is (which the readers of the book by now do). This is followed by his explanation of the inner workings of Swedish research politics, where critical voices are eliminated and research is steered by industry and their lackeys, a group that he also refers to elsewhere as the "nuclear energy mafia"

¹⁸² In Swedish: "Man måste ju rösta på det parti vars politik ligger en närmast." Eva Marling, "Nu säger han ja till sol- och vindenergi," *Dagens Industri* 29/4 1976, 22.

¹⁸³ Hannes Alfvén, *Kärnkraft och atombomber* (Stockholm: Aldus, 1975), 18. (Italics from original)

(*kärnkraftsmaffia*). And, he lays out the connection between nuclear power plants and atomic weapons, saying that it is now proven that a simple nuclear weapon could be made by the leftover plutonium from a fission reaction. He ends the book with reference to the possible annihilation of humanity through nuclear destruction and asks if we will fight for our survival.

The book is an excellent example of Alfvén performing as an expert directly to the audience of ordinary citizens. He established his character as the expert, demonstrating his knowledge of the anti-nuclear arguments, which he picked up during his time in the USA and working with Pugwash. He also showed his intimate knowledge of Swedish research politics, which allows him to establish a reputable counter narrative to the government's reasons for pursuing nuclear energy by introducing a new character into the drama: the nuclear energy mafia. He attacked the composition of Sweden's team of nuclear advisors, claiming they are all blind supporters of the government (and industry) line. And he attacked the government's analysis of its energy needs, provided by the scientific experts. Instead, he questioned if there really was a crisis around energy production that needs solving and suggested that a better managed research program could maximize existing energy sources and create new, safer alternatives in the future. Once again, he emphasized that the problem may not lay in the science but rather with those who steer scientific research in Sweden, the politicians.

4.3.2. An Expert for the Center Party

Despite Alfvén's persistent criticism of politicians, in the mid-70s he still believed that it was in the hands of governments to make the changes necessary to save the world from nuclear destruction. "There is unfortunately no reason to believe that anything other than a change in government can alter the current Swedish nuclear energy policy," he wrote in 1975.¹⁸⁴ He also said as much during his Pugwash speeches during the same period when he emphasized that scientific advisors should work to influence politicians. Thus, he joined the Center Party during this time after convincing the party, its leaders and ordinary members, that nuclear energy was extremely dangerous and irresponsible. The party ran their 1976 general election campaign with the nuclear question as the primary issue and succeeded in becoming the head of the first non-socialist government in Sweden since 1936. Moreover, this electoral victory signaled the emergence of a new "green way" in Swedish politics where a party won based on

¹⁸⁴ In Swedish: "Det finns tyvärr ingen orsak att tro att något annat än ett regeringsskifte kan ändra den nuvarande svenska kärnkraftspolitiken." Hannes Alfvén, "Kärnkraft och atombomber," in *Hannes Alfvén: Politiska och etiska inlägg 1967-1986*, ed. Hannes Alfvén and Thomas Carlsson (Stockholm: Pilgrim Press, 2002), 3.

an environmental issue rather than socialist vs capitalist economics.¹⁸⁵ Several historians have described this course of events as unique to Sweden where the anti-nuclear movement was subsumed into a political party, giving the members of the movement a clear political option in an election.¹⁸⁶ Moreover, Hannes Alfvén, is also identified by many as being largely responsible for the Center party's turn to the anti-nuclear position.¹⁸⁷ Because the intensifying environmental concerns were quickly absorbed by an established political party, this allowed the debate to continue largely within the halls of government rather than in the form of public protest, which was the case in most western countries. It was the former Agrarian party, now the Center Party, who took up the issue and raised the temperature on the nuclear debate in the parliament and also quickly forced the other parties to develop a line on energy issues.¹⁸⁸

It was a single member of parliament from the Center party, Birgitta Hamraeus, who first sounded the alarm on nuclear energy and drove the issue within the party, which ultimately led to its success in the elections of 1976. It is important to note Hamraeus' role as the primary actor within the Center Party who led the anti-nuclear fight, as it is often party leader Torbjörn Fälldin who gets the focus in the retelling of this history, partly because he became prime minister and partly because he is a man. If it were not for Hamraeus' actions, then it is unlikely that either Fälldin or Alfvén would have had the platforms on which to make their cases. The story largely began in 1972 when the United Nations held its first ever conference on the environment in Stockholm. Hannes Alfvén had requested to speak at the conference regarding nuclear energy and was denied by Olof Palme, who considered Alfvén too controversial on the topic. This stoked the interest of Hamraeus, who had already become concerned about the moral aspect of storing nuclear waste. She later contacted Alfvén in the USA by letter requesting a meeting and asking for more information regarding his thoughts on Sweden's energy policy and the dangers of nuclear energy. Here, she describes Alfvén as a person and an advisor:

Hannes var en karismatisk och mycket skicklig pedagog...han kunde övernog för att förklara det jag behövde veta för att inse att det fanns oerhörda risker med kärnkraften. Tecknet på kunnighet är koncentration på det väsentliga, som kläs i begripliga ord för den inte invigda.¹⁸⁹

¹⁸⁵ Schagerholm, "För het att hantera: Kärnkraftfrågan i svensk politik 1945-1980," 64.

¹⁸⁶ See...Jasper, *Nuclear Politics*; Schagerholm, "För het att hantera: Kärnkraftfrågan i svensk politik 1945-1980"; Björn Elmbrant, *Fälldin* (Stockholm: Fischer & Co, 1991).

¹⁸⁷ Ibid.

¹⁸⁸ Schagerholm, "För het att hantera: Kärnkraftfrågan i svensk politik 1945-1980," 67-71.

¹⁸⁹ Birgitta Hamraeus, *Att göra uppror i riksdagen: Självbiografi Birgitta Hamraeus* (Self-published 2009), 29, <http://arkis2dok.ra.se/ra/721378/Birgitta.%20Hamraeus%20sj%C3%A4lvbiografi.pdf> (2017-04-09).

In her first letter on 8 June 1972 she introduced herself as “a new member of Parliament and only an alternate on the Industry Committee,” as well as on the Center Party’s committee for energy issues. She explained that there were a number of motions regarding energy that were up for discussion in the fall session of the parliament and that it would be “extremely useful” for her to meet Alfvén “for advice and help!”¹⁹⁰ Alfvén responded to her letter by sending her information on the nuclear debate in the USA, and this started an exchange between Hambraeus and Alfvén that took place via post while he was in the USA and in person while he was in Sweden. Alfvén began to function as a primary advisor to Hambraeus on nuclear issues, and she asked him questions on technical issues and arguments and sent him copies of her upcoming motions and interpellations. It was in that very fall of 1972 that Hambraeus submitted her first interpellation to Minister of Industry Rune Johansson, which started a new phase in the nuclear debate in Sweden.¹⁹¹ In this document, she asked the Minister of Industry directly if he thought it was responsible to use an energy source that created a poisonous by-product that had to be stored safely for thousands of years. She also raised several of the other key issues of the international debate at the time and those directly advocated by Alfvén: the connection between nuclear energy and the nuclear bomb; the health risks associated with radioactive leakage; and whether the enormous amount of money already poured into nuclear development by the state prevents an objective discussion of the advantages and disadvantages of nuclear energy.

The early exchanges between Alfvén and Hambraeus also included acts of networking that would strengthen the anti-nuclear fight, particularly in Sweden, and increased the effectiveness of their efforts. Hannes Alfvén put Hambraeus in contact with Senator Mike Gravel, who performed a similar task to Hambraeus in the US legislature. He also put her in touch with Ralph Nader, who was a leading figure at the time in the US struggle. Conversely, Hambraeus mentioned in several letters that she has forwarded the information from Alfvén to Björn Gillberg, who founded the "Miljöcentrum" and a monthly magazine that Alfvén eventually published in. Gillberg was known as Sweden's Ralph Nader, as he began his public advocacy warning on the dangers of chemical food additives. She also forwarded the information to Lennart Daléus, who founded a Swedish branch of the Friends of the Earth, Jordens Vänner, who became known during his work around the UN conference in Stockholm in 1972.

¹⁹⁰ “oehört värdefullt för mig att få träffa Dig för råd och hjalp!” Letter Birgitta Hambraeus to Hannes Alfvén 8/6 1972, F 1:2, Birgitta Hambraeus archive, RA.

¹⁹¹ Schagerholm, “För het att hantera: Kärnkraftfrågan i svensk politik 1945-1980,” 74.

Now with Alfvén's expertise to aid her, Hambraeus was able to instigate the first real debate on Sweden's nuclear energy program in parliament. Up to this point, the program had been run largely without interference under different ministries, the Ministry of Industry (*Näringsdepartementet*) during this time, in consultation with the expert advisory committees. In the beginning of 1973, Hambraeus submitted her first individual motion calling for a moratorium on nuclear energy if could be shown that the risks were as serious as stated in the motion.¹⁹² In the months prior to submitting the motion, Hambraeus and Alfvén engaged in a letter exchange where he advised Hambraeus on the technical issues and the main points of the anti-nuclear arguments. As evidence of the directness on Alfvén's involvement, she wrote in a letter to Alfvén on 27 January 1973 that she had "relied on [his] thinking regarding an atomic moratorium in [her] motion."¹⁹³ She mentioned further that the Committee on Industry and Trade (*näringssutskott*) had promised to further discuss the issue through a series of hearings involving experts from all sides of the debate. She invited Alfvén to attend these hearings and also asked him for suggestions for other experts on the critical side. Further, she asked him which questions should be put to experts in order to "extract also the hidden problems?"¹⁹⁴ As a result of these hearings, the committee recommended, "No decision to develop nuclear power should be taken before new, comprehensive decision data has been submitted to Parliament."¹⁹⁵

Coinciding with the industry committee's hearings on nuclear power in early 1973, Central driftsledning (CDL), the organ that organized the Swedish electricity system, presented its plan for a total of 24 reactors in Sweden: eleven to be constructed/activated in the 70s and a further 13 in the 80s. In alignment with the Industry Committee's recent statement on atomic energy, a motion was put forward that the plan not be approved, and this view was supported by a majority of the parliament on 15 May, dealing a blow to the government's energy plans.¹⁹⁶ It was decided that the eleven existing/planned reactors for the 70s would remain untouched, but the additional 13 planned for the 1980s would need to be decided by the parliament no later than 1975. This temporary stoppage of Sweden's nuclear project was a success for the anti-side and a shock for the pro- and government side. Minister of Industry Johansson and Olof Palme responded that nuclear energy was safe and reliable, as

¹⁹² Hambraeus, *Att göra uppror i riksdagen: Självbiografi Birgitta Hambraeus*, 31.

