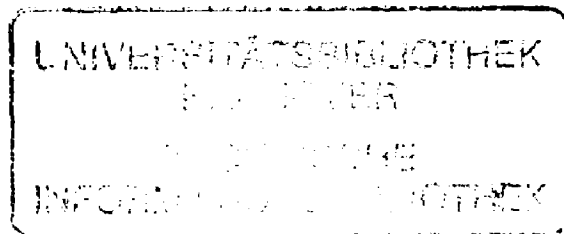


SYSTEMS, EXPERTS, AND COMPUTERS

The Systems Approach in Management and Engineering,
World War II and After

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FROM OPERATIONS RESEARCH TO FUTURES STUDIES:
THE ESTABLISHMENT, DIFFUSION, AND TRANSFORMATION
OF THE SYSTEMS APPROACH IN SWEDEN, 1945–1980

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INTRODUCTION

In 1948 the Nobel Prize in Physics was awarded to the British physicist Patrick Blackett for his discoveries in cosmic radiation. Blackett, a fifty-year-old professor from the University of Manchester, was already something of a hero in his home country, not because of his scientific work, but because of his contributions during World War II to the development of operations research (OR).

At the outbreak of the war, Blackett was asked to head a group of scientists at the Anti-Aircraft Command working on a new air defense system based on radar technology. The group improved the functioning of this system considerably, a factor of great importance during the Battle of Britain. The success of this group led to the establishment of similar groups of scientists at other Commands in the British army, navy, and air force. Their activities were referred to as Operations Research, and “Blackett’s circus,” as the groups were sometimes called, played an important role throughout the war in improving the efficiency of a variety of military operations.

The Nobel Prize awarded to Blackett was an important event in the early history of operations research in Sweden. Blackett stayed in Stockholm for ten days, and he gave several lectures and had many informal discussions with leading Swedish scientists from universities and from the recently founded National Defense Research Institute (FOA). He probably also met high-ranking military officers. Blackett’s wartime experience and his personal charisma created a strong interest in OR and was one impetus for establishing OR in Sweden.¹

The purpose of this chapter is to describe and analyze the development of the systems approach in Sweden from 1945 to 1980. We use the term “systems approach” to signify a specific intellectual tradition, which started with operations research in the 1940s, but later developed in a variety of ways into systems analysis, policy analysis, and

futures studies. Our demarcation is mainly sociological in character; that is, we start with operations research and the people and organizations in this particular field, and then we move on to the activities that grew out of operations research, which to a great extent involved the same people and organizations. The boundaries of this tradition are somewhat arbitrary. First, there were activities similar to operations research long before World War II. In particular, scientific management, developed by F. W. Taylor and others at the turn of the century, had a number of similarities with OR. Second, there were other activities in the postwar period that resembled the systems approach (for example, economic and regional planning) but did not involve operations researchers.

One area the chapter focuses on is the gradual transformation of the systems approach. Operations research was primarily tactical, aimed at improving existing weapon systems or production systems, and the methods employed had a scientific and mathematical bias. In the late 1950s, operations researchers, or operations *analysts* as they were often called, gradually turned to broader problems of finding the best designs for future systems. Handling uncertainty became a key issue, and the OR toolbox was complemented with economic methods and models and with concepts such as flexibility and adaptivity. To emphasize this wider approach, the term "systems analysis" was introduced. In the late 1960s, the approach was broadened once again to more general societal problems, and methods from the political and social sciences supplemented the earlier approaches. In the United States, this new approach was labeled policy analysis, but in Sweden the emphasis was more on what was called futures studies.

Another focus of this chapter is on the diffusion of the systems approach into different sectors of Swedish society. In the early 1950s, OR was carried out by four academic groups in Stockholm. They worked with both military and civilian applications, often on a consultancy basis. In the late 1950s, OR was established in the defense sector on a permanent basis, and there has been a fairly coherent and organizationally unified development of the systems approach in this sector since then. There were also attempts to establish OR more permanently in industry, in the academic world, and in the public sector, but in these civilian sectors the systems approach has been more scattered, with no strong organizational center. The Swedish Operations Research Association, established in 1959, played an important role as a meeting place for operations analysts and also as a lobbying organiza-

tion for the systems approach, but it had no permanent staff and limited economic resources.

The second section describes the development of the systems approach in the Swedish defense establishment, and the third section deals with the systems approach for civilian applications. This means that the article is not strictly chronological, as these two developments occurred in parallel. In the concluding section some characteristic patterns and factors in the development of the systems approach in Sweden are outlined.

The sources for the article are of four kinds: archive material;² contemporary official publications and journals; interviews with eleven persons involved in or knowledgeable about OR activities in the 1950s, 1960s, and 1970s;³ and secondary literature.⁴

THE SYSTEMS APPROACH IN THE SWEDISH DEFENSE ESTABLISHMENT

At the outbreak of World War II, Sweden had a weak defense establishment with equipment that was largely obsolete. After the German invasions of Denmark and Norway in the spring of 1940, acute fear of a German invasion arose in Sweden, and the country started a rapid military buildup. The country was blocked from most of its foreign trade, and the war economy focused on establishing and expanding a domestic industry for all kinds of military equipment. Thanks to a strong and diversified engineering industry, within a few years Swedish industry was able to produce everything from airplanes and tanks to ammunition and gas masks. This domestic industry for military equipment was in large part retained after the war, although the levels of production were lowered.

The Swedish government succeeded in its ambition to keep the country out of World War II. In the late 1940s, Sweden tried to establish a Nordic defense treaty with Denmark and Norway. However, these countries chose to join NATO in 1949, and Sweden decided to return to its traditional neutrality policy, based on the formula: "non-alignment in peace, aiming at neutrality in case of war." Even if the Swedish neutrality was not as strict as officially maintained,⁵ this decision meant that Sweden would have to rely largely on its own military strength. There has been a broad political consensus ever since that a strong military defense is necessary in order to gain confidence and respect for the country's neutrality policy. Sweden has been unique in this respect. Apart from Israel, no other nation of Sweden's size has

built such a strong defense establishment and such a diversified domestic industry for military equipment.⁶

The First OR Activities

Blackett's visit to Stockholm in 1948 was not the first time that operations research was discussed in Sweden, but it spread interest in OR to wider circles. Furthermore, Blackett arranged for a British OR specialist, C. E. G. Bailey, to come to Stockholm in February 1951 to give three lectures on operations research to an audience of officers, academics, and civil servants. Bailey gave an account of British experiences concerning the kind of problems that had been solved, the techniques that had been used, and the forms of organization that had been most effective. Based on the impressions he had received during his stay in Sweden, he also drew some conclusions, emphasizing that

O.R. methods have still much to offer to Sweden, and in particular to Swedish Defense Forces. I believe those forces are still in the stage where small groups of men could cause an increase in the effectiveness of 2 or 3 times in the units they are attached to. First class men are needed and they will have to be paid for.⁷

However, in an official letter from the Defense Staff in September 1951, it was argued that the Swedish defense establishment could not afford to employ full-time civilian personnel for OR work. It was recommended instead that scientists be employed on a part-time consultancy basis, and that young scientists should be encouraged to do their compulsory military service as operations analysts.⁸ Thus, in the early 1950s the first OR activities were started in the Swedish military forces on a small scale. Each of the services established cooperation with a specific academic environment in Stockholm.

