Space Policy in West Germany 1945-1965: Strategic Action and Actor Network Dynamics

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1 Introduction: Purposive Actors and the Autodynamics of Social Networks

Empirical studies on the history of West German space policy present us with a variety of actors faced with trouble who sometimes manage to cope, and sometimes do not. However, most examples analyzed in this chapter fit neither into the pattern of total success nor into that of total failure. Most frequently we find what will be referred to here as *successful failure* or *unintended success*, indicating that the key actors were usually able to attain (at least some of) the goals they had set for themselves, but also produced effects which were either unintended, suboptimal or, in the long run, even counterproductive.

This chapter attempts to explain the phenomenon of successful failure by analyzing the mutual interrelations of coping activities and troublesome activities of different actors. An interactive approach will be developed – based on the concept of the purposive actor borrowed from Max Weber, James Coleman, Humberto Maturana and others – which claims that trouble is a cause of coping reactions and that, in addition, coping activities are a trigger of new trouble (either for the acting unit or for other coplayers).[1] Thus, coping and trouble-inducing activities cannot be distinguished systematically; the distinction depends on the view of the respective actor and the interdependen-

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1 Cf. Weber (1985); Coleman (1990); Maturana (1987). See also Stucke and Musselin/ Vilkas in this volume.

cies generated by the interplay of trouble, coping and, again, trouble – sometimes an endless chain. One main argument presented here is: It is necessary to create a notion of the actor in order to understand why he or she reacts (to trouble), acts (strategically, for example, to avoid trouble), and finally gets into trouble or creates trouble for other actors.

It would, however, be misleading to conceptualize social interaction as a simple sequence of trouble (as a trigger of coping reactions), coping activities (as a source of new trouble) and so on, being produced by different actors who are isolated from each other. The success of actors' strategies (of which coping strategies are a subgroup) depends to a considerable extent upon establishing a consensus of interest among strategically acting actors, which in turn is manifested in the creation and stabilization of a social network. Such interest-based social networks form the foundation for social and technical innovations; they are also the social space enabling the participating partners to exercise a mutual influence on each other. For our analysis, the fact that actor networks can develop autodynamics and thus become a source of trouble in their own right is very important.[2] An actor network represents an emergent phenomenon obeying its own rules over which none of the players exercises exclusive control. Maintenance of the network can turn into a serious constraint when further participation comes to depend upon the very existence of the network. In this case, the actions of the participants are more strongly determined by the requirements of the network than by their own individual interests. At this point, questioning the social logic of the network increasingly comes to mean questioning oneself. The alternative becomes: continue playing the game or quit.

Although they are a result of previous coping activities, social networks can develop internal dynamics whose effects may provoke ambivalent or even negative feelings from the participating actors. Central protagonists begin to view themselves as victims of a process that has led to suboptimal results for all participants, although they all have played a prominent role in creating it. Therefore, two levels of trouble can be distinguished analytically: the first resulting from actors' uncertainty about the future and their doubts about being able to succeed at implementing the goals they have set for themselves, the second resulting from the (sometimes very rigid) constraints social networks can exercise. This second level of uncertainty depends upon the probability that a social arrangement will work whose function is to facilitate the success of the strategies at the first level. In order to understand the interplay of trouble and coping, we must not only develop a notion of the purposive actor, but also comprehend the (auto)dynamics of social networks and the mechanism of self-production of social constraints induced when strategically acting actors form a network.

A case study from the history of West German space policy will serve to illustrate the hypothesis sketched (very briefly) above.[3] After explaining the function of the private rocket and space associations and their contributions to the revitalization of the policy field of "space flight" (Section 2), the analysis concentrates on the extrauniversity aeronautics (later: aerospace) research institutes and their contribution to the creation of that policy field during the period from 1945 to 1965 (Section 3). After a short summary of the case study, theoretical conclusions will be discussed (Section 4).

2 Early Attempts to Reestablish the Policy Field of "Space Flight" after 1945

To set the stage for the case study, the development of German space policy will be reconstructed up to the moment when the aeronautics research institutes became the key actor. As indicated above, this history shall be presented as a sequence of successful failures and unintended successes which can be related to the interplay of trouble and coping.

2.1 Hobby Rocket Constructors in the Immediate Postwar Period

In 1945, the space (as well as the aeronautics) research community was in big trouble. Research activities had come to a standstill because of the destruction of many of the facilities, the lack of resources and the (generally) prohibitive policy of the Allied occupation forces. Immediately after the war,

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2   Readers will note that my notion of an actor network differs from the notion developed by Latour (1988) and Callon (1991).