¹⁹³ In Swedish: "tagit fasta på Dina tankegångar om ett atom-moratorium i min motion." Letter Birgitta Hambraeus to Hannes Alfvén 27/1 1973, Box 17 Folder 30, Hannes Alfvén Papers, UCSD.

¹⁹⁴ In Swedish: "få fram också dolda problem?" Ibid.

¹⁹⁵ In Swedish: "Inga beslut att bygga ut kärnkraften bör fattas förrän ett nytt, allsidigt beslutsunderlag...har förlagts riksdagen." Hambraeus, *Att föra uppror i riksdagen: Självbiografi Birgitta Hambraeus*, 32.

¹⁹⁶ Annki Schagerholm, "Svensk atomenergi politik 1972-1976" (Historiska Institutionen Göteborg, 1986).

well as the only way the country could meet its energy needs. Further, they stated that approximately 5000 jobs would be lost if the nuclear project was closed down. Nevertheless, the government planned to carry out a study and issue a new energy report in 1975. This event can be seen as the first success of Alfvén's efforts as an expert in the Swedish nuclear debate. While Hambraeus deserves the lion's share of the credit, her consultations with her expert advisor on nuclear issues gave her the arguments and the information that she needed to raise a credible objection to the government's previously unchallenged nuclear energy program.

Hambraeus was also responsible for arranging the consequential meeting between Alfvén and Center Party leader Torbjörn Fälldin. This meeting occurred the same day Alfvén testified in the Industry Committee and would soon lead to the Center party's leader taking a strong stand against nuclear energy. Hambraeus noted that Fälldin was clearly impressed by Alfvén's conviction and knowledge, and he invited Alfvén to speak at the party's annual meeting to be held in Luleå in June, which would serve as a historic moment in cementing the Center Party's anti-nuclear platform and eventually led to their victory in the 1976 election.

Alfvén's addressed the membership of the Center Party in Luleå in June of 1973 with a speech entitled, "The Energy Problem," which Birgitta Hambraeus described as a "factual, engaging educational speech."¹⁹⁷ The title refers to Alfvén's very first assertion in the speech that meeting Sweden's energy needs is "possibly our most important technical-scientific-political problem" (as is the case in most countries, he added).¹⁹⁸ But when attempting to approach the problem in an "objective" way, remarked Alfvén, one encountered obstacles from "economic interests" and even political interests. That is, governments who committed for so long to a particular solution to the energy question that they could not let go of it, even if the country's interests were best served elsewhere. He observed that internationally the energy problem had been a topic of intense debate, but "Sweden has...to a great degree been shielded from this." Further, he stated that the most recent parliamentary debate in May of that year (around the CDL proposal) demonstrated the fact that very few in the parliament had any idea of these debates.¹⁹⁹ He concluded that it would be good to discuss the aspects of these debates at that time, so it could place Swedish energy policy in the international context. He began his summary with discussing the "most controversial question," nuclear energy.

¹⁹⁷ Hannes Alfvén "Energiproblemet" June 1973, F 2:1, Birgitta Hambraeus archive, RA; Hambraeus, *Att göra uppror i riksdagen: Självbiografi Birgitta Hambraeus*, 33.

¹⁹⁸ In Swedish: "Vårt kanske viktigaste tekniskt-vetenskapligt-politiska problem..." Alfvén, "Energiproblemet," p. 1.

¹⁹⁹ In Swedish: "Sverige har...i hög grad varit avskärmad från denna." Alfvén, "Energiproblemet," p. 2.

Alfvén continued with a background on the history of atomic energy starting in 1939 with the discovery of a technique for splitting the atom. He continued with the developments of the atomic bomb and then the work on atomic energy. Referring to the history of the Swedish program, he provided this critical insight:

Den svenska utvecklingen bestämdes också av den speciella avoghet och misstro som regeringen alltmer visade de svenska forskarna, vars kritik ofta irriterade regeringen. Som en följd av detta gled ledningen av atomenergiarbetet snart över från de vetenskapligt-tekniska kompetenta till en grupp, vars kompetens låg i att manipulera statsmakterna och mjölka statskassan på pengar. Regeringen började snart uppdelat landets forskare...i sådana som var fogliga och sådana som var kritiska. Forskningsanslagens fördelning bestämdes nu ofta enligt den...klassificeringen.²⁰⁰

In this remarkable statement, Alfvén called into question the credibility of the current scientists in the nuclear program, something which then strengthened his own authority. He also accused the government of incompetence and neglect by harassing those scientists, like himself, who had been critical of their plans.

Alfvén continued the speech with informing the audience of the risks associated with nuclear energy which began to be raised in the USA in 1968 and 1969. He provided simple but scientific explanation on the poisonous effects of plutonium and the dangers of nuclear waste storage, and how these risks would only increase the more reactors were built worldwide. He reiterated that it was unbelievable that these concerns never reached the Swedish government. He followed this with a review of alternative energy sources, noting that there were other feasible means to meet the country's energy needs, if larger amounts of money were put towards their development.

Finally, Alfvén concluded by calling for a stop to Sweden's nuclear program through a moratorium on nuclear power, and he offered two suggestions for clarifying the solution to Sweden's energy needs: a radical re-evaluation of energy politics that put people in the center rather than the "reactor lobby" (*reaktorlobbyn*); and, a broad research initiative into alternative sources of energy. Alfvén's persuasive arguments helped cement the party's position as anti-nuclear. "He convinced us," said Hambraeus. Or, as another commentator observed, "Had the professor suggested that they should take down the moon, the members...probably would have loudly approved it."²⁰¹

Here, the dramaturgical analysis reveals how Alfvén succeeded in this task. First, Alfvén embodied the role of the knowledgeable expert simply through his persona as an

²⁰⁰ Alfvén, "Energiproblemet," p. 4.

²⁰¹ In Swedish: "Hade professorn föreslagit att man borde ta ner månen, hade stämman förmodligen efter hans tal med acklamation beslut om detta." Elmbrant, *Fälldin*, 138.

internationally recognized plasma physicist and Nobel prize winner. In addition, he established his authority by retelling the story of the development of atomic energy both internationally and in Sweden, where he was a first-hand witness. His knowledge of the debates in the USA, and his indignation over their insignificance to Swedish politicians, successfully painted him as the more informed party in the debate. He could also pedagogically explain the technical issues, and he questioned the competency of Sweden's pro-nuclear scientists. All of these "techniques" worked to strengthen the authority of Alfvén and present his "character" as an informed, socially responsible scientist while also weakening the representation of his opponents.

In the following year of 1974, members of the Center Party continued to cement their profile as nuclear opponents and broadened their critique from nuclear waste to the issues of meltdowns and questioning cost effectiveness. Otherwise, it was largely quiet in the halls of government regarding Sweden's energy program as everyone waited for the government report to be released, which occurred in February 1975. It suggested a "careful" (*försiktig*) increase in the number of reactors with the addition of two more for a total of 13 by 1985. While the government considered all risks associated with fission energy to be solvable and/or unlikely to happen, they noted that these concerns worried the public, thus the reduction in the plans. The Center party filed an additional motion rejecting nuclear energy outright if its problems could not be solved. They suggested the five currently active reactors be allowed to continue operation, but they should be decommissioned if solutions to the waste and security problems were not found. The other six reactors being planned, the motion suggested, should be used for something else.²⁰² The other parties in the parliament, as mentioned earlier, were now forced to have a clear position on nuclear energy. The Moderates were pro-nuclear while the Left party, under the name *Vänsterpartiet Kommunisterna* (VPK) at the time, were against it. The Liberal party (*Folkpartiet*) fell somewhere in between. They approved the eleven reactors but held reservations about a further expansion. A final interesting note to come out of the 1975 debates was the first suggestion of a popular vote (*folkomröstning*), in a motion from VPK, regarding the expansion of nuclear energy. The motion obviously did not pass, but it would become a reality only a few years later.

