THE ENGINEERING PROFESSION AND CIVIL SOCIETY IN FINLAND

Towards a Political History of Technology

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The history of technology has both embraced and been embraced by new approaches in social sciences and humanities. The ways in which the mainstream of 19th and 20th-century historical writing – political and international history – now understands its tasks have created an opening for the development of a political history of technology. The following article highlights how the political dimension of technology can be approached from the viewpoint of the engineering profession, its organisation and civic activities.

The changing studies of technology

Some time has now passed since the history of technology began its transformation from the internalist study of technological artefacts and the design of machines and techniques into a more complex study of technological systems, and social, even sociological and cultural history of technology.[1] In addition to what still seems to be a happy marriage between economic history and technology, these new trends have taught us a lot more about the place of technology within the wider society. Our understanding of technology itself has benefited greatly from the new approaches. Probably one of the main contributions of the historical study of technology over the last couple of decades has been the way in which technology has gained a place in our understanding of society and human culture as a whole. With a more sophisticated understanding of the relationships between technological development and the human environment, we have also been able to see how the societal context of technology is one of its critical components.[2]

A sub-theme in the studies of technology has been the study of people directly involved with technology: engineers, scientists, technological innovators, and increasingly also the end-users of technologies. In the western historical tradition prominent individuals have always been a legitimate

subject of scholarly inquiry. This has applied to statesmen, soldiers, artists, businessmen, and technological innovators alike. The personalising approach has been common in traditional accounts of rapid technological change, scientific advances, innovations, and business history.

Recent trends in the history of technology have in many ways followed wider trends of historical science. Micro-historical studies on what may be called 'ordinary' people have concentrated on issues like the practices of everyday life and the underlying mental structures of culture, which also bear an interest from the point of view of history of technology. Gender history has made its way into the history of technology as well.[3]

From the point of view of sociology or traditional social history, individuals have not been generally hold as interesting as larger cohorts of people, classes, or modern professions. In the history of technology too, there has been an attempt to reach beyond the influence of few prominent individuals. Both sociological and historical studies have brought into focus the engineering profession as a whole or specific parts of it, or as in Karl-Erik Michelsen's recent work on the Finnish engineering profession, at least a larger group of prominent individuals than has been usual in the past.[4] Studies of scientists, engineers, and the engineering profession have sought to see the human experience amidst such impersonal engines of historical change as the abstract concepts of economics or technological development.

There are many examples of how technology and engineers, or science and scientists, have entered the popular historical imagination as key protagonists of the modern era, especially in the processes of industrialisation and modernisation, which still remain closely associated with technological advances, innovations, and increasing complexity of technological systems. The weight that is currently placed upon technology both economically and culturally may have increased rather than decreased the mystification of technology as an agent of historical change, and hence an interest and a need for an objective study of it.

New political history

Traditional political history, as it was practised until after the Second World War, placed very little weight on so-called non-state actors. Even when it came to the state, which for long was the lonely beacon of political history, actors below the drama of high politics tended to receive scant attention. Political, and in the same vein international history, was usually reduced to the history of political and international events, narrating the sequences of national and international power battles.

Various developments challenged this view after the Second World War. Within academia, pressure was felt from the direction of social sciences which, in the 1960s in particular, claimed success in explaining the anatomy and functions of contemporary societies with what seemed to have been their superior methodological toolkit. His-

torians found fresher pastures in social, cultural, and economic history, and many of them completely lost interest in what seemed outdated, parochial and irrelevant political superstructures.

The challenges led to a revision of the terms of reference and goals of political and international history. In order to understand the forces behind the creation of the modern world, the tasks of political and international history had to be revised. Political historians' interests followed closely developments in the role and the scope of the state, which saw a marked increase in the post-war world.[5]

Political and international history has thereafter enlarged its focus from high politics and the nation-state's central political and administrative institutions into wider studies of the relationship between the concepts of state and society, national and international, structures and action. Non-state actors including pressure groups, institutions of civil society and economic actors have been brought into the analysis of the political process. Alongside the traditional concerns of power, influence and decision-making, political historians today take increasingly into account questions such as political ideas and concepts, identities, perception, and other psychological factors in order to explain political processes as fully as possible.