The air force started cooperating with Professor Lamek Hulthén at the department of mathematical physics at the Royal Institute of Technology (KTH). Hulthén had been a consultant to FOA in matters related to atomic weapons since 1945,⁹ and moreover he knew Blackett personally.¹⁰ Hulthén was teaching the students of technical physics, which was one of the most prestigious academic careers in Sweden at the time. Each year he would suggest that one or two of his best graduating students should do their military service as so called "research technicians" for the air force.

Hulthén was a scientific advisor for these “research technicians” on a consultancy basis, advising them about suitable problems and appropriate methods for solving them. Furthermore, a career officer was assigned to provide them with military expertise. In the early years the OR work was focused on aircraft warning systems, and it was concluded that the present warning system at military air bases would not give sufficient time for airplanes to take off in case of a sudden air attack. When the commander in chief of the air force was informed about these findings, he was quite disturbed about this deficiency.¹¹

The Navy Staff established cooperation with Professor Harald Cramér from the department of mathematical statistics at the University of Stockholm. Cramér was a man of high standing in the academic world; in 1951 he became vice chancellor of the University of Stockholm, and in 1959 he became chancellor of all Swedish universities. In 1948, Cramér and some of his colleagues had established the Statistical Research Group (SGF) to do statistical studies and OR studies on a consultancy basis for industry (this will be outlined in the second part of this chapter). Now the group extended its work to include the military sector. It focused on mathematical models of naval artillery. In particular the probabilities for hitting targets using different firing modes were analyzed as a basis for developing more efficient battle tactics.¹²

The Army Staff chose FOA as its OR partner. FOA had been founded in 1945 as a joint research agency for all the defense authorities and was based on wartime experience of defense research. In the 1950s it became the center for Swedish military R&D and its personnel grew from 200 in 1946 to more than 1,600 in the late 1960s.¹³ The OR work in the Army Staff was headed by a young mathematician at FOA, Lars-Erik Zachrisson. He developed a special kind of game theory (Markov games) for analyzing battlefield behavior. This theory was applied in the analysis of duels between tanks, or similar situations, as a basis for developing better battle tactics.¹⁴

The OR work in the Swedish military in the first half of the 1950s was thus of limited scope and was mainly carried out by young “research technicians” doing their military service. This way of organizing OR work was cheap, but prevented the buildup of a more permanent competence base. Most of the OR work was focused on finding the most efficient use for existing weaponry and other resources.

The purpose was to identify weak spots and to propose better fighting methods and battlefield tactics. This focus was similar to that of the allied OR groups during World War II.

From Operations Research to Systems Analysis

In the early 1950s, Sweden's military situation changed with the growing tensions between East and West, and the rapid armaments race on both sides. There was a growing conviction both in the military and among leading politicians that Sweden's military equipment was becoming obsolete and that new, modern weapon systems would have to be developed. Fighter aircraft and nuclear weapons were seen as two key technological areas.

The director general of FOA, Hugo Larsson, became an outspoken proponent for using operations research as a key instrument in this technological modernization. In an article entitled "Which Weapons Shall We Choose?" Larsson warned that the traditions and prestige of the three services could have a dangerously restrictive effect. He argued that it was imperative to make a thorough analysis of the kind of weapons an enemy might use against Sweden in the future, and that choices of future weapon systems must be based on this analysis. "Everywhere abroad Operations Research is used for this end," he asserted, and argued that Sweden should do the same.¹⁵

Larsson convinced the minister of defense of the importance of OR, and in 1955 the minister commissioned the Supreme Commander to investigate the future organization of military OR. A special committee with representatives from the services was appointed to this end. In its final report it recommended the creation of one central OR office, which was to coordinate and support the work of permanently established OR groups in the army, navy, and air force staffs. A tug-of-war developed between the Defense Staff and FOA about the location of this central office. The final outcome, in 1958, was that this office was placed at FOA, within a new planning department, called FOA P.¹⁶

At the same time, FOA became more and more involved in the overall military planning process. In 1959, the director general of FOA, Martin Fehrm, became a permanent member of the Military Council under the supreme commander, which had previously consisted only of the commanders in chief of the services. This was a recognition on the part of the military of the increasing importance of R&D in the

development of Swedish defense. It was largely the task of the personnel of FOA P to support Fehrm's work in the council.¹⁷

Thus, in the late 1950s, military OR work was organized on a permanent footing. At the same time a gradual transition of the content of OR work toward more strategic issues began. The role of the analyst was changing from a "trouble-shooter" and efficiency improver of existing weapon systems to a planner and designer of future weapon systems. It is interesting to note that the term "weapon system" was increasingly used at this time. A large part of the inspiration for this development came from the United States. In a 1957 article, an OR researcher from FOA very clearly acknowledged this American influence when he pointed out that "the Americans have coined the term Systems Analysis for this kind of OR."¹⁸

OR for Military Planning

When FOA P was created it established permanent OR groups within the services and Defense Staff. In the first years, there was only one permanently employed analyst on each staff, but gradually the groups were expanded to a full size of about five persons each. The central OR office at FOA P was kept rather small and was primarily responsible for methods development, coordination of the work of the OR groups, and the recruitment of analysts. Between 1958 and 1970 the number of people on the OR staff grew from six to more than forty.¹⁹

Carl-Gustav Jennergren, an expert on explosives from FOA's physics department with no prior OR experience, was appointed director of FOA P. Jennergren became deeply involved in the military planning process as Fehrm's adviser, and this influenced the work of his staff. In the early years of FOA P, a great deal of energy was devoted to the development of new methods for long-range planning: evaluation principles for comparing the effectiveness of different weapon system designs and defense compositions, methodology for large-scale war games carried out by military officers for simulating combat situations, and computer simulations of large-scale military operations.²⁰

At the outset, the methodologies employed had a quantitative bias. For example, many analysts thought that measures of effectiveness of future weapon systems could be quantitatively determined. However, when the analysts were confronted with broader and more future-oriented issues, the limitations of pure quantitative methods became obvious. Instead, more qualitative questions about the flexibility and adaptability of weapon systems to future changes in enemy

weaponry were seen as vitally important. The participation in the military planning process thus stimulated a reevaluation of methods and approaches. Jennergren and his staff also found that actual planning and implementation was not as rational as they had assumed, and they became increasingly interested in the planning and implementation process as such and in how it could be improved.²¹