The Social Democrats' energy plan, valid from 1975-1978, was approved by the parliament. While the reduction in planned reactors, along with a conservation plan for energy use, cooled the anti-nuclear side somewhat, the issue would heat up again as the election

²⁰² Schagerholm, "För het att hantera: Kärnkraftfrågan i svensk politik 1945-1980," 22.

approached in the Fall of 1976. “For several weeks before the election on 19 September, Fälldin spoke almost exclusively about nuclear energy, and his moral, uncompromising position showed clearly.”²⁰³ He stated adamantly that he would never participate in a government that built more nuclear reactors and that no minister position was so desirable that he would go against his principles. He also promised that nuclear energy would be dismantled by 1985. The moralism of the Center Party’s stance on nuclear energy created an interesting dynamic in the election and allowed voters to choose a party other than the one to which they belonged without feeling like traitors.²⁰⁴ Hannes Alfvén, a lifelong Social Democrat, provided himself as an example to voters when he said “I have stood before the choice between party loyalty and the pursuit of an ideal. And then must the pursuit of the ideal count more,” in an article on 10 June 1976 in his hometown newspaper, *Norrköpings Tidningar*.²⁰⁵ This statement is consistent with the previous statements and actions of Alfvén that have been mentioned throughout this thesis, which show that his commitment to his principles and ultimately to humanity were most important to him. The Center Party’s efforts put the nuclear question back at the top of the agenda during the weeks leading up to the election, and riding this wave of support, the Center Party became the head of the first non-socialist government in 40 years in the election of 1976.²⁰⁶

4.4 Performance Summary 1967-1976

I will now briefly summarize Alfvén’s performance as an expert with a look at his activities in Pugwash and the Swedish nuclear debate up until 1976 with reference to my original research questions and theoretical models. An important part of my inquiry is examining expert performances in light of the changing relationships between science, society and the state. As a reminder, scientists both shape, and are shaped by, these changes, or in other words, they are co-produced. So, at the time concerned scientists were raising concerns about the dangers of nuclear energy from a scientific perspective, environmental and social movements were calling for a new society based upon concern for nature and democratic decision making, and these two efforts are mutually reinforcing.

²⁰³ James M. Jasper, *Nuclear Politics: Energy and the State in the United States, Sweden, and France* (Princeton, N.J: Princeton University Press, 1990), 144.

²⁰⁴ Robert Sahr, *The Politics of Energy Policy Change in Sweden* (Ann Arbor: University of Michigan Press, 1985), 83–84.

²⁰⁵ In Swedish: ”Jag har stått inför valet mellan partijojalitet och idealitet. Och då måste idealiteten väga tyngst” “Nobelpristagaren Alfvén kämpar med Centern mot kärnkraftsamhället,” *Norrköpings Tidningar* 10/6 1976, 8.

²⁰⁶ Schagerholm, “För het att hantera: Kärnkraftfrågan i svensk politik 1945-1980,” 85–86.

Specifically, with regards to Hannes Alfvén, I have used the material from his activities in Pugwash primarily to locate his views on the role of science in society. These experiences within Pugwash had a substantial impact on Alfvén and his views on science became quite different than the period prior. Now, instead of the view that all knowledge produced from basic research was valuable in its own right, he supported a more cautious view given the destructive aspects of S&T. More importantly, he began to encourage scientists to take responsibility for their discoveries and be involved in their application, which is a significant deviation from the “linear model” of scientific production that he adhered to before. Along with this, he no longer trusted national governments to responsibly handle the developments of science and technology, and he supported the involvement of the public on decisions relating to S&T. In Pielke’s terms, he reflected the attributes of an Issue Advocate, as he openly chose a side in the nuclear debate and believed in a model of knowledge production that took the end users into account.

Alfvén exemplified these new ideas with his expert performance in the Swedish nuclear debate, this time as an all-out critic of the Swedish nuclear program. He took the anti-nuclear message directly to the public via the press and his popular science publications, where he established his own “character” as a knowledgeable expert and undermined the authority of the pro-nuclear, government scientists. Further, he advised Birgitta Hamraeus of the Center party on her anti-nuclear campaign within the parliament, and he convinced the leadership and general membership of the party that nuclear energy was immoral and unsafe, leading the party to adopt an anti-nuclear platform. He embodied the role of the expert in every performance: he was a Nobel prize winner in physics; he was an insider in the world of Swedish research politics and could “reveal the backstage” of the biased nature of the government’s approach to nuclear science by offering an alternative narrative as to why it was pursuing nuclear power; and he had worked in the USA and could speak intelligently about the nuclear debate there, while portraying the government as ignorant of these important developments. Finally, he knew how to tailor his message to his audience, explaining the technical components with enough detail to be convincing while remaining understandable. Sundqvist describes the novelty of Alfvén’s actions at this time:

Alfvén represented a kind of expert new to the Swedish society. Traditionally, scientists have influenced the policy process by becoming members of government committees or in other ways advising ministers and authorities....More rarely, scientists were involved in the public debates in the mass media or connected to political parties. These channels for influencing policy, if not condemned, were judged as second rate compared to committee work, where decision makers could be advised more directly.²⁰⁷

²⁰⁷ Sundqvist, *The Bedrock of Opinion*, 70.

Analyzing this observation by Sundqvist through a lens performativity, it can be said that Alfvén created a new type of expert role in Swedish society through his actions in the nuclear debates. Unlike the traditional scientific experts who gained their credibility primarily through institutional affiliations and places on government committees, Alfvén constructed, reproduced and defended his scientific authority using dramaturgical methods, establishing his character as an informed, responsible scientist bringing the message of truth about nuclear energy to the Swedish public. Given this uncommon type of expert performance in Swedish society, Alfvén can be said to have successfully used his expert role to bring about a significant change in Sweden's energy politics with regards to nuclear energy; however, as the next section will show, this success would be somewhat short lived and not go as far as hoped.

5. Epilogue: 1976-1980

The months and years that followed the surprising election results in 1976 were filled with controversy surrounding the nuclear program, culminating in a nationwide referendum on nuclear power in 1980. Almost immediately after the election, the Center party backtracked on its campaign promises to not expand the nuclear program; more friendly commentators attributed this to a tough bureaucratic structure that required compromise in the running of a coalition government, while more critical voices accused the Center party of deception. The anti-nuclear discourse in Sweden took a different turn in this process, as well, switching from its previous moral emphasis to a more technical one. This shift eventually weakened the anti-nuclear side and left the debate largely up to the experts, who were largely pro-nuclear.²⁰⁸ Below, I summarize the events of this period and then place Hannes Alfvén into its context to round out the events covered in my narrative. As this is an epilogue, it is not meant to be an exhaustive analysis, but it shows Alfvén extend his role as a type of Issue Advocate; however, he operated away from the halls of government as Fälldin chose not to have him as an official advisor, and he took the fight to the streets via his participation in mass demonstrations and other actions against Sweden's nuclear energy program.

The day after Fälldin's victory, Hannes Alfvén paid a surprise visit to the incoming Prime Minister at the home of the party's vice-chairman, Karin Söder, to congratulate Fälldin on the victory. Two weeks later, on October 5th, Fälldin disappointed Alfvén by agreeing to fuel the newest nuclear reactor in Sweden, Barsebäck 2. During the campaign, Fälldin had specifically promised that his government would not to load any new reactors with fuel; however, his coalition partners, the Liberals and Conservatives, argued that it would be irresponsible to abandon nuclear plants that were in advanced stages of construction. Fälldin compromised, and his flip-flop was seized upon by Olof Palme who accused the Center party leader of hypocrisy and making unrealistic promises during the campaign. As a concession for the compromise, however, two demands of Fälldin's were agreed to: a plan accounting for the safe storage of the reactor's spent fuel (i.e. waste) had to be presented within a year; and, a new energy commission was to be created for the purpose of developing a new energy policy for Sweden, to be presented in 1978. As I explain below, these demands were part a two-pronged strategy Fälldin hoped could herald the end of nuclear energy in Sweden.²⁰⁹

²⁰⁸ Jasper, *Nuclear Politics*, 221–22.

²⁰⁹ Jasper, 219.

The first part of this approach, as reflected in the first demand, was to place the focus on the problems nuclear waste disposal as a means to prevent the fueling of any new reactors. The idea was to introduce a requirement that before a nuclear reactor could be activated, a detailed plan demonstrating the safe disposal of its waste had to be presented. This was an idea that Fälldin had received from Alfvén before the election, who had witnessed similar legislation being passed in the state of California in the summer of 1976.²¹⁰ In Sweden, this resulted in the Nuclear Stipulation Act (*Villkorslagen*), passed in April 1977, which would apply to all future reactors. (Barsebäck 2 was given a special exception.) The Swedish law required proof that the nuclear waste of a reactor would be stored with “absolute safety” (*helt säker*) before a permit for operation would be granted. In the reasoning of the Center party, this was an impossible standard to meet because no existing or future technology could guarantee the ultimate safe storage of nuclear waste, thus no new nuclear plants in Sweden could go into operation. Pro-nuclear parties had a more positive view on the ability of technology to solve the waste problem; therefore, they also agreed to the new law assuming its conditions could be met.²¹¹

The first test of the Stipulation Act occurred in late 1977 when an application for the fueling of Sweden’s seventh reactor, Ringhals 3, was submitted, followed within six months by an application for another reactor, Forsmark 1. Both provided the same plan for the disposal of the reactors’ spent fuel, and the government rejected both applications at the same time on 29 September 1978. In their announcement, the government stated its reasons for the rejections rested mainly on the geological data: the applicants had not demonstrated that a suitable rock formation had been found for the storage of the waste. This argument carried its own particular dangers, however, in that the government had now opened the door to the theoretical possibility of safely storing nuclear waste, as they made it clear that if the geological data could prove a location is safe, then the requirements of the Stipulation Act would be met.²¹² In addition to opening the door to the possibility of an “absolute safe” storage method, the narrow, technical reasoning in the government’s announcement signaled a shift in its anti-nuclear discourse from its previous moral emphasis to a much more scientific one. This shift is further emphasized in the fact that the government simultaneously announced that all future determinations on the Stipulation Act would be made by the

²¹⁰ Schagerholm, “För het att hantera: Kärnkraftfrågan i svensk politik 1945-1980,” 93.

²¹¹ Jasper, *Nuclear Politics*, 220.

²¹² Dean Abrahamson, “Governments Fall as Consensus Gives Way to Debate,” *Bulletin of the Atomic Scientists* 35, no. 9 (November 1979): 33.