3   For a more detailed analysis of this case, see Weyer (1993a).

different members of the community started an – uncoordinated – series of attempts to preserve as much as they could of the still-existing potential in aeronautics and rocket research. The active researchers remaining in Germany made quite a variety of efforts, employing all manner of indirect schemes to ensure that a certain continuity was maintained. In the late 1940s, the rocketry community reorganized itself, although the only possible form of institutionalization available to it was private societies such as the Society for Space Research (*Gesellschaft für Weltraumforschung, GfW*), founded in 1948, or the Work Group on Rocketry (*Arbeitsgemeinschaft für Raketentechnik, AFRA; later DAFRA*), founded in 1952. For these societies, developing small rockets not only had the important function of demonstrating the self-confidence of the rocketry community, but also represented a suitable method for testing the limits of tolerance of the Allied occupying powers. Nonetheless, despite its importance for the revival of rocket construction, the DAFRA quickly sank into insignificance during the mid-1950s: The phase of private rocket construction as a hobby ended when political agencies began to become interested in this technology and rocket research was institutionalized in the form of federal big science centers. The DAFRA was transformed within a few years into the *Hermann-Oberth-Gesellschaft*, a private association of rocket research "veterans," which is still in existence but has played at best a marginal role in the policy field of "space flight."

2.2   The Development of Big Science

The initial phase characterized by the private rocket and space societies ended between 1952 and 1954, when the GfW was able to convince the Federal Ministry of Transport *(Bundesverkehrsministerium, BMV)* to support rocket research and to set up the first institute for rocket research in the Federal Republic, the Research Institute for the Physics of Jet Propulsion (*Forschungsinstitut für Physik der Strahlantriebe, FPS*), in Stuttgart in 1954. This event, which occurred before the Allied forces lifted their ban on research and two years before the first nuclear research institutes were founded, marked the beginning of the strategic interaction between science and politics in the Federal Republic. The fact that the BMV successfully reclaimed federal responsibility in questions of research and deliberately oriented the founding of the FPS along the lines of big science reveals that the contours of a new

policy area were beginning to take shape. In the face of this development the private construction of small rockets was quickly pushed into the background.

But this rapid development had only been made possible by the GfW's prior occupation of the field through its public rehabilitation of space and rocket technology and its (coping) strategy of informal preinstitutionalization: It had paved the way for the BMV. It was primarily due to the GfW's deliberately pursued policy of integrating German rocketry into international space and rocket research that West Germany was able to reenter the field in this way – just a few years after the last German V-2 rocket had been fired. This policy included systematic efforts to improve the image of rocket technology; its peaceful nature was propagated tirelessly by GfW protagonists Heinz Gartmann, Heinz-Hermann Koelle and Eugen Sänger. A quote by Sänger reveals the argumentative tightrope walk they took: "Rockets are *not only* weapons, *but also* instruments of peaceful research" (*Beiträge zur Weltraumforschung und Weltraumfahrt* 1/1949: 14, italics added). For the Germans to get a new start in rocket research, presenting such an image was absolutely essential. In addition, the phrase coined by Sänger, "Raumfahrt als Verkehr" (space flight as transport) had a high legitimatory value for the federal transport ministry.

Setting up the FPS was undoubtedly an auspicious success, with effects going far beyond the single case. The social network created by the GfW and the BMV played an essential role not only in the establishment of "big science" in Germany, but also in constituting the policy field "research and technology," which helped to legitimate state intervention in research. At the same time, the network also produced constraints which became evident, for example, at the beginning of the 1960s when debates about a European space program started: The West German government sought at all costs to avoid creating the impression that it was pursuing rocket construction as a strictly national policy, possibly even for military purposes. This was, however, precisely the program that Eugen Sänger and his FPS were pursuing. Sänger refused to recognize practical constraints on his work, even accepting the lucrative offer of the Egyptian government to participate in the development of medium-range missiles in Egypt. This resulted in the collapse of the network after only a few years. The remains of his institute passed over into the hands of the largest aeronautics research institute. The remains of his institute passed over into the hands of the largest aeronautics research institute. The BMV lost responsibility for rocketry and space research, and later for aviation

in general as well, disappearing altogether from the research policy area of West German rocket research which it had created in the 1950s – and which was to bear the BMV's stamp for some time to come. The social and political structures created during this phase (to which Sänger had refused to yield) remained; other actors entered upon the scene, pocketed the profits and continued the game on another level, until they, too, foundered due to their very successes.

3   The Battle for Autonomy and Control of Extrauniversity Aeronautics Research

In addition to what could be called the FPS precedent, it was the parallel developments in aeronautics research which were primarily responsible for the emergence of the policy field of "space flight" and the development of federal authority for technology policy. In order to understand the interplay of trouble and coping here, we will look at this case in detail.