The current field of political and international history is at least as diversified, or fragmented, as is any other area of historical research, creating both opportunities for new approaches to emerge, but also challenges resulting from the fragmentation of knowledge and problems of communication within the scholarly community. How could we then best fit as diversified disciplines as political history and the history of technology together? How should we conceptualise interaction between politics, technology and societal change? Can there be a special role for the organisational and civic activities of the engineering profession in such an attempt? Besides addressing these problems, this article shall point out what interest political history may have in such an enterprise and what could its contribution be to the further development of the history of technology. In the last section of the article the organisation of the Finnish engineering profession is outlined and observations are made about its collective behaviour.

Political technology

If our starting point is that technology is in a systemic interaction with the wider society, its values, cultures and material conditions, and this indeed is its essence, we are confronted with the problem how to study this interaction. What are the links and what are the spheres of society and the political system they connect? What interests are channelled through them? In short, what is the research agenda for political technology?

The relationship between technology and the political system is interdependent in a sense that technological development has the potential to lead into changes in the political system, which in turn may influence the development of technology. This rela-

tionship is not deterministic in the sense that technology inescapably would determine political, social, and economic consequences.[6] However, such innovations as the printing press and mass communication through newspapers and electronic media have both had a profound influence in the ways in which the political process has functioned and political parties have organised. The Internet is expected by many to lead into similar changes in political mobilisation, in the legitimisation of political authorities and the increased effectiveness to the spread of political ideas. Technology's contribution to political change can also be indirect, in as much as changes in economic and social structures subsequently lead into political changes. The specific goals set by national governments, democratic or other, on the uses of technology in war and peace have also had an influence in the development of technology, the Manhattan project developing the first atomic weapons probably being the a most illuminating case of point. The history of warfare has always had a close interest in technological innovations.[7]

Politics and technology have thus always had an intimate relationship, as well as economics and technology, although the systematic study of political technology has been overshadowed by other concerns in both political history and the history of technology, and has yet to develop beyond the most obvious and explicit cases mentioned above.[8] Compared to the relative inactivity of historians of domestic political processes, historians of international relations have recently made some headway towards combining the history of technology with Cold War history.[9]

An area of political history where a further contribution to the history of technology can be made is the study of the political system and its relationship to the civil society. The civil society comprises various non-governmental actors of different size and status. In the widest sense, it can include most of society's institutions, economic and cultural, but from the point of view of political history the civil society is normally regarded as the representation of collective interests outside the constitutional framework of the nation-state. The civil society, in this sense, is the sphere of self-organized activity of the people, the wide network of voluntarily organised activity, like clubs and associations, which in Finland began its rapid development during the latter half of the 19th century.[10]

The technological elite, the engineering profession, took its position in the civil society too, when it was organized into professional associations.[11] In Finland, as in many other countries, the engineering profession has a long history of organized activities, such as lobbying the causes of technology and industry, and later also taking a distinctive role in trade union activities. The gradual widening of the scope of their activities beyond the traditional range of the so-called non-political causes of technology and industry brought the profession into the sphere where the civil society and political and administrative decision-making practically became one: the sphere of modern corporatism.

Corporatism in western societies has for long been actively studied within political history, although the main concern has not been the higher educated and professional groups, but the numerically stronger workers' trade unions and their relationship to the political system, the employers' organisations, and the national governments.

The traditional trade unions have been a natural choice of interest to political history due to their contribution to the development of communist and social democratic parties and the development of working class political identities, but also because of their direct political significance as one of the corners of the classical corporatist triangle together with the national government and the employers' federations.

The professional groups, such as engineers, can be studied within the same framework too, although their direct political influence has been much weaker compared to the methods of the older trade unions. This does not, however, mean that they would have been politically insignificant. The professional groups are increasingly considered as a key component in the development of late modern societies. Their actual, concrete work, be it the law, commerce, medicine or engineering, have all shaped profoundly the societies in which we live today.

How they have organized collectively offers political history a twofold opportunity. Political historians have a long experience in the study of such collective organizations as the engineers' federations and clubs. There already exists a tested theoretical and methodological framework in which to fit these organizations. By doing this, political history can establish the engineering profession within a wider frame of the history of the civil society and its functions, and find out what the profession's political and societal role has in fact been. The study of these organizations offers political history a window through which it can meet the history of technology half-way, on half-familiar terrain at best, but at least with certain landmarks in sight.

Society's techno-political arena

Before outlining the organization and the main characteristics of the engineering profession's collective activity in Finland, a brief note on models and concepts shall be made. What is suggested here is a sketch of a simple model, called society's techno-political arena, which is a concise way to present the relevant spheres involved in the study of the engineering profession as a civic actor.