Swedish Nuclear Inspectorate (*Statens kärnkraftinspektion*, or SKI), who would make their decisions based upon an analysis of the scientific evidence. Fälldin had thus removed any possibility of raising an objection to nuclear energy other than on technical grounds.

According to Dean Abrahamson, the previously mentioned physicist who participated in the Swedish nuclear debates, with this decision Fälldin handed over the fate of nuclear power to the experts by making the issue largely a technical issue.²¹³

The switch to technical issues also affected the overall energy discussion as the Energy Commission released its energy report in June 1978. Again, the energy commission had been tasked with creating several alternative plans to meeting Sweden's energy needs, and the commission had been instructed by the government to include one option that assumed a decommissioning of nuclear power by 1985. The commission came back with the conclusion that nuclear power could not be stopped by 1985 without serious economic and social consequences, which was another blow to Fälldin and another opportunity for some of his opponents to accuse him of hypocrisy.

The environmental movement heavily criticized the Energy Commission's report, and a coalition of groups set out to create an alternative report, which would be an attachment to the original. In two months, the group had authored an 800-page document given the acronym, MALTE (*Miljörörelsens alternativa energiplan*), but the report lacked any of the previous visions of the environmental/ecological movements suggesting a radically alternative vision of society. Rather, this report also focused on technical arguments: demonstrating through quantitative measures that nuclear energy could be taken out of service by 1985; that energy needs could be met by renewable sources by year 2000; and that dependence on oil and coal could decrease. Conversely to the technical arguments, the authors went to considerable lengths to appeal to ordinary citizens by not emphasizing the more radical tenets of the ecological critique of the nuclear society and focused on the technical arguments instead.²¹⁴

While Hannes Alfvén did not participate in the creation of the MALTE report, he was very active during this period with the extra-parliamentary (*utomparlamentarisk*) movements involved in the issue: the peace movement, the environmental movement and the anti-nuclear movement. There is nothing to indicate that he joined any particular group, which could explain his absence from the MALTE report, rather Alfvén spoke at large rallies and provided

²¹³ Abrahamson, 34. See also...Jasper, *Nuclear Politics*, 220; Schagerholm, "För het att hantera: Kärnkraftfrågan i svensk politik 1945-1980," 100.

²¹⁴ Anshelm, *Mellan frälsning och domedag*, 225.

information to the anti-nuclear side via articles in both the mainstream press and activist publications. He had lost nearly all contact with the Center Party, who chose not to bring him on as a scientific advisor, which Birgitta Hambraeus later identified as a mistake by Fälldin. She attributed this to the new prime minister's sole reliance on trusted, long-time party members and his aversion to having a scientific advisory group to the government.²¹⁵ The perception of Alfvén as an expert was not the least bit diminished, as reflected in an August 1978 article in the magazine *Veckojournalen*, with the revealing title of, "Hans röst är en av de mest bärande." The journalist presented Alfvén in a most positive light, referring to his friendly, gentle smile and easy going movements and tone while at the same time delivering articulate and precise arguments against nuclear energy. She listed his scientific qualifications, his membership in nine different academic societies around the world and his Nobel Prize, of course. Alfvén, himself, described his own role as a "messenger" (*budbäraren*), bringing scientific reports, books and arguments about the dangers of nuclear energy from the USA back to Sweden, where they are ignored by the Royal Swedish Academy of Engineering Sciences (IVA), whom he accused of being pro-nuclear: "IVA gör inte skäl för sitt namn, bokstäverna V och A, för vetenskap och akademi, skulle bort. Jag anser att IVA fungerar som en reklambyrå för kärnkraften!"²¹⁶

Alfvén was not any kinder to the members of the Energy Commission after the publishing of their energy report. At a demonstration of 1500-2000 people next to the uranium processing plant Ranstadsverket on 26 August 1978, which was part of a larger nationwide demonstration that day which attracted a total of 8,000 persons, Alfvén told the crowd the no one in the energy commission had even a high school knowledge of physics.²¹⁷ Forced to defend these remarks, he published an article in *Svenska Dagbladet* a week later where he repeated the accusation and then followed it up with a basic explanation on the laws of thermodynamics. Because energy is neither created or destroyed, he explained, it is misleading to discuss energy in terms of production and consumption, as the mainstream narrative goes. He belittled the experts at the Energy Commission for not knowing the difference between energy and exergy, which he named as the proper term for the issues relevant to the debate. He demonstrated his intellectual superiority by introducing the readers to a new technology that exploits low-value energy sources, and he stated emphatically that

²¹⁵ Hambraeus, *Att göra uppror i riksdagen: Självbiografi Birgitta Hambraeus*, 35.

²¹⁶ Margareta Hall, "Hans röst är en av de mest bärande," *Veckojournalen* 22/8 1978, 4.

²¹⁷ "Ingen laddning krävde 8000," *Dagens Nyheter* 27/8 1978, A 1.

Sweden can manage to meet its energy needs without nuclear power or oil imports. “What we cannot manage without,” he emphasized, “is a drastic change in the lousy Swedish research politics—and even of some scientists’ way of talking.”²¹⁸ In addition to the insults, Alfvén in this article has expressed a technical argument against the expansion of nuclear energy which was consistent with the anti-nuclear discourse in Sweden at this time.

Fälldin ultimately rejected the Energy Commission’s plan, but he could not find much support for his anti-nuclear views outside of his party. In addition, despite the efforts of Alfvén and others, the environmental movement was suffering from infighting based on ideological differences and personal squabbles, thus it could not organize enough pressure from the outside.²¹⁹ After a few months of fruitless negotiation among the ruling coalition parties over the future of nuclear energy, Fälldin resigned as prime minister out of protest in October of 1978, as he was no longer willing to make the compromises necessary to satisfy his coalition partners. This led to a minority government led by the Liberals, who proposed an energy bill in March of 1979 largely based on the recommendations of the Energy Commission. The bill was to be voted on in June, which should have settled the nuclear energy debate for the foreseeable future; however, on March 29, 1979 a nuclear reactor meltdown at Three Mile Island in Pennsylvania changed everything.²²⁰

Coverage of the meltdown, referred to in Sweden as the Harrisburg accident (*Harrisburgolyckan*), was extensive, and the issue of a catastrophic failure was now to be taken seriously. Simultaneously, the public was increasingly demanding its say on the matter. A petition drive for a referendum on nuclear power had been going on for years, and on 4 April Olof Palme, still a supporter of nuclear energy, announced his party’s support for a referendum, to which the other parties agreed. The members of parliament were allowed to determine the contours of the vote, including its timing and the language placed on the ballots. The anti-nuclear side, consisting of the Center Party and the Communists, clearly formulated their line, which stated no further reactors would be activated and the existing six reactors would be decommissioned within 10 years. The pro-nuclear side wanted to see all twelve existing and planned reactors used until they were no longer operable; however, for political reasons, the Social Democrats did not want to share the vote with the Conservatives, so they created enough of a difference in their formulation to create a separate, pro-nuclear

²¹⁸ In Swedish: ”Men vad vi inte kan klara oss utan är en drastisk omläggning av den urusla svenska forskningspolitiken—och även av vissa teknikers sätt att diskutera;” “Norrländsköld i stället för olja,” *Svenska Dagbladet* 9/9 1978, 3.

²¹⁹ Abrahamson, “Governments Fall as Consensus Gives Way to Debate,” 34.

²²⁰ Jasper, *Nuclear Politics*, 224.

option on the ballot. Thus, there were ultimately three choices given to the voters in the referendum, referred to as ‘Lines.’ Line 1, supported by the Conservatives, called for a total of twelve reactors, which would operate until circumstances allowed for their decommissioning without affecting the generation of sufficient electricity to maintain employment and welfare; Line 2, supported by the Social Democrats and the Liberals, shared the same language with line 1, with the addition of a few qualifications such as the public ownership of all nuclear plants and the promise to aggressively pursue alternative energy options. While it did not specifically state a time for decommissioning all nuclear power, the number of 25 years was thrown around and became attached to this line; Line 3 was the anti-nuclear option already mentioned, supported by the Center Party and the Communist Party.²²¹

As to be expected, the public discussion around the referendum was immense, and two articles in major Swedish newspapers by Hannes Alfvén during this time exemplify his performance as an expert. The first article makes his argument and tone clear from the very title, “Detta försöker man inbillar oss” with the by-line, “Det existerar en svensk kärnkraftsmaffia, som har en förödande makt. Den har lärt hur man manipulerar Sverige. Den politiska debatten gäller om vi skall kunna befria oss från kärnkraftsmaffian.”²²² Alfvén laid out his proof for the existence of a nuclear energy mafia, using the failed project at Marviken as the prime example, and he argued that in a functioning democracy such a clear waste of taxpayer money would not be tolerated. According to Alfvén, the “mafia” hid the enormous amount of taxpayer money that supported the nuclear energy program in Sweden. He described their arguments in the nuclear debate as sounding like an advertising campaign for their side, against which the opposition responded with ever more convincing facts. Alfvén then attacked all of the nuclear industry’s main arguments for nuclear power with facts, wit and sarcasm. Responding to the argument that nuclear power was necessary to maintain a decent standard of living or even basic survival, Alfvén responded that nuclear energy is necessary for the *mafia’s* survival, but “the rest of us will do just fine or even better without it.”²²³ As for the argument that oil dependence had to be replaced with nuclear energy, he offered a range of alternative solutions and pointed out that it would take 50 reactors to fully replace the energy supplied by oil. “The mafia knows this but an effective selling point is more important than the truth,”²²⁴ he added. Of course, he reserved some of his harshest

²²¹ Schagerholm, “För het att hantera: Kärnkraftfrågan i svensk politik 1945-1980,” 107.