3.1   The First Step: Informal Reinstitutionalization as a Coping Strategy during the Immediate Postwar Period

After 1945, the aeronautics research institutes – most of which had been founded at the beginning of the century or under the Nazi regime – were in maximum trouble: Aeronautics research was prohibited by Allied law, the facilities were either destroyed or confiscated, and the possibility of resuming research and development activities seemed to have receded into the distant future. In this situation, different groups of former members of the Nazi aeronautics research community developed a coping strategy to survive the immediate postwar period and to get things started again in what they hoped would be "better times."

This coping strategy was facilitated by the fact that the big science centers of aeronautics research in Germany had always had the legal status of *eingetragene Vereine* (e.V.), a special construction often adopted by private associations such as sport clubs or scientific societies in order to avoid being taxed for their activities. From a legal standpoint, the aeronautics research

institutes in Nazi Germany had not been state-run big science centers (like the NACA – later NASA – in the United States), but private organizations with an extraordinarily high share of external funding. This enabled them to continue certain activities after 1945 without coming into conflict with Allied law.[4]

A second factor which facilitated the survival and subsequent reconstruction of the aeronautics research institutes was their close connections to a number of technical universities. Friedrich Seewald, for example, who was a leading member of the German Institute for Aeronautics Research (*Deutsche Versuchsanstalt für Luftfahrt e.V.*, DVL), had been a professor in Aachen since 1941. He held onto this position after 1945, managing to gather together a small staff of former DVL people in Aachen and even to reorganize small-scale aeronautics research at his university institute, which he used during the early 1950s to demonstrate to the public that it was necessary to reconstruct the big science centers. This coping strategy of using the technical universities as a location where aeronautics research could go into a "holding pattern" was very successful – Friedrich Seewald and his DVL were ready to get started when aeronautics research was permitted again in 1954.

But all these activities would have failed if the American occupying power had not tolerated and even promoted the maintenance and reconstruction of such aeronautics associations as the DVL and their research institutes. In the immediate postwar period, British and US agencies gave research contracts to various DVL institutes in southern Germany, which expired in late 1945 or mid-1946. And, by keeping plunderers out of the facilities, the US authorities ensured that documentation work on Nazi aeronautics and rocket research (which the Allied forces considered very valuable) could be conducted without interference. What was most important for further developments, however, was the certification given by the Office of the Military Government (US) in 1947 confirming "that the association 'Deutsche Versuchsanstalt für Luftfahrt' does not belong to the organizations which have been dissolved by the Allied Control Council," even though "every activity in the area of aeronautics research still remains forbidden" (quoted in German in Bruders 1962: 50, translation by the author).

To sum up, the coping strategy of an informal reinstitutionalization of extrauniversity aeronautics research in postwar Germany pursued by Friedrich

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4   Cf. Trischler (1992).

Seewald and his colleagues was based on three elements, each indispensable for the subsequent success: the legality of (non-research-oriented) engagement in aeronautics subjects in private associations, the possibility to survive and to reorganize research at the technical universities and provide "holding patterns" for parts of the aeronautics community, and, finally, the tolerant and encouraging policy of the US Military Government. It was only due to these circumstances that the scientists even had a chance to resume their activities as quickly and vigorously as they did. But neither the circumstances nor the strategies and intentions of the key actors suffice to explain the remarkable success of their coping strategy. The decisive element in what turned out to be a success was the creation of an actor network consisting of aeronautics research associations and West German federal states *(Länder)*.

3.2   The Second Step: Networking with the *Länder* as a Coping Strategy in the Reconstruction Period

From the point of view of the *Länder*, the coping activities of the aeronautics researchers and, more importantly, the informal reinstitutionalization of the research institutes had created an attractive opportunity for politicians to link up with aeronautics research in order to exploit the political benefits of (what later came to be called) high-tech policy. Leo Brandt, Undersecretary in the Ministry of Economics of North Rhine-Westphalia, considered aeronautics to be a key technology and "an important pacemaker of modern technology," and therefore assigned it "a pivotal role in a modern economy" (Brandt 1954: 35, translation by the author). With this concept of technology policy, Brandt actually became the first research minister in West Germany, although this policy field had not yet been formally created. The aeronautics associations profited very strongly from his activities, which not only protected the steps toward a reconstruction of the research institutes before 1955, but also provided the funds urgently needed to build new facilities. On January 23, 1952, the parliament of North Rhine-Westphalia decided to fund the construction of aeronautics research institutes at the Mülheim airport and in Bad Godesberg. This bold measure not only promoted the recommencement of aeronautics research in West Germany, but also brought a completely new branch of research into the region. This decision had far-reaching consequences: The German Aerospace Research and Test Institute *(Deutsche Forschungs- und*

Versuchsanstalt für Luft- und Raumfahrt, DFVLR; now DLR), which came into being in 1969 as a merger of all aerospace research institutes of West Germany, is still situated in North Rhine-Westphalia (in Cologne). Without doubt this can be regarded as a political success, irrespective of the critical question of whether state funds should not better have been directed into other fields of research.