Important impulses for new methods and approaches came from abroad, and in particular from the United States. In 1961, a group of FOA P analysts visited the RAND Corporation, which had extensive experience in military long-term planning. In the following year some prominent RAND researchers, among them the OR pioneer E. S. Quade, came to Stockholm to give lectures and seminars on systems analysis and long-term planning. The RAND researchers advocated a broad multidisciplinary approach, and they stressed the importance of including economists. This had an impact on FOA P's subsequent development, according to Jennergren. As a direct result, FOA P recruited some economists, who came to play an important role in the development of more sophisticated methodology and organization for military long-term planning.²²

In the mid 1960s, analysts at FOA P played a vital role in the development of a new planning system for the defense sector. It had four major elements. The first involved broad studies of international developments within the political, military, economic, technical and social domains as a basis for constructing possible cases of aggression in the form of "crisis scenarios." The second element, a prospective planning process with a fifteen-year perspective, included the design of different future defense structures for different budgetary constraints. The third element was directed toward the planning and design of major weapon systems, such as new fighter aircraft. The fourth element, based on the first three, was the formulation of five-year program plans, which were adapted—"rolled"—every year.²³

FOA P: The Spider in the Military Web

In the 1960s FOA P gradually became a very influential "spider" in Sweden's military web. Through its OR groups it had close ties with and extensive knowledge of each of the three services and of the properties and efficiency of existing weapon systems. FOA provided an access to the expertise of the other FOA departments doing military research on new weapon systems. And the involvement in the military

planning process offered a bird's-eye view of the military sector. This broad expertise gave FOA P considerable influence.

This influence is clearly demonstrated in the nuclear weapons issue, which was the overarching question for military planning in Sweden from the mid-1950s to the mid-1960s. FOA was the center for research on nuclear weapons, and around 1960 a large number of FOA's personnel were involved in different aspects of this research. In the mid-1950s most of the emphasis was on how to construct nuclear weapons as quickly as possible. There was a fairly broad consensus that acquisition of nuclear weapons was of critical importance for Sweden and would have a significant deterrent effect.

In the late 1950s opposition to nuclear weapons grew, within both the opposition and the governing Social Democratic Party. As a result, nuclear weapons research was partly reoriented toward assessing the effects of nuclear bombs on military installations, military personnel, and the civilian population. These studies indicated that the effects were much more pervasive than had previously been imagined. Based on these results, operations analysts initiated studies and war games together with officers to clarify the tactical, strategic, and political aspects of nuclear warfare. Two important results emerged from these studies. First, the previous conception of limited nuclear warfare restricted to the battlefield was abandoned; once nuclear weapons were introduced in a battle, it would be very difficult to prevent an escalation. Second, the lack of limits on nuclear warfare meant that the effects of such a war would be a total catastrophe for Sweden. These studies played a decisive role in showing leading military figures limitations of the nuclear strategy and led to a new consensus in the mid-1960s not to develop nuclear weapons in Sweden.²⁴

Analysts, Officers, and Politicians

From the late 1950s onwards, operations analysts acquired a growing influence in the military and on the military planning process. This "civilian invasion" into the military hierarchy was in a way the most essential feature of the systems approach in defense. It is hardly surprising that a number of prominent officers felt threatened in their professional role. An illustrative example of this occurred when the head of the military academy wrote an article in one of the major Swedish newspapers entitled "Strategists and Counting Experts," questioning whether military decisions should be based on "seemingly mathematical

calculations instead of applying military judgment, intuition, and experience.”²⁵

Serving as an operations analyst in the military demanded a certain diplomatic skill, and on several occasions analysts lacking this skill were frozen out. In most cases, however, the operations analysts were able to establish a successful cooperation with their military counterparts. One reason for this was that the analysts were seen as a valuable resource in the eternal battle for economic resources between the services.²⁶

At the Defense Staff, representing the highest level in the military hierarchy, the OR researchers were considered valuable in preparing decisions about how to optimize allocation of resources between the services. When Jennergren met the supreme commander for the first time, after having been appointed head of FOA P, the latter exclaimed: “Very good, write up your damned formulas so that we can finish all these discussions about resource allocation!”²⁷

In the mid-1960s the politicians and administrators at the Ministry of Defense also began to see operations analysts as a valuable resource. At this time the general political attitude to defense became more restrictive, and politicians were worried about the cost escalations in the development of a new aircraft, Viggen. As a result, there was growing antagonism between government and the military authorities.²⁸ The operations analysts were highly knowledgeable about the services and new weapon systems, and yet did not belong to the military hierarchy. So, in 1965, a handful of analysts were employed by the ministry to develop a planning system which would give government a stronger position vis-à-vis the military.²⁹

The Swedish historian Wilhelm Agrell has described the major changes in the Swedish defense in the postwar era in terms of three concepts or trends: technology orientation, professionalization, and politicization. The development of new, technically sophisticated weapon systems has been a key issue in defense policy and has led to allocation conflicts between the services. The growing complexity of these systems has led to a change in the military profession, with higher demands on theoretical knowledge and management skills. And the high costs and long lead times of these weapon systems have forced the politicians to try to increase their control over the long-term development of the defense sector.³⁰

The role of the operations analysts can be seen against these three trends. Their background and training, in combination with their organizational location at FOA and the military establishments, gave

them a unique knowledge of weapon systems. This knowledge made them a valuable resource both for professional officers in their fight for resources and for politicians in their efforts to curb excessive military ambitions.

Above, we have tried to explain the rapidly growing influence of operation analysts in Swedish defense in the 1960s. Another salient feature is the persistence of FOA P as an organization and of the systems approach as an intellectual tradition within the defense sector. In fact, the whole organizational structure of OR work and the military planning process built up in the 1960s is more or less intact today.