²²² Hannes Alfvén, “Detta försöker man inbillar oss,” *Svenska Dagbladet* 14/8 1979.

²²³ In Swedish: “...men resten av oss klarar oss lika bra eller mycket bättre utan.” Ibid.

²²⁴ In Swedish: “Detta vet maffian men ett effektivt försäljningsargument är viktigare än sanningen.” Ibid.

criticism for the claim that nuclear power is safe. Regarding this, "...the mafia lies. And so too do many of the leading politicians and upper level administrators who are caught in their claws—because of ignorance and stupidity—or even worse reasons."²²⁵ He finished the article by claiming there are two debates that are being blended into one. The first was how to find a scientific—technical—economic--environmental solution to the energy problem. The other debate was political, which could only be conducted if the people can be freed from the nuclear energy mafia. Solving this problem would make the first debate easier to solve.

A shorter article by Alfvén appeared a month later in *Dagens Nyheter* entitled, "Förnuft och känsla I kärnkraftsdebatten" which was published on 21 October 1979. Turning the tables on the pro-nuclear side, who argued that they hold the facts while the opposition is irrationally fearful, he wrote it is truly they who are emotional, as they simply refused to let go of their precious invention that had now been proven to be inadequate. Going through the short history of nuclear development, he noted the enthusiasm that he also held in the 50s regarding the potential for atomic energy. Referring to himself and his fellow scientists at the time, he wrote "we were starry-eyed optimists and we had few rational arguments."²²⁶ This era ended, according to Alfvén, around 1970 when strong arguments against nuclear power were raised, and these arguments were not emotional but "a number of clear, incontrovertible facts."²²⁷ He then listed the type of facts regarding the dangers of nuclear energy that were revealed: biological and medical effects; physical and technical deficiencies; geological issues; and enormous economic costs. He concluded that by 1974, nuclear energy was essentially dead, as reflected in the huge decrease in the number of reactors ordered in the USA during that year compared to the previous one. The real debate was finished, he says, and people started looking for alternative energy sources.

The debate in Sweden only continued, claimed Alfvén, because emotional arguments from the pro-nuclear side are presented as facts and supported with state money. He likened the pro-nuclear side to the supporters of the zeppelin, which was to be the revolutionary aviation technology in the 1920s and was abandoned only after a number of tragic accidents. Similarly, the pro-nuclear supporters, including its scientists, industry men and politicians, would not let go of their failed technology, and all of the money that they had invested into it.

²²⁵ In Swedish: "...i detta avseende ljuger maffian. Och det gör också de många ledande politiker och höga administratörer som råkat i dess klor—till följd av okunnighet och dumhet—eller av ännu värre orsaker." Ibid.

²²⁶ In Swedish: "Vi var blåogda optimists och vi hade få rationella argument." Hannes Alfvén, "Förnuft och känsla i kärnkraftsdebatten," *Dagens Nyheter*, October 21, 1979.

²²⁷ In Swedish: "ett antal klart redovisade oemotsägliga fakta." Ibid.

The anti-nuclear side is also emotional, he conceded, but their emotions are based on the “facts” and that they have been deceived by the propaganda of the pro-nuclear establishment.

In the end, the pro-nuclear establishment emerged victorious. The referendum on nuclear power occurred on 23 March 1980, and line 2, seen by many as the middle way, won the referendum with 39.1% of the vote. Line 3 received 38.7% of the vote and Line 1 got 18.9%. It was said in the run-up to the vote that all three options ultimately represented a stop to the Swedish nuclear program, as they all supported an eventual decommissioning. This has yet to occur.

Before concluding this epilogue, it is worth reviewing one more performance of Alfvén during this period that is revealing of his views on the role of science in society. Alfvén addressed his fellow scientists at the Nobel Symposium on Ethics for Science Policy in August 1978. His lecture, entitled “Science, Progress and Destruction,” contained some of the themes heard from Alfvén previously, such as his historical summary of the development of science leading to its current phase with its destructive ability and its bondage to industrial applications. He identified not only nuclear physics but chemistry and particularly genetic engineering as potentially dangerous fields. Referring to these threats, he made a suggestion that would have been unthinkable for him previously:

We may be compelled to conclude that in certain fields scientific knowledge itself is dangerous. In other words, in certain fields knowledge and power of destruction are so intimately coupled that we have to accept both or limit the research or even close down these fields of research. If we accept this conclusion we cannot claim an unconditional right of freedom of research in all fields of science.²²⁸

This is a long way from the Pure Scientist that we saw in Hannes Alfvén thirty years prior! He was now suggesting that certain investigations into the functioning of the natural world should not be carried out because of their potential harmful effects on society. This is the clear reflection of what Mitcham calls “techno-science idealism.” Rather than viewing the products of science as neutral and merely susceptible to misuse, Alfvén is stating the science could be dangerous in and of itself.

As in previous periods, his ideas on the role of science in society are also reflected in his overall performances as an expert. During this period, he was a full-fledged anti-nuclear activist, and he used his position as a scientific expert and previous experience as a government advisor to influence public opinion and stop the march towards a nuclear society. He no longer talked directly to powerful government decision-makers but instead took his

²²⁸ Hannes Alfvén, “Science Progress and Destruction,” lecture at Nobel Symposium on Ethics for Science Policy, Stockholm, 1978, 8.

message directly to the people. Gone were his earlier concessions to the pro-nuclear side, as he did during his Pugwash speeches, where he stated it was undecided whether fission based nuclear energy could be viable or not. Instead his tone was combative, and his distrust of politicians and large industry actors had increased. From a dramaturgical perspective, his character was that of a Rebel Scientist (my term), who battled on the stage against a powerful foe, the nuclear energy mafia, who wanted to deceive the people for selfish, misguided ends. It was a struggle, in part, for scientific authority, which Alfvén fights with the tools of persuasive rhetoric, appealing to the “facts” of the anti-nuclear discourse versus the “lies” and “propaganda” of the mafia. He described his opponent as irrationally optimistic and emotional about nuclear energy and undemocratic with respect to policy. And though Alfvén’s performances are effective in support of the anti-nuclear side, the mafia won in the end.

6. Conclusions

6.1 Summary and discussion

Over the course of 35 years, Hannes Alfvén's expert opinion changed from inconspicuously advocating the building of a modern Sweden, powered with the latest nuclear technology in energy production, to urging all who would listen about the dangers of that plan. Along the way, he moved the spaces in which he advised from the halls of power in the Swedish government to the public sphere, giving public addresses at large demonstrations and via the press, where he attacked the same institutions he once supported. At a first glance it may seem that these are two radically opposing performances, and they are in many ways different and reflect different beliefs on the role of science in society; however, there are also consistencies that Alfvén reproduced across the entire period covered in this thesis. Below I summarize the changes and the continuities from Alfvén's career as an expert advisor that were identified by applying an STS framework to the historical material. In doing so, I will address my research questions and will end with recommendations for additional research.

The picture I present of Alfvén in the first twenty years of his career is that of someone who is very much a part of the relatively small scientific establishment in Sweden, although, as Svante Lindqvist has pointed out, his initial presence there was more a result of the quality and relevance of his work than his social capital, which was the case with many of the top scientists at the time. Ideologically, Alfvén personified the dominant view on the role of science at the time in that it was going to be the basis for a prosperous future, built on a foundation of basic research, and Alfvén even referred to himself as "a starry-eyed optimist" when reflecting back on this period. Free, unconstrained basic research was the ideal for Alfvén (and his colleagues) at the time, and they used their status as objective, non-political scientists to convince the government to significantly fund these efforts with money for atomic and natural science research. Alfvén's appointment as one of only 10 members of the Atomic Committee and then as one of only four government representatives on the board of the Atomic Energy Corporation only added to his credibility as a scientific authority. Within these bodies, he was the voice for the promising new nuclear science, fusion energy, and in this role he managed to direct substantial amounts of research money to it. His character as the fusion expert involved the larger task of advocating for more money to basic research in general, particularly within the Atomic Energy Corporation, which he did more often and more passionately than anyone else on the board of directors. His character was officially that of a Pure Scientist, in Pielke's terms, but he was more akin to a Stealth Issue Advocate. In

other words, he used the argument of the need to fund unbiased, objective basic research to drive a vision of a future Swedish state, which included allocating more money to his own research area. This is not a conscious act of deception by Alfvén, but, as Pielke points out, one of the shortcomings associated with the linear model that ignores the inherent mix of values and science and leads to the temptation of scientists to make these claims.

Roughly 15 years after the creation of the Atomic Committee and the other research councils, Alfvén and his fellow expert advisors mobilized their identities, again, as seasoned experts on science policy as they sought to persuade Prime Minister Erlander to create a new expert body to oversee government sponsored research, and they took their message about the need for this body directly to the Swedish public via the newspapers. In his well-publicized article, “Vår svälftfödda vetenskap” Alfvén constructed his expertise once again as he explains to the public the social importance of basic research in the natural sciences and then revealed to the public the government’s mishandling of research strategy (and funding). This was part of a larger rhetorical attempt to return control over the domain of science to the scientific experts, and this was not the last time he employed this technique. This episode also reflects the beginning of his activities as a critic of Swedish research politics. The scientists’ performances prove effective with the creation of the Advisory Board on Science, but Alfvén was quickly disillusioned. He wrote to Torsten Gustafson after the first meeting that he is worried about the abuse of power he sees by the ministers in the government, who he still insisted are not listening to researchers. He felt that democratic principles were being violated, that the government was not acting in the best interests of the people, and he suggested revealing this via the press. This discloses a part of his view on the role of science, and experts, in a democracy: that it provides the necessary information for political representatives to make the best choices on behalf of the citizenry, and his idealism shows with his irritation about this transgression by the politicians.