The creation of an actor network in which different actor groups with various interests and motives link up and build a coalition thus can be regarded as the crucial factor influencing the success or failure of a coping strategy. A major social innovation such as the reestablishment of aeronautics research in West Germany as well as the subsequent technical innovations could only be achieved by networking between politics (which regards aeronautics research as a resource for successful politics) and science (which regards technology policy as a resource for successful research).

As stated in the introduction of this chapter, networks are not only the foundation of success; they can also develop their own dynamics and thus become an independent source of new trouble. For the research institutes, the fact that aeronautics facilities were scattered around the country – a result of wartime and postwar necessities – became a source of trouble in the long run. Some facilities were located in Bavaria, the institutes having been moved there from Berlin when the bombings became too heavy toward the end of the war. After the war, the Bavarian authorities began to imitate North Rhine-Westphalia's new technology policy and supported the reconstruction of former DVL institutes at Oberpfaffenhofen, which is still an important site for German space activities. There are also institutes in Baden-Württemberg and Lower Saxony. The old facilities of Berlin-Adlershof, finally, are the most recent addition since reunification to this complex of regionally scattered institutes with sometimes divergent interests, which the central administration in Cologne was hardly able to "govern" during conflict-ridden phases. But this trouble did not arise until the 1960s – in the 1950s, the aeronautics research institutes were deeply satisfied that they could start up their work again with the help of the *Länder*, which provided the subsidies the federal government could not contribute for legal and legitimatory reasons.

So the aeronautics community had intentionally produced a suboptimal result which can be interpreted as a failure of a successful coping strategy. But the *Länder* also became victims of their own strategy when the financial burden of big science in the aeronautics field grew. In the first phase, when

the institutes were to be reconstructed, the promotion of aeronautics was hardly expensive. But in 1956, at the latest, it became evident that the *Länder* would soon be reaching their limit financially: The DVL demanded a sum of 60 million DM (to be spread over five years) for the building of new research and test facilities, in addition to the regular annual budget. Only a few years after the successful reinstallation of aeronautics research under the responsibility of different *Länder* governments and the parallel creation of early predecessors of technology policy, the *Länder* got into trouble, which in the end can be regarded as a result of their attempts to seize opportunities as they arose.

Just as the social network was in danger of weakening or even collapsing, a new actor, the Federal Ministry of Transport (BMV), stepped in, took advantage of the opportunities that were opening up and finally reconstructed the network to such an extent that the *Länder* lost their formerly dominant position and were relegated to the periphery of the policy field. This case provides an example for the thesis that coping activities can have three different (sometimes interrelated) effects:

– They may help to overcome trouble,
– they may produce opportunities which another actor can take advantage of, resulting in an actor network, and finally
– they may produce new trouble for the actors concerned.

The Federal Minister of Transport from 1949 to 1966, Hans-Christoph Seebohm, who regarded both air and space transport as his domain, had been interested in promoting aeronautics research since the early 1950s. Two factors restricted his activities, however: Allied occupation laws, and West German constitutional law, which rendered the West German federal government relatively weak compared to the *Länder* governments in the fields of culture, education and science. One of the few niches left to Seebohm was the supervision and control of technical systems – a classical sphere of responsibility for every central government.[5] But his aim was to establish aeronautics research in institutes directly responsible to the federal government (*Ressortforschung*). From the point of view of the transport ministry, a commitment to aeronautics research was a suitable coping strategy to overcome the re-

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5   Cf. Lundgreen et al. (1986); Stucke (1989).

strictions of the competencies of the federal authorities – with the long-term objective of state-controlled research.

Wielding a fair amount of power thanks to the funds at its disposal, the BMV very soon achieved a central position in the policy field, which it immediately used to call for a "reorganization of aeronautics research" (Seebohm 1953: 11) – i.e. coordinating and eventually merging together the aeronautics institutes, which were still small and regionally scattered at this point. The irrefutable argument in favor of such a reorganization was the foreseeably enormous costs of aeronautics research, especially if it was to continue to be conducted in six independent institutes – each of which would soon be requiring its own wind tunnel, a test stand and other expensive devices. For the aeronautics institutes, which had just overcome their previous problems, real trouble was now looming, since it became obvious that the (absolutely necessary) federal funding at the same time entailed political control of science and political intervention into the research process. But it must be noted that the transport ministry did not achieve its objectives, either, since it paid a high price in order to get the research institutes to accept the coordination of their work – maybe a higher price than it would have had to pay for the funding of uncoordinated research. Nevertheless, its policy can be regarded as an important contribution to a process which culminated in the establishment of the first federal research ministry in 1962.