Society's techno-political arena can be seen as the meeting point of technology, political and administrative systems, and civil society. These three spheres are all embedded within the prevailing economic and social order and its material structures and cultures. As is by definition the case with politics, the arena is essentially about action. Its actors may be individuals (engineers, scientists, politicians, administrators, economic actors), or larger groups or institutions representing collective interests. Organizations representing

electoral interests (political parties), trade unions and technical societies, business and industry can all be players within the arena alongside the national or local government, the parliament and even the wider public. Relationships between different actors may be based on institutional arrangements, or they may be informal.

Although the links between these players are based on communication, negotiation, and exchange of ideas and views, the arena should not be understood only as discoursive. As opposed to actual policy-making, and what is most important for the subject matter dealt with on the arena, the direction and definition of nation's technological policy, the arena incorporates a wider array of players and interested parties than are directly involved in governmental policy making.

Society's techno-political arena is a way to conceptualise practical and actual interaction between different interests concerning the function of technology in society at large. It is about concrete political action, negotiation of interests between different groups and goal setting amongst them. It is best understood within the context of corporatist management of state–society relationships, i.e. the continuous negotiation process by which political and administrative decision-making incorporates the institutions and the interests of the civil society beyond formal political institutions such as political parties, the parliament or other constitutional bodies. But it goes beyond corporatism in the sense that groups with little official standing or influence may be taken for legitimate players on the arena.

What kind of issues are dealt with in the techno-political arena? It is where technologies' normative ramifications, for example, are established. These may eventually take the form of legislation passed by the parliament, administrative or judicial practices or precedents established over time concerning the usage and development of certain technologies, or self-regulation. But whatever the final source of authority in enforcing the norms may be, the goals of these interventions are none the less always established in a dialogue with other interested parties. This process takes place on the arena.

The extent to which the material facilities for technological development, education, and innovation should be provided from the public purse is another recurrent theme on the techno-political arena. Although many important decisions concerning the social position of engineers and scientists, their terms of pay, and employee-employer relations may be established bilaterally far away from the arena, we can see that questions of their social standing have been discussed there too. The establishment of trade union activities from the 1960s onwards by the Finnish engineering profession made such questions a permanent feature of the techno-political arena, although the classical corporatist triangle of the largest trade unions, the employers' federations and the national government has been where most of the decisions affecting the overall pay and taxation of the professional groups have been made over the last three decades.

Engineers' professional organization in Finland

The oldest professional association of engineers in Finland is the Swedish-speaking *Finland's Technical Society TFiF* which was founded in 1880 during a time of rapid technological change and Finland's first wave of industrialization. In 1896 the Finnish-speaking section of the profession founded *The Engineering Society in Finland STS*, today known as the *The Finnish Association of Graduate Engineers TEK*.[12]

STS was established as a forum for Finnish-speaking engineers and architects, who then formed a minority in a largely Swedish-speaking profession. STS was established during a time when the Finnish national spirit ran high, and the political scene was still divided along the linguistic cleavage. A need for a more assertive and self-conscious Finnish-speaking elite to replace the older Swedish one within the engineering profession was high on the agenda, although at first the Finnish-speaking organization spent most of its energy in developing Finnish-language technological terminology.[13] In this sense TEK, the largest engineers' association in Finland today, is an offspring of the Finnish nationalism.

The Swedish-speaking organization, TFiF, remained for long the most important and prestigious of the two, and was furthermore identified with strong private industrial interests. Like STS, it had many non-engineers as members as well. In the 1920s and the 1930s, the balance began to shift in favour of the Finnish-speaking organization, first in numeric terms, and later also in terms of influence and public standing. The somewhat strained relations between the two organizations also warmed up, when language-based politics were subsumed by more pressing problems at the beginning of the Second World War in 1939. After the Second World War, STS grew steadily in size and increasingly took the character of a mass organisation in the 1960s and 1970s. Due to its larger membership, it also became to be considered the more or less official voice of the engineering profession.