Alfvén’s grievances with the direction of Sweden’s atomic program increased in the mid-1960s, as he persistently demanded more money to basic research in board meeting of Atomic Energy Inc, and he resented the influence of industry and government on what should be a scientifically based decision on reactor type. In an attempt to resolve these issues, he enhanced his position by weakening the other side. For example, he deftly maneuvered to get the information from a confidential board meeting made public thus revealing the backstage of the controversy surrounding the Markviken project and the Swedish line. He wrote a scathing critique of the internal workings of the company and threatened to send it to the entire government. He wrote another article for *Dagens Nyheter* to further convince the public

that Sweden's research politics needed a drastic overhaul and injection of capital. And, he eventually left Sweden in protest, claiming that he can no longer carry out his work in such an environment.

Alfvén performed during this first period time primarily in front of two audiences: politicians and the Swedish public. In front of politicians, the construction of expertise was initially rather simple. His institutional affiliations, involvement in the international scientific community and academic training established his credibility. In addition, his commitment to the objective scientific ideal of the time made him a trustworthy advisor. These same qualities made Alfvén an authority in the eyes of the public but more was required. In his press articles, he demonstrated his knowledge of a subject by relaying the information in a pedagogical way, as the teacher informs the student. He made his arguments following the logic of science, which is built on objective facts, by presenting tables, numbers and statistics. He then used these numbers to compare Sweden with other developed countries with respect to research expenditures, thus exhibiting his knowledge of the scientific state of affairs worldwide. He also introduced some of the techniques that he would use increasingly as he became a more open critic of science such as adding characters to the drama and revealing the backstage.

His idealism is also a consistent theme throughout his entire expert career, including this period between 1945-1967. It is true that many, if not most, scientists held the same ideal on the role of science in society during this time: to increase knowledge about the world through free, unrestricted research which would lead to beneficial social applications. But in the contexts that I examined, Alfvén was the primary individual who insisted on this point repeatedly in board meetings at Atomic Energy Inc and in press articles, as he repeatedly called for more money to basic research. Moreover, he was also the only one from within Atomic Energy Inc who took the risk to criticize the Marviken project so publicly to the detriment of his own career, as he claimed that he was told of reprisals if he spoke out. By his own account, there were several researchers and others who shared the same concern about the misguided nature of the Marviken project, but Alfvén was the one to speak out. Finally, Alfvén was one of only small minority of researchers who chose to leave Sweden to work abroad, partially for political reasons.²²⁹ Alfvén left behind everything that he had built over a successful 25-year career because, in part, because he did not believe that the government was

²²⁹ He is not the only scientist who left Sweden during these years for better opportunities abroad, and there was even talk in the media of a possible “brain drain” at the time, but this is a little sensational considering the vast majority of Swedish scientists remain in the country.

acting in good faith regarding the role of science in a democracy, and this is a function of his scientific idealism.

Alfvén's idealism expanded even more clearly in the years covered in second empirical section, 1967-1976, and his view on the role of science in society expanded along with it. He believed that the scientific process could diagnose and solve the largest problems facing humanity like the threat of war and world hunger. Science could also function as it did in the days of Brahe and Galileo to revolutionize the very ideological foundations upon which worldviews are constructed. His critique of science and technology increases, too. He believed that certain aspects of science and technology had become too dangerous to be trusted in the hands of irresponsible political leaders, as the development of nuclear weapons posed a threat to all of humanity. The power gained from developments in science and technology that was now concentrated in the hands of governments, and industry, posed the real threat to democracy and not the technocrat advisors. Nevertheless, scientists should still perform their roles as expert advisors, but the nature of the performance should be different. Thus while expanding his view on the role of science in society, he changed his views regarding the relationship between science and the state. He not only did not trust governments with the developments from science and technology, but he also wanted politicians out of the process of directing scientific research.

Alfvén's time in Pugwash helped to convince him that it was no longer responsible to maintain the ideal of the objective, politically disinterested scientific advisor as he grew to realize the inherent connection between science and politics. Additionally, he changed his view on the process of scientific knowledge production, no longer believing that a scientist engaging in basic research should remain separate from the application of their work. He promoted the message within Pugwash conferences, scientific journals, academic talks and the general press that scientists must take responsibility for the applications of their knowledge since they are the most qualified to understand its dangers and benefits. Together, these new views on the relationship between science, society and the state plus his changed view on the production of scientific knowledge place affect his performance as an expert, which align largely with the description of an Issue Advocate by Pielke.

Alfvén performed his new role as an Issue Advocate in the nuclear debates in Sweden in the mid to late 1960s. He began by working with opposition member of parliament, Birgitta Hamraeus, advising her on what issues to raise in her interpellations and motions in the Swedish parliament. They achieved an almost immediate success when the parliament, following the recommendation of the industry committee, rejected a proposal for the

expansion of Sweden's nuclear energy program. Alfvén continued working with Hambraeus and the Center Party and also performed directly for the public in the form of articles in Sweden's major newspapers and also a book on the dangers of atomic energy. In these performances, we see the usual techniques of constructing expertise, something that has not changed from the period before, but he increased the usage of practices to delegitimize the expertise of the pro-nuclear side. He attacked their science, their integrity and their motives. He introduced a new character on the stage, the nuclear lobby, who were hijacking the nuclear program at the expense of the best interests of Sweden. He revealed the backstage based on his own experiences in the nuclear program. Alfvén was convinced that nuclear energy was dangerous, particularly in its connection to the making nuclear bombs, and he dramatically spread this message in hopes of electing a new government that would stop Sweden's march towards a nuclear society.

The discourse of a nuclear society, which is more than just the issue of nuclear energy, reflects a change in the relationship between science, society and the state, as the issue of nuclear power, and who would decide its fate, was a symbol for the larger critique of political power and a question regarding setting the priorities of society. Alfvén addressed these issues, from a scientific perspective with respect to resource usage, when he spoke about the unsustainability of the dominant growth paradigm. He also incorporated this new view in his attacks on the "nuclear energy mafia," and invited public participation into the decision making around science policy. These attributes are consistent with his new role as an Issue Advocate and also his belief in techno-science idealism as he still envisioned a better world via science and technology but only if people are free to choose their course without the interference of those who wish to subvert the process.

In conclusion, the dramaturgical analysis along with Pielke's ideal types help to show both the consistencies and changes in Alfvén's outlook on the role of science in society and how the scientist can effect change in the world. A key consistent factor in Alfvén's expert advising is that it was always political, though it may not appear so at first glance. Using Pielke's notion of a Stealth Issue Advocate reveals that even in the early years, Alfvén was indeed involving himself in political matters. The nature of his political involvement changes, however, when he begins to clearly advocate for one side in the nuclear debate, thus reflecting more as Pielke's Issue Advocate. Another consistent variable in his expert career is the ways in which he constructed his scientific authority, although this also transforms as the boundaries between state and society shift. As he shifted increasingly to advising the public in the contested field of nuclear science, he needed to further construct his role as the well-

informed scientific authority, always maintaining his views were built on objective facts, while also delegitimizing the pro-nuclear side and its scientists. Ultimately, Alfvén believed in the value of expert advising, and, as he increasingly seemed to realize the inherent mixing of science and politics, he took it upon himself to educate the public what he perceived to be the dangers of nuclear energy, winning their hearts and minds along the way. His performance at the Center Party's 1973 annual meeting in Luleå, and the resulting victory of the Center Party in the election, is emblematic of the success of his performances to effect change.

6.2 Further Research

The existing research on Hannes Alfvén is very minimal, and some of the areas covered in this thesis can open the door for further interesting studies. First, the story of his specific role in the early years of Sweden's atomic program has not been told. He is usually mentioned as only one name of many in this history, but a deeper look into activities here could be fruitful. More interesting, I think, is a thorough look into his role in Pugwash and especially his activities as president. I have provided only a brief overview of the history of the group and looked primarily at his major pronouncements as president. There is certainly more to the story, there, which could also include a closer look at the history of the Swedish Pugwash group. Last, there is also more to be written on his time in the USA, especially in the early years when he converts to the anti-nuclear side. Tracing his personal contacts and influences would add to the story as it exists now, which is that he was simply exposed to the newest data on the dangers of nuclear energy and was convinced.

From an STS perspective, I would hope that more historical research is done on the scientists who exhibit what Mitcham calls the techno-scientific ideal. There are a number of organizations, which he lists in his article, that are worthy of study and analysis. With respect to theory, there are also many tools in the STS toolbox with which to analyse these historical actors. I chose to use the performance model of Hilgartner combined with Pielke's types to frame Alfvén's views and actions, but other approaches that use Jasanoff's concepts of "civic epistemologies" or "sociotechnical imaginaries" would also create valuable insights. These concepts can loosely be described as focusing the reception of scientific expertise by the public; however, the problem still arises in that much analysis of this type is directed at how governments engage with the public in order to legitimize their policies, thus these theories have to be reworked in order to apply it to a dissenting scientist like Alfvén.