3.3   The Third Step: Coping with Network Dynamics

The coping reactions of the aeronautics research institutes to these political initiatives were stimulated mainly by the prospect of losing their autonomy, which had been considerable during the period of *Länder* sponsorship and even during the Nazi era, the so-called 'golden age' of aeronautics research in Germany, when funds had been plentiful and political intervention had been either chaotic or – contrary to the common perception of the Nazi regime – even nonexistent. The institutes were now in an ambivalent situation: Their consolidation and expansion to an internationally competitive level could only be achieved with a strong partner (especially financially) in politics. Hence, the old network created with the *Länder* became less important, while a new network with federal authorities had to be created. This strategy was, in fact, extremely successful: The aeronautics research institutes enjoyed a period of

rapid expansion which was followed by another developmental leap triggered by the European space program in the early 1960s, so that in 1965 the DVL had reached the size (in terms of staff) it had once had in 1935 – undoubtedly a great success. But the risks of that networking strategy were clear. The principle of independence of the different research institutes was constantly threatened, until in the mid-1960s their position became so weak that resistance became useless; in 1969 the fusion of the aeronautics institutes could finally take place. The German Aerospace Research and Test Institute (DFVLR; now DLR), founded as a central organization, was much easier for the central political authorities to control than the six independent institutes, each of which had been sponsored and protected by "its" respective *Länder* government.

The period from 1953 (the first announcement of an interventionist policy by Seebohm) to 1969 (the fusion of the aeronautics research institutes) can be viewed as a continuing defensive battle in which different coping strategies – some active, some reactive – were developed and carried out that led, however, to a result the research institutes judged negatively. The main obstacle making failure almost inevitable was the fact that the aeronautics research institutes were repeatedly confronted with new trouble before they had managed to solve the old. This may explain why they did not react to the political disturbances in the same way an independent observer – living, say, in the 1990s – might suggest they should have, but adopted strategies which, at least viewed with the benefit of hindsight, had to fail.

The first step in this struggle with politics was the creation of an independent representation of the interests of extrauniversity aeronautics research. The Association for Aeronautical Sciences (*Wissenschaftliche Gesellschaft für Luftfahrt*, WGL), founded in 1952, played an important role in reorganizing the aeronautics community – by publicly promoting a new peaceful image of aeronautics research in order to justify their petitions for political support – and in reintegrating German aeronautics research into the international community. The most important function of the WGL was to be a competent partner for the political actor, the Federal Minister of Transport, who had indicated as early as 1951 that he had at his disposal a small amount of money which could be spent on aeronautics subjects and that he needed scientific advice in setting priorities for the distribution of these funds. In 1953, the Committee on Aeronautics Research (*Ausschuß für Luftfahrtforschung*, AfL) was founded as a subsection of the WGL, serving simultaneously, however, as an advisory

board for the transport ministry. This was the first case of institutionalized policy advising in the R&D sector in West Germany, which proved to be useful for both partners concerned. For the transport ministry, the institutionalization of a hybrid organization between politics and science was the first step toward a central coordination and control of R&D (here in the field of aeronautics), whereas the aeronautics community, represented by the WGL, succeeded in obtaining quasi-monopolistic access to the political key actor in its respective field. Every research proposal, be it from WGL members or not, now had to pass through the hands of the WGL president, who – not surprisingly – had also become chairman of the advisory committee AfL.

Nevertheless, the WGL could not serve as a strong representative of the interests of extrauniversity aeronautics research, since this umbrella organization of the West German aeronautics community encompassed heterogeneous groups from different branches of aeronautical science and industry. In addition, the WGL had to fulfill bargaining functions in the interplay of politics and science which was just beginning to take place. It became especially obvious that the aeronautics research institutes were in need of a representative organization of their own when the transport ministry began to call more insistently for a coordination of research planning and made its willingness to fund the expansion of the research institutes dependent on their willingness to cooperate. In March 1955, three out of the six institutes therefore founded the Community of Interests of the Aeronautics Research Institutes (*Interessengemeinschaft der Luftfahrtforschungsanstalten*) – the weakest form of cooperation they could have chosen. The reason for this half-hearted move was each institute's separate fear of losing its autonomy. Once again, the success of a previous coping strategy – leading to a network between aeronautics research and the transport ministry – became the source of still greater trouble, for the BMV's objective was clear: the fusion of all research institutes, the creation of one big science center, and the central political control of aeronautics research. Obviously, the establishment of this weak Community of Interests was the wrong reaction to this trouble.