CIVIL OR IN SWEDEN

The civil operations research that developed in Sweden after World War II derived its inspiration from several sources. In the initial stages, as we will see, military OR activity was the most important of these sources. The military's OR work became the mold for the civilian approaches.³¹ But early civilian OR also had clear roots in the intellectual environments arising around the classic administrative sciences. One such was the rationalization movement dating from the 1910s.³² Inspired by F. W. Taylor's concepts of scientific management, many ideas of rationalization found support in influential industrial and academic environments at that time. The Federation of Swedish Industries (Industriförbundet), formed in 1910, stated in its first annual report, for example, that industrial management was to be a subject of key importance for the organization. In 1913, two years after its original publication, the Federation published Taylor's book *The Principles of Scientific Management* in Swedish. The Royal Academy for the Engineering Sciences (IVA)—which was established in 1919 to support technical research and development—also became an important institution for the spread of the rationalization movements ideas.³³ During the interwar period this movement, with its echoes of Taylor, swept over Swedish industry, and gradually concepts such as time studies and production planning became standard prose among top Swedish industrialists. New statistical tools for the optimization of stockholding and for the planning of long-time investments also appeared at this time. In 1934, a big conference organized by IVA and the Swedish Association of Engineers (Teknologföreningen) dealt with time studies and in 1945 the Swedish omnibus book *Handbook of Industrial Productions Economy and Organization* was published.³⁴

The core ideas of the rationalization movement were developed further and the theories found an institutionalized form when education and research programs in industrial economy and organization were established at the universities. In 1940, the first professorship in industrial economy and organization was set up at the Royal Institute of Technology in Stockholm.³⁵ Courses for engineers were offered in production planning, among other things. The material used in that course later appeared in revised form, as a Swedish textbook on operations research.³⁶ Thus, even if few of the OR pioneers in Sweden after 1945 stressed the fact, the OR techniques that they proposed had methodological roots in the Swedish academic world independent of any military influence.

Early Civilian OR

In 1947 Professor Harald Cramér delivered a speech at IVA on statistical methods for industry. Most of Cramér's speech consisted of an exposition of the acute need for more resources in this research area. He mentioned the American efforts to raise money for this purpose and pointed to the work done at the Statistical Research Group at Columbia University as worthy of imitation. At the end of the lecture, Cramér mentioned OR. He stressed its wartime successes and its continuing military relevance, and argued for its future industrial use:

... according to experts in the matter, military OR in time of peace will be followed by industrial OR, where the efficiency of different industrial processes of production will be studied in the same way, with mathematical/statistical methodology.³⁷

In 1948 the Statistical Research Group (SFG) was formed at Cramér's department for mathematical statistics at Stockholm University. The group carried out commissioned research in OR for industries in Sweden and abroad. Most of their work in the 1950s was "clean" OR: empirical, and aimed at finding solutions to well-defined and isolated industrial problems. In other words, studies similar to the work done in the armed forces during the 1950s. These early OR studies, industrial as well as military, thus resembled earlier Taylor-influenced work; they aimed at making existing processes and technologies more effective, rather than replacing them with new ones.

Among other things, the analysts at SFG worked for Swedish newspapers on distribution issues, for the oil industry on prospecting methods, and for the Swedish state mines and steel plants on transpor-

tation and location models. Around the corner from SFG in downtown Stockholm was the School of Economics where the Group for Model Conception in Business Administration had its office. This group, under Professor Paulsson Frenckner, became the platform for the introduction of OR into managerial economics in Sweden. The two groups did not compete for commissions. The demand for the new services was far higher than the group's combined capacity.

Three kinds of arguments frequently recurred in the rhetoric of the Swedish OR propagandists. One was simple: it sold OR as tried-and-true for military applications.³⁸ Now, it was argued, the techniques that had helped to win the war could also help corporations hit their business competitors. A second argument arose from the idea that in modern industry, labor would gradually be replaced by machines and other new technologies. These technologies were expensive, locking production in set patterns for long periods of time. Analysts argued that inflexibility, characteristic of highly technology-dependent industries, required a broad general knowledge about processes of change and about future trends. OR teams, experienced in applying new mathematical/statistical methods, were ready to provide this knowledge. A third argument used by the OR propagandists was to point to a new class of managerial problems in modern industry which could only be solved with OR techniques. This new class of problems resulted from the multidivisional character of modern industry and led to inconsistent and sometimes conflicting goals within corporations. With the tools of OR, the managers were promised a way to re-create harmony and regain an overview and control of their organization. To obtain that overview, however, the management of the corporation had to allow the OR teams considerable freedom in their work. This was because the OR methodology, according to analysts, was organizationwide in scope, which meant that no matter what specific problem the analyst was to examine, it had to be examined as part of the whole. This inherent characteristic of OR, analysts claimed, required the teams to have access to all kinds of information, including that which might appear irrelevant to the uninitiated.

The young scientists selling OR to Swedish industry were clearly not modest in their ambitions. One of them, at the IVA meeting in 1953, outlined three levels on which OR should be applied: the lowest level (compared with weapons in the military) was concerned with effectiveness in use and arrangement of machines. A tactical level was for handling production efficiency and optimization of the resources.

Finally, there was the strategic level, where problems concerning the organization as a whole, location issues, market analysis, and so forth were discussed.³⁹ Another analyst presented a survey of articles in the British and American OR journals. He showed that industrial subjects outnumbered military and theoretical/philosophical and historical topics, and that this trend was on the increase. Using this survey, he argued that OR was soon going to be an indispensable tool for any industrialist seriously wanting to compete in the market.⁴⁰

Shortly after the IVA meeting, an ad hoc committee for operations research was created within IVA. In 1955, the committee sponsored a study tour for Professor Paulsson Frenckner to the United States. During the six-week trip, Frenckner visited twelve universities and a countless number of corporations, think tanks, and state agencies where OR was practiced. In 1956, IVA invited top Swedish industrialists, academics, and military figures to an OR conference. Frenckner started by presenting his experiences from the study tour in the United States. Other papers were presented as well, on OR for industrial management, OR methods for optimization of quality in the processing industry, and the optimization of route design for public transport. The conference resulted in the creation of a permanent committee within IVA for OR issues.

The Swedish Operations Research Association

In February 1959 Professor Edwards H. Bowman from MIT in Boston delivered a speech at the Stockholm School of Economics entitled "Some Difficulties in Doing Operations Research." Invitations were sent out to forty-five men—academics, military figures, and industrialists. The letter of invitation informed them that an OR association was going to be formed, and that Bowman's speech was to be the starting signal for the club's activities.⁴¹ Contacts had been made in advance with the sister associations in America and Canada and their statutes and membership regulations had been copied. On this occasion, then, the Swedish Operations Research Association (SORA) was formed, and it soon became part of the International Federation of Operations Research Societies (IFORS). Harald Cramér was appointed president and Lamek Hulthén and Paulsson Frenckner were elected to the board. From the start, analysts from FOA P also occupied high offices within the association. A year later, a group of twenty SORA members attended the second annual IFORS conference in Aix en Provence.⁴²

The association started up with a lecture series on classic OR problems such as queue theory and location problems. By the mid-1960s, a wider variety of subjects was seen at SORA's meetings. Planning and security issues in road traffic, transport planning analysis for the switch to righthand traffic, peace research, and more were dealt with at recurrent "OR days" arranged by SORA.⁴³ The association grew from around 100 original members to about 400 in the early 1970s. Throughout the 1960s the majority of the members were engineers and mathematicians/statisticians. Many of the most active members of SORA were employees at FOA P. Courses in OR for civilians were given by FOA P analysts during the 1960s, and measures for the establishment of institutionalized education for operations analysts were discussed within the association. A step toward this kind of program was taken in the mid-1960s when FOA P agreed to start courses in classic OR for students in engineering. The FOA mathematician Lars-Erik Zachrisson, who developed game theory for tank duels in the early 1950s, became a teacher and researcher at KTH with his salary paid by FOA. Later, in 1969, KTH managed to get government funding for establishing a new department named "Optimization and Systems Theory," and Zachrisson became permanent professor.⁴⁴ An important step for the institutionalization of OR in Sweden had been taken.