At the same time as STS grew, its role began to change. What still in the 1940s had been a gentlemens' club gradually started shifting its focus towards serving a larger membership of engineers that had practical needs, such as further education and training, access to information about job markets, and legal advice. Also identification with industrial employers began to weaken when more and more ordinary shop-floor engineers became members. In particular during the 1960s pressure grew to shift the focus of activities from as wide and important issues as the furtherance of the nation's industry and technology, to a more concrete level that concerned the ways in which individual engineers worked, and what they were paid for their work. Trade unionism began to raise its head.[14]

The non-academically trained engineers were organized into their own associations as well. The history of the Finnish-speaking *Union of Professional Engineers of Finland IL* goes back to 1919, while their Swedish-speaking sister organisation DiFF dates from

1936. There have also been many other local clubs and associations of engineers with certain expertise or common professional interests, and specific organizations for the promotion of the engineering sciences, technological education, as well as research and development. The graduate engineers employed by the state organized into a trade union in the 1960s, just before the rest of the graduate engineers and architects took up formal trade union activities within *The Central Organisation of University Engineers and Architects KAL* in 1972. KAL and STS were formally kept apart as two different organizations, but in reality they were the two arms of one organisational entity, which eventually were merged together completely in 1990 as STS-KAL, renamed TEK in 1993.

The fragmented professional organization of the Finnish engineering profession is the result of particular historical circumstances, but it cannot be said to have substantially deviated from an overall pattern of collective professional representation in Finland. Many other professions, like lawyers, found the linguistic divide insurmountable too, and have discussed the problems of collective bargaining and trade unionism in terms familiar to the engineering profession. From the viewpoint of collective bargaining, the organizational fragmentation should not be stressed too much as, in the end, trade union activities have been largely coordinated within *The Confederation of Unions for Academic Professionals in Finland AKAVA*.

The relations of all these different engineers' organisations have oscillated between competition and co-operation, with their interests often converging far enough to allow formal institutional co-operation, if not up to a point where a merged or roof organisation could be established for all. Today, peaceful coexistence and rather close co-operation is the norm, but that has not always been the case. Two organizations dominate the scene: TEK and IL together represent almost 100.000 engineers in Finland.

Engineers, civil society and politics

The beginning of trade union activities was a very heated and disputed issue within the Finnish engineering profession. When the collective identity and organization of the profession developed and their numbers grew in the 1960s, it was not exactly clear what their civic role should be. Should the engineers' organisations be civic actors at all in a wider sense of the term, or should they concentrate on their internal affairs, or affairs directly touching upon their traditional interests: industry and technology? In the end, the positions of the collectivist employee and the individualist employer were found in a diametric opposition to each other.

Concentration of trade union activities into a separate organisation, KAL, was a part of a compromise between modernisers and traditionalists within the profession. Many engineers of the old school held that the profession was not a similar employee

group as ordinary workers were, and still identified themselves with the employers' interests. To begin collective action as a trade union was also feared to endanger the engineers' previous role as politically and ideologically neutral experts and advisors, with their own material interests at least not displayed on the forefront. Further, the traditionalists believed at the time of the most tense debate in the late 1960s and early 1970s that engineers did not need to participate in collective bargaining as they were fully capable to ensure their pay and terms of work on their own. The traditionalists, however, were fighting a losing battle. The tide against the old school was stronger than these arguments and KAL too joined AKAVA in 1976, together with IL.

Even if the engineering profession created their own organisational profile and took their place in the techno-political arena, it has to be pointed out, that their activities within the forums of the civil society have largely related to their actual professional work with technology and industry. There has been clear reluctance to become embroiled in the political battles of the day, at least not on the side of the political left, which was one of the motivations of the traditionalists not to enter trade union activities in the first place.

None the less, the ways in which the programmatic furtherance of the more familiar and comfortable themes under the traditional banner "Technology and Industry" has been done, has brought them, reluctantly perhaps, firmly on the techno-political arena. Whether the engineering profession wanted it or not, developments in part beyond its own control made it a civic actor too.[15] Even the original reluctance became less prominent in the 1960s with the modernisers gaining the upper hand over the traditionalists, and with the establishment of self-conscious attempts to develop forms of collective action in the 1970s.

What in the end is an unavoidable conclusion, is that the engineering profession has manifested itself politically comparatively rarely. The engineering profession has not taken such an explicit political stand that has been the norm in employee and trade unions in general. They have not launched direct political challenges to the current state of affairs in the country and have displayed little political colour, although the nationalist-conservative light blue has been most common. Their influence has been based on their knowledge-power and their advisory role, and to a large extent their significant position as representatives of industry and enterprise, which in turn has had a close relationship with the state in Finland. The role as employers also posited them simultaneously on two corners of the corporatist triangle, causing unavoidable friction.