The aeronautics research institutes continued the coping game, the rationale of which was to satisfy the transport ministry by (at least) symbolically uniting the institutes and at the same time letting each of the institutes be able to keep its traditional autonomy. This was difficult to achieve because the smaller institutes suspected that their larger fellow institutes, especially the big DVL, might use this game to swallow them. After long deliberations, the

High Council of Aeronautics Research Institutes *(Präsidialrat der Luftfahrt-forschungsanstalten)*, made up of representatives of all six institutes, was founded in October 1956. They now had a stronger representation of interests, but the political actors were still dissatisfied because the unclear legal construction of the *Präsidialrat* made it impossible to use this organization either as an instrument for the distribution of federal funds (as the legal construction of the *eingetragener Verein* would have allowed) or as an instrument for the political control of science. Thus, the political actors insisted that the High Council be reconstituted as a "body corporate" (DGF 1965: 133). The game continued during the following years, but the position of the research institutes became increasingly weaker because they were in a tight financial spot. In April 1959, they founded the German Association for Aeronautics (*Deutsche Gesellschaft für Flugwissenschaften e.V.*, DGF), which all extrauniversity research institutes in the field of aeronautics joined. The DGF served as an umbrella organization which distributed the federal funds among the members and as the bargaining partner toward politics. The statute of the DGF shows that this body was constructed as an instrument of political control of science.

The aeronautics research institutes felt they were the losers of this game; their coping strategy had obviously failed. Their objective during the 1950s had been more funding for aeronautics research; now they received more funds than they had ever dreamed of, but only in combination with political intervention and control of their research work. But also from the point of view of politics, the result of this game was suboptimal, since the federal actor (first the transport ministry, later the science ministry) paid a high price for the unification of the research institutes. The costs of research soared, but now politics was obliged to shoulder its new responsibilities, which was not easy, since the large DGF, later the DFVLR, and, finally, the DLR proved to be difficult to control.

3.4 The Fourth Step: Coping with the Space Age

The outcome of the battle for autonomy and control of extrauniversity aeronautics research was not predictable at the moment when the real trouble began, which finally kicked the transport ministry out of the game, brought new actors in, and led to an (unintended and unwanted) accelerated expansion of the research institutes. In 1960, the first initiatives were launched by Great

Britain and France to set up a European space organization. The federal government of West Germany began to deal with this new subject at the end of 1960 and, more intensively, in early 1961. For German federal politics, space flight was an accidental opportunity which improved its ability to cope with the trouble of its restricted sovereignty in comparison with the neighboring European countries and, domestically, with the trouble of its relatively weak position in comparison with the *Länder*. This coping strategy, however, could only be successful if a national base for the planned participation in European space flight was at hand. Now, the early initiatives of the transport ministry and the aeronautics and rocket societies aimed at reinstitutionalizing aeronautics research finally paid off. But what might have been considered the greatest success in the history of West German aeronautics research was regarded as the most threatening trouble the aeronautics community had been confronted with since 1945, because the federal government's new initiatives to promote space research – in dimensions inconceivable only a few years earlier – inevitably entailed its calling for a fundamental shift of research priorities from aeronautics to space flight and from basic to applied research. Besides, it was foreseeable that the trend toward a political control of science would intensify if research priorities now had to be negotiated not only between different national research institutes, but also between various European states with disparate (political, scientific, economic, partly also military) interests in space flight. The game the aeronautics community had so enthusiastically initiated was about to slip out of its control due to the powerful autodynamics that had developed. At this point, the community would have preferred to stop the "film" rather than to continue playing its role, since it no longer had any control over the script.

The aeronautics community developed and performed a variety of coping strategies, most of them fruitless. Three different types of coping efforts can be distinguished:[6]

a) *Defensive-reactive coping,* which tried to maintain the status quo, complaining that the foreseeable predominance of space flight over aeronautics was unfair to the aeronautics community. In this futile battle, the advocates of aeronautics frequently argued that aeronautics is the real basis of space flight, and that, consequently, space flight can only be successful if a solid

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6   Cf. the introduction to this volume by Schimank and Stucke.

foundation of aeronautics research exists. But in politics there was no one who was willing to adopt this argument. Space was on the agenda!

b) A second coping strategy which was launched when the institutes recovered from the initial shock over the fatal threat posed by "space" can be called *half-hearted offensive coping*. The aeronautics research institutes tried to present themselves to the public and politics as the only competent partner with adequate experience in the field now ready to step into space research. Relabelling the research institutes and some of the (formerly pure aeronautical) research fields was part of this effort. This strategy was partially successful: The establishment of new space research institutes and a concomitant phasing-out of support for aeronautics in favor of new competitors could be avoided. It failed, however, in another way: The continuation of former (aeronautical) activities under a new label proved to be an insufficient tactic when the federal government decided in June 1961 to participate in European space flight. By then, at the latest, the scientists were forced to actually make the switch from aeronautical to space research; just talking about space no longer sufficed.