Early Swedish OR: Consensus

The first period in Swedish OR activity is characterized by consensus among its different practitioners. There was enough work for everyone at this time, and there was no explicit antagonism between the different spokesmen for OR. The members of the IVA committee agreed, not only about the benefits of the new techniques, but also about the best course of action in the launching process. No voices critical of OR thinking were raised at this time. Consequently, there were no discussions about the possible dangers of applying the new techniques, or about overall aims.

The situation in the United States at this time was rather similar. Giandomenico Majone explains the lack of conflicting interests in early American OR by the fact that it was a young and developing profession.⁴⁵ As such, it was missing a mechanism for quality control that is one of the distinguishing features of more established professions. Ida Hoos sees another factor behind the consensus situation, that is to say, the "width" of OR. She claims that the myriad forms and manifes-

tations that constituted the new “science” made it almost immune to attack and critical reading.⁴⁶

The situation in Sweden and the United States differs from that in Britain, where efforts were made by left-wing intellectuals, among whom were prominent OR heroes from the war, to create alternative and more radical OR after the war.⁴⁷ Rosenhead has shown how conflicting British interests involving consumers, scientific workers, nationalized industries, and government ministries fought over control of OR in the late 1940s. The defeat of the Labour party in the 1951 elections meant an end to efforts to develop an OR methodology aimed at increasing the power of consumers at the expense of that of private capital.⁴⁸

There were no groups trying to establish a more radical OR in Sweden after the war. Why not? Many explanations are possible. The left-wing views of the scientific community creating OR in Britain were not prevalent among their Swedish counterparts. Furthermore, the atmosphere that had characterized the British OR groups during the war—hard and innovative work for a common aim, to win the war—never prevailed in the Swedish OR environment. In addition, Swedish industry in 1945 stood intact and ready to provide the country with economic wealth. Nationalization of industry was therefore not such a lively idea in Sweden as it was in Britain, where industry was in ruins and private capital was scarce.⁴⁹ It was not until the late 1960s that conflicting interests around the systems approach arose in Sweden.

OR in the Public Sector

By the early 1960s, OR had changed substantially, compared to the work of the early 1950s. Many teams had left the easily isolated tactical problems, and the studies had broadened. Operations analysts, at FOA and elsewhere, had by the early 1960s understood that many of the problems they examined were too complex to be understood only with the help of their square tools of mathematics and mathematical statistics. Through meetings with RAND representatives, FOA analysts became convinced of the need to incorporate, among other things, economic considerations in their analyses. Consequently, a group of economists entered the Swedish OR scene in the early 1960s. From this time on, OR changed its focus from industrial applications to increasing number of applications in the public sector, such as health, housing, and social welfare.

In 1958, a paper by Professor Tore Dalenius on queue theory in the health sector was published.⁵⁰ Dalenius was a statistician from SFG and had been prominent in the creation of SORA. In the mid-1960s he was engaged by the Council for the Rationalization of the Health Sector (SJURA) to make an inventory of the possibilities of using OR methods to solve problems arising in the health care system. The report describes how questions concerning everything from the optimization of hospital size and location to personal administration and optimal diet for patients could be answered with the help of quite rudimentary OR methods. Two organizations for the planning of the rapidly growing health sector appeared at this time, and a commission for OR in the health sector was formed in the mid-1960s on the initiative of IVA and the State Technical Research Council. In 1968, the State Planning and Rationalization Institute for Health Issues (SPRI) was established by the government.⁵¹

The activities within SORA partly reflect the change in Swedish OR methodology from the early 1960s. The proportion of speeches at SORA's OR days concerned with public administration increased while topics concerning military applications diminished. OR days in the mid-1960s were also explicitly focused on systems analysis. The RAND connection was emphasized, as several of the speeches were delivered by FOA P analysts with close contacts with the United States.⁵² The association's membership structure did not, however, change correspondingly. The preponderance of natural scientists continued into the 1970s. SORA also retained its industry-oriented position and remained an environment where OR in its more original mathematical form was practiced. This continued to be true even when the reputation of that kind of OR fell dramatically among planners and the general public in the 1970s. In 1974, SORA published a booklet containing a selection of recent applications of OR. They were all very traditional studies concerning optimization of industrial processes and similar topics. From the mid-1970s onward the membership and activities of SORA decreased. Today the association is not very active.

Systems Analysis in Sweden

From around the mid-1960s the term systems analysis (SA) started to be used in Swedish OR circles. The first systems analytical studies initiated in the 1960s differed in a number of ways from traditional OR. Per Molander has written a survey of systems studies in Sweden.⁵³ He holds that SA dealt largely with synthesizing new systems or part systems,

something that OR did not do. SA problems, Molander says, were more dynamic and their time perspectives were longer. Furthermore, the goals for SA studies were, unlike in OR, only rarely well defined. SA studies also differed from early OR in that they often tended to avoid fixed systems demarcations. Moreover, the systems analysts worked with a higher general uncertainty than did the OR teams in the 1950s. These characteristics result partly from the extended time horizons in SA studies.

New academic disciplines were incorporated when OR was extended to systems analysis. Theoretical fields such as organizations theory and decision theory were included in the SA work of the 1960s. This was because the importance of considering the organizational frames within which a decision should be made was recognized by systems analysts both at FOA and in civilian sectors at this time. This, in turn, was a result of the growing concern that the results of OR work often appeared to have no impact on decision making within the organization where the studies had been performed. In other words, the results from OR work in some way "got lost" on the way up to the decision-making layers of the organization.

FOA P felt the need to establish courses and research in systems analysis and planning methodology. To this end a research group in planning theory was set up by FOA at the mathematics department at KTH in 1969. Lars Ingelstam, a young mathematics professor with previous experience of OR work at FOA P, was appointed head of this group. Ingelstam and his staff came to play an important role in the introduction of futures studies in Sweden, as will be outlined below.