This, what their critics from the other side of the 'two cultures' divide, may have seen as 'their sinister technocratic silence', has led to the fact that individually they have left little mark in the records which political history usually relies upon when analysing the past and creating its narrative accounts of it. For example, there has been few politicians of note with an engineering background. This creates a certain methodological problem, which can

only be overcome by combining the sources we have from individual engineers with the records of the collective representative bodies. However, it has to be noted, that even these organisations have not always produced the wealth of material we often have of the thinking and motivations of others.

A further problem that affects our practical research strategies is the fact that engineers have not formed a single, coherent organisation, but have organised into different clubs and associations, and have had a role in employers' and industry's organisations as well. The organisational fragmentation makes it more difficult to see exactly where, how and when they have left their mark on political decisions, legislation or administrative practices. Of course, one should not overstate the engineering profession's exceptionality as one of the modern professions, but from a methodological point of view they are something of a challenge.

The engineering profession has in no way acted in a vacuum. In a sense the development of their collective identity and action rather belatedly mirrored developments elsewhere in the country which had established solid corporatist practices between the state, employers and employees as the anchor of the national consensus and a method of decision-making. Other developments in politics and administration also gave more room to more or less technocratic professional experts in an advisory role.

With the great importance and role of the centralised state in Finland during the 20th century from the point of view of technology and industry, and the particularly close relationship between a strong state and civil society, the engineering profession were brought, or forced, to the discussions and decision-making of the techno-political arena. Various developments contributed to this end. Especially after the Second World War they were brought into close contact with the central and local administrative apparatuses, its structure of expert committees and advisory panels, and indeed the administrative system itself as servants of the state and local administration.[16] The management of the publicly owned industries brought them to close contact with the political and administrative systems. Technical education was ran by the directives of the relevant ministries, and through them. Public debates over the many faces of technology from the 1960s onwards brought engineers too in the debate.[17] And finally, with the establishment of collective bargaining as the basis of incomes and payments politics in Finland from the late 1960s onwards they were inexorably brought within that system as well.

The political and civic role of the engineering profession has undoubtedly been somewhat problematic. But it has not entirely been their own fault. It could be said that what has marginalised the engineering profession's direct political influence has been only partly due to their own inactivity in political and social questions. One major reason for their marginal role in political decision making was the general exclusion of the professional and academically educated classes from the inner circle of the corporatist practices that were established during the post-war decades in Finland. When it came

to pay and incomes policies and negotiations, the main players in the corporatist triangle were the labour union SAK, the employers federation STK and the government – the professional organisations were completely marginalised by them.[18]

How loyal adherents to the rules of consensus-politics the professions were, can be seen in the ways in which no challenges to this established pecking-order was mounted on their behalf, at least not before the 1990s. This was so even if for a long time in the 1960s and 1970s equalising trends in pay or taxation policy were in direct conflict with their essential, material, short-term interests. Indeed, one of the main influences behind the consensus era in Finland was the backing it received from the educated and traditionally better off classes, who received social peace and stability in return.

To repeat an often said dictum: appearances to the contrary, technology is not and has never been value free. What is interesting from our purposes is that it has therefore never been politically neutral. The technological elite may have been a loyal supporter of the goals established by the political system, such as consensus politics or the management of pay and incomes negotiations or industrial relations. Hence, they have probably been an important stabilising force in Finnish society, but this does not mean that their activities have been entirely determined by forces beyond their own control. The technological avenues opened by them and choices made, may not have been directly politically motivated, but politically significant none the less.

Such has been the societal impact of various visions arising from the engineering profession, that there is a need to go beyond the traditional technological and economic spheres for a proper social and political contextualisation of their activities. Even if engineers have formed a relatively quiet, loyal, and accomodating profession, we cannot consider the profession only as an object of such impersonal forces like technology, economics or society. If we understand the engineering profession as an active and willing agent of social change, be it with their own methods and conventions, it will give us a better understanding of the way in which the technological future has arrived upon us, how it has changed the way we live, work, consume, communicate, vote, and who do we thank or blame for it.