c) An actual reorientation toward space research (as opposed to the tactical one described above) is at the heart of the third response, which can be labelled as an *offensive-preventive coping strategy*. The DGF was too clumsy and its members too much at odds with one another to adopt this strategy. In a sort of double game, the largest single institute – the DVL – supported the activities of the DGF, while at the same time trying a more offensive strategy based on the assumption that only the orientation toward specific space projects and not the desire to conduct general basic research would provide the research institutes with legitimacy and, hence, public funds. The DVL thus proposed to build a German satellite in cooperation with the (emerging) space industry; in November 1962, it presented a detailed project proposal written by the DVL, the aerospace company Bölkow and the Meteorological Institute of the University of Cologne. This cooperation with the industry can be regarded as a new coping strategy with the intention of reducing the influence of politics on research; at the same time, however, it created a new risk of subordinating research to industrial priorities. Here, a new network emerged that supplied its participants with special advantages over rivals in the respective fields. Bölkow (later MBB; now DASA) became the leading aerospace company in West Germany, and the DVL advanced to become the undisputed leader in extrauniversity aeronautics research. The DGF tried to pursue this strategy, too: Together with the Association of German Aeronautical Industry (*Bundesverband der Deutschen Luftfahrtindustrie*, BDLI), the spokesman of the aviation companies, it had established the Committee on Space Technology (*Kommission für Raumfahrttechnik*, KfR) in August 1961. This lobby organization's purpose was to influence the initial political decisions on the West German and European space program. But it was not until July 1962 that a first, very preliminary program proposal could be presented by the KfR. This proposal sank into oblivion very rapidly only a few months later when the Bölkow-DVL satellite appeared; the threat of a complete Europeanization of the West German space program, which would probably mean increasing amounts of German marks flowing into French or British research institutes and lower expenditures for national programs on aeronautics research, produced a new kind of trouble the KfR was unable to cope with. As has been shown in more detail elsewhere, the Bölkow-DVL satellite was an adequate means to cope with this trouble and to redirect the federal funds into building up West German aerospace companies and research institutes.[7]

3.5   The Final Step: The Establishment of the First West German Research Ministry

In the 1950s, the field of aeronautical research was a kind of testing ground for essential instruments of governmental control of research. Furthermore, the organizational prerequisites for translating programmatic political goals into research were created when the big science center, DGF, was established. This fulfilled two of the conditions required for space flight to be classified as big science; what was still lacking was the industrial underpinning. It was the Minister of Defense at that time, Franz Josef Strauß, who was the main driving force behind the development of the aerospace industry and, hence, the establishment of the paradigm of an industrial policy that was not market-directed – a story which cannot be presented here in detail. Finally, the French and British initiatives to launch a European space program triggered

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7   cf. Weyer (1993a: 280-315).

the formal establishment of space policy in West Germany, which then became one of the responsibilities of the new Ministry for Scientific Research (*Bundesministerium für wissenschaftliche Forschung*, BMwF), founded in December 1962.[8] Since the mid-1960s, the policy field "space flight" has been governed by a triad of research ministry, space industry and big science centers which has even influenced the style of research policy in other fields. Although this institutional structure had been established by goal-oriented behavior of the participating actors, the actual shape it eventually took had been intended by no one. By the end of the 1960s, this constellation had acquired a dynamic of its own, increasingly becoming a constraint for its participants and influencing their freedom of action. Thus, the social network itself became a source of trouble.

4   Conclusion

4.1   Winners and Losers in the History of West German Space Policy

The history of West German space policy in the 1950s and 1960s reveals that hardly any of the initial actors who had contributed significantly to the creation of a particular aspect of the network were able to profit from their success. Coping efforts employed by the respective actors usually caused new trouble, resulting from the autodynamics of actor networks, but at the same time created new opportunities, which mostly could only be exploited by other actors who proceeded to play a major role in the next part of the sequence. Thus, several of the actors named above disappeared from the network completely or were forced into the periphery (hobby rocket builders, the *Länder*, the transport ministry). In other cases, there was a strange mixture of success and failure (the aeronautics research institutes, the aerospace industry, the defense ministry). These examples of successful failure or unintended success confirm the hypothesis formulated in the introduction: The success of social strategies results from the exploitation of situational opportunities as well as from the networking of various actors. At the same time, these strategies give

8   Cf. Krige (1993), Stucke (1993b).

rise to an autodynamics of social networks whose consequences may well conflict with the intentions of the participants and which, as a result, are often judged negatively by the initial actors. Although the networks are created strategically, unintended structural effects issue from them which can result in the failure of the manifest strategies of the founders of the network.