7. References

Unpublished material

Riksarkivet (Marieberg), Stockholm

AB Atomenergi angående anslag till bolagets verksamhet för budgetåren 1966/67, 31/8 1965, 79, Elam Tunhammars archive

AB Atomenergi angående anslag till bolagets verksamhet för budgetåren 1967/68, 31/8 1966, 79, Elam Tunhammars archive

Alfvén, Hannes Energiproblemet June 1973, F 2:1, Birgitta Hamraeus archive

Bilaga 3 to protokoll for FB working group 9/4 1964, A 2:1, 1962 Års forskningsberedning

Hannes Alfvén, ‘Beträffande det svenska atomenergiprogrammet’ 27/8 1970, F 2:1, Birgitta Hamraeus archive

Kritisk översikt över AE:s verksamhet, bilaga till PM beträffande AB Atomenergi och dess organization 14/7 1965, Box 81, Elam Tunhammar’s archive

Letter Birgitta Hamraeus to Hannes Alfvén 8/6 1972, F 1:2, Birgitta Hamraeus archive

Letter to CEO Harry Brynielson 17/9 1965 Box 81, Elam Tunhammar’s archive

PM beträffande AB Atomenergi och dess organization 14/7 1965, Box 81, Elam Tunhammar’s archive

Protokoll nr. 85 for board meeting of AB Atomenergi 12/5 1958, Box 80, Elam Tunhammar’s archive

Protokoll nr. 90 for board meeting of AB Atomenergi 13/1 1959, Box 81, Elam Tunhammar’s archive.

Protokoll nr. 96 for board meeting of AB Atomenergi 23/10 1959, Box 81, Elam Tunhammar’s archive

Protokoll nr. 106 for board meeting of AB Atomenergi 10/5 1961, Box 81, Elam Tunhammar’s archive

Protokoll nr. 118 for board meeting of AB Atomenergi 8/5 1963, Box 81, Elam Tunhammar’s archive.

Protokoll nr. 120 for board meeting of AB Atomenergi 22/8 1963, Box 81, Elam Tunhammar’s archive

Protokoll nr. 125 for board meeting of AB Atomenergi 6/10 1963, Box 81, Elam Tunhammar’s archive

Protokoll nr. 126 for board meeting of AB Atomenergi 21/8 1964, Box 81, Elam Tunhammar's archive

Protokoll nr. 128 for board meeting of AB Atomenergi 20/1 1965, Box 81, Elam Tunhammar's archive

Protokoll for Forskningsberedning working group 9/4 1964, A 2:1, 1962 Års forskningsberedning

Styrelsen PM 85, 'Femårsplan för budgetåren 1963/64 – 1967/68' 8/5 1963, Box 81, Elam Tunhammar's archive

Särskilt yttrande till professor H. Alfvén, bilaga till AB Atomenergis anslagsskrivelse för budgetåret 1966/67, Box 79, Elam Tunhammar's archive

Untitled document 16/9/1965, Box 81, Elam Tunhammar's archive

Lund University Library, Lund

Draft, Hannes Alfvén to Torsten Gustafson, date missing, Box 1, Torsten Gustafsons efterlämnade papper

Draft of *Tage Erlander. 1960-talet: samtal med Arvid Lagercrantz*; Box 1, Torsten Gustafsons efterlämnade papper

Letter Hannes Alfvén and Torsten Gustafson to Tage Erlander 19/5 1961, Box 57, Torsten Gustafsons efterlämnade papper

P.M. angående kontakt mellan regering och forskningsrepresentanter 24/2 1961, Box 57, Torsten Gustafsons Efterlämnade papper

Protokoll nr. 80 of Atomkommittén 20/9 1957, Box 29, Torsten Gustafsons efterlämnade papper

Hannes Alfvén Papers, Mandeville Special Collections Library, UCSD.

Letter Birgitta Hambraeus to Hannes Alfvén 27/1 1973, Box 17 Folder 30, Hannes Alfvén Papers

Letter Hannes Alfvén to M.D. Millionshchikov 28/5 1970, Box 19 Folder 27, Hannes Alfvén Papers,

Published Material

- “AB Atomenergi satsar på ny reaktortyp.” *Svenska Dagbladet* 2/9 1965.
- Abrahamson, Dean. “Governments Fall as Consensus Gives Way to Debate.” *Bulletin of the Atomic Scientists* 35, no. 9 (November 1979): 30–37.
- Alfvén, Hannes. “Detta försöker man inbilla oss.” *Svenska Dagbladet* 14/8 1979.
- . “Förnuft och känsla i kärnkraftsdebatten.” *Dagens Nyheter* 21/10 1979.
- . “Forskningspolitik i baklås.” *Dagens Nyheter* 23/2 1966.
- . *Kärnkraft och atombomber*. Stockholm: Aldus, 1975.
- . “Kärnkraft och atombomber.” In *Hannes Alfvén: politiska och etiska inlägg 1967-1986*, edited by Hannes Alfvén and Thomas Carlsson. Stockholm: Pilgrim Press, 2002.
- . “Professional and Amateur Politicians.” In *Hannes Alfvén: Politiska och etiska inlägg 1967-1986*, edited by Hannes Alfvén and Thomas Carlsson. Stockholm: Pilgrim Press, 2002.
- . “Science Progress and Destruction.” In *Nobel Symposium*. Stockholm, 1978.
- . “Science, Technocracy and the Politico-Economic Power.” *Impact of Science on Society* 22, no. 1/2 (June 1972): 85–92.
- . “Vår svältfödda vetenskap.” *Dagens Nyheter* 2/3 1962.
- . “Vår svältfödda vetenskap.” *Dagens Nyheter* 26/11 1963.
- . “Vetenskap och politik.” In *Hannes Alfvén: politiska och etiska inlägg 1967-1986*, edited by Hannes Alfvén and Thomas Carlsson. Stockholm: Pilgrim Press, 2002.
- Anshelm, Jonas. *Mellan Frälsning Och Domedag: Om kärnkraftenspolitiska idéhistoria i Sverige 1945-1999*. Stockholm: Brutus Östlings Bokförlag Symposion, 2000.
- Brissman, Henrik. *Mellan nation och omvärld: Debatt i Sverige om vetenskapens organisering och finansiering samt dess internationella och nationella aspekter under 1900-talets första hälft*. Lund: Lunds universitet, 2010.
- Brown, Andrew. *Keeper of the Nuclear Conscience: The Life and Work of Joseph Rotblat*. Oxford : New York: Oxford University Press, 2012.
- Bruno, Sandra. “The Origins of the Russel-Einstein Manifesto.” History Series. Council of Pugwash Conferences on Science and World Affairs, May 2005.

Carl-Gunne Fälthammar, and Alexander J. Dessler. "Hannes Alfvén, 30 May 1908 · 2 April 1995." *Proceedings of the American Philosophical Society* 150, no. 4 (December 2006): 649–62.

Carlsson, Thommas, and Hannes Alfvén. *Hannes Alfvén: Politiska och etiska inlägg 1967-1986*. Stockholm: Pilgrim Press, 2002.

"De arbetar för våra barnbarns skull." *Svenska Dagbladet* 2/9 1965.

Eberson, Lennart. "AB Sverige och forskningen." *Dagens Nyheter* 2/2 1962.

Elmbrant, Björn. *Fälldin*. Stockholm: Fischer & Co, 1991.

Erlander, Tage, and Arvid Lagercrantz. *Tage Erlander. 1960-Talet: samtal med Arvid Lagercrantz*. Stockholm: Tidens Förlag, 1982.

Fälthammar, Carl-Gunne. *Hannes Alfvén: en pionjärs liv och verk*. Stockholm, 1998.

———. "Plasma Physics from Laboratory to Cosmos--The Life and Achievements of Hannes Alfvén." *IEEE Transactions on Plasma Science* 25, no. 3 (June 1997): 409–14.

Fälthammar, Carl-Gunne. "The Scientific Legacy of Hannes Alfvén." *Eos, Transactions American Geophysical Union* 93, no. 21 (2012): 201–2.

Fjæstad, Maja, and Thomas Jonter. "Between Welfare and Warfare: The Rise and Fall of the 'Swedish Line' in Nuclear Engineering." In *Science for Welfare and Warfare: Technology and State Initiative in Cold War Sweden*, edited by Per Lundin, Niklas Stenlås, and Johan Gribbe. Sagamore Beach, MA: Science History Publications, 2010.

Gieryn, Thomas F. "Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists." *American Sociological Review* 48, no. 6 (December 1983): 781–95.

———. *Cultural Boundaries of Science: Credibility on the Line*. Chicago: University of Chicago Press, 1999.

Gustafsson, Torsten. "Ett anslag mot forskningen." *Dagens Nyheter* 22/2 1967.

Kaijser, Arne. "Swedish Nuclear Power Policies in Historical Perspective." *Annual Review of Energy and the Environment* 17 (1992): 437-462.

Lindberg, Dag. "Delar sin tid mellan USA och Sovjet." *Vi* 25/3 1967.

Hall, Margareta. "Hans röst är en av de mest bärande." *Veckojournalen* 22/8 1978.

Hambraeus, Birgitta. *Att göra uppror i riksdagen: självbiografi Birgitta Hambraeus*. self-published, 2009.
<http://arkis2dok.ra.se/ra/721378/Birgitta.%20Hambraeus%20sj%C3%A4lvbiografi.pdf>

Hilgartner, Stephen. *Science on Stage: Expert Advice as Public Drama*. Stanford, Calif: Stanford University Press, 2000.

“Ingen laddning krävde 8000.” *Dagens Nyheter* 27/8 1978.

Jamison, Andrew, Ron Eyerman, and Jacqueline Cramer. *The Making of the New Environmental Consciousness: A Comparative Study of the Environmental Movements in Sweden, Denmark, and the Netherlands*. Environment, Politics, and Society Series, vol. 1. Edinburgh: Edinburgh University Press, 1990.

Jasanoff, Sheila. “A Field of Its Own: The Emergence of Science and Technology Studies.” In *The Oxford Handbook of Interdisciplinarity*, edited by Robert Frodeman, 191–205. Oxford: Oxford University Press, 2010.

———. “Science and Democracy.” In *The Handbook of Science and Technology Studies*, 4th ed., 259–87. Cambridge, MA: MIT Press, 2017.