In the United States, the more executive oriented policy analysis appeared at this time. Attempts to create an academic environment with such policy analytical features were made by FOA representatives in the early 1970s, but failed. The executive-oriented American policy studies do not appear to have fit into the Swedish academic organization, at least not at this time. Policy analysis, of the kind argued for by Yehezkel Dror and others, never became institutionalized in Sweden.⁵⁴ Instead a series of studies oriented toward a more general public appeared in the early 1970s.

Swedish Futures Studies

In the early 1970s a new process of change in the systems approach began in Sweden. Political, domestic, and international situations changed dramatically. Economic stagnation and the energy crisis

replaced the unquestioned optimism of the 1960s, and the awareness of environmental problems and the situation in the developing countries grew, especially among young citizens. People with a past in the OR environment at FOA P, and with close ties to the Social Democratic Party, now started to argue for a broadening of the systems approach to long-term analysis of entire sectors of society, suggestions not very different from the studies that British OR radicals had proposed in the 1940s.

Swedish industry also showed a growing interest in long-range planning and futures studies. As early as 1969, IVA had presented a report suggesting a joint institute for futures studies between private industry and the government. The report was inspired by IVA's experiences as a client at the Hudson Institute under Herman Kahn. With the IVA report, a period of intense debate over the aims of, and control over, futures studies started in Sweden. The conflict reflects the general antagonistic political climate of the time.

The IVA proposal for a joint institute was rejected by the Social Democratic government. Instead, Prime Minister Olof Palme appointed a committee—with Alva Myrdal, a well-known promoter of the welfare state, as chairman. Lars Ingelstam, head of the FOA-financed group for planning theory, became secretary. The committee was given the task of investigating possible forms for Swedish futures research. It presented its report in the summer of 1972, suggesting state-financed forms for futures research and stressing that the complexity of the issue should not be neglected.⁵⁵ The committee stressed that “odd” and less well-established competence be utilized as part of the effort to avoid the creation of an isolated “science” with sole rights in futures studies, and opposed any form of technological determinism. It also emphasized the need for broad public participation and involvement in the work of futures studies. In 1973 a secretariat for futures studies was founded and was housed in the prime minister's office.

Lars Ingelstam was appointed to lead the secretariat. He recruited young scientists, some of whom were analysts from FOA P, to carry out futures studies. A general goal of the secretariat's work, Ingelstam writes, was “the raising of the forecast consciousness” of political decision makers, civil servants, and the general public.⁵⁶ Four initial studies were begun at the secretariat in the early 1970s: “Sweden's International Conditions,” “Resources and Raw Materials,” “Energy and Society,” and “Working Life in the Future.” One of the aims was to stimulate general public debate on these issues.

Many of the reports from this first generation of futures studies questioned the growth paradigm and led to heated public debates. Systems studies were for the first time in Sweden not only a concern for a small planning elite. The final report from the energy study was particularly influential. It outlined two contrasting energy scenarios, one based on renewable energy sources and one on nuclear energy. The report, entitled *Solar versus Nuclear*, became an important element in the debate preceding the 1980 Swedish referendum on nuclear power. It was published in numerous editions and also reached an international audience when translated into English.⁵⁷

A second generation of studies started in 1978 on the themes "Care in Society," and "Sweden in a New World Order."⁵⁸ The third generation in the early 1980s concentrated on regional issues, human communication, and values and changes in values.

The reports from the secretariat were often controversial, not least for leading politicians. In particular, the energy report questioning the decision that Sweden should be highly dependent on nuclear power led to a weakening of the secretariat's political position. Gradually the secretariat was removed from the political center. This process started in 1975, when the secretariat was transferred from the prime minister's office to a much less prestigious address at the Ministry of Education.⁵⁹ Political support continued to weaken, and by the early 1980s the secretariat was nothing but a subdivision within one of the state research councils.⁶⁰

The epoch when Swedish futures studies were conducted at the prime minister's office and were of top political interest was thus short. But the studies undoubtedly had contributed to a growing societal interest in planning issues.

CONCLUDING DISCUSSION

In the early 1960s, some dozen years after Blackett and Cramér first introduced the concept of operations research in Sweden, an organizational basis for this activity had been created. OR work was carried out on a regular basis in the defense sector, and also in some academic environments consulting for industry. A new paradigm for the study of industrial, military, and social issues was developing. Highly skilled persons had been recruited, people who soon occupied positions in various sectors in society and thereby gave the systems approach momentum.

The mid-1970s were the high-water mark of the systems approach in Sweden. Futures studies were carried out at a secretariat placed at the prime minister's office. The studies were largely conducted by people fostered in the systems approach tradition, and some of them had a considerable political impact. In the defense sector an elaborate planning system, developed by the analysts at FOA P, had been firmly established.

In this concluding discussion we will try to discern some characteristic patterns and factors in the development of the systems approach in Sweden. We will argue that three factors in Swedish society have been important for the way in which this approach was established and diffused in Sweden. Furthermore, we will underline two ways in which this approach was transformed from the 1940s to the 1970s. However, we want to emphasize the tentative character of our analysis. To be able to conclude what has been characteristic for the development in Sweden one would have to compare it with developments in other countries, but this has been outside the scope of this chapter.

The firm and persistent position of the systems approach in the defense sector is one salient pattern. Sweden's foreign policy of neutrality and nonalignment is an important factor for explaining this. When Sweden in the late 1940s failed to create a Nordic Defense Treaty and chose to stay outside NATO, there was a consensus among the political parties that the country had to have a strong military defense, including a domestic capacity for developing new, sophisticated weapon systems. In the mid-1950s, the director general of FOA argued that operations research was essential as a basis for choosing which future weapon systems to develop. This led to the creation of a permanent OR organization, with OR groups located at the Military Staffs. This OR organization became an important element in the country's military planning process in the 1960s and has remained so ever since.

Another characteristic is the small size of and the proximity within the Swedish "systems approach community." A close planning elite of operations analysts was formed in the 1950s and 1960s, and many of these met regularly at meetings of the Swedish Operations Research Association. This enabled a fast diffusion of new ideas and approaches within this community. An important reason for this proximity has been the geographical concentration of OR activities to the Stockholm area, which in turn has to do with Stockholm's role as capital and the localization of all military staffs and organizations like

FOA and IVA in the city. Furthermore, there were academic groups at the Stockholm University, the Royal Institute of Technology, and the Stockholm School of Economics that were able to respond to the growing demand for operations analysts.

A third characteristic in the Swedish history of the systems approach is the penetration of, and the political importance of, systems-based futures studies in the 1970s. This, we argue, was due to the Social Democratic Party's leading role in the steering of Swedish society at this time (in the early 1970s the social democrats could look back to some forty continuous years in office) together with the party's ambition to reconstruct society and build a solid welfare state. The social democrats' welfare ambitions and the systems approaches developed at FOA found each other. A result of that meeting was the broad, interdisciplinary futures studies of the 1970s.