One reason why the participating actors continue to play the game despite its having unintended consequences is that, having begun it, they cannot give it up without abandoning themselves. The special advantages they have gained over their various opponents depend on the – continued – existence of the network. This means that maintenance of the troublesome network can become an independent rationale for playing the game.

4.2   Trouble as a Permanent Condition

Summing up, the history of extrauniversity aeronautics research in the 1950s can be reconstructed as a brilliant success story, but the winner of this game had lost so much of its former identity that it felt like a loser. In 1950, there were six autonomous aeronautics associations lacking in resources, institutes and funding but, at the same time, free of political control. By the mid-1960s, they had turned into one unified, well-equipped, politically directed, quasi state-run agency for research in a field that was dominated by the requirements of European space technology instead of the inner logic of basic aeronautical research.

Despite twenty years of nonstop coping efforts, trouble never decreased; on the contrary, the coping strategy of networking, which can be detected at every stage of the development, always produced new, usually greater trouble. External trouble such as the emergence of a European space program and internal trouble such as the unintended effects of networking (between the transport ministry and aeronautics research, for example) sometimes reinforced each other, as has been shown in detail in the case study. Trouble does not seem to be an extraordinary state, but the normal business of social actors who act strategically and are, at the same time, the focus of other actors' strategic activities. The interactive character of social action proves to be a major source of trouble which in general allows only two meta coping strategies: exiting the policy field or continuing the game, which usually requires

an actor to change its own identity and adapt its aspiration level to the changing context.[9]

4.3   Coping Activities as a Source of Trouble

What theoretical conclusions can be drawn from the case presented above?

a) To begin with, we can conceptualize social organizations such as ministries, science associations, and research institutes as social actors which pursue organizational interests and develop strategies to achieve their objectives. Whether these strategies are rational or not, measured by a quasi-objective criterion of social rationality, does not matter in this context; the strategies must, at the very moment of their conception, be considered (by the respective actor) to be adequate, i.e. the best alternative available for accomplishing the aims that have been set. Which alternative is the best depends largely on the options available within the social context, which in turn are products of actions of other co-players. Thus, the foundations of actors' decision making vary in the course of social interaction.

b) The chances of actors' strategies being realized and, ultimately, successful can be related to their ability to establish social networks, which must be regarded as a very important base of social innovations. The opportunities to profit from network dynamics, however, are inevitably connected with its risks, which largely result from the fact, that – as frequently mentioned above – networks can develop autodynamics and thus produce social constraints which run counter to the actors' initial intentions.

c) Assuming these conclusions are accurate, we can distinguish between two kinds of trouble and two types of coping with trouble. Trouble may be produced by *external forces* outside the respective actor's sphere of influence, which are usually a surprise and can hardly be anticipated. This applies for example to the initiatives to launch a European space program, which were triggered by Sputnik and other events that could not have been anticipated in the mid-1950s. On the other hand, trouble may be the *internal product* of network dynamics, as was shown, for example, in the analysis of the interaction of the aeronautics community and the transport ministry. Here trouble is not caused by unforeseeable external forces, but is related to an actor's own (risky) decision to join a network and to profit from its advantages.

d) In addition to this distinction between "internal" and "external" (sources of) trouble, we can also distinguish between two types of coping strategies: The first type can be called *defensive-reactive coping*, a behavior (not really a strategy!) that only activates organizational energies when trouble actually occurs (i.e. when the focal actor has perceived certain events and interpreted them as being trouble). The actions of the DGF, the umbrella organization of the extrauniversity aeronautics research institutes in the late 1950s, fall into this category. The second type can be called *offensive-preventive coping*, a strategy that anticipates that somewhere in the future trouble might happen and that it would be advantageous now, in advance, to equip oneself with (financial, legitimatory and other) resources in order to deal with it. The strategy of the DVL, the largest aeronautics research institute, to risk going out on a limb and cooperating on its own with the aerospace industry can be regarded as an example of this type.

The two points I want to emphasize here are that this very strategy of offensive-preventive coping is one main source of trouble, and that each actor's perception that trouble resulting from other actors' offensive measures will occur in the future in turn accelerates this process. The mutual assumption of offensive activities and the tendency to grasp at every opportunity that opens up (even if it cannot be exploited now, but only – presumably – in the future) seems to be an important trigger of the autodynamics of the social process. In advanced industrial societies in which each actor stands to gain from his or her own (risky) decisions, trouble seems to be more likely than stationary equilibrium, which would imply that everyone is satisfied (and which, at the same time, means that there is no room for maneuver to improve one's own position). Coping with trouble and, in so doing, producing new trouble – this seems to be an endless evolutionary game with, at best, short periods of calm.

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9   Cf. the introduction to this volume by Schimank and Stucke.

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