———. *Science and Public Reason*. Abingdon: Routledge, 2012.

———, ed. *States of Knowledge: The Co-Production of Science and Social Order*. London: Routledge, 2004.

———. *The Fifth Branch: Science Advisers as Policymakers*. Cambridge, Mass: Harvard University Press, 1990.

Jasper, James M. *Nuclear Politics: Energy and the State in the United States, Sweden, and France*. Princeton, N.J: Princeton University Press, 1990.

Jonter, Thomas. “Nuclear Weapons Research in Sweden: The Co-Operation between Civilian and Military Research, 1947-1972.” SKI Report 02:18. Stockholm: SKI, May 2002.

———. “Sweden and the Bomb: The Swedish Plans to Acquire Nuclear Weapons, 1945-1972.” SKI Report 01:33. Stockholm: SKI, September 2001.

Karsberg, Arne. “Alfvén hotar flytta: ‘är inte önskvärd.’” *Dagens Nyheter* 11/2 1967.

Larsson, Ulf. “Physics in a Stronghold of Engineering: Professorial Appointments at the Royal Institute of Technology, 1922-1985.” In *Center on the Periphery: Historical Aspects of 20th-Century Swedish Physics*, edited by Svante Lindqvist, 58–75. Canton, MA: Science History Publications, 1993.

Lindqvist, Per. “Det klyvbara ämnet: diskursiva ordningar i svensk kärnkraftspolitik 1972-1980.” Lunds universitet, 1997.

Lindqvist, Svante. “De motstridiga bilderna av Hannes Alfvén.” *Forskning & Framsteg*. Accessed April 24, 2017. <http://fof.se/tidning/2008/4/de-motstridiga-bilderna-av-hannes-alfven>.

- . “La lagom longue durée: Tidsanda och struktur i en studie kring Hannes Alfvén.” In *Forskarbiografen: föredrag vid ett symposium i Stockholm 12-13 maj 1997*, edited by Evert Baudou. Konferenser 41. Stockholm: Kungl. Vitterhets-, historie och antikvitets akademien, 1998.
- . “Om konsten att ligga lägt, inte sticka upp och sitta ner i båten.” in *Till en konstnärssjäl: en vänbok till Stig Ramel*. Stockholm: Atlantis, 2002.
- . “Symbolernas arkeologi : Teman i en studie kring Hannes Alfvén.” *Nordisk Museologi* 2003, no. 2 (2003): 27–50.
- Lindström, Stefan. “Hela nationens tacksamhet: svensk forskningspolitik på atomenergiområdet: 1945-1956.” Stockholm University, 1991.
- . “Implementing the Welfare State: The Emergence of Swedish Atomic Research Policy.” In *Center of the Periphery: Historical Aspects of 20th-Century Swedish Physics*, edited by Svante Lindqvist, 179–95. Canton, MA: Science History Publications, 1993.
- “List of Pugwash Meetings, 1957-2007.” *Pugwash Newsletter* 44, no. 2 (October 2007): 26–155.
- Lundin, Per, and Niklas Stenlås. “Technology, State Initiative and National Myths in Cold War Sweden: An Introduction.” In *Science for Welfare and Warfare: Technology and State Initiative in Cold War Sweden*, edited by Per Lundin, Niklas Stenlås, and Johan Gribbe. Sagamore Beach, MA: Science History Publications, 2010.
- . “The Reform Technocrats: The Strategists of the Swedish Welfare State, 1930–1960.” In *Scientists’ Expertise as Performance: Between State and Society, 1860–1960*, edited by Joris Vandendriessche, Evert Peeters, and Kaat Wils, 135–46. London: Pickering & Chatto, 2015.
- Malström, Sven. “Varför forskar vi?” *Dagens Nyheter* 20/2 1962.
- Marling, Eva. “Nu säger han ja till sol- och vindenergi.” *Dagens Industri* 29/4 1976.
- Mitcham, Carl. “Professional Idealism among Scientists and Engineers: A Neglected Tradition in STS Studies.” *Studies in Science, Technology, and Society (STS) North and South* 25, no. 2 (April 1, 2003): 249–62.
- “Nobelpristagaren Alfvén kämpar med centern mot kärnkraftsamhället.” *Norrköpings Tidningar* 10/6 1976.
- “Norrländsköld istället för olja.” *Svenska Dagbladet* 9/9 1978.
- Nybom, Thorsten. “The Socialization of Science: Technical Research and the Natural Sciences in Swedish Research Policy in the 1930s and 1940s.” In *Center of the Periphery: Historical Aspects of 20th-Century Swedish Physics*, edited by Svante Lindqvist. Canton, MA: Science History Publications, 1993.

Pease, R. S., and S. Lindqvist. "Hannes Olof Gösta Alfvén. 30 May 1908-2 April 1995." *Biographical Memoirs of Fellows of the Royal Society* 44 (1998): 3–19.

Pielke, Roger A. *The Honest Broker: Making Sense of Science in Policy and Politics*. Cambridge: Cambridge University Press, 2007.

Pugwash Conference on Science and World Affairs. *Disarmament and Peaceful Collaboration among Nations: Proceedings of the Thirteenth Pugwash Conference on Science and World Affairs, Karlovy Vary, Czechoslovakia, September 13-19, 1964*. London: Pugwash Cont. Comm., 1964.

———. *Disarmament, Energy Problems and International Collaboration: Proceedings of the Twenty-Fourth Pugwash Conference on Science and World Affairs, Baden, Austria, 28th August - 2nd September 1974*. London: Pugwash Cont. Comm., 1974.

———. *European Security, Disarmament and Other Problems: Proceedings of the Twenty-Third Pugwash Conference on Science and World Affairs, Aulanko, Finland, 30th August - 4th September, 1973*. London: Pugwash Cont. Comm., 1974.

———. *Problems of World Security, Environment, and Development : Proceedings of the Twenty-First Pugwash Conference on Science and World Affairs, Sinaia, Romania, August 26th - 31st, 1971*. London: Pugwash Cont. Comm., 1971.

———. *Scientists and World Affairs: Proceedings of the Seventeenth Pugwash Conference on Science and World Affairs, Ronneby, Sweden, September 3-8, 1967*. London: Pugwash Cont. Comm., 1967.

———. *Scientists and World Affairs : Proceedings of the Twenty-Second Pugwash Conference on Science and World Affairs, Oxford, England, September 7th - 12th, 1972*. London: Pugwash Cont. Comm., 1972.

"Regeringen skapar nytt forskingsråd." *Dagens Nyheter* 16/12 1962.

"Reservation i Atombolaget." *Svenska Dagbladet* 13/11 1964, sec. A.

Rotblat, Joseph. *Scientists in the Quest for Peace; a History of the Pugwash Conferences*. Cambridge, Mass: MIT Press, 1972.

———, ed. *Scientists, the Arms Race, and Disarmament: A Unesco/Pugwash Symposium*. London: Taylor & Francis, 1982.

Rüdig, Wolfgang. *Anti-Nuclear Movements: A World Survey of Opposition to Nuclear Energy*. Harlow, Essex: Longman Current Affairs, 1990.

Rudling, Anna. *Kampen mot atomvapen*. Stockholm: Tidens forlag, 1975.

Sahr, Robert. *The Politics of Energy Policy Change in Sweden*. Ann Arbor: University of Michigan Press, 1985.

- Schagerholm, Annki. "För het att hantera: kärnkraftfrågan i svensk politik 1945-1980." Historiska Institutionen Göteborg, 1993.
- . "Svensk atomenergi politik 1972-1976." Historiska Institutionen Göteborg, 1986.
- "Staten finanserar inte mer än 50 proc av svensk forskning." *Dagens Nyheter* 8/2 1962.
- Stevin, Peter. *Den samhällsstyrda forskningen: En samhällsorganisatorisk studie av den sektoriella forskningspolitikens framväxt och tillämpning i Sverige*. Stockholm: LiberFörlag, 1978.
- Sundqvist, Göran. *The Bedrock of Opinion: Science, Technology and Society in the Siting of High-Level Nuclear Waste*. Dordrecht: Springer Netherlands, 2002.
- "Svensk Atomenergipolitik: Motiv och riktlinjer för statens insatser på atomenergiområdet 1947-1970." Industridepartementet, 1970.
- Tunlid, Anna. "Den nya biologin." In *Vetenskapens sociala strukturer: Sju historiska fallstudier om konflikt, samverkan och makt*, edited by Sven Widmalm. Lund: Nordic Academic Press, 2008.
- . "Forskningspolitisk aktör och vetenskaplig institutionsbyggare. Arne Tiselius och etableringen av molekylärbiologin i Sverige." In *Det forskningspolitiska laboratoriet: förväntningar på vetenskapen 1900-2010*, edited by Anna Tunlid and Sven Widmalm. Lund: Nordic Academic Press, 2016.
- Vandendriessche, Joris, Evert Peeters, and Kaat Wils, eds. *Scientists' Expertise as Performance: Between State and Society, 1860 - 1960*. History and Philosophy of Technoscience 6. London: Pickering & Chatto Ltd, 2015.
- Wittner, Lawrence S. *The Struggle Against the Bomb: A History of the World Nuclear Disarmament Movement, 1954-1970*. Vol. 2. Stanford Nuclear Age Series. Stanford, Calif: Stanford University Press, 1993.
- . *The Struggle Against the Bomb: A History of the World Nuclear Disarmament Movement, 1971 to the Present*. Vol. 3. Stanford Nuclear Age Series. Stanford, Calif: Stanford University Press, 1993.
- Wittrock, Björn, and Stefan Lindström. *De stora programmens tid: Forskning och energi i svensk politik*. Stockholm: Akademilitteratur, 1984.