The content of the systems approach has changed substantially from early OR in the 1950s, over systems analysis in the 1960s, and to futures studies in the 1970s and early 1980s. This process of change has been decisively influenced from abroad. In the first stage, these influences came from the United Kingdom, and the OR experiences there during World War II. Later, from the late 1950s onward, the inspiration came almost exclusively from the United States, primarily from the RAND Corporation, to which FOA had created contacts. Another reason for the broadening of the systems approach was that since the early 1960s FOA had gotten more deeply involved in the military planning process, which "forced" the analysts, in order to be credible, to broaden their approaches.

Not only the methodology but also the mode of work among analysts has gradually changed character. OR originally was focused on guidance for military executives, in other words, a secret activity taking place behind locked doors. Also on the civilian side, in industry, the analysts directed their energy toward the high-ranking executives, and their advice was, as a rule, secret.

In the early 1960s, an increasing openness was palpable among analysts, strangely enough starting in the military sector. This was partly due to the fact that OR had been incorporated into the military planning process, which was a political process, and as such had to be made public, at least partly. Furthermore, the nuclear weapons debates created a broader interest in defense issues within the electorate. Some analysts at this time chose to make results public, and got involved in

the political debate over the issue. As a result, a series of booklets and paperbacks on military planning and on nuclear arming written by OR analysts appeared in the bookstores around the mid-1960s.

With the futures studies in the 1970s, an era of more programmatic openness started in Swedish systems thinking. This is not surprising, as the explicit purpose of these studies was to try to create a public debate on planning- and future-oriented issues. This aim was attained, and the systems approach had firmly taken the step out of the sealed rooms and into the Swedish general public.

The broadening in content, and the growing openness in the 1960s, together seem to have contributed to a gradual “rubbing out” of the specific character of the systems approach. In the 1980s and 1990s, conceptions such as OR, systems analysis, and futures studies are no longer widely used. It is true that within the military sector the OR organization and the whole planning system still exists, but it seems to have become more set in a fixed mold than was the case in earlier times. Against this background one could argue that the systems approach in Sweden is fading out. However, the trains of thought it contained have been incorporated into new academic disciplines and into computer software. Furthermore, in modern forms of organization much of the systems thinking elaborated during the 1950s and 1960s is taken for granted. What has happened though is that the systems approach community has dispersed and lost its identity, which is illustrated by the only slumbering existence of SORA and other similar associations.

However, as history often seems to be more circular than linear, perhaps it is soon the time for him or her to appear again: the young scientific genius, ready to provide the world with unimpeachable formulas of everything’s future development.

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chapter was made possible by funding from the Swedish Research Council (FRN).

NOTES

1. According to interviews with C. G. Jennergren and G. Tidner. See also *Dagens Nyheter*, 8, 9, 10, and 11 December 1948.

2. At the War Archive in Stockholm C. G. Jennergren has left extensive material about OR in the military sector (Krigsarkivet. FOA: Ö.IV.d, box 1–12.) In the following this is referred to as “the Jennergren file.” Furthermore, the archive of the Swedish Operations Research Association, SORA, has been used.

3. Rolf Björnerstedt, Jan-Robert Eklind, Nicolai Herlofsson, Lars Ingelstam, Carl Gustav Jennergren, Mårten Lagergren, Bengt Nagel, Brita Schwarz, Peter Steen, Torbjörn Thedéen, Gunnar Tidner.

4. Publications dealing specifically with OR introduction in Sweden are C. G. Jennergren, S. Schwarz, and O. Alvfeldt, eds., *Trends in Planning: A Collection of Essays from the Planning Department of the Swedish National Defence Research Institute* (Stockholm: FOA, 1977); B. Rapp, “Operations Research in Sweden,” *OMEGA International Journal of Management Science* vol. 16, no. 3: 189–195, 1988; Per Molander, *Systemanalys i Sverige—en översikt* (Stockholm: Swedish Council for Systems Analysis, 1981); and Björn Wittrock, *Choosing Futures—Evaluating the Secretariat for Futures Studies* (Stockholm: Swedish Council for Planning and Coordination of Research, 1985).

5. A recent government commission has made clear that all Swedish military planning in the 1950s and 1960s concentrated solely on defense against attack from the Soviet Union, and there was considerable secret cooperation with NATO to enable support in case of an attack from the Soviet Union. See *Om kriget kommit . . . Förberedelser för mottagande av militärt bistånd 1949–1969*, SOU 1994:11.

6. Wilhelm Agrell, *Vetenskapen i försvarets tjänst* (Lund: Lund University Press, 1989), 240.

7. Bailey’s lecture notes are kept at the War Archive, in the Jennergren file, box 11.

8. Ibid.

9. *FOA och kärnvapen*, FOA VET om försvarsforskning nr 8 (Stockholm: National Defense Research Institute, 1995), 78f.

10. Hulthén visited Blackett in Manchester in the summer of 1948 to discuss meson theory, according to an interview with Professor Nicolai Herlofsson. Herlofsson was a guest researcher at Blackett’s department in Manchester in 1948, and later became a colleague of Hulthén at the Royal Institute in Stockholm.

11. Interview with Professor Bengt Nagel, who was the first “research technician” recruited by Hulthén. See also Kungl. Krigsvetenskapsakademiens Årsberättelse 1955, 224.
12. Interview with Thedéen. See also Kungl. Krigsvetenskapsakademiens Årsberättelse 1955, 223.
13. See Wilhelm Agrell, *Vetenskapen i försvarets tjänst* (Lund: Lund University Press, 1989); Hans Weinberger, “Physics in Uniform: The Swedish Institute of Military Physics, 1939–1945” in Svante Lindqvist, ed., *Center on the Periphery: Historical Aspects of 20th-Century Swedish Physics* (Canton, Mass.: Science History Publications, 1993), 141–163; and Ann Kathrine Littke and Olle Sundström, eds., *Försvarets forskningsanstalt 1945–1995* (Stockholm: National Defense Research Institute, 1995).
14. Kungl. Krigsvetenskapsakademiens Årsberättelse 1955, 222. In the 1950s and 1960s Sweden concentrated solely on defense against attack from the Soviet Union, and there was considerable secret cooperation with NATO to enable support in case of an attack from the Soviet Union. See *Om kriget kommit . . . Förberedelser för mottagande av militärt bistånd 1949–1969*, SOU 1994:11.
15. William Pansar, *Militärteknisk tidskrift*, no. 11–12, 1955, 1–4.
16. M. Lagergren, “Operations Research in Swedish Defence,” in *Trends in Planning*, 110f. See also O. Krokstedt. *Förberedande utredning angående organ för operationsanalys vid försvaret*, mimeo, Stockholm, 1957.
17. Interview with C. G. Jennergren. See also C. G. Jennergren, “Operationsanalys och den rådgivande funktionen,” in *Försvarets forskningsanstalt, 1945–1995* (Stockholm: FOA, 1995).
18. T. Magnusson, “Operationsanalys för försvaret” in *Militär teknisk tidskrift*, no. 2, 1957, 1–6.
19. Lagergren, 112ff.
20. Ibid.
21. Interview with Jennergren. See also Lagergren, 113f.
22. Interviews with Jennergren and Tidner.
23. B. Schwarz, “Programme Budgeting and/or Long-Range Planning,” in *Trends in Planning*, 40ff. See also L. Grape & B.-C. Ysander, *Säkerhetspolitik och försvarsplanering* (Stockholm: SNS, 1967).
24. See for example Agrell, 175; R. Björnerstedt, “Sverige i kärnvapenfrågan,” *Försvar i nutid*, no. 5, 1965; *Svenska kärnvapenproblem*, R. Björnerstedt & L. Grape, eds. (Stockholm: Aldus/Bonnier, 1965); and FOAs *kärnvapenforskning*, 87ff.
25. G. A. Westring, “Strateger och räknemästare,” *Svenska Dagbladet* 23/9 1960.