[1] Overviews of new trends of the history of technology in Sweden and Finland are found in Kimmo Antila, 'Tekniikan historian läpimurto Ruotsissa', *Tekniikan Waiheita* 1/1998, pp. 39 - 44; and in Kimmo Antila & Panu Nykänen, 'Suomen tekniikan historian ja museotoiminnan lyhyt historia', *Tekniikan Waiheita* 1/2000, pp. 28 - 43. See also Karl Erik Michelsen, 'Onko teknologialla menneisyyttä? Pohdintoja teknologian historiasta ja sen tutkimisesta', in Tarmo Lemola (ed.), *Näkökulmia teknologiaan* (Helsinki: Gaudeamus, 2000), pp. 62 - 89.

[2] The concept 'societal' includes here also the cultural, economic and political spheres.

[3] Judy Wajcman, *Feminism Confronts Technology* (Cambridge: Polity Press, 1991). More specific case studies on women and motoring are Virginia Scharff, *Taking the Wheel: Women and the Coming of the Motor Age* (New York: Free Press, 1991); Sean O'Connell, *The Car in British Society. Class, Gender and Motoring, 1896-1939* (Manchester: Manchester University Press, 1998).

[4] Karl Erik Michelsen, *Viides sääty. Insinöörit suomalaisessa yhteiskunnassa* (Helsinki: TEK/STS, 1999).

[5] Jukka Nevakivi, Seppo Hentilä & Lauri Haataja, *Johdatus poliittiseen historiaan* (Espoo: Weilin + Göös, 1983), pp. 16 - 19.

[6] 'Introduction', in Merrit Roe Smith & Leo Marx (eds.), *Does Technology Drive History? The Dilemma of Technological Determinism*

(Cambridge, MA: MIT Press 1994), pp. xii - xiii.

[7] For a recent example, see Louis Brown, *A Radar History of World War II: Technical and Military Imperatives* (Bristol & Philadelphia: Institute of Physics Publishing, 2000).

[8] Pauli Kettunen's studies of labour history, and the studies of rationalisation and workplace practises in early 20th century Finland, can be seen as a fresh departure to connect social and political history with the history of technology. Pauli Kettunen, *Suojelu, suoritus, subjekti* (Helsinki: SHS, 1994).

[9] The articles in a recent issue of Diplomatic History underline these trends in the history of international relations. Walter Lafeber, 'Technology and U.S. Foreign Relations', *Diplomatic History*, Vol. 24, No. 1, (2000), pp. 1 - 19; Joseph Manzione, '"Amusing and Amazing and Practical and Military": The Legacy of Scientific Internationalism in American Foreign Policy, 1945-1963', *Diplomatic History*, Vol. 24, No. 1, (2000), pp. 21 - 55; Richard V. Damms, 'James Killian, the Technological Capabilities Panel, and the Emergence of President Eisenhower's "Scientific-Technological Elite"', *Diplomatic History*, Vol. 24, No. 1, (2000), pp. 57 - 78. A further call for the study of technology in international relations is found in Odd Arne Westad, 'The New International History of the Cold War: Three (Possible) Paradigms', *Diplomatic History*, Vol. 24, No. 4, (2000), pp. 551 - 565.

[10] On the development of the Finnish civil society, see further Risto Alapuro, Ilkka Liikanen, Kerstin Smeds & Henrik Stenius (eds.), *Kansa liikkeessä* (Vaasa, 1987).

[11] Michelsen (1999), pp. 179 - 207. Michelsen summarises the origins of organised activities by the Finnish engineering profession in the 1880s and its subsequent division along the language divide in the 1890s.

[12] Ibid. The last sections of the article are based on author's research underway on the history of the STS/TEK 1896-2000.

[13] 'Kertomus Suomenkielisten Teknikkojen Seuran toiminnasta vuonna 1897', *Suomen Teollisuuslehti*, 2/1898, p. 15.

[14] Alari Kujala, 'Diplomi-insinöörien ja arkkitehtien työmarkkinatoiminta STS:ssä, *Tekniikka* 3/1971, pp. 31 - 36.

[15] Michelsen (1999), p. 229, 336.

[16] On the relationship between engineers and the state in Finland, see Michelsen (1999), pp. 223 - 251, 298 - 306.

[17] A hallmark of engineers' participation in public debates was the publication of *Tekniikka kulttuurissa* in 1969, which was a special issue of *Teknillinen Aikakauslehti* 7-8 B/1969.

[18] Heikki Saari, 'Akavan historia kulkee suurten muurosten kautta', *Tekniikan Akateemiset* 5/2000, pp. 11 - 13, introducing this and other findings by Jukka Vuori in his official history of Akava, to be published shortly.