26. Interviews with Jennergren, Tidner, Schwarz, and Lagergren.
27. Interview with Jennergren.
28. Agrell, 243.
29. Hellman, 91f., and Agrell, 243.
30. Agrell, 108 and 133.
31. This is not only the case for OR. Industry, in Sweden and abroad, has a long tradition of copying the military in management issues.
32. An in-depth study of the Swedish rationalizations movement is found in Hans de Geer, *The Rationalization Movement in Sweden: Efficiency Programs and Social Responsibility in the Interwar Years* (Stockholm: SNS, 1978).
33. Bo Sundin writes that one of the issues that led to the formation of IVA was the conflict between scientifically oriented engineers with roots in the civil service tradition and the "modern" engineers who emphasized the role of the engineer as an industrial manager trained in economics, etc. Bo Sundin, *Ingenjörsvetenskapens tidevarv* (Umeå: Almqvist & Wiksell International, 1981), 63 ff.
34. Carl Tarass Sällfors, ed., *Handbok i industriell driftsekonomi och organisation* (Stockholm, 1945).
35. The first professor was the engineer Carl Tarras Sällfors.
36. Berglund et al., *Vad är operationsanalys?* (Stockholm: Aldus/Bonnier, 1965).
37. "Statistiska metoder i tekniken," lecture by Harald Cramér at IVA, 4 December 1947. Printed in IVA 1948:3.
38. In 1953, Harald Cramér gave a second lecture at IVA in which he stated that wartime OR had obtained industrial relevance "simply by exchanging terms such as weapons, attack and defense methods to machines and production methods." "Operationsforskning," lecture by Harald Cramér held at IVA, 27 November 1952. Printed in IVA 1953:2. The same arguments were used in both Britain and the United States. See Stephen P. Waring, "Management by Numbers: Operations Research and Management Science," in *Taylorism Transformed: Scientific Management Theory since 1945* (Chapel Hill, University of North Carolina Press, 1991), Rosenhead (1989), and M. Fortun and S. S. Schweber, "Scientists and the Legacy of World War II: The Case of Operations Research (OR)," *Social Studies of Science*, vol. 23 (1993): 595–642.
39. Bengt Magnusson, lecture at IVA, 27 November 1952. Printed in IVA 1953:2.
40. Nils Blomqvist, lecture at IVA, 27 November 1952. Printed in IVA 1953:2. The journals he referred to were *JORSA* (*Journal for Operations Research of America*) and the publication from *The English Operations Research Club*.

41. The invitation was signed by employees both from SFG and from Frenckner's group at the Stockholm School of Economics.
42. The first international OR conference was held in Oxford in 1957. Sweden sent the fourth biggest group, after England, the United States, and France.
43. Svenska operationsanalysföreningens jubileumsskrift 1979-02-26. SORA's definition of OR reads "the preparation of support for rational decisions by means of systematic, scientific methodology and, when feasible and purposeful, quantitative models."
44. Interviews with Jennergren and Thedéen.
45. Giandomenico Majone, "Systems Analysis: A Genetic Approach," in H. J. Miser and E. S. Quade, eds., *Handbook of Systems Analysis* (Chichester: John Wiley, 1985).
46. Ida R. Hoos, *Systems Analysis in Public Policy: A Critique* (Berkeley: University of California Press, 1972).
47. In 1945 the Association of Scientific Workers (AScW) presented the report *Research into Consumers Needs*. Several of the authors of the report were operational researchers.
48. J. Rosenhead, "Operational Research at the Crossroads: Cecil Gordon and the Development of Post-War OR," *Journal of the Operational Research Society* (JORSA), vol. 40 (1989): 3-28.
49. Twenty percent of British industry was nationalized after the war. In Sweden, attempts in the late 1940s to nationalize only small industrial sectors failed for political reasons. See Thomas Jonter, *Socialiseringen som kom av sig: Sverige oljan och USA:s planer på en ny ekonomisk världsordning 1945-1949* (Stockholm: Carlsson, 1995).
50. T. Dalenius, *Operationsanalys inom sjukvården* (Stockholm: SJURA, 1966).
51. One of its employees in the early 1970s was Mårten Lagergren, operations analyst and head of FOA P's OR division in the 1960s. In the late 1970s and early 1980s Lagergren led the study "Care in Society" at the Secretariat for Futures Studies.
52. SORA, newsletter 29, 1969.
53. Per Molander, *Systemanalys i Sverige—en översikt* (Stockholm: FRN, 1981).
54. In 1982 Dror was in Sweden and attended a SORA meeting where he presented the paper "Policy Analysis for Top Executives."
55. *Att välja framtid: Ett underlag för diskussion och överväganden om framtidsstudier i Sverige*, Stockholm, SOU 1972:59.
56. Lars Ingelstam, "Forecast for Political Decisions," in Peter R. Baehr and Björn Wittrock, eds., *Policy Analysis and Policy Innovation* (London: Sage, 1981).

57. J. Lönnroth et al., *Solar versus Nuclear: Choosing Energy Futures* (Oxford: Pergamon Press, 1980).
58. Björn Wittrock, "Futures Studies without a Planning Subject: The Swedish Secretariat for Futures Studies," in Peter R. Baehr and Björn Wittrock, eds., *Policy Analysis and Policy Innovation* (London: Sage, 1981).
59. H. Glimmel and S. Laestadius, "Swedish Futures Studies in Transition," *Futures*, July 1987, 635–680.
60. Wittrock, 